"Property Platform" – Your trusted intelligent property platform

By

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Furthermore, I also would like to show my gratitude to both my parents and my friends and those who helped me during the developing of FYP for their motivation and also their help if I needed any.

Contents

Chapter 1: Introduction to the study

This chapter provided a better view of the current project which much information will be provided to help reader to better understand its aim and objectives.

1.1| Background to the project

Since the independence of Malaysia in 1957, Malaysia has been developing rapidly, improving its economy which helped boost the residents living lifestyle and pushed Malaysia to be recognise globally. A country with GDP of 6.0 and labelled as a developing country by the International Monetary Fund (Monetary Fund, 2021), Malaysia have been rapidly developing its land with various breath-taking building and residential housing. an essential for us humans. The improving of lifestyle of Malaysian has increase in demand for residential house properties.

First of all, property is defined as anything or item that a person or a business owns in which he or she has legal title over item, giving them the rights over said items (Bloomenthal, 2020). In here, we describe property as house that a person owns. For a person to own a house in Malaysia, one's Central Credit Reference Information System (CCRIS) and CTOS score needs to be in good condition to apply loan from banks. He or she will also need to have a low Debt Service Ratio (DSR) to increase the chances of getting a loan approval. A lawyer is optional but will make the process smoother (Bloomenthal, 2020).

Housing affordability in Malaysia has been improved since these few years back. Based on the Economic Outlook 2021 (Ministry of Finance Malaysia, 2021), home affordability in Malaysia has been improve which the overall median house price has lowered by one per cent annually from 2016 to 2019. In terms of number, based on the report released by Ministry of Finance, the overall median house price on average has fallen from RM298K since 2016 to RM289646 in 2019 in just 4 years (Ministry of Finance Malaysia, 2021). On the other hand, the annual median household income was raised from RM62736 to RM70476 in the same period which has increase by four per cent annually (Bernama, 2020). On top of the stated fact above, home ownership also improved between the stated years to 76.9 compared to 76.3 per cent in 2016 (Bernama, 2020). Although the different is very small, it is still an improvement as this related to the average income of residents in Malaysia which also has improved.

In 2019, the Malaysia government has announced the National Housing Policy 2.0 which contains various action plans to help the people with purchasing houses (Mahalingam, 2021). The five foci for the new policy will be improving the accessibility and affordability of housing, improve housing quality, cohesive neighbourhoods, improve communication, connection between housing development and transport and finally strengthen institutional capability for National Housing Policy. All these plans are to increase the affordability of citizen for them to own a house they desired. Besides that, the government also promised to build 100,000 houses which are affordable to citizen by the year end of 2019 which these houses are capped at RM300,000(Mahalingam, 2021). The Bank Negara also announced its Affordable Homes and Rumahku portal fund which has allocated RM1bil fund to help with homeownership (Mahalingam, 2021). This programme benefits citizen with more than 20 per cent less in monthly commitments compare to the current financing schemes in the market. This fund is for citizens who have a maximum monthly household income of RM2300 and clear of any impaired financing within the past 12 months. Most of the banks in Malaysia are participating in this programme (Mahalingam, 2021).

1.2 | Problem Context

For a project to process smoothly, one need to fully understand the problem background that the project is trying to solve. With this in mind, this section is written. The problem this project trying to solve is to help those who are seeking to sell or buy houses by providing them the most beneficial price range for the house he or she is trying to sell or buy. With reference from the previous section, we can see that the government has did a lot to help Malaysia citizen to buy a house. Nevertheless, housing affordability is still an issue in Malaysia despite all the effort. For example, in 2016, Malaysian monthly median income of RM5228, the median house price tag of RM313000 was unaffordable compared to the recommended maximum affordable price of RM282000(Watch, 2021). In some more economic busy states such as Kuala Lumpur, Penang and Sabah have the most unaffordable as the gaps between the actual median house price and the maximum price of an affordable home is very huge. In year 2019, the National Property Information Centre (NAPIC) provided a report which stated there are 43% of overhang units in Malaysia which are condominiums and apartments. Besides that, in Johor there are 18.8 per cent of overhang units, followed by Kuala Lumpur with 14.9 per cent (Watch, 2021). Theses statistic showed that there are more properties in Malaysia which are not own by anyone than citizen-own properties.

Maximum affordable house price by household income

Household Income Brackets[1], RM	Percentage of Households by Income Brackets[1], %	Maximum Affordable House Price[2,3], RM
≤ 1,999	8.8	112,200 - 124,700
2,000-3,999	26.1	222,150 - 247,200
4,000-5,999	22.6	318,600 - 354,100
6,000-7,999	14.6	408,300 - 453,600
8,000-9,999	9.3	493,500 - 556,100
10,000-14,999	11.3	699,560 - 777,600

Source: Department of Statistics, Malaysia, and Bank Negara Malaysia estimates

Based on the above table provided by Department of Statistics, Malaysia, and Bank Negara Malaysia estimates, we can see that most of the household's owner by income are centre between the RM2000 to RM5999 bracket. Their maximum affordable house price is RM247200 for the RM2000 to RM3999 bracket while RM354100 for the RM4000 to RM5999 bracket. These maximum affordable house prices are only below and slightly above the actual median house price. With all these evidence provided, we can see that if a person wants to buy a house, he or she need to know the best price range so they can plan in advance to buy their desired house.

1.3 | Rationale

As the problem stated above, a property website equipped with artificial intelligence robot advisor will be a standalone web application which allow both buyers and sellers to post houses that are for sold and buying. Intelligent predictor with machine learning can be included on the website to give users a better experience. Users can make use of the intelligent price predictor on the website to check the best price for the house of their choice in a specific area or just to get to know the best price of buying or selling property. This advantage will prevent new users from buying or selling houses at disadvantages and the price predictor can advise them on how to sell or buy to gain maximum profit.

The performance of the machine learning model will play an important part on providing users with the price range that he or she can benefit the most. This in turn will reduce burdens on those who are seeking to buy or sell a house and stabilize the volatile market.

1.4 | Potential Benefits

Provides a website which has a house price prediction model to provide users the most suitable price range for he or she to buy or sell to gain maximum profit. The benefits are then further dividing into tangible and intangible benefits.

1.4.1 | Tangible Benefits

- Cost saving, resources can be saved as users do not required to drive or take any transportation to the house he or she are interested as they can view the house using the picture posted by seller.
- Give precise prediction on house price trend to save money.
- Reduce workload from people who are doing the processing of household data.
- Cost and time efficient as it reduces the cost for hiring people to process the data and reduce time required to filter and process the data as machine can do it faster and better.

1.4.2 | Intangible Benefits

- A greener environment as this website can help to reduce the use of transportation, this makes the user happier for contributing to help the environment.
- Regulate the average price for houses as the robot advisor can help to suggest the best price at a specific timeline in a specific location.

1.5 | Target Users

The users who will be using this system are those who are interested in either purchasing, selling, or just browsing for houses. So, the target users of this project are adults who are interested in buying or selling houses that are located within Malaysia.

1.6 | Scope and Objectives

1.6.1 | Aim

The aim of this project is to develop a machine learning model which can predict house price and provide it to users. The model will be implemented in a property website with features to help the users to find the best price for the house they desired.

1.6.2 | Objectives

- Conduct analysis to identify house price trend using data received.
- To build a machine learning predictive model to predict house price.
- Provide a platform for users to browse houses upload by sellers.
- Allow users to predict the house price.

1.6.3 | Deliverables – Functionality of the proposed system

"Property Platform" – Your trusted property platform allows users to buy or sell houses while being assist by a machine learning integrated price predictor. This website can predict the house price for a particular area in particular time and inform the user about the predicted price range. Users can then use this info to setup selling or buy the house within the price range to maximise their profit. This can help to reduce burden of the users from going through all the raw data to filter and process the data themselves to know the price range for a house.

Below are functions and aim of the system which need to be accomplished before delivering.

For all end-users:

- Allow end-users to register, login and logout from the website.
- Allow end-users to browse the houses uploaded to the website.
- Inform users about the price range of the house they choose.
- Price predictor integrated with machine learning to predict house prices
- Guide users to use the website with manual in about page
- Allow users to save time as they do not need to filter the house market data themselves
- Allow users to input multiple parameters they wanted to predict the house price

1.6.4 | Nature of Challenges

Firstly, the user browsing experience is the priority I need to fulfil as they website will be used by different users, and they will view the website in different screen resolution, browser, and devices. Furthermore, if a user is using his or her smartphone to browse the website, a

micro site will need to be created which will be a great challenge. Another important and difficult challenge will be the security of the website. Prevention SQL injection, and encryption of the user's information will be some of the methods taken into consideration to increase the level of security of the website. Database will need to be develop and maintain to ensure the website is up 24/7.

1.7 | Overview of this report

This report is divided in to 11 chapters which will discuss different area in each chapter. The first part of the section which is chapter 1 will be discussing the project's background and the problem it is trying to solve. Advantages, aim, objectives as well as the challenges will be faced will be research and written in the first chapter.

In chapter 2, multiple literature reviews will be conduct on different domain related to the topic of this project. For example, research on machine learning, house price will be done and written in this chapter. Similar systems will also be review and comparisons will be stated out.

For chapter 3 which is the technical research for this project will be focusing on examinate programming languages and IDE to be used in this project. Database and operating systems will also be compared and chosen in this section.

In chapter four, the software methodology for this project will be discuss. Comparison will be done between two chosen methodology and the better one will be picked with appropriate reasons.

Requirement validation will be done in chapter 5, the methods to collect information from various source and the design of the method will be discuss in this very chapter.

For chapter 6, analysis will be conducted on the information collected from chapter 5. The information will be analysed and documented in this chapter. The information collected will also be used to improve the developing system.

For chapter 7 the architecture of the system will be written, its core features, elements and multiple diagrams will be included for a better understanding.

A detail project plan will be included in chapter 8. Besides that, a test plan will also be added in this chapter to show what will be done in testing phase.

Chapter 9 will mainly be showing all the features within the system. Comparison between all tested machine learning model is done here to show the best model being chosen and its reasons.

System validation is done in chapter 10 which testers will be found and ask to test the system. User acceptance testing is done in this section.

The final conclusion of this whole project is written here in chapter 11 and the rest is references for this paper.

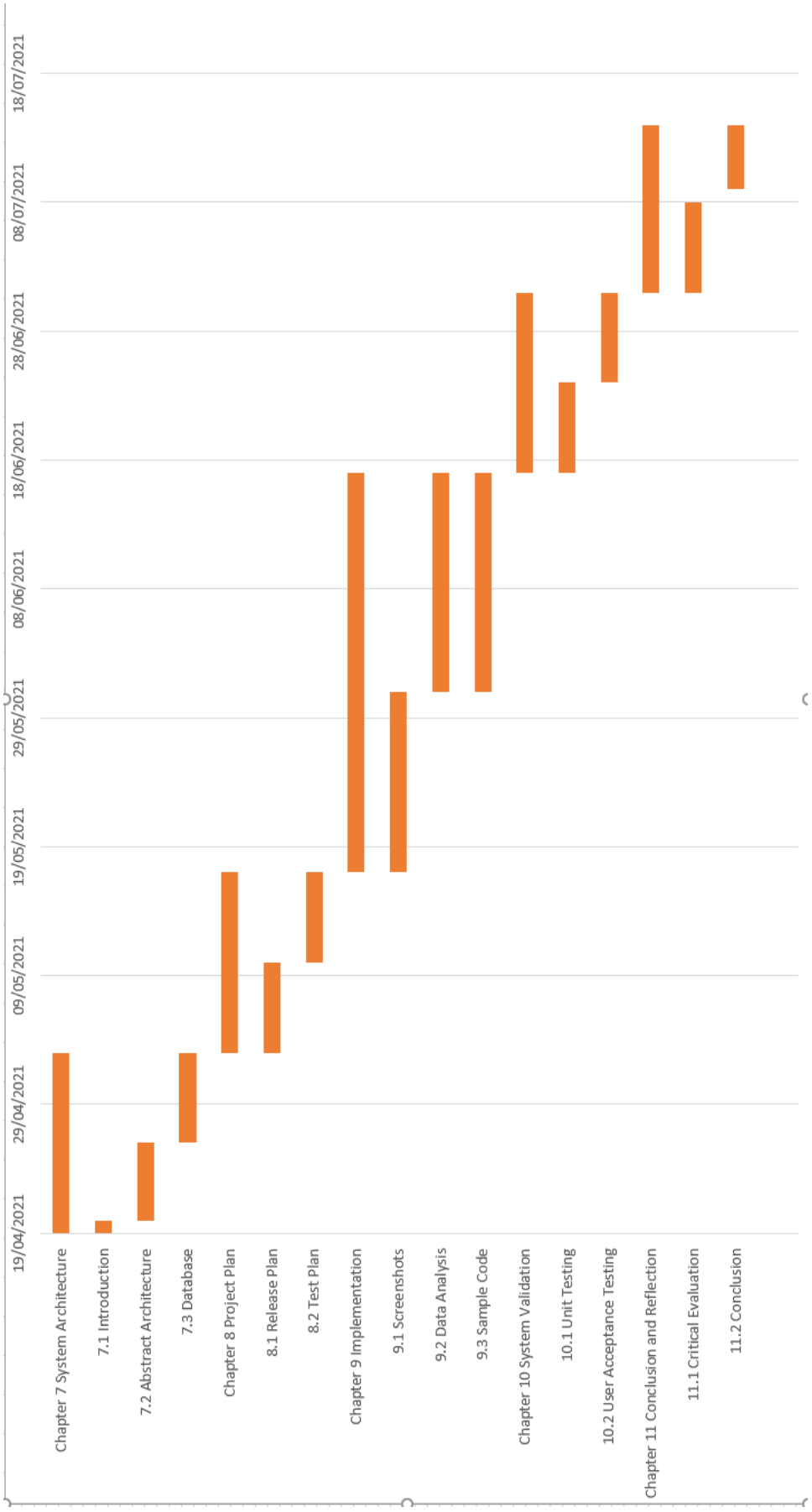
1.8 | Project Plan

Task \Time	January		February				March	
	20 Jan 2021	24 Jan 2021	5 Feb 2021	10 Feb 2021	15 Feb 2021	25 Feb 2021	1 March 2021	3 March 2021
Introduction to the study								
Literature Review								
Technical Research								
System Development Methodology								
Research Methods								
Requirements Validation								
Conclusion and Reflections								

Final Year Project				
Semester 1				
Task Name	Duration	Start Date	End Date	Status
Project Proposal Form	8 days	2020	27th November 2020	Submitted
Project Specification Form	10 days	2020	18th January 2021	Submitted
Introduction to the study	4 days	20 Jan 2021	23 Jan 2021	Completed
Literature Review	13 days	24 Jan 2021	9 Feb 2021	Completed
Technical Research	6 days	10 Feb 2021	14 Feb 2021	Completed
System Development Methodology	11 days	15 Feb 2021	24 Feb 2021	Completed
Research Methods	5 days	25 Feb 2021	28 Feb 2021	Completed
Requirements Validation	5 days	25 Feb 2021	28 Feb 2021	Completed
Conclusion and Reflections	3 days	1 March 2021	3 March 2021	Completed

Semester 2

Task Description	Duration	Starting Date	Completion Date	Status
Chapter 7 System Architecture	14	19/04/2021	03/05/2021	Completed
7.1 Introduction	1	19/04/2021	20/04/2021	Completed
7.2 Abstract Architecture	6	20/04/2021	26/04/2021	Completed
7.3 Database	7	26/04/2021	03/05/2021	Completed
Chapter 8 Project Plan	14	03/05/2021	17/05/2021	Completed
8.1 Release Plan	7	03/05/2021	10/05/2021	Completed
8.2 Test Plan	7	10/05/2021	17/05/2021	Completed
Chapter 9 Implementation	31	17/05/2021	17/06/2021	Completed
9.1 Screenshots	14	17/05/2021	31/05/2021	Completed
9.2 Data Analysis	17	31/05/2021	17/06/2021	Completed
9.3 Sample Code	17	31/05/2021	17/06/2021	Completed
Chapter 10 System Validation	14	17/06/2021	01/07/2021	Completed
10.1 Unit Testing	7	17/06/2021	24/06/2021	Completed
10.2 User Acceptance Testing	7	24/06/2021	01/07/2021	Completed
Chapter 11 Conclusion and Reflection	13	01/07/2021	14/07/2021	Completed
11.1 Critical Evaluation	7	01/07/2021	08/07/2021	Completed
11.2 Conclusion	5	09/07/2021	14/07/2021	Completed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Chapter 7 System Architecture
7.1 Introduction
7.2 Abstract Architecture
7.3 Database
Chapter 8 Project Plan
8.1 Release Plan
8.2 Test Plan
Chapter 9 Implementation
9.1 Screenshots
9.2 Data Analysis
9.3 Sample Code
Chapter 10 System Validation
10.1 Unit Testing
10.2 User Acceptance Testing
Chapter 11 Conclusion and Reflection
11.1 Critical Evaluation
11.2 Conclusion

Chapter 2: Literature Review

This section will discuss the study of this project's problem and compare its similar system. A project can only be successful if the problem and existing system is well studied and investigated.

2.1 | Introduction

For this project, multiple journals and article will be review for better understanding of research topic. Articles related to housing price, neural networks, prediction models and similar system will also be review.

2.2 | Domain Research

2.2.1 | Housing Price

In any country, it is very common for a person to do research on the house they desired before purchasing. House price changes as time passes so finding out what affects the house price can help to predict the house price in the future. After many research, the findings are that there are many different factors that affects the housing price. Each research paper has used different factors to predict the house price. From a journal written by Nur Sabrina Abdul Lati and her team (Sabrina Abdul Latif et al., 2020), they have found out that there are five factors affecting house price. Five of these factors are Foreign Direct Investment (FDI), Gross Domestic Product (GDP), Interest rate, unemployment, and inflation (Sabrina Abdul Latif et al., 2020). Another research paper by Ong Tze San also proved that GDP, population and RPGT have deep influence in changing of house price (Tze San, 2013). GDP, lending rate and population around the house seems to be the common factors for most of the research papers as these variables are commonly found in the research papers. The paper written by Lim Sze Yoong and his team also proven that the mentioned three factors deeply influence the housing price after analyse data provided by Bursa Malaysia (SZE YOONG et al., 2016).

One the other hand while in machine learning, to predict house price different variables are taken for prediction, not just the factors stated in the previous paragraph. In a research paper done by Wang Lipo and his team, their prediction model used many variables such as population, unemployment rate, labour cost and many more (Lipo et al., 2020). Some of these variables are related to the house itself such as its number of floors and rooms, distance to nearest city and school (Lipo et al., 2020). In another house price prediction model, variables

such as population, GDP of construction, number of households, interest rate, private completion units are taken in for learning process of the prediction model (Naga Satish et al., 2021). Another research report shows that building type, distance to subway, community, age of house and many more other variables can be used in prediction model (Truong et al., 2020). All of the stated prediction model all has very high accuracy, this proves that the variables stated above are viable to be used as learning data for the machine learning model.

As we can see, there are many different variables that can be taken into account to predict house price. Variables should be discussing and research before choosing, trial and error should also be done to find the most suitable variables to be used to get the best result.

2.2.2 | Prediction of house price using different methods.

In machine learning there are various ways for predicting house price. One of them is using regression model. In a case study by Adyan Nur Alfiyatin and her team, the house price was predicted using regression analysis (Nur Alfiyatin et al., 2017). They used linear regression to perform house price prediction which got good result with the condition that sufficient data Is provided. In another research paper by Thuraiya Mohd, Suraya Masrom and Noraini Johari, they used five different machine learning algorithm which are random forest regressor, decision tree regressor, ridge, linear regression, and lasso (Thuraiya et al., 2019). All of the above algorithms have given out good result.

2.2.3 | Machine Learning

Machine learning is a term defined as a section of computer science that focus on understanding the pattern recognition and computational learning theory in artificial intelligence (Simon, et al., 2015). The aim of machine learning is to have a system which can learn from data sets, identify patterns by itself and make decision with minimal human intervention (Chahal & Gulia, 2019).

“A computer program is said to learn from experience E with respect to some task T and some performance measure P, if its performance on T, as measured by P, improves with experience E.” -- Tom Mitchell, Carnegie Mellon University (Simon, et al., 2015).

Machine learning can help us human to achieve objectives that are hard for us to complete, or the problem is simply out of our reasoning capabilities, for example, navigation

on Mars and calculating webpage ranks. In a simple manner, machine learning comes in four steps (Chahal & Gulia, 2019):

1. Feature extraction
2. Selection of corresponding machine learning algorithm
3. Training and evaluation of the data model's efficiency
4. Lastly, use the trained model for prediction and other uses

During the 18th century multiple key concepts in machine learning were derived from the probability theory and statistics (Donelly, et al., 2017). For example, the Bayes Theorem introduced by Thomas Bayes in 1763 became a central concept to some modern approaches to machine learning (Donelly, et al., 2017). In 1950, the infamous Turing Test was introduced by Alan Turing, to pass the test, a machine will need to response to question given by a human and convince them it is a human talking to the user (Donelly, et al., 2017). If the machine pass, it is good enough to be categories as intelligent.

Great progress on the field of machine learning has been made throughout the year. For example, in 1992 researcher Gerald Tesauro created a program which uses artificial neural network to play backgammon and its skill could match the skill of top players and in 2011, the IBM's Watson successfully defeat two human Jeopardy! Champions which are a huge step in the field of machine learning (Donelly, et al., 2017).

2.2.4 | Artificial Neural Network

Artificial neural networks are replicas of human brain neural structure (Mishra & Gupta, 2021). It is an interconnected group of nodes which are distantly related to the huge network of neurons in a brain (Veera Manickam et al., 2021). In the simplest form, neural networks only consist of three layers which is the input layer, hidden layer, and output layer such as the diagram below. Hidden layer will always be between the input layer and output layer.

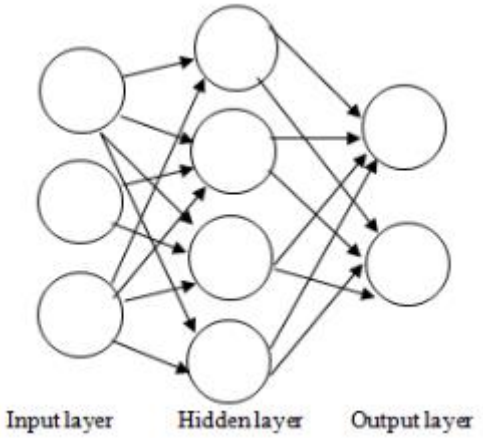


Figure 1 : Neural Network Layers

Many research papers have proven that artificial neural network can be used for various application. In a research paper by Veera Manickam predict housing price with high accuracy. Some of the examples comes from the research paper by Nitin Malik, which in his paper he proved that artificial neural network can be used to develop alarm processing, eddy current analysis and harmonic source monitoring (Malik, 2021). Besides that, artificial neural network can also use to develop prediction model. A research paper written by Ahmed Khalafallah used a neural network model to predict house market. His model has a relatively low error rate of +-2% which is extremely low (Khalafallah, 2017). Besides that, Mohamad Shukry b. Mohd Radzi and his team also used artificial neural network to forecast house price (Shukry b. Mohd Radzi et al., 2012). Their model has a very high accuracy as the mean absolute percentage error (MAPE) is less than 10% which an ANN model with a 20% is considered average.

2.2.4 | Backpropagation training method on feed-forward multilayer perceptron neural network

Backpropagation training method on neural network is one of the many popular neural network methods used by the machine learning community. It is one of the many supervised learning, multi-layered training model that will take the errors found when adjusting the weight value within backward process as well as the forward propagation to adjust the weights. Back propagation algorithm is also a popular learning approach to feed forward multilayer perceptron network. But suffers from problems within back propagation, called local minimum and slow speed of convergence (HAMID et al., 2012). But even with the said downside, it has quality in conducting good training to facilitate the convergence rate(Izhari et al., 2020).

Backpropagation training method was developed by Rumelhart based on the generalization of least mean square error (LMS) algorithm. It uses the gradient descent search technique to ensure the cost function equal to the mean square different between the required and actual net output is minimal. Network using backpropagation is trained by choosing small random weights and internal threshold, then present all the training data in a loop by using the supervised training technique. Weights are adjusted and tuned till the desired error level or cost functions reaches acceptable level (Ogmen, 1990).

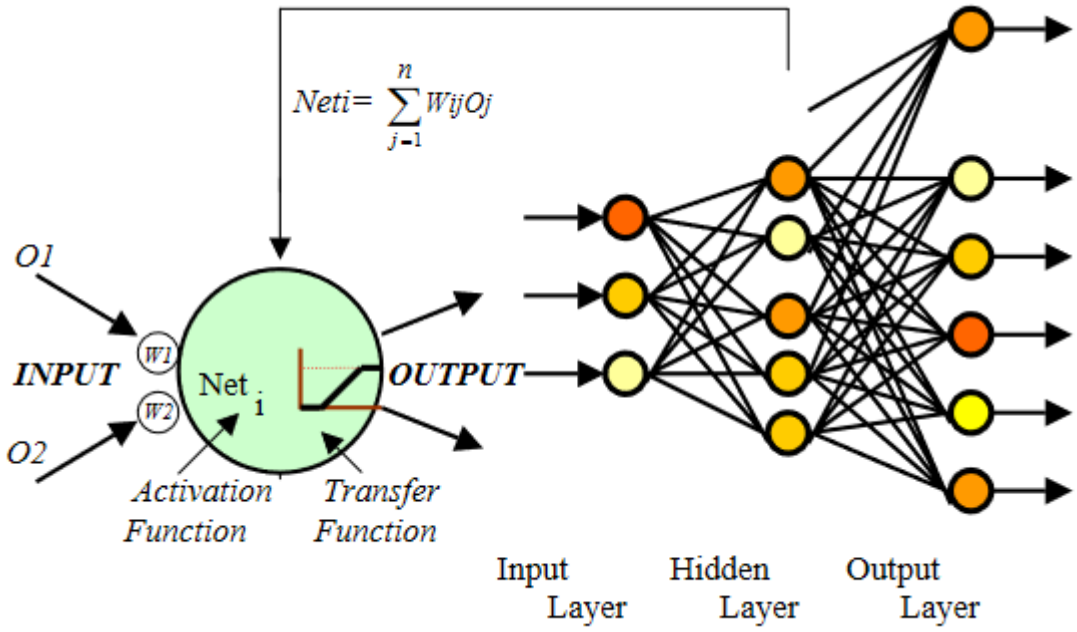


Figure 2: Backpropgation Architecture

In back-propagation architecture, each neuron within the network receives input from external real-world environment or from other processing elements, then process the input and give a specific output. All these operations are done at the same time which is also known as parallelism. This feature is unique to artificial neural network. Inputs send to the neural comes with a weight indicating its strength. Within the neuron, the values of input are times by the corresponding weight and all result are added to get a net value. After this, the result is combining with previous state of neurons to product a new activation value. The chances of neurons fire will depend on eh magnitude of this value. The activation is then sent to an output or transfer function that products the actual neuron output. The transfer function changes the value of output signal. Normally a typical transfer function in building ANN includes a linear threshold transfer functions, step function, sigmoid unction, and some other's function (Al-Alawi, 2002).

In Keres library, backpropagation technique is automatically applied during training. A feed-forward neural network using Keras will always have backpropagation training technique by default. This is to reduce the error and increase accuracy as backpropagation is proven to be useful in neural network training (Al-Alawi, 2002).

2.2.5 | Linear Regression

Linear regression is one of the many popular regression algorithms used to do prediction and to show relationships between chosen variables with some variables categories as dependent while the other is independent. The final objective for a linear regression is to predict or solve the dependent variable. Linear regression comes in two types, single linear regression, and multiple linear regression which as the name suggested, uses multiple features to predict (Nelson,2021).

Multiple linear regression normally will be used as most dataset contains many variables that can be used for training the model. The algorithm or equation used for linear regression will extend by the N number of variables found within the chosen dataset. Linear regression will use different values for the weight to produce different lines of best fit. The weights of trained model can be adjusted until the weight configuration gives out the least or lowest amount of error (Nelson,2021).

Linear regression is quite famous within the community of machine learning as it was used in many different areas. For example, prediction of house price, stocks, and car prices. There will be certain variables or features that will deeply impact a model's accuracy in prediction. One popular way of determining this will be using the correlation coefficient (Aiyin & Yanmei, 2018). One of the advantages of using linear regression is that it is simple and straightforward. Besides that, it uses relatively small processing power, short training time and can generate good results. Relationships between variables can be easily find out and shown using linear regression(OpenGenius, 2021). On the other sides, linear regression is prone to overfit or underfitting. However, this can be solving by doing regularization or have a bigger dataset. Another downside is that linear regression is easily affect by outliers which will affect the accuracy of the model (SameerchandPudaruth, 2014).

2.2.6 | Gradient Boosting

Gradient boosting is a powerful machine learning technique which has shown considerable success in many practical applications. It is highly customizable to the very specific needs of the application. For example, gradient boosting can be used for regression, classification, and other tasks. Gradient boosting normally creates a prediction model by ensemble weak prediction models, normally decision trees(Piryonesi & El-Diraby, 2020) . Within gradient boosting, if a decision tree is used for gradient bosting, the resulting algorithm will be named gradient boosted tree. Gradient boosting build model in a stage-wise style like other available boosting method does. It will generalize all the used model by allowing optimization of an arbitrary differentiable loss function(Natekin & Knoll, 2013) . The high flexibility of gradient boosting makes it highly customizable to any sorts of data-driven task. It gives a lot of freedom in model design, making it the choice for the most appropriate loss function a matter of try and error. Similar to random forest, gradient boosting is relatively simple to use, which allows one to try different model design. Moreover it has shown success in both various machine-learning and data mining challenges(Natekin & Knoll, 2013).

Gradient boosting was used in many different areas. For example, in a journal by Sina Dabiri and Montasir Abbas (Dabiri & Abbas, 2018) , they build a system to estimate car-following behaviour using gradient boosting of regression trees. Besides that, Tao Wang and his team used gradient boosting regression trees to predict shared-car us(Wang et al., 2020)e. Gonzalez-Recio and his team too used gradient boosting for genome-assieted evauation in large dataset which proofed to be successful (González-Recio et al., 2013).With these examples, gradient boosting can be said to be quite common and popular within the machine learning community.

2.2.7 | Random Forest

Random forest is one of the intelligent machine learning algorithms that can adapt to different dataset and has good flexibility. It is popular within the machine learning community and is computational friendly. It can be used for classification, regression, semi-supervised learning, and any other problems that are under the same framework. Random forest can be used in two ways which is a generative or discriminative way which also can be used for both label and unlabelled data ((A. Criminisi, et al., 2011). Random forest algorithm is an ensemble intelligent machine learning technique that uses decision tress as its base classifier, which is

suitable for both regression and classification data, consisting of a number of trained classifiers that are combined to categories new cases (Goel & Abhilasha, 2017).

For classification dataset, the dependent variable will be categorical due to classification tasks involves tagging label to data. In regression, dependent variable will be the opposite which is numerical where result given will be in real or continuous numbers as price or length. Within random forest, more individual decision trees will have a better performance. This is to increase the chances of getting the correct result or correct path (MELTZER, 2020).

In order to improve the accuracy of random forest, correlation within dataset should be minimal while at the same time, maintaining its strength. Random forest works by randomly pick its inputs or combining inputs at each of the branches to grow the tree. This is the reason for random forest to generate good accuracy. In terms of outliers and noise, random forest is very robust and also simple yet fast (Goel & Abhilasha, 2017).

Random forest has been used in many different domains, for example, it was used for house price prediction (Data Blogger, 2017) and car price prediction (Li, 2021). Another example will be stock price prediction and detecting customers who will be more likely to pay their debts. Two of these examples are regression and classification dataset respectively (MELTZER, 2020)).

For this project, random forest regressor will be used to train the random forest model if used. Random forest regressor uses multiple decision trees to train and each of these decision tresses will be taking random sample from the given dataset so it can prevent overfitting (MELTZER, 2020).

2.2.8 | Three-tier architecture “client-server”

Client-server technology current is one of the popular and commonly used in modern society. The concept of this technology is that the client who is the user send requests to the server and then the server will give results according to the request. There are several criteria to meet for an application to be called client-server technology. The functions on client should be as follows: sending request to the back-end server, process the result send from server to client and present the result to user in form the user desired (Barabanova et al., 2019) . On the backend or server side, it needs to receive request from client, process its request, execute query to database and send the result back to client application. These are the description of client-server interaction but only on a classic two-tier architecture (Barabanova et al., 2019).

A three tier architecture "client-server" web application consists of three layers, the front-end or client, middleware which is the application server and also a database backend (Zhang & Wang, 2003). The three-tier architecture can be extended by n-tiers. The reason for the increase of tiers are to provide better flexibility and scalability. For example, some distributed computing system have multiple layers, but the base rules are still the same as three-tier applications. The middle tier or layer of three-tier architecture can be dividing into tow with one for the web server while the other one for the application server. Generally, the more n-tier the better the overall application efficiency. The below diagram shows an overall view of the said three-tier architecture (Zhang & Wang, 2003).

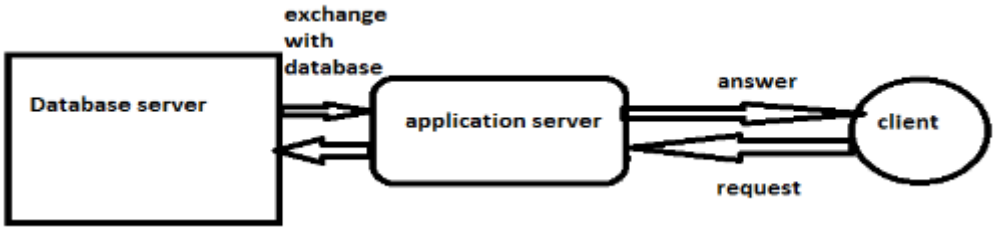


Figure 3 3 tier architectures

There are many benefits of three-tier architecture according to the research done by Barananova and his team. Some of them are the scalability as a complex network configure can be develop. Besides that, it has a very high security and reliability (Barabanova et al., 2019). All these benefits can only be achieved with the addition of application server. In simple words, application server is a middle ware between client and server. Normally they are connected through a local and distributed network (Barabanova et al., 2019).

2.3 | Similar System

For this section, similar system related to this project will be discuss. A few of the popular similar system is selected which all of them are already available in the market.

2.3.1 | iProperty.com.my

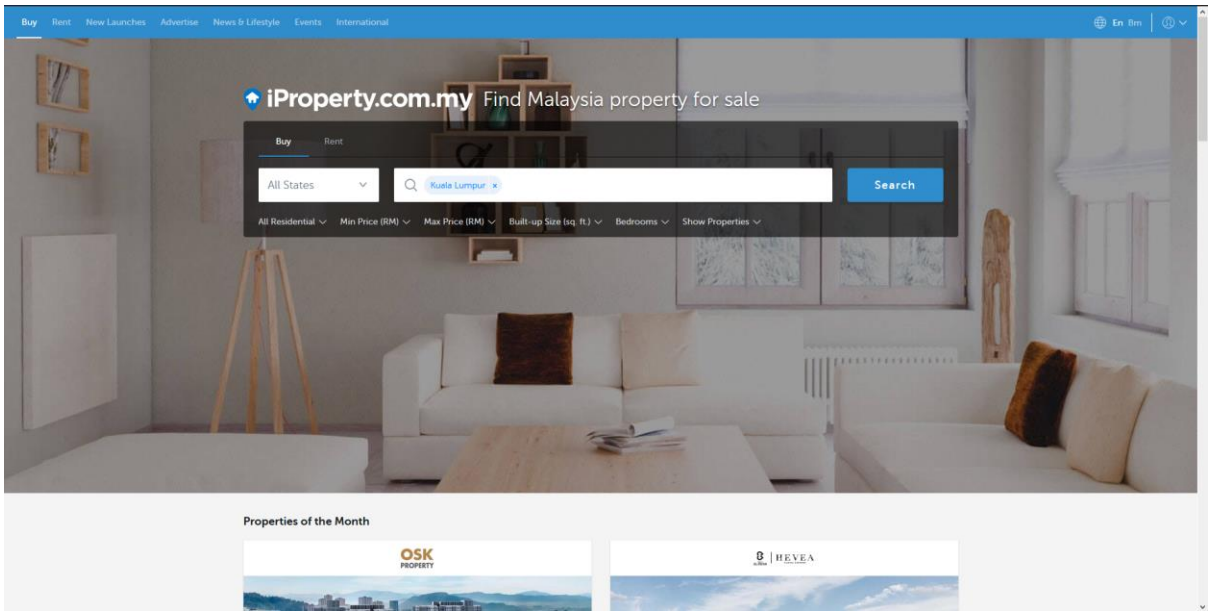


Figure 4: Homepage of iProperty

Source: https://www.iproperty.com.my/

This first one is iProperty.com.my which is one of the many popular to-go property websites in Malaysia for whoever that wants to browse for houses online. REA Group which headquarters in Australia, is the owner of the iProperty website which is also the owner of multiple property websites from different countries such as Thailand (thinkofliving.com and Prakard), and the Greater China Region, including Mainland China (myfun.com) and Hong Kong (squarefoot.com.hk and SMARTExpo). iProperty website offers searching for difference kinds of houses in both English and Bahasa Malaysia. They also provide users consumer solutions such as content to improve the users' property journey, loan support and events. Users can also become a seller by register an account and upload the necessary info and image to start selling. Many filter options are available for users to find the house they desired.

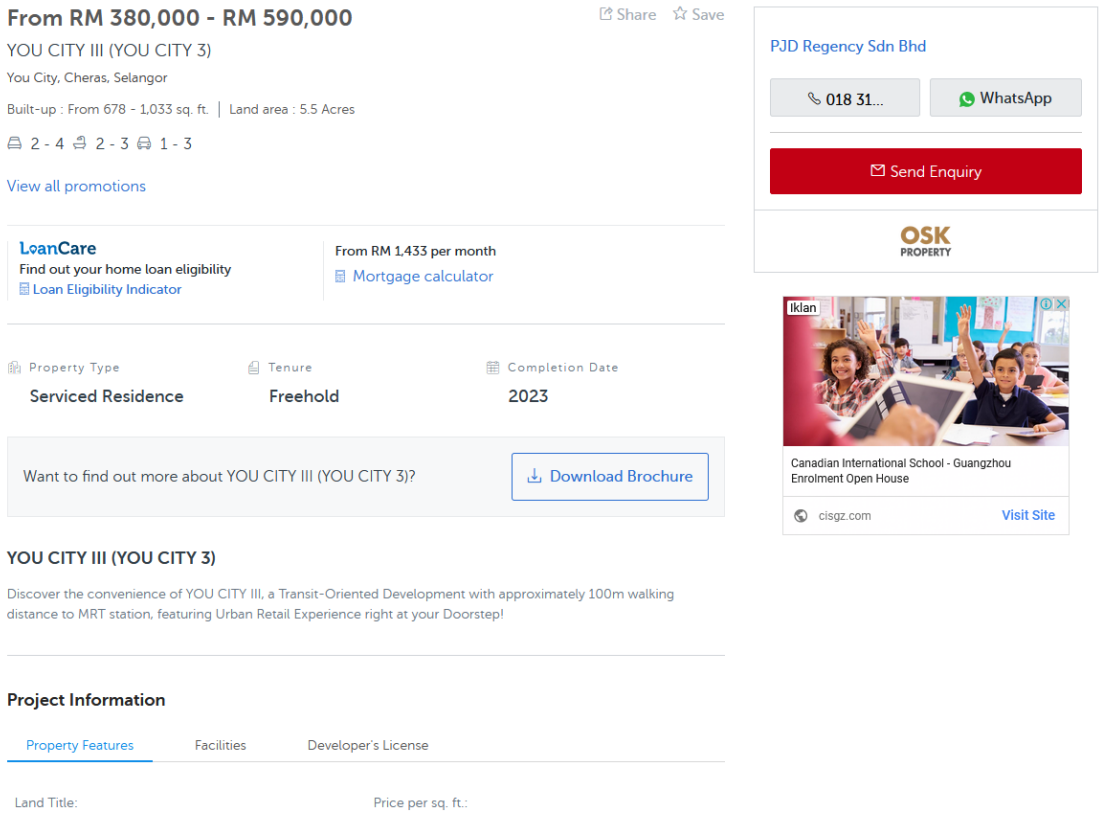


Figure 5 : Random house with details about it

Based on the diagram above we can see that iProperty will show user all kinds of data about the house a user picked. Information such as the house's floor, number of bedrooms, facility if any and the location are clearly stated on the website. Contact information on the seller is provided so they can communicate with each other if the buyer is interested. iProperty also has a clear interface which user found it comfortable to use.

2.3.2 | propertyguru.my

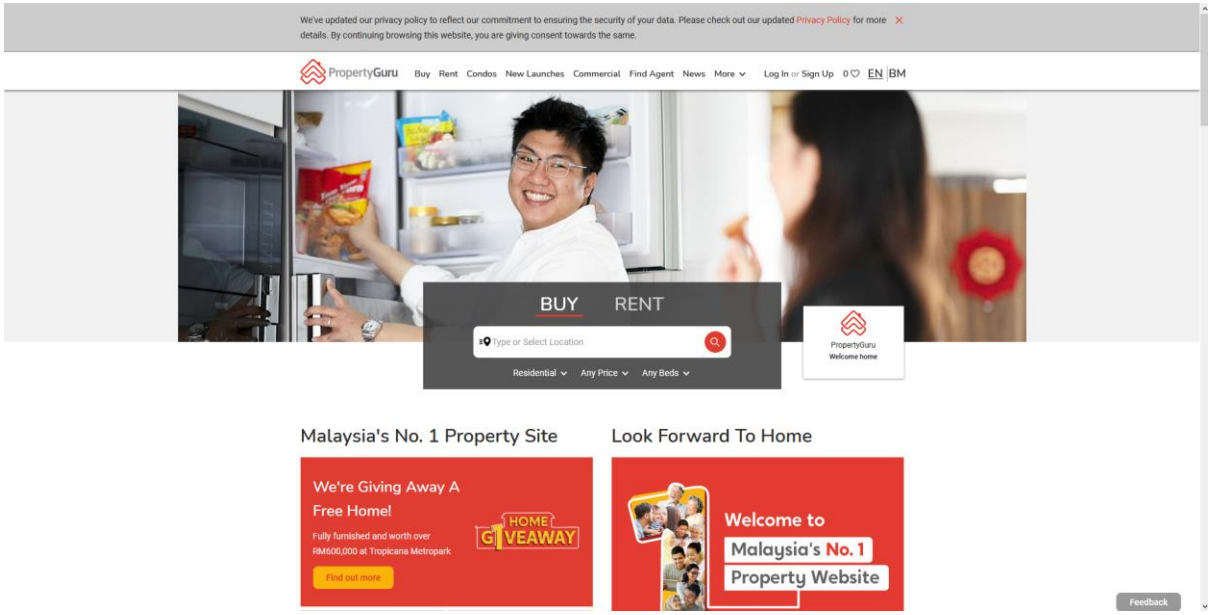


Figure 6: Homepage of PropertyGuru

Source: https://www.propertyguru.com.my/

The second property website is PropertyGuru which is founded in 2007. Their journey started from Singapore and expanded throughout Southeast Asia. PropertyGuru is a property searching website which offer a variety of houses for people to Brower. Besides that, PropertyGuru offer not just a platform for selling, and buying, they also offer many other products such as guide and tools on properties, home loan pre-approval, project reviews and much more.

Our Latest Products

Buying a home is one of the most important decisions in life. Discover how our products solve our customer problems through technology.

PropertyGuru Lens

Lens utilises Artificial Intelligence, Augmented Reality, and PropertyGuru's propriety property data, and your phone's camera to define the future of property search.

Point, tap, and discover homes on-the-go. It is as simple as that.

Find Out More >

Home Loan Pre-Approval

Malaysia faces over 60% home loan rejections, which means a setback of 4 to 6 months. Home Loan Pre-Approval is a free credit check. With it, you can know for sure how much you can borrow from the bank.

Find Out More >

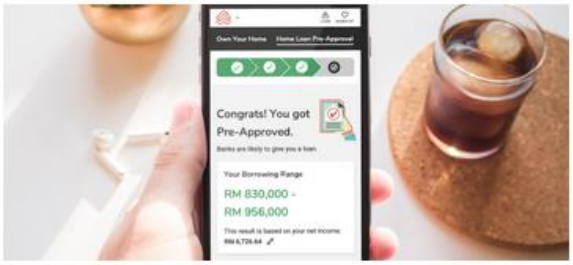


Figure 7: Discription on PropertyGuru's latest produce

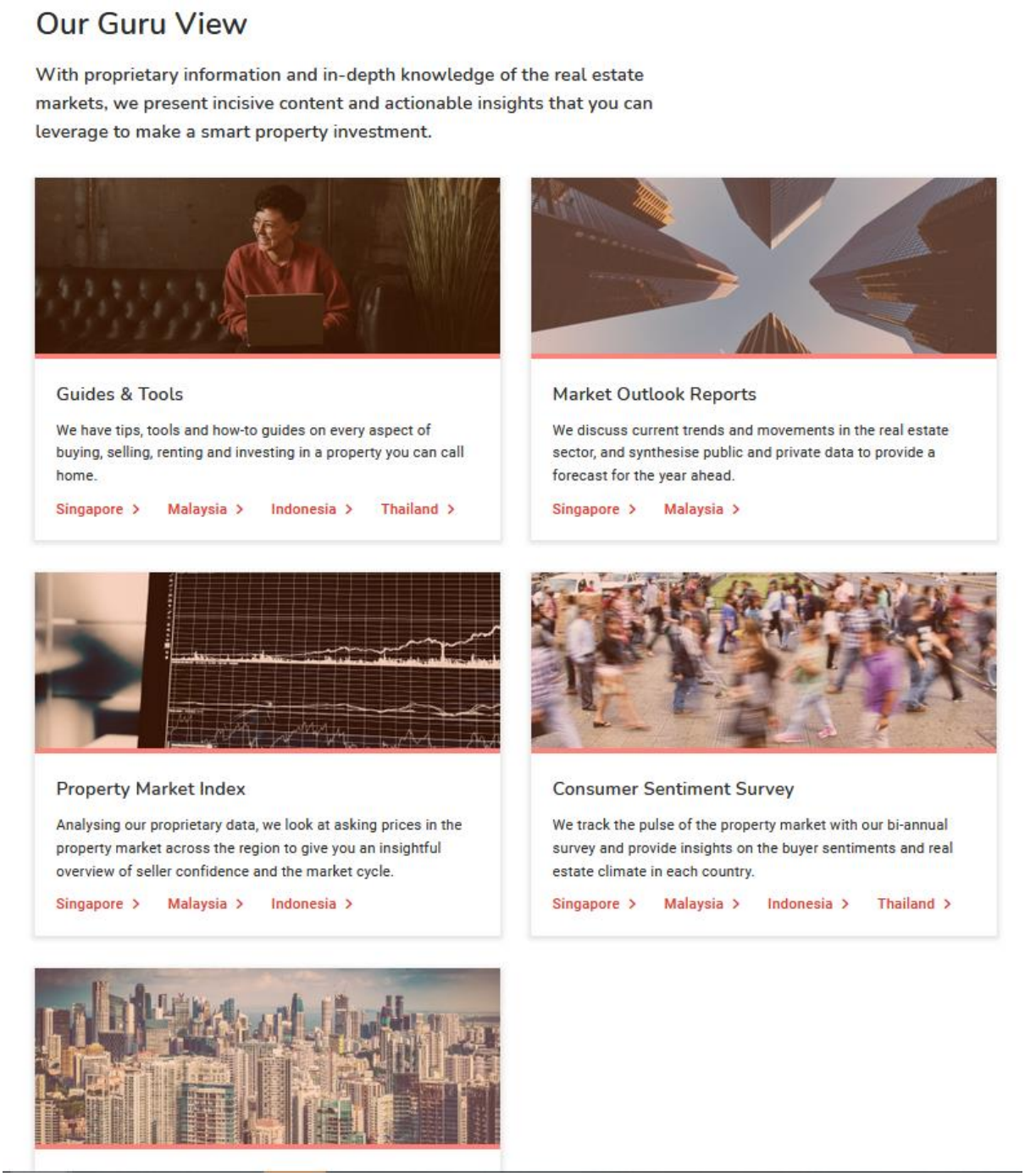


Figure 8: Other products provided by PropertyGuru.

As seen on both diagrams above, PropertyGuru provides other services related to property. Their latest product, PropertyGuru Lens which has Augmented Reality feature to help user to discover homes using their smartphone. They also provide property market index .and consumer sentiment survey for analyst to use to predict property market.

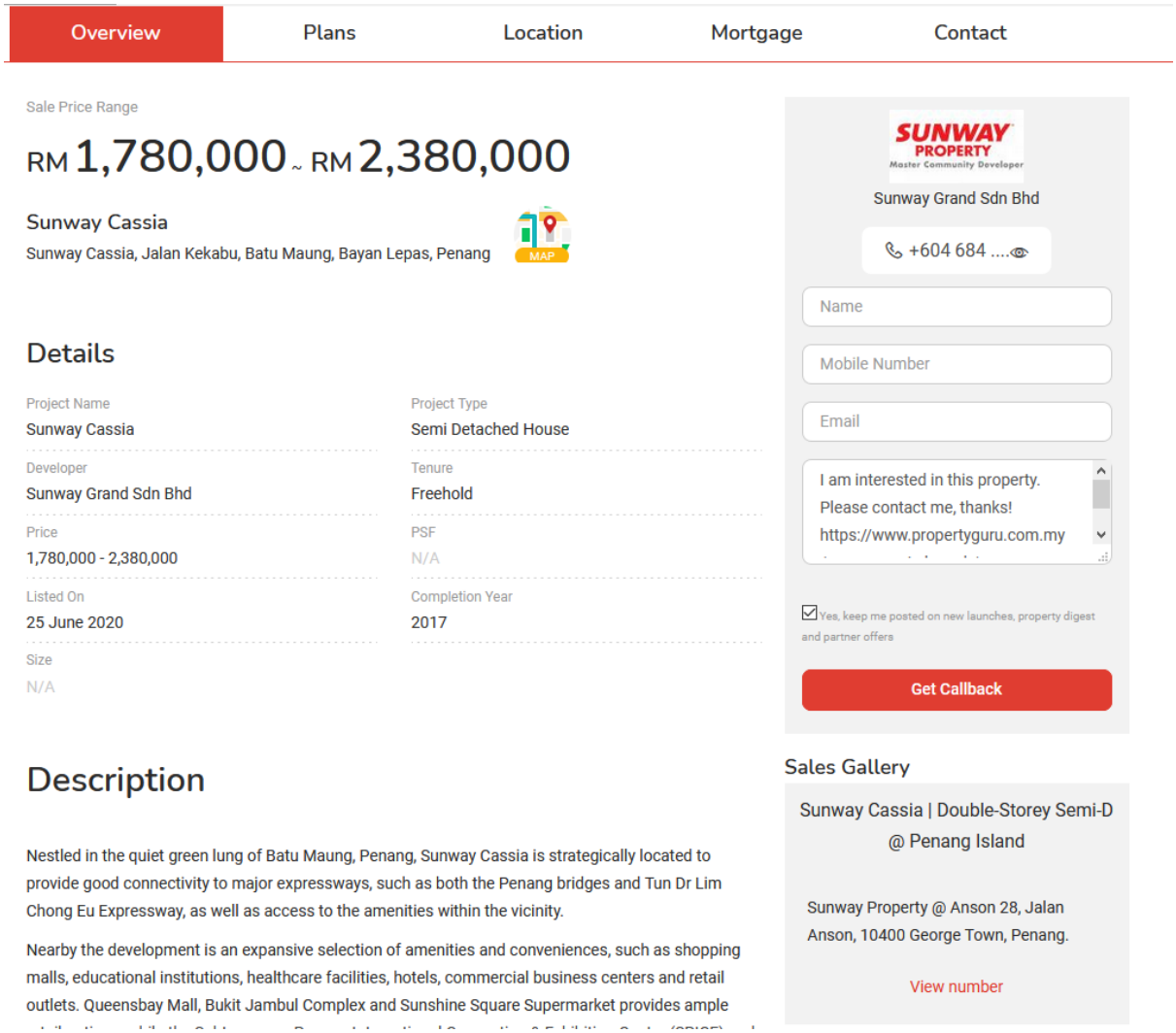


Figure 9: Details on one of the houses sold in PropertyGuru.

Similar to iProperty the information provided for a house is displayed clearly. Contact of seller are provided but they also include a feature where interested buyer can send the seller their info and some messages. A basic description is also provided for buyer to understand more about the house they are interested in.

2.3.3 | edgeprop.my

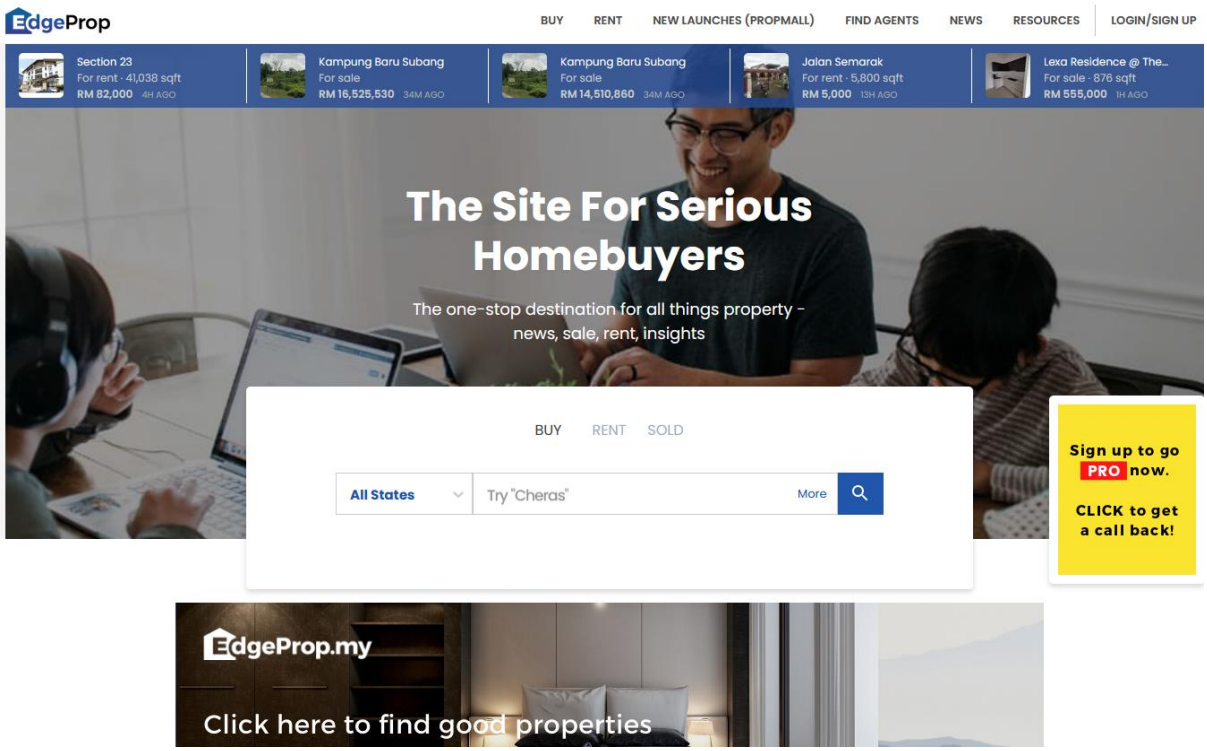


Figure 10 Homepage of EdgeProp

Source: https://www.edgeprop.my/

EdgeProp.my is another property website that provide users a platform to search for houses. Unlike other website stated above, EdgeProp also provide the latest property news where user can update themselves to find the best promotion they can get. One of the downsides of this website is that this website has quite a number of advertisements, but these ads do not block the content of the houses a user is browsing.

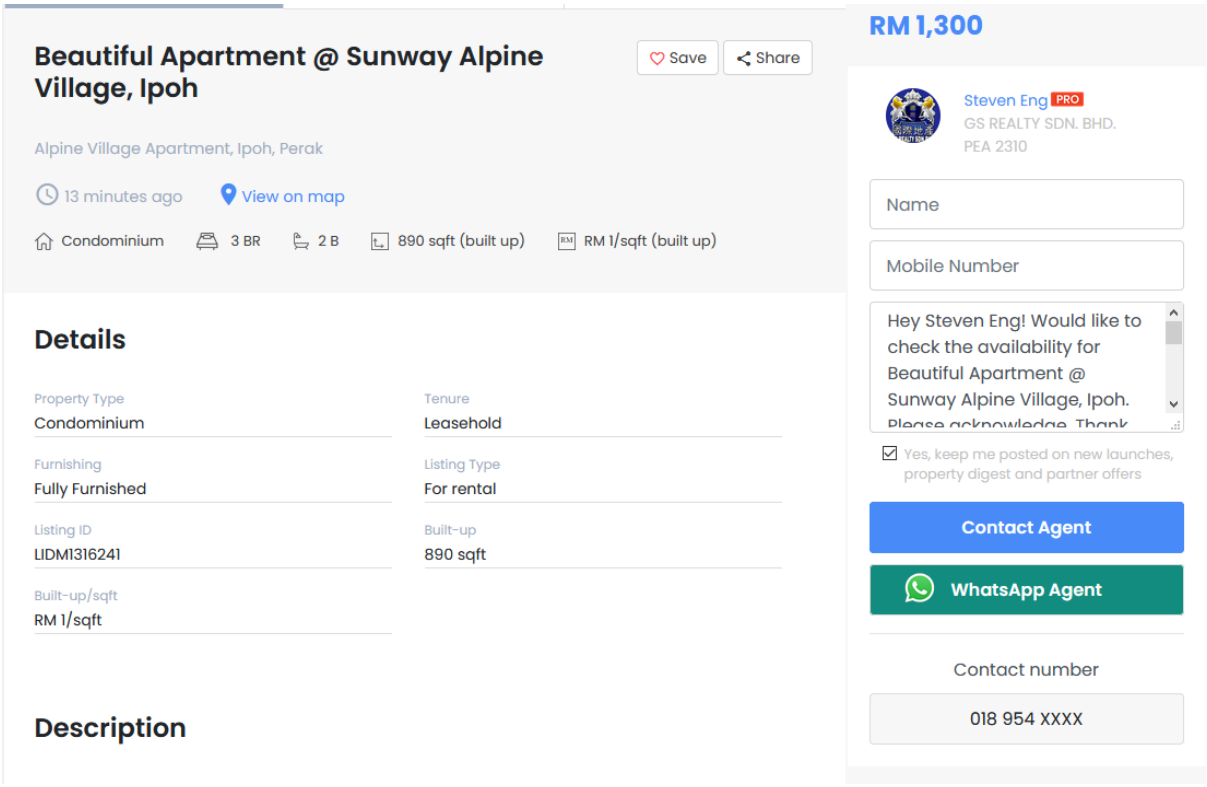


Figure 11 Information on house sold.

EdgeProp has similar interface compared to other property website, the main information is displayed. Contact method is also provided for interested buyer and detail description on the house is also given.

2.3.4 | Comparison of Chosen Similar System

System	**iProperty**	**PropertyGuru**	**EdgeProp**	**Property Platfrom**
Interface	Clean and simple	Clean with its signature colour	Clean and simple	Clean and simple
Extra Features	Guide on property, loan approval assistance	Guide and Augmented Reality technology on property	Property News	Predict the future price of house. Option to filter selection

Information on house	Sufficient	Sufficient	Sufficient	Sufficient
Ads Free	Yes	Yes	No, but do not block the house information	Yes
Ranking	57 (KC, 2021)	98 (KC, 2021)	Not available	Not Available
Virtual Tours	No	Yes	No	No

2.4 | Summary

After multiple researches on different literature reviews, a better and clearer understanding on the field of study such as neural network and house price index has achieved. These valuable knowledges will be used during the development of system. By comparing similar system, we can improve the being develop website by learning the pros of the similar system while removing the downside of the similar systems.

Chapter 3: Technical Research

This section will be discussion on all technical research and technical tools chosen to be used in this project. Below contains details description on the reason the tools are chosen and comparison to their counterparts.

3.1 | Programming Language Chosen

3.1.1 | Front-end

For the front-end development of website, there are not much option as current web browsers only support three of the website programming languages which are HTML, JavaScript, and CSS. However, there are many different frameworks which developers can use to develop website. Two of the popular frameworks are chosen and compared. The comparisons are as below:

React	Framework	Angular
Able to use libraries from other sources	Libraries	Complete solution itself
Easy, difficult when augmented with Redux	Learning curve	Difficult
JavaScript library	Type	Complete framework
Does not offer much	Community support	Supported by a huge community
Gives freedom Ove the tools, architecture, and libraries for development	Best features	Offers limited amount of freedom and flexibility
JavaScript	Written In	Typescript
One-way data binding, means that UI elements cannot be change without updating the corresponding model state	Data binding	Two-way binding which helps to make sure the model state automatically changes

Relatively faster even though it has many regular updates	Documentation	Ongoing development process, documentation is slow
Yes	Adding JavaScript library to source code	No
Allow to manage code as the user wish	Use of code	Comes with many ready to use codes, mainly comes from specific sources

Source: https://www.guru99.com/react-vs-angular-key-difference.html

The table above has shown two of the popular frameworks to create a website. Each of them has their own special features, pros and cons. React is more of a library which developer can import to use while Angular is more of a complete solution where develop can create a website using just the tools provided by Angular. Based on the table, we can see that React has a better documentation which is useful if developer is trying to use a new function or debugging but on the other hand, Angular has a bigger community support which can be a big help when searching for solution on popular coding website such as Stackoverflow.

After much research, react framework has been chosen for its simplicity and was better learning curve compared to Angular. Besides that, react has more freedom which developers can choose the tools and extra libraries they want but for Angular, developers are forced to use the provided tools by Angular. All though the community support coming from React is smaller, it has a well-documented documentation which in return filled-up the gap.

3.1.2 | Backend

Programming language will be one of the core elements in this project as the project objective is to develop a property platform website. To ensure the project go smoothly, all technical tools including programming language will need to be researched thoroughly before being chosen to maximize its potential and increase efficiency.

Programming language chosen for this project will be used to develop both the machine learning and other backend functions. This programming language will also be used to create API to both supply and receive data from websites.

Two programming languages are chosen to be compare before making the final decision, their comparison is as below:

Programming Language	**Python**	**Java**
Cost	Free, fully open source (Python, 2021)	Free, fully open source (Oracle, 2021)
Speed	Slow (SnapLogic, 2021)	Fast (SnapLogic, 2021)
Memory Management	Reference counting and garbage collection features, slower (JavatPoint, 2021)	Garbage collection (JavatPoint, 2021)
Length of code	Short (JavatPoint, 2021)	Long (JavatPoint, 2021)
Compilation process	Interpreted language, compile and execute simultaneously line by line (JavatPoint, 2021)	First compile and convert to bytecode, then depends in JIM (JavatPoint, 2021)
Syntax	Dynamically typed, works using inundation (JavatPoint, 2021)	Hardcore and strict rules (JavatPoint, 2021)
Ease of typing	Do not need to define types of variables (JavatPoint, 2021)	Need to define exact types of variables (JavatPoint, 2021)
Machine Learning Library	TensorFlow, Pytorch	Weka, Mallet, Deeplearning4j, MOA

As the table above show, both programming language has their own share in the machine learning field. Both of them are open source making it easily accessible for developing software and deploying the product without having much concern on the licensing. In terms of speed, Java has better performance compared to Python. The reason behind this is because of Java's Just-In-Time (JIT) complier which improves Java performance by compiling codes into native machine code (JavatPoint, 2021). With this, Java Virtual Machine (JVM) can call the compile code directly which bypass interpreting code step saving time and memory usage (JavatPoint, 2021). For memory management, both languages have garbage collection feature which helps to manage unused or freed memory (JavatPoint, 2021). On the other hand, python

is slightly slower as Python rely on reference courting (DeBrie, 2021). The length of code for both languages has big difference, for example:

Python code to print “Hello World”.

```
print (“Hello World”)
```

Java code to print “Hello World”.

```
public class HelloWorld {
public static void main (String[] args) {
System.out.println("Hello, World").
}
}
```

As we can see, Python has much shorter and more straight forward coding compares to Java which can save a lot of time when coding for the software. Python has less strict rules compared to Java and do not require a person to define types for variables. This can reduce the chances of facing syntax error and reduce time usage. The main aim of this project is to create a prediction model using machine learning so the number of libraries for machine learning in each programming language is very important. For Python, the more popular machine learning library are TensorFlow, PyTorch while Java have Weka, Mellet and many more both languages have huge varieties of libraries to be used for machine learning.

After research and consider the pros and cons of both programming languages, Python is chosen. The reason is because of its easier to code and understand nature which can help to increase efficiency during coding. Python also has less code length which can help to increase developing speed. Although Java has a faster compiling speed, this advantage is not fully utilizing in this project as the model is not complex to the point which the model will slow down a programming languages compilation speed.

3.2 | IDE (Interactive Development Environment) Chosen

IDE will also need to be research before choosing any as an IDE is one of the important tools use to code with the programming language chosen. Two IDE will be chosen for this project which are Visual Studio Code and Google Colaboratory.

Visual Studio Code is a powerful source code editor which is equipped with IntelliSense code completion and debugging. This feature can help to auto complete long code which both can assist user on choosing the correct functions to select and save time. Besides that, Visual Studio Code is completely free and support most of the operating system available in the market which make it very versatile. Visual Studio Code support multiple programming language unlike other IDE such as PyCharm or NetBeans which only support either Python or Java.

Google Colaboratory will be mainly used to develop the prediction model. Similar to Visual Studio Code, it is completely free. Google Colaboratory is a coding notebook which is based on Jupyter notebook which has the advantage of code and execute step by step (Google, 2021). Google Colaboratory also do not require any installation as it runs on the browser. This is very useful for those who are training machine learning model as Google Colaboratory provide on the cloud training GPU.

3.3 | Library Chosen.

Multiple libraries will be selected to be used in the developing of the project as the project will required various functions to both train the prediction model and develop backend and front end. Some of these libraries are TensorFlow, MySQL connector, Beautiful Soup, NumPy.

TensorFlow is an open source, all-in-one machine learning library develop by Google. This library includes multiple tools to help develop and train machine learning model. It has a well-defined documentation and huge community that support this library. User can develop neural network, regression model and many other different choices through TensorFlow.

MySQL connector is a library that enables Python programs to connect and access MySQL databases (w3school, 2021). It lets the Python program to request or send data to the database using API. This library will be the sole connector to the database.

The next library is Beautiful Soup library which let user pulls data out from HTML and XML files. This will be used to do data mining for developing machine learning model (Crummy, 2021).

NumPy is another library which will be used to during machine learning process. NumPy let users to group data into matrix or array for easier data processing before sending it for machine learning.

3.4 | Database Management System (DBS)

MySQL database will be chosen for this project as the database that holds all data for the website. MySQL database is chosen for its reliability as it has been operated for more than 10 years (Microsoft, 2021). This database is supported by a huge community making debugging and developing database process easier.

Similar to Oracle database, it is open source and free to use which is very good for this project. Both databases are Relational Database Management System (DBMS) that support multiple operating system. The difference between both of these popular databases is their licence which MySQL is GPL while Oracle is proprietary.

3.5 | Operating System Chosen.

Operating system chosen for this project will be Microsoft Windows 10. Windows 10 is the latest operating system develop by Microsoft company to replace the previous Windows 8. It has the latest technologies and equips with a new virtual assistant Cortona.

Windows 10 is chosen with the reason for simplicity and easy to understand GUI. Coding will be mainly on Visual Studio Code which is develop by Microsoft Company and Google Colaboratory which is an online browser IDE which do not require the version or type of operating system to operate.

3.5 | Summary

Various tools have been research and discussed to be used in the development of this project. Although all the tools chosen are free, they are well managed and support by a huge community which make sure that the tools are good enough for latest technology research.

Chapter 4: System Development Methodology

Two system development methodology is chosen for comparison to find the most suitable method for this project. As this project is heavily focus on data mining, processing, and machine learning, data mining methodology is chosen. The available SDM in the current market do not fit in this project as there are missing factors such as clients ,third party sources and additional staff. So, the sdm chosen need to be customize in order to fit into the project.

4.1 | Knowledge Discovery in Database (KDD) Methodology

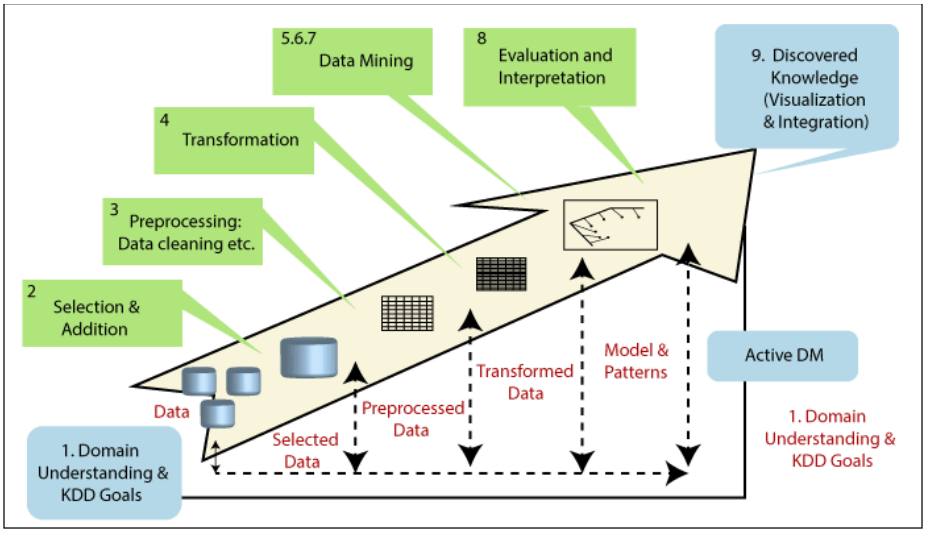


Figure 12 Overall view of KDD

Knowledge Discovery in Databases or KDD for short is a methodology used for data mining, data science and also analytics project. KDD consists of a total of nine iterative and participatory phases. Each level's process is iterative, telling us that returning to previous activities might be needed. Procedures of KDD contains various components which there is no single formula or scientific classification that can be presented for proper selection for each phase and application type. These nine phases within KDD are as follows paragraphs.

In the first phase, understanding of application domain is done here. The information acquired after end users has given all the requirements and objectives should be documented as problem description and objectives. Also, a preliminary project plan should be develop to satisfy the objectives.

The second phase will involves analysing dataset that will be used in the knowledge discovery process. In this phase, steps such as determining what data can be take, obtaining significant data and after that merging all of them together for knowledge discovery which will

include the attributes to be evaluated for the process. This technique is crucial as data mining learns from the data which is given. If missing important attributes within the dataset exist, it will affect the study, yet this process is costly to organize, gather and execute advance data repositories. With these factors, choosing the perfect dataset is crucial. This is why KDD is interactive and iterative. It is crucial to start this phase with the perfect dataset and then expands and check the influences on knowledge discovery and modelling.

On the third phase which will involves preparing of the dataset. This includes the cleaning of data, eliminating or filling in missing values, create new features and identify features. These data will be feed into model for training after all preparation are done. This process may ned to be redone to get the optimum result from the trained model.

The fourth phase will involve the preparation and also the development of relevant data for data mining. Dimension reduction techniques such as feature selection, extraction and also record sampling are used here. Attribute modification process such as discretization of numerical attributes and functional transformation are done here if needed. This phase heavily depends on the project and can be a key point to success KDD project.

The fifth phase will be prediction and description. The main objectives of data mining are prediction and description. Prediction is referring as supervised data mining while descriptive data mining includes both unsupervised and visualization element of data mining. Inductive learning is used on most of the data mining approaches which a model is developed explicitly or implicitly by generalizing from sufficient passed model. Inductive method is referred from the basic premise that developed model applies to future situations. This approach also considers the amount of meta-learning for the unique collection of given data.

The sixth phase will involves choosing the perfect data mining technique. This phase focus on choosing the specific approach to find patterns with numerous inducers. There are various ways in which a meta-learning system can succeed. Meta-learning focus on determine factors that cause data mining algorithm to be effective or not in a giving scenario. This technique seeks to comprehend the circumstances which is the most suitable data mining algorithm.

On the seventh phase which will be the implementation of selecting data mining algorithm. The algorithm is executed multiple times and some of the attributes are adjusted by changing the algorithm’s control parameters till a satisfied result is collected,

In the eight phase which is evaluation, patterns found from the previous phases should be shown in various discrete forms such as pie charts, histograms to check the result of data collected and transformed in previous phases This also helps in identifying the efficiency of specific data model in relation to the chosen domain.

On the final phase, knowledge obtained from the trained model will be used in another system for future activities. The knowledge obtain could be useful during the modification of the system to improve performance. The success of this phase will determine the efficiency of the KDD project.

4.2 | Cross Industry Standard Process for Data Mining (CRISP-DM)

Cross industry standard process for data mining or CRISP-DM for short is a process model where there are six phases in total. These phases represents the data science life cycle. It is a guide to help users to better plan and implement the data chosen for machine learning projects as well as data science projects. CRISP-DM was first introduced in 1999 for the reason of standardizing the data mining process. CRISM-DM became one of the popular and common methodology for data relatd project since then. As said before there are six phases within CRISP-DM, these phases are business understanding, data analysis, data pre-processing , modelling of data , evaluation as well as deployment((Data Science Project Management, 2021).

Within CRIPS-DM, the common way would be first find out the objectives and data mining goals. After that, collect and explore the data, check for the quality of data. The data then will be clean and merge. The modelling technique will be selected to process the data after that, and it will then be assessed. The result will then be evaluated. If the results are satisfying, the model can then be approved. After approval, the final step would be deploying the model (Ullamc, 2015).

In the first phase which is ,business understanding, the objectives are determined and knowledge gain will be convert to data mining problem definition. On the next phase, initial data collection will take place, along with steps to familiarize the chosen data. This is phase also known as data understanding. The third phase is data per processing or preparation in which dataset will be constructed from raw data. This will be where the data chose is cleaned

so the data quality raise. This can be done by removing error while filling in missing values. If merging is needed, it will be also done In this phase(May,2017).

The forth phase is modelling. Where the modelling technique is chosen and implemented in the project. The most suitable modelling technique will be chosen depending on the situation. After that, the model will be developed and tuned (Vorhies, 2016). The fifth phase would be evaluation of data which the result generated will be evaluated using business success criteria. If the result is satisfying level, it will process to the next phase. If other wise, developer will need to move to the previous phase and tune the system. The final phase will be deployment which the developed model will be implemented in to the system (May,2017). Deployment plan will first be develop as well as monitoring and maintenance of the model as data mining work takes places. The model will need to be updated regularly. This final phase also where the report document will be written (Brown,2021).

4.3 | RAD methodology

RAD	Software Methodology	Waterfall
One of the many forms of agile development	Type of software methodology	Classic or traditional model
Low	Risk	High
Small	Team size	Large
Small	Project size	Small
Any changes can be made anytime	Sudden Changes	Changes can be made only at beginning
As soon as possible	Delivery speed	Only after completion of all tasks
Can be work around to fit client requirement	Client Requirements	Not compatible with change in client requirements

Source: https://www.geeksforgeeks.org/difference-between-rad-model-and-waterfall-model/

The table above has shown two of the popular software methodology methods which are RAD and Waterfall model. RAD is one of the many forms of agile methodology while waterfall is more of a classic or traditional methodology. Both are only capable of handling

small project but RAD required only a small team compared to waterfall. Besides that, RAD also has better features compared to the traditional waterfall model.

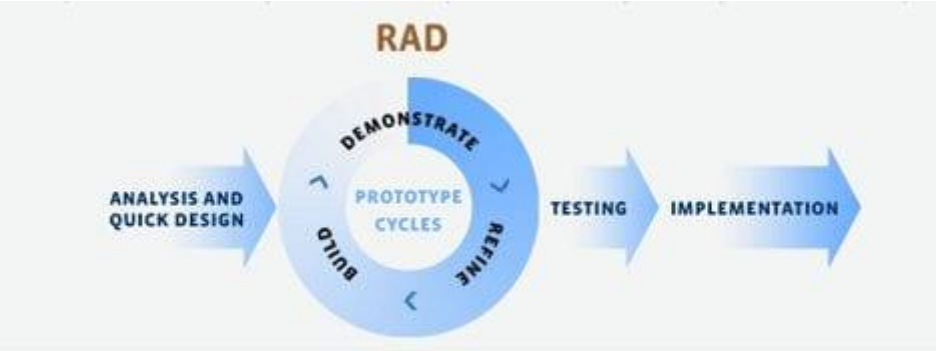


Figure 13 Overall view of RAD

Rapid Application Development or RAD methodology will be chosen for this project after further research. The reason this methodology was chosen because it prioritizes rapid prototype. As the time frame for development is short, a flexible and adaptable approve is required to ensure that the product is completed on time. RAD fulfil this requirement.

RAD is one of many agile software development methodologies that popular for project which has short time frame. It encourages reuse of code which reduce manual coding and less error, saving up precious time (Singh, 2021). Besides that, RAD also encourage coordination between stakeholders and developers, in this project stakeholders are replaced by volunteers and mentor to make adjustments to the project for better performance (Singh, 2021). Risk management can also be greatly reduced as discussion will be made on routine basis to address code errors and vulnerabilities while developing.

Given that this project is required to develop the software and design its GUI, workload will be heavy. Because of this, room for error should be minimized to reduce time wasted. Choices and changes are to be selected carefully and done quickly. Software methodology can help to improve the performance of the development.

4.4 | Comparison of methodology and Justification of chosen methodology.

In the above section researcher has done may research and analysed and compared the most suitable methodologies to be used for this project.

	CRISP-DM	KDD
Phases	1. Requirement gathering and analysis. 2. Designing 3. Prototyping of model 4. User evaluation 5. Refining and improving of prototype 6. Implementation and maintenance	7. Domain Understanding 8. Selection and addition 9. Pre-processing and data cleaning 10. Data transformation 11. Prediction and description 12. Choosing data mining algorithm 13. Visualization and integration of data 14. Evaluation 15. Using knowledge obtained

CRISP-DM methodology is chosen for this project after further research and analysis. CRIPS-DM is chosen as it is better to understand and properly understand the business aim and objectives will help to foresee the end result of how will the system be like. CRISP-DM can help to give guides on how it can be used in real world scenario. In the following section a detailed justification about the selection of methodology will be stated out.

4.5 | Explanation on progression of chosen methodology by phase.

CRISM-DM

CRISM-DM will be mainly used for developing of machine learning model. As this data mining methodology is suitable for this project.

1. Business Understanding

Requirements, aim and objectives for this project will first be collected and defined through communication with supervisor, potential users and opinions collected from respondents that complete the survey. Research on similar system will also be conducted to find out their pros and cons. Collected data and requirement will be written in document for future use which anyone can refer to if needed.

2. Data Understanding

In this process, developer will select and chose the most suitable dataset for the development of both the model and project. Exploring on chosen dataset will be conducted once dataset is confirmed. Dataset which contains various info on houses within Seattle, USA is chosen. Developer will need to familiarize with the data, check for the types of variables within the dataset, visualization of dataset can be done with pie chart or bar chart for a better understanding.

3. Data Preparation

Dataset will be prepared here before sending to the model for training. Method such as data cleaning, filling in missing values, removing outliers will be conduct on the chose dataset to increase the dataset's quality. Once the dataset is cleaned and processed, developer can continue to the next phase.

4. Modelling

This phase will be where modelling technique is chosen. Model will use the dataset from previous phase for development. The dataset will first be divided into train and test set of 75/25 ratio before developing of model. Once the model is fitted using the dataset, it will be trained and the result will be collected.

5. Evaluation

Evaluation of result will be done here. The result collected from the model will be compared to the objectives stated in phase 1. The accuracy of model will also be evaluated. If tunning is required, developer will need to go to the previous phase to tune and train the model again until a acceptable result is gain.

6. Deployment

In the final phase, the model will be implemented into the system which it will be called and used. In this case the model will be implemented in the backend of a website. A deployment plan is then created, along with the final report.

RAD

Will be mainly used for website development. As RAD is one of the popular methodology for web application and suitable for small and rapid project such as this project.

1. Requirement gathering

   First phase of RAD is requitement gathering. For this project, requirements are fairly simple and straightforward as researcher's aim is only a working, user-friendly website to allow users to predict house price, login and logout and view houses.

2. User Design

In the next phase, design of website will be determine. This is the phase which researcher will be modifying design of website multiple times to the point where all requirements are fulfil. Once design is acceptable and meet all requirements, developer can proceed to the next phase. Within the design for this project, multiple pages are included such as login, register, about. Profile update, upload house, view houses and the core page which is a page to allow user to predict house prices using intelligent house price predictor.

3. Rapid Construction

In this phase, the construction of system according to the previous planned design will be done. IDE and web browser will be used to build and view the design of web application. The model will be implemented into the backend of the system using the backend framework mentioned in chapter 3. Database will also be connected to the backend.

4. Cutover

Last phase will be project cutover in which the deploying on localhost for demonstration will be done. Prototype will be release for user acceptance test. Develop would like to deploy the system on cloud for other users to use but due to development time and funding, this idea was scraped.

4.6 | Summary

Within this chapter, different types of methodology have been documented and comparison have been made. Both CRISP-DM and KDD has their own uniqueness and both of them are data mining methodology. RAD is a methodology for developing of application which in this case is implemented in website developing. Justification of chosen methodology has been made. CRISP-DM is the most suitable data mining methodology for developing of model for Property Platform, house price predictor which is also one of the popular methodology used for data related project.

Chapter 5: Requirement Validation

This chapter will be discussing the design and gathering method of information required. All questions will be research and discuss before conducting the actual research.

5.1 | Introduction

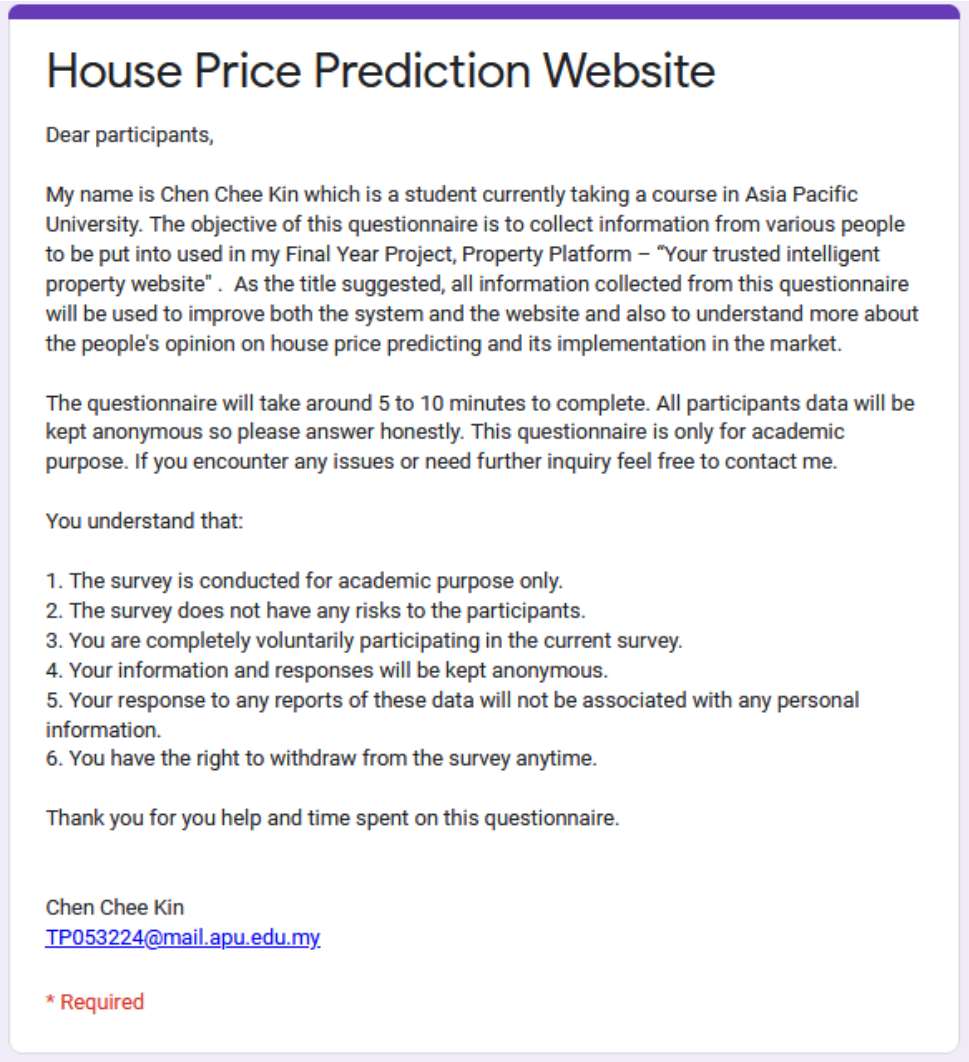
Requirement validation is very important for any project. Validation is the phase where the requirements are check for completeness and correctness. This ensure that all requirements meet the needs of stakeholders and make sure that the requirements are clear and understand by developers (Parker, 2021). This phase is essential as missing requirements or wrong requirements can be identified and modified.

5.2 | Method chosen for collecting information.

For this project, questionnaires will be done to collect various information from different participants. One of the many reasons behind this is due to the recent pandemic which has cause Malaysia to be forced to put into the Movement Control Order (MCO). All outside activities are halted to reduce human interaction to prevent spread of disease. For this reason, questionnaires are considered the best choice as participants can do the questionnaires online. Besides that, questionnaires do not require much preparation, time and multiple questionnaires can be conducted at the same time. Furthermore, more information can be collected as the questionnaires can be done in other parts of Malaysia as it is done online.

5.3 | Design

In the design of questionnaires, multiple aspects are taken into consideration. The questions asked should be valuable and usable for the validation of requirement and the design of the system.



House Price Prediction Website

Dear participants,

My name is Chen Chee Kin which is a student currently taking a course in Asia Pacific University. The objective of this questionnaire is to collect information from various people to be put into used in my Final Year Project, Property Platform – "Your trusted intelligent property website" . As the title suggested, all information collected from this questionnaire will be used to improve both the system and the website and also to understand more about the people's opinion on house price predicting and its implementation in the market.

The questionnaire will take around 5 to 10 minutes to complete. All participants data will be kept anonymous so please answer honestly. This questionnaire is only for academic purpose. If you encounter any issues or need further inquiry feel free to contact me.

You understand that:

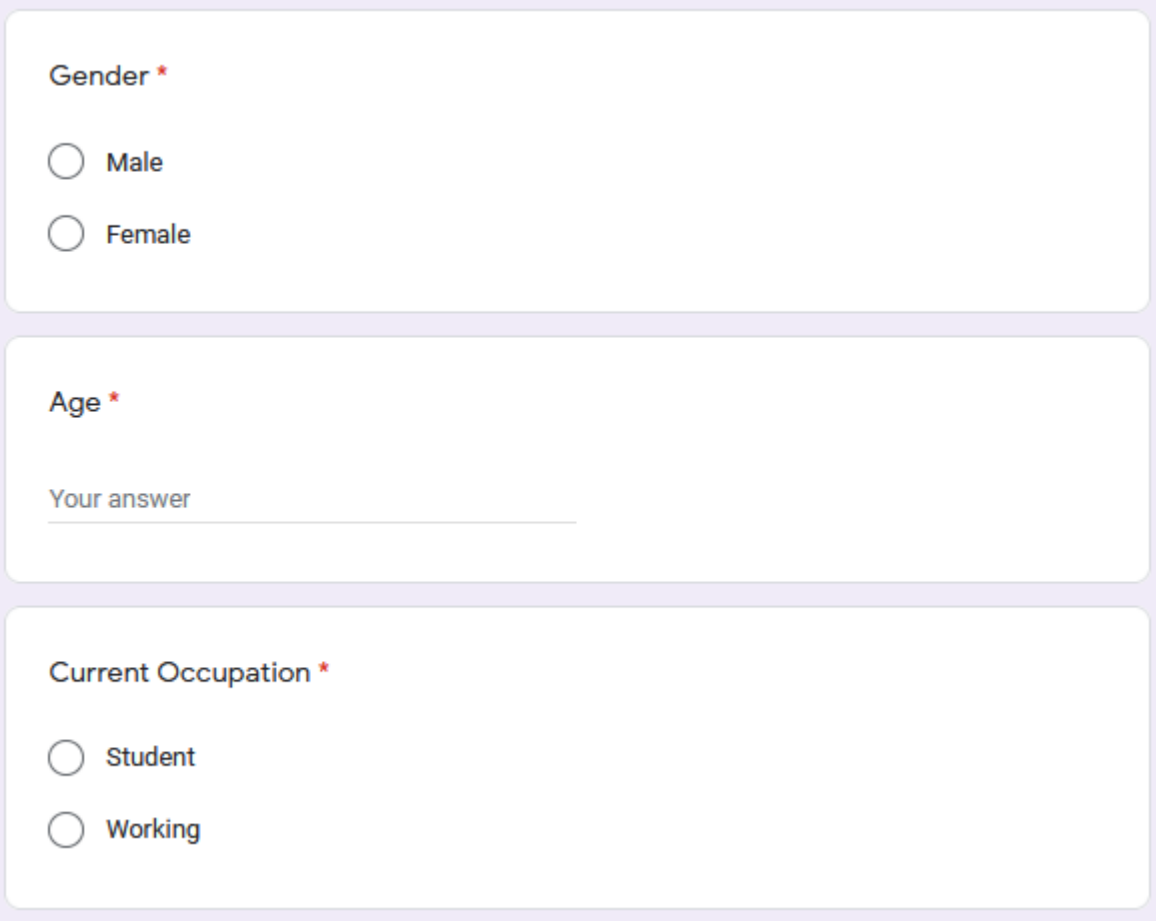
1. The survey is conducted for academic purpose only.
2. The survey does not have any risks to the participants.
3. You are completely voluntarily participating in the current survey.
4. Your information and responses will be kept anonymous.
5. Your response to any reports of these data will not be associated with any personal information.
6. You have the right to withdraw from the survey anytime.

Thank you for you help and time spent on this questionnaire.

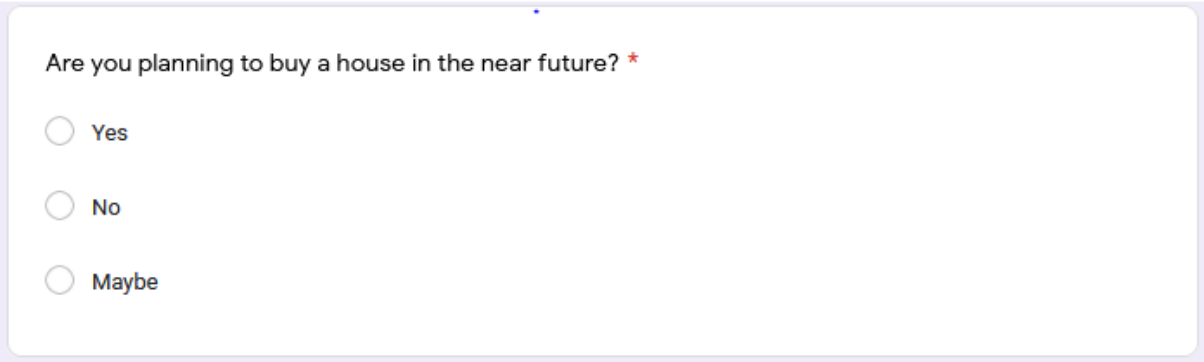
Chen Chee Kin
TP053224@mail.apu.edu.my

* Required

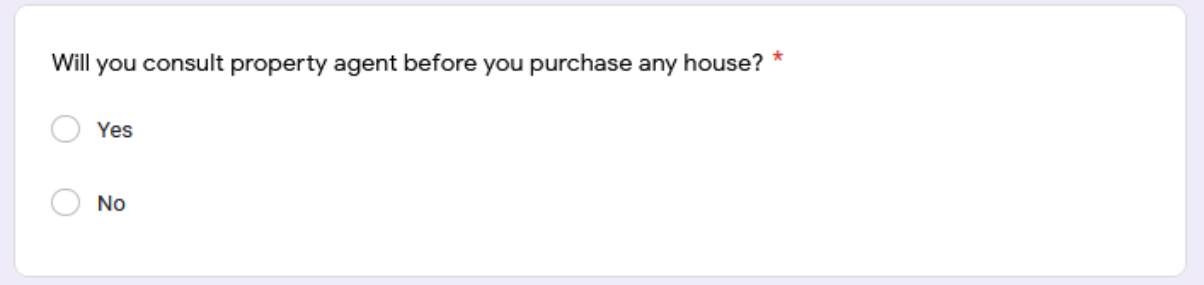
The snipper above is a small section of the questionnaires where participants are informed about this questionnaires' purpose and what kind of right do, they have. The author's name and email are included should any participants need further help or inquiries from the author.



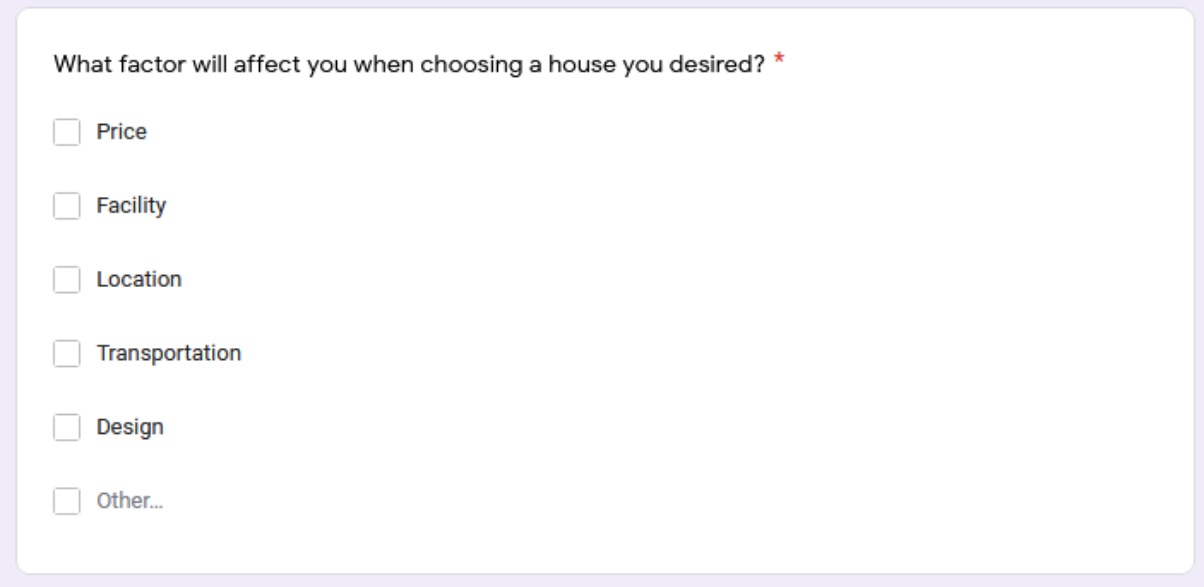
The first few questions of the questionnaires will be asking for participant's basic info such as their ages, occupation, and gender. This is to check the kind of participants that participated in this questionnaire.



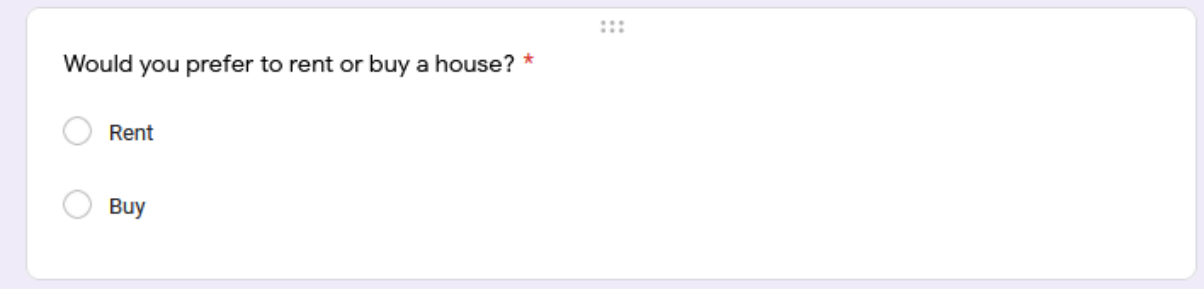
Objective: To identify if anyone is looking to buy a house recently which will lead to more or less users browsing property website



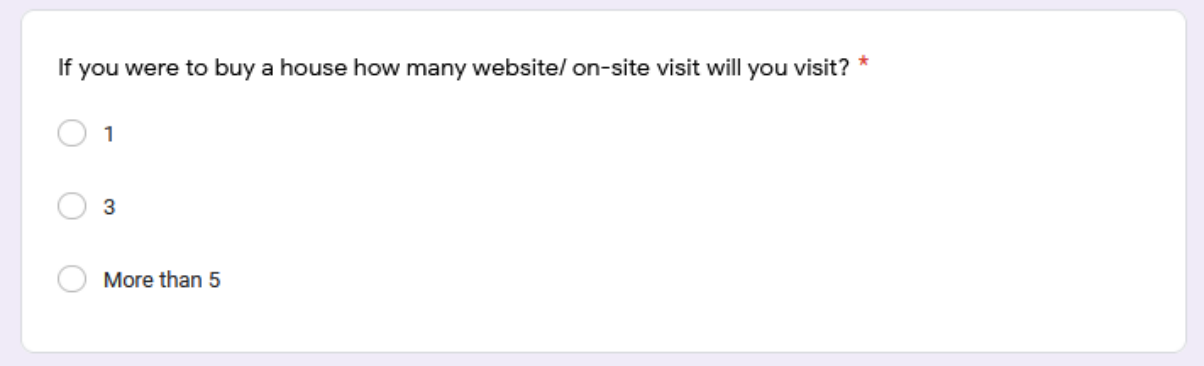
Objective: To identify if a buyer will seek advice from agent before purchasing a house or buy it with only their own research



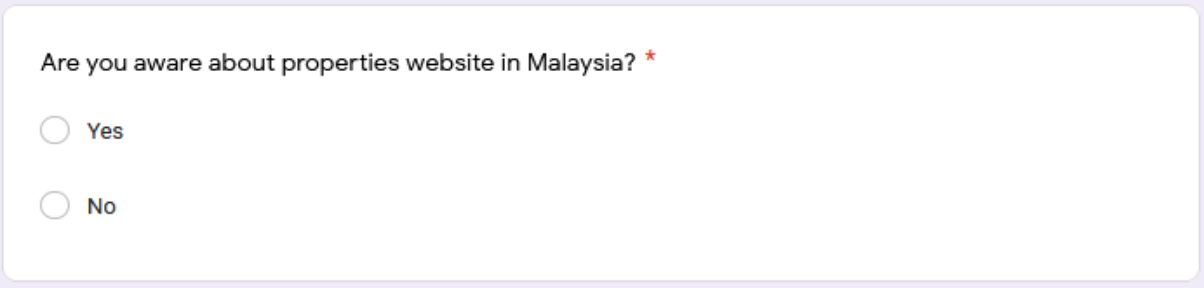
Objective: To identify what people desired the most when seeking for a house, what is the most important element of a house



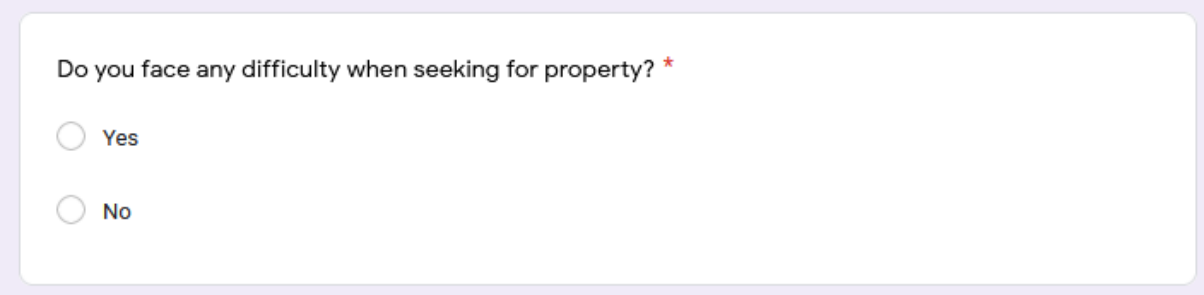
Objective: To identify if people prefer to rent a house or buy a house which will affect the price of selling and renting house.



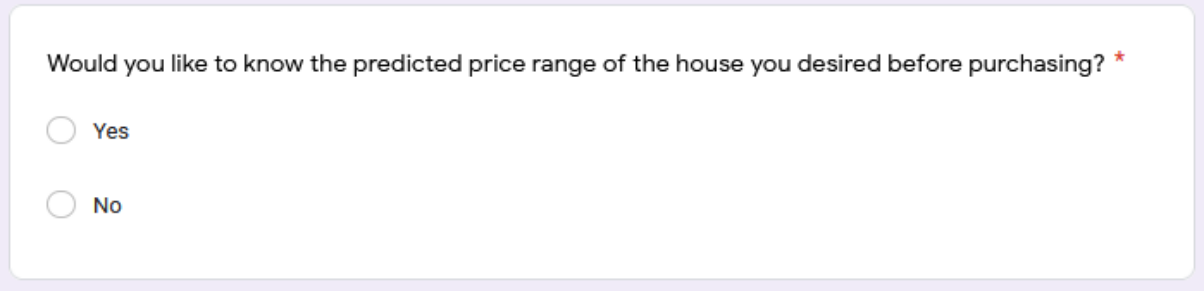
Objective: To check how frequent a user would search for multiple websites before making the final decision.



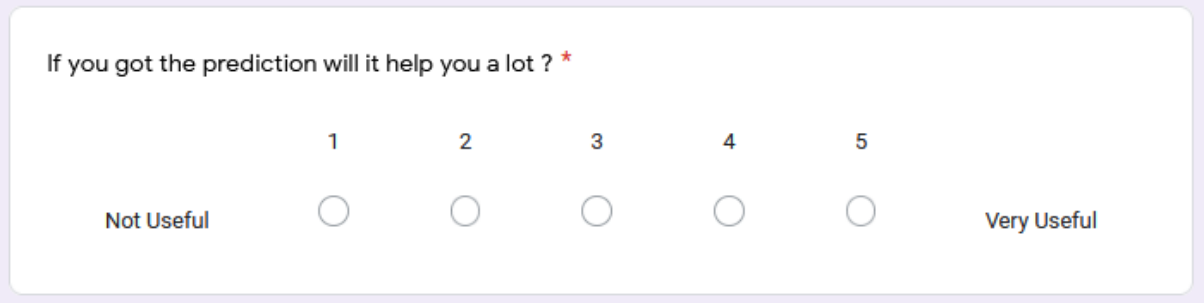
Objective: To identify how many of the participants have awareness about the existing of properties website.



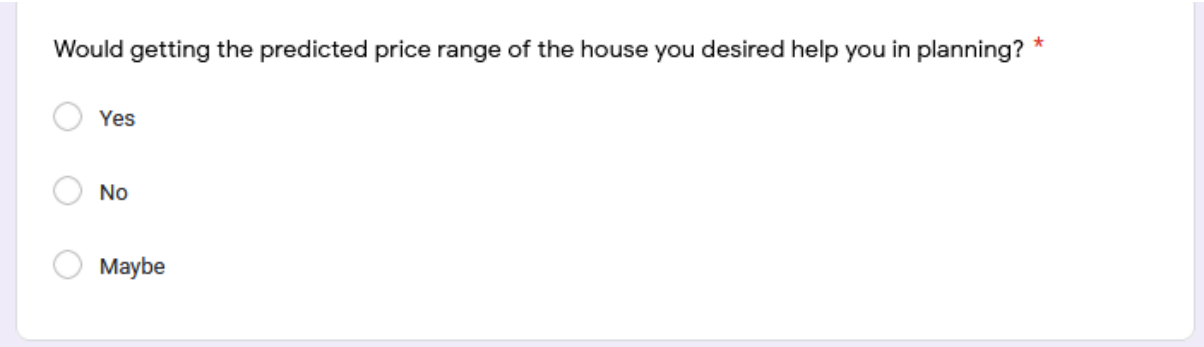
Objective: To identify if the properties website nowadays has frequent problems.



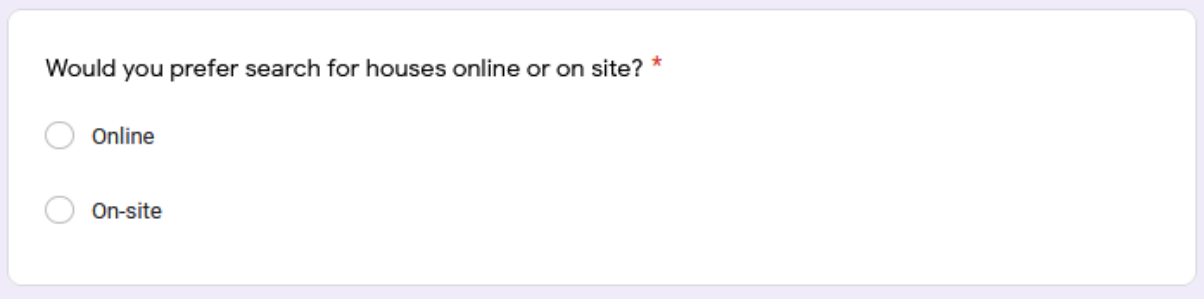
Objective: To check the feasibility of prediction model's result



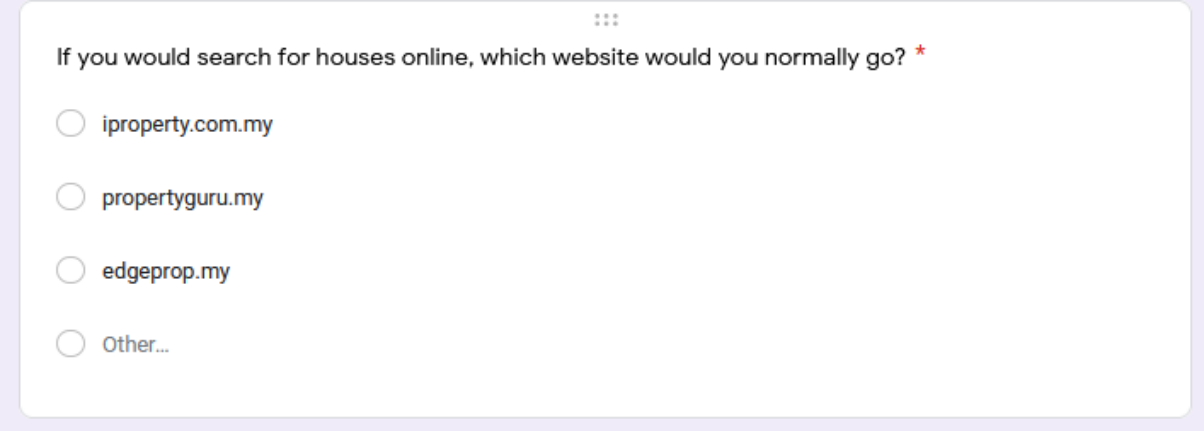
Objective: To identify the usefulness of the predicted price



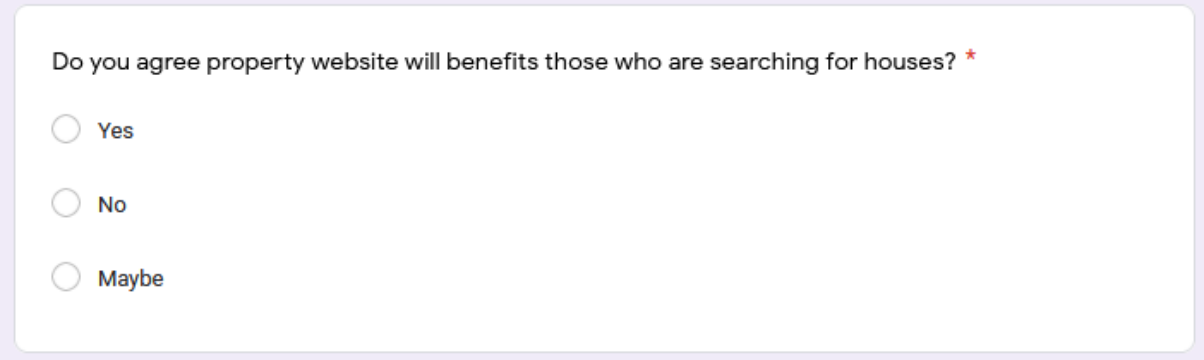
Objective: To identify the predicted price given will be used fully or just a suggestion



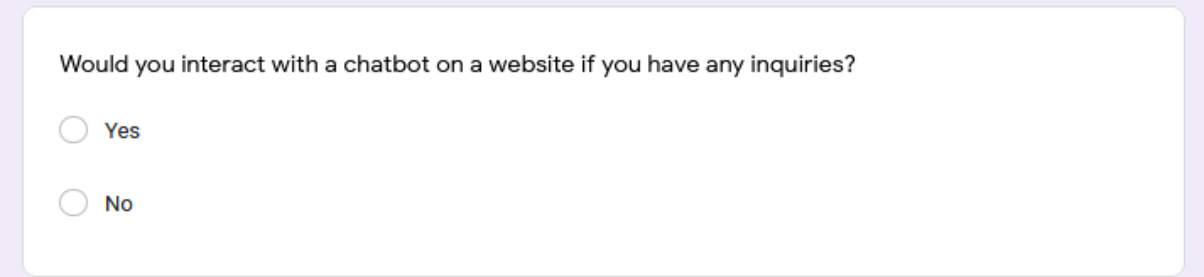
Objective: To identify if online or site is considered more popular.



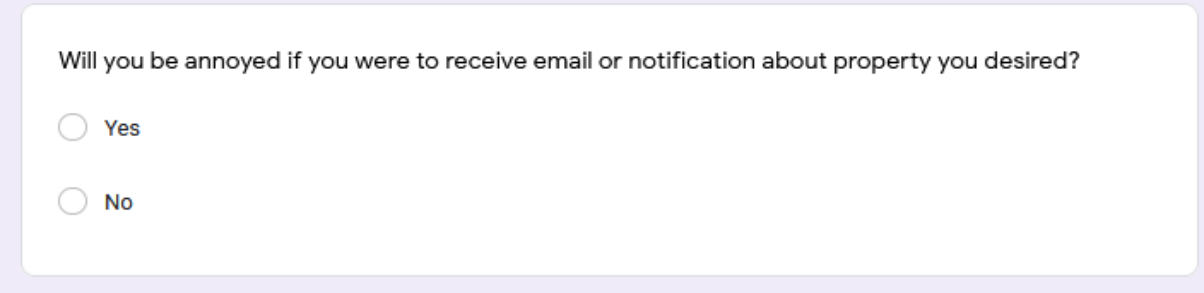
Objective: To check the popularity of similar system



Objective: To identify the usability of property website.



Objective: To check if chatbot is a good feature for property website.



Objective: To identify the usability of SMS or email notification.

Objective: To ask more suggestion to improve the website

5.4 | Summary

For summary, all above questions listed in the questionnaires have their own objectives. Each of these questions can collect valuable information to aid in the developing of the system. The

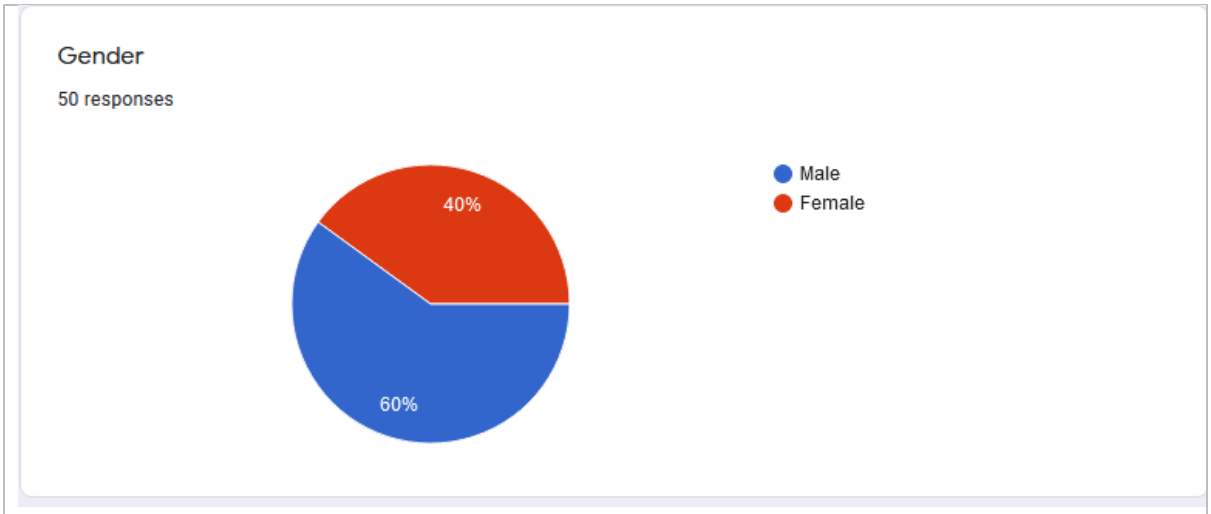
questionnaires will later be sent to multiple volunteers to collect data after being approve by mentor.

Chapter 6: Requirements Validation

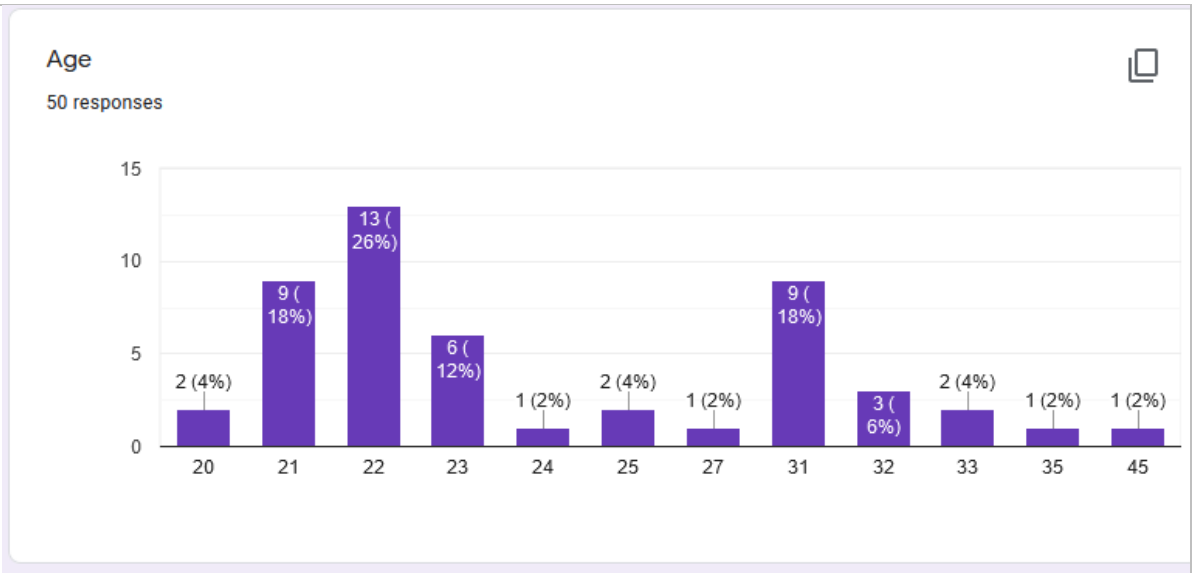
6.1 | Introduction

The questionnaire was conducted by 50 respondents through Google Forms online. The information is collected and analyse in the following section. All this information will provide insight on the feasibility of this project and the system development will adjust according to the responses from the participants.

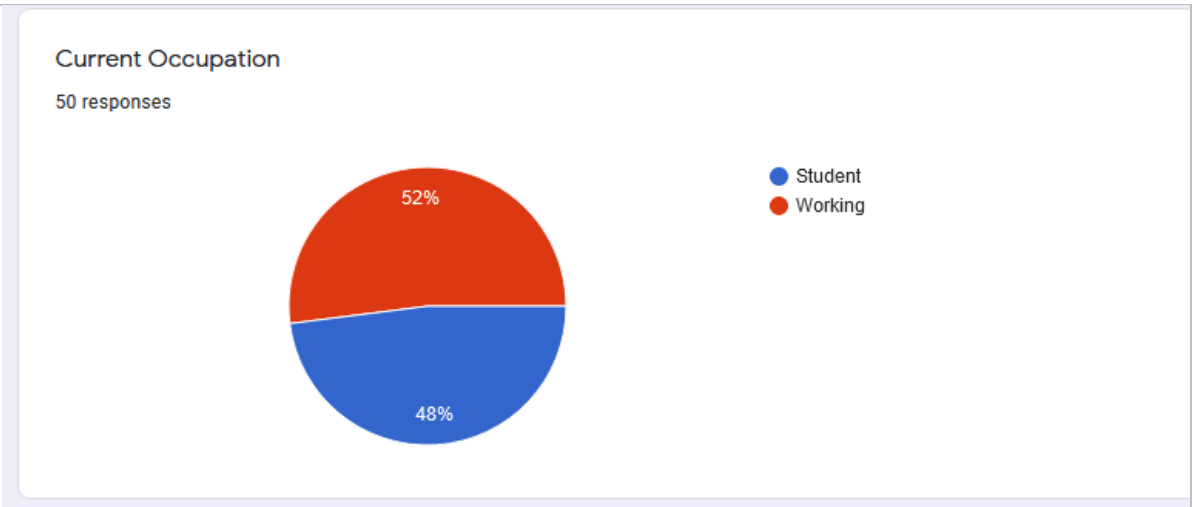
6.2 | Analysis of Data



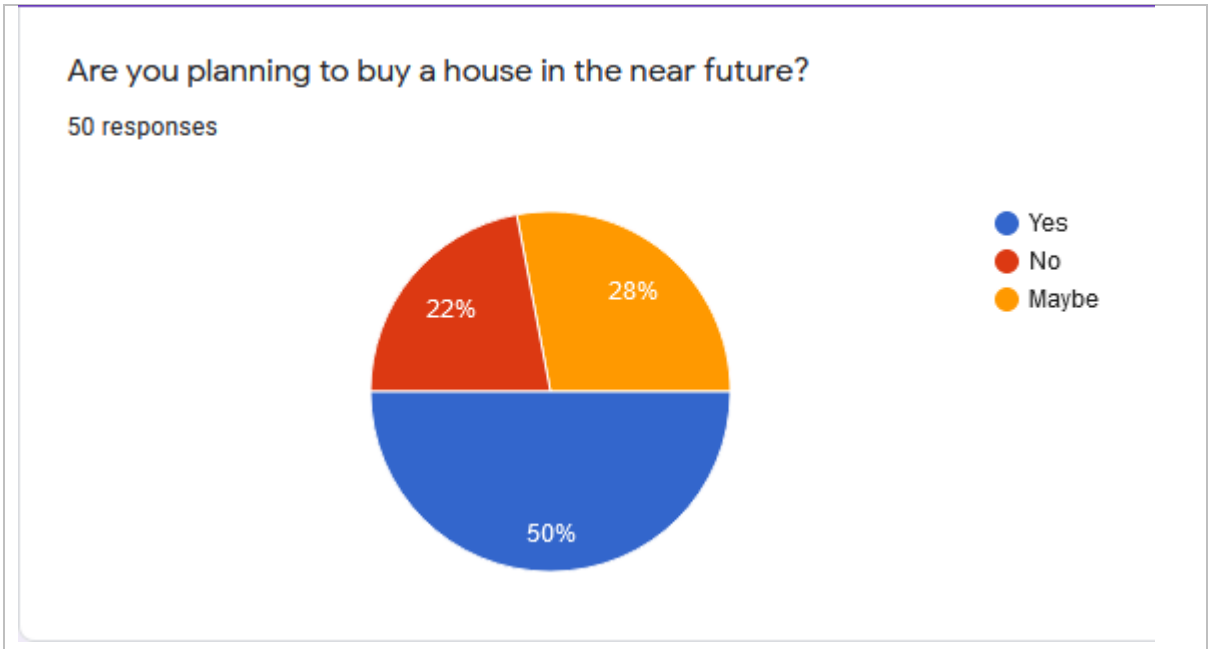
Analysis	Based on the above chart shown, we can see that there are slightly more male respondents compare to female but only by a 20% which is around 10 people. This project does not really consent on gender too much, so it is still considered acceptable.



Analysis	According to the results received from the bar chart above, the majority of respondent falls between 21 to 23 and 31- 33. For respondent aged 22, they took the highest number followed by respondent who are aged 31. They are only a few who are aged above 35 which indicates It is hard to reach people who aged 35 above.



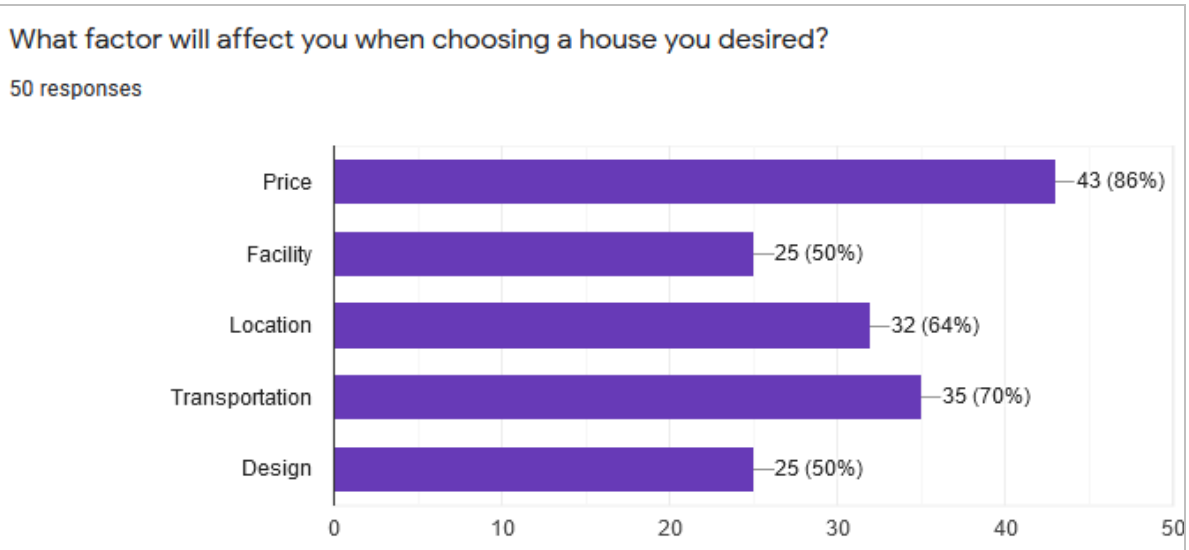
Analysis	By analysing the chart above we can see there are more working respondent compared to student. We this a more realistic result for the questions later on can be obtained as they are already experiencing the working life.



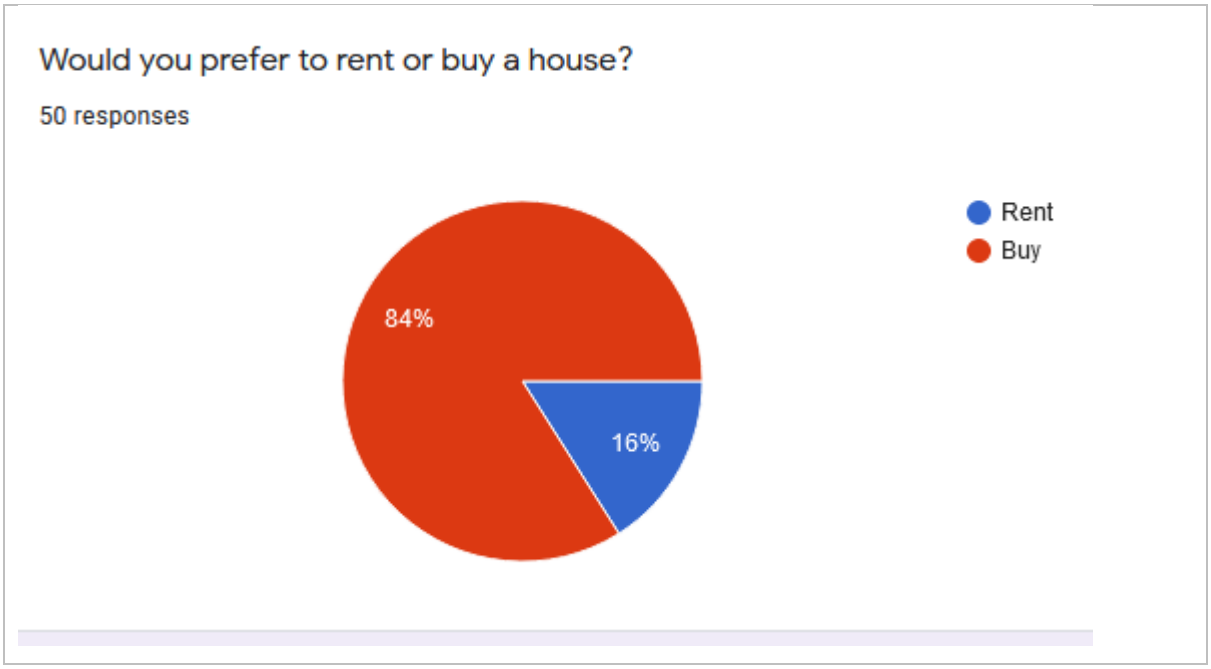
Analysis	Most of the respondents for these questionnaires are planning to buy a house in the near future. 50% of the respondents are planning to buy a house in which the other 28% indicates that they will be considering which shows that the affordability of Malaysian to buy a house is still high.

Analysis	86% of the respondents are willing to consult property agent before buying any house. This indicates that people are still unsure about buying a house themselves and prefer to seek help from property agent. More guides can be

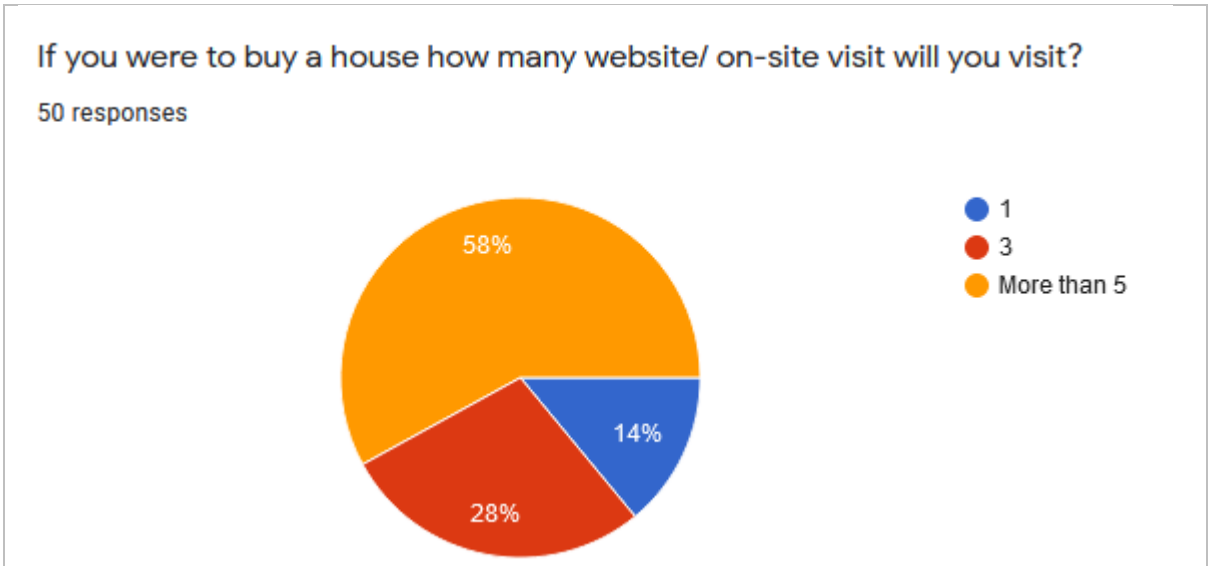
	upload onto the website to help users to get to know more about the procedure and tips to buy a house.



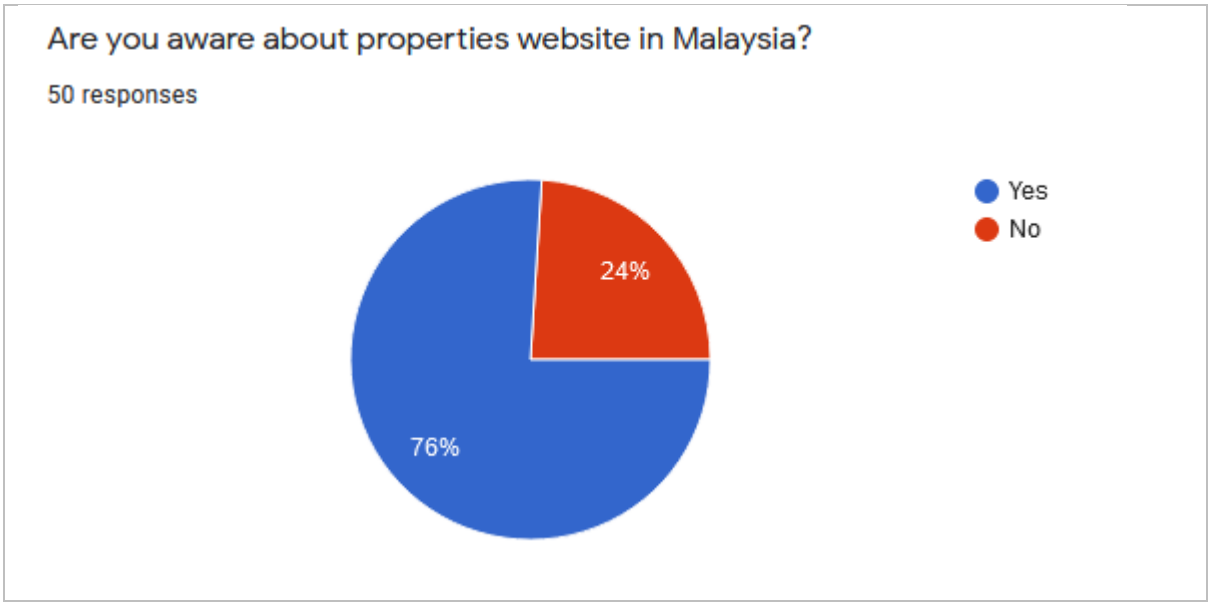
Analysis	Based on the information given above, the main factor for choosing a house will be price unsurprisingly followed by transportation near the house. This indicates that people who wanted to buy house first look at the price above any other factor which a house price prediction model can come in handy.



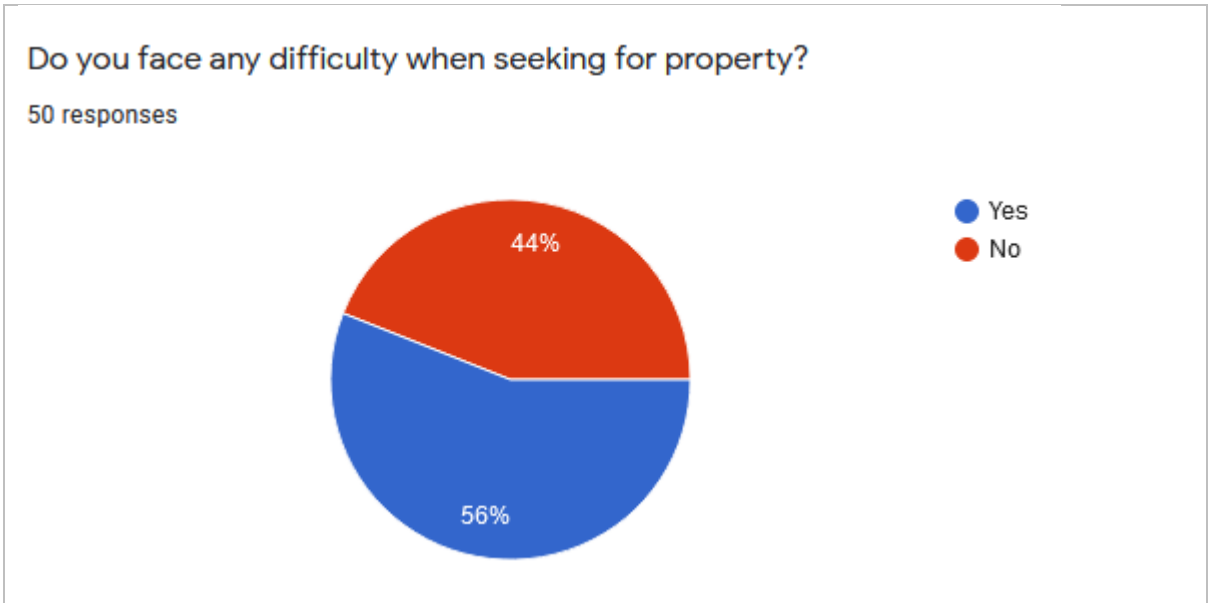
Analysis	Most of the respondents prefer to buy a house instead of renting, however there are still people who willing to rent. As the chart shown, there are 84% of the respondents who prefer to buy a house instead of renting it.



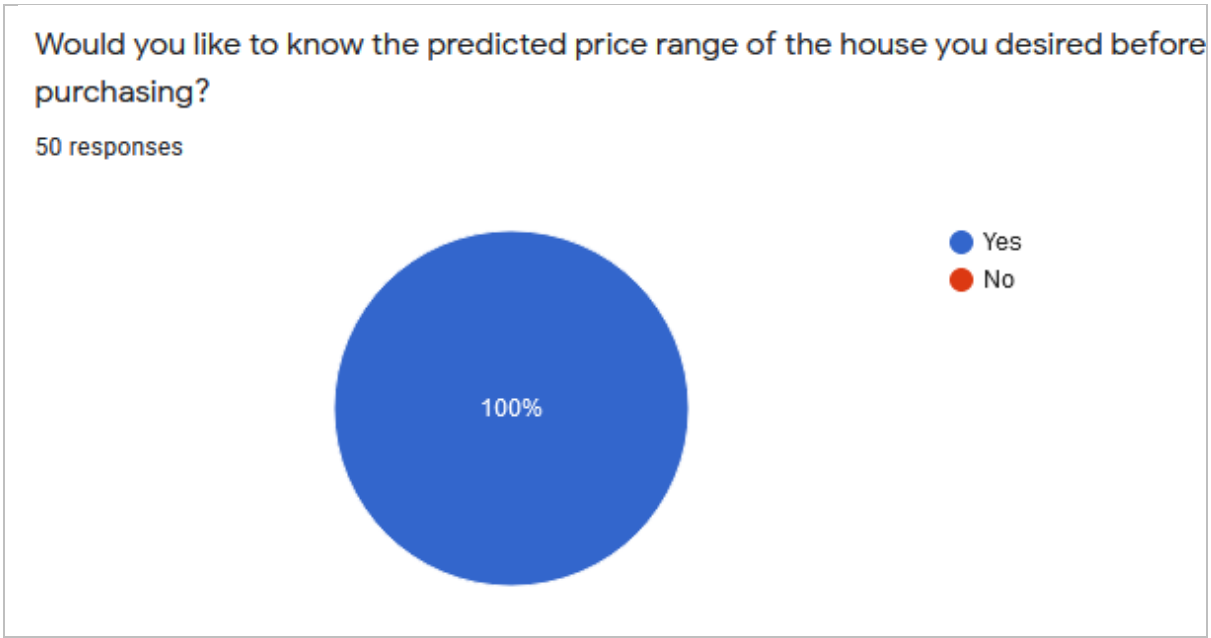
Analysis	Based on the above pie chart, we can see that people are willing to do more searching on multiple websites before doing the final decision of buying a house. 58% of the respondents browse more than 5 websites before they make the final decision.



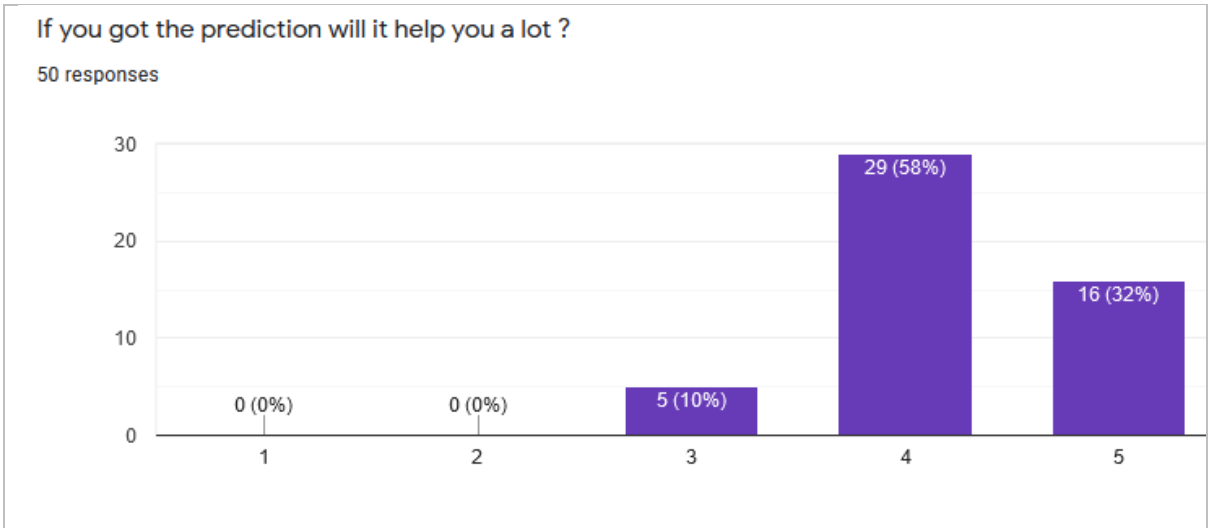
Analysis	Based on the information given by the respondents, there are a huge number of people aware of properties websites in Malaysia which a 76% of Yes coming from the respondents. This indicates that property websites are becoming a trend and there is hope it will be everyone's to-go tool to use when in need to find houses.



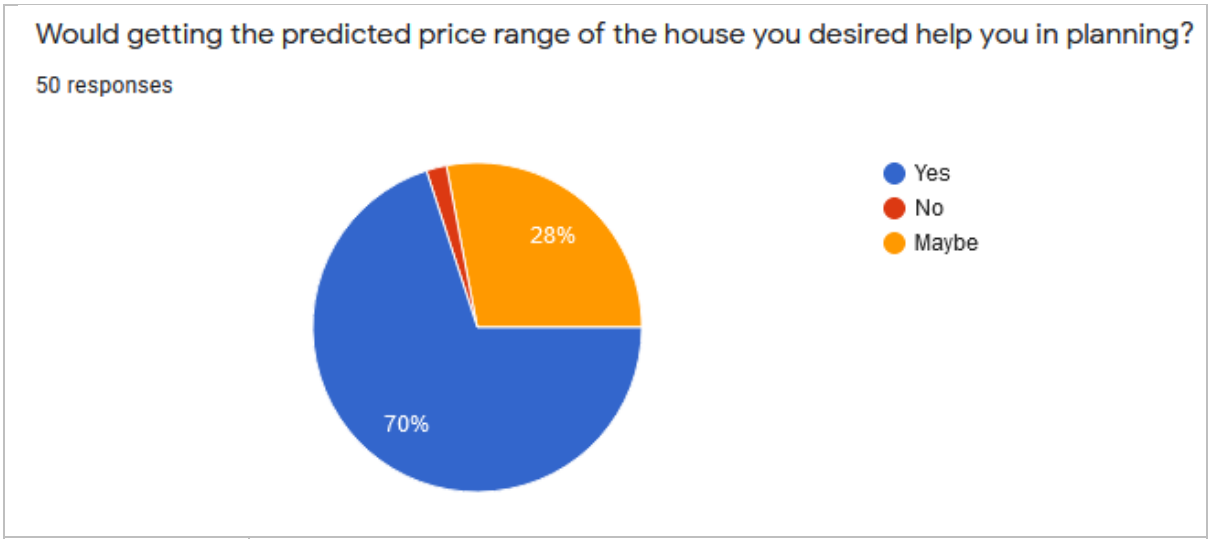
Analysis	We can see that there a good number of people that have faced difficulty when seeking for property. One of the factors maybe be the fact that they do not know any ways or tools to search for them. A property website can be introducing to them to help them to solve the problem.



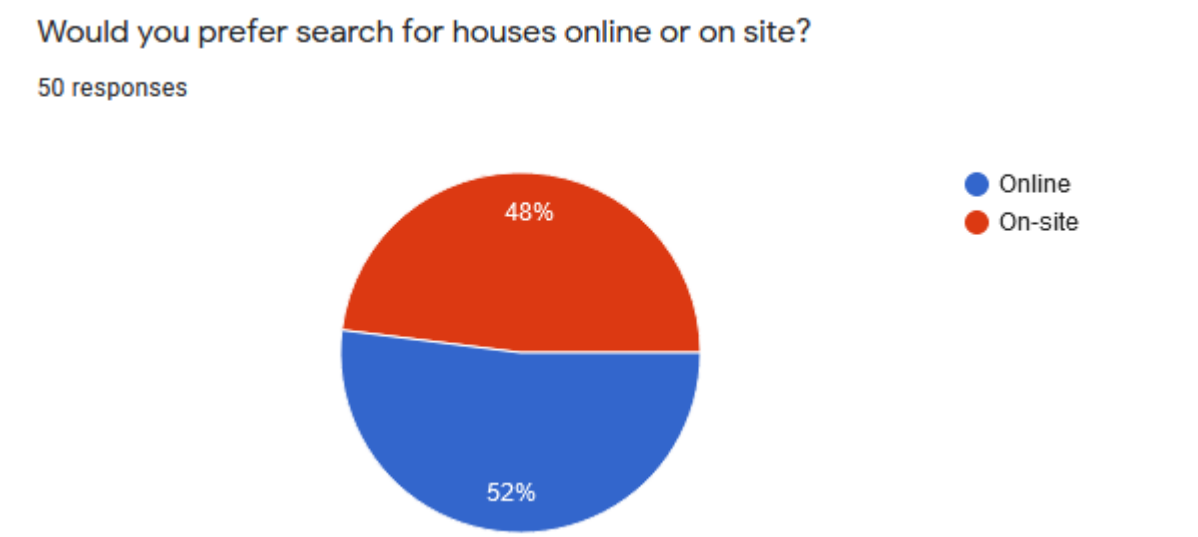
Analysis	Surprisal, all of them respondents are very willing to know the predicted price range provided by the predicted model. This is a very good indicator indicating that a good prediction model can be implement in property websites to improve its performance.



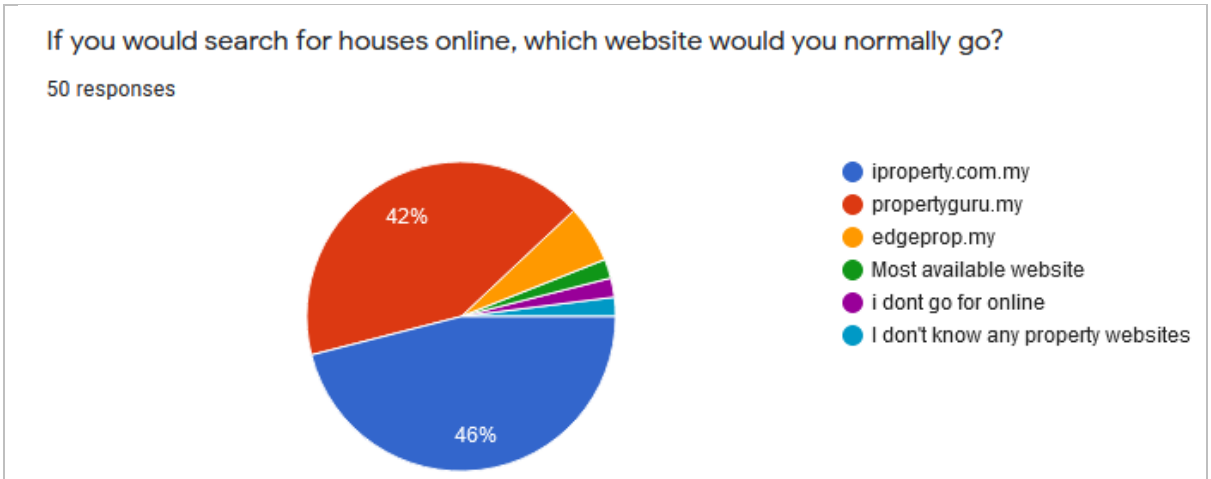
Analysis	A positive feedback from respondents stating that the prediction given by the prediction model is very useful for them when making decision to buy or sell a house. Another good indicator to show the importance and value of using prediction model.



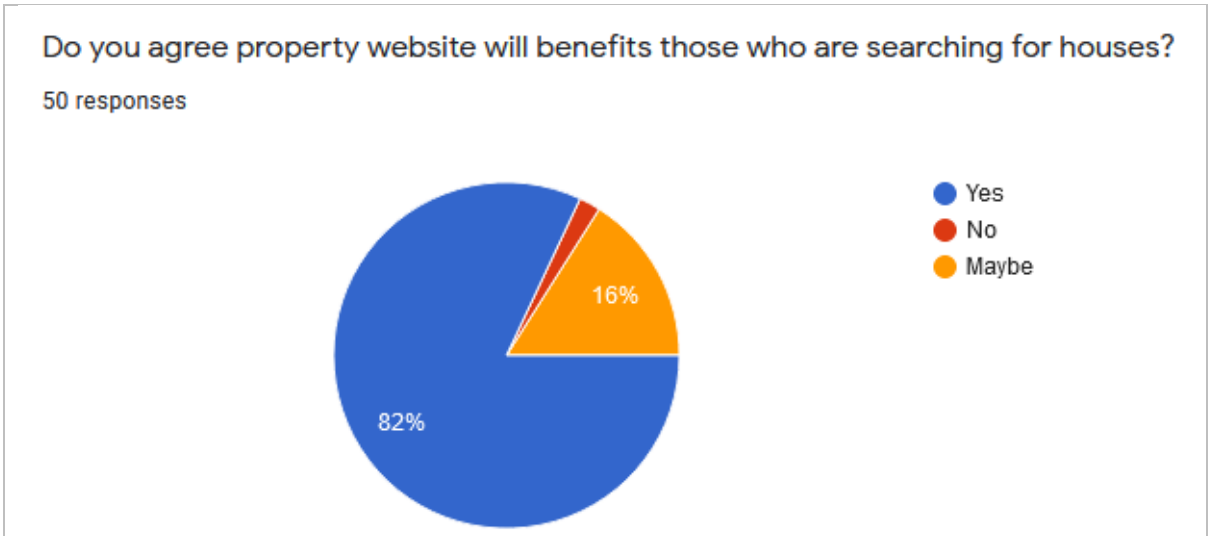
Analysis	70% of the respondents are very positive on the give predicted price will help them in planning which is also a very good indicator on the usefulness of the prediction model.



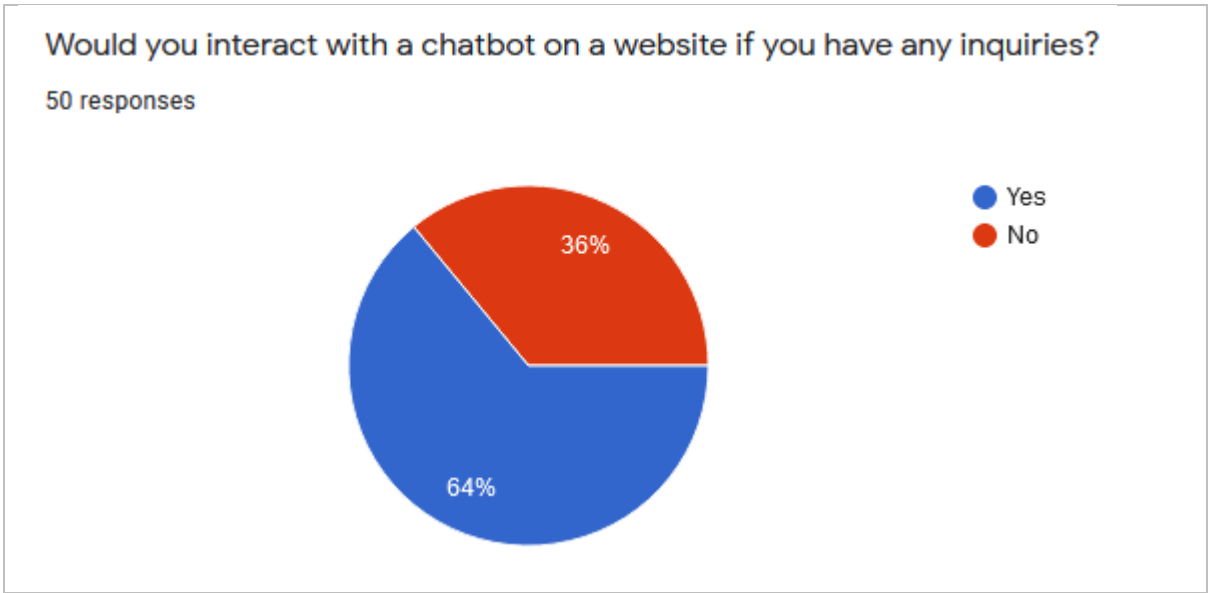
Analysis	Based on the pie chart above, people still prefer to go on-site to check for the house they are interested in rather online, but there Ares till people willing to browse online.



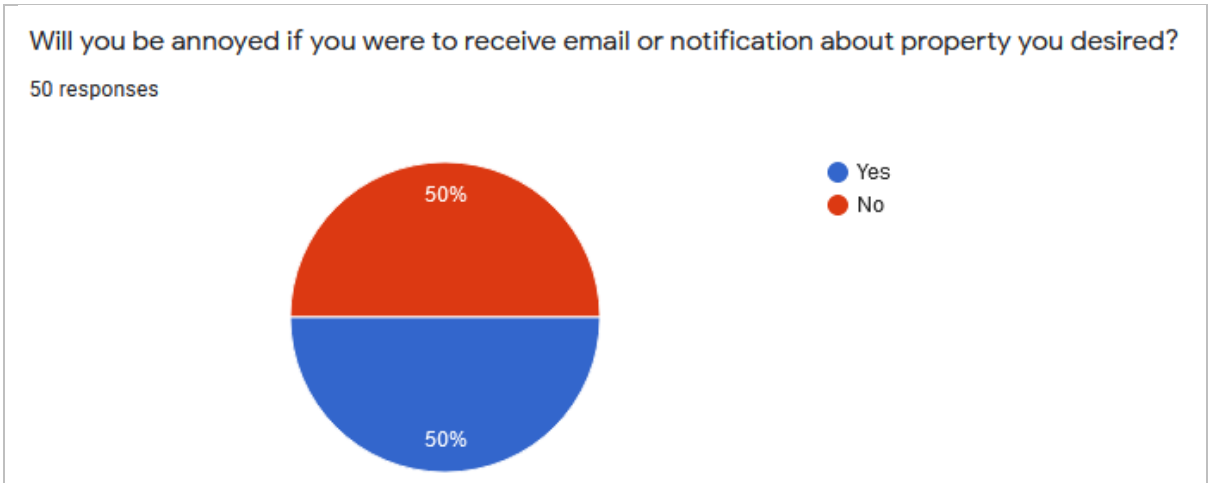
Analysis	The most popular to-go property website is property followed by propertyguru. Both of this website has been reviewed in the similar system section and both of them are well made property website. Therefore, it is so popular among the respondents.



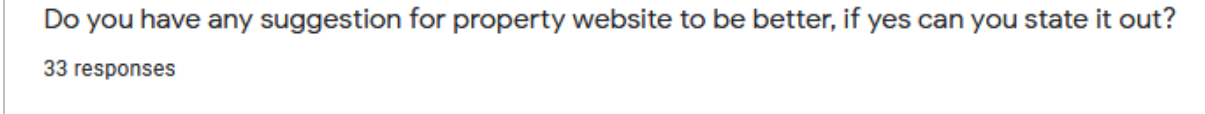
Analysis	The respondents have shown that property website is a very good tool to help people to search for houses. This proved that why there are so many varieties of property websites in Malaysia.



Analysis	Based on the information collected above we can see that people are still willing to interact with chatbot provided even though there are still people not willing to. A better chatbot can be implemented to attract users to use.



Analysis	Surprisingly there the number of respondents who are okay to receive notification or email about property are same as those who felt annoyed. With this, an option to be choose if a user will receive notification should be implemented to prevent system from annoying some people.



Analysis	Many respondents have given valuable suggestion to improve the property website. For example, one of the respondents stated that guide and tips on

	purchasing property can be upload onto the website to help users. Besides that, another respondent stated that a friendly UI should be implemented to help users to understand the working of the website easily.

6.3 | Summary

The valuable information provided by respondents are analysed and many new findings are found. Besides that, the information is also used to verify the validity of requirements of this project. The questionnaires have given good indicator and proves that the house price prediction model is a very good tool to help people to make decision on buying and selling a house he or she wanted. Overall, the responses from participants will surely improve the developing system which will be adjusted according to the market needs.

Chapter 7: System Architecture

In this chapter, a detailed description of the project's core features is provided, an abstract on the architecture of the system will also be shown in this section.

7.1 | Introduction

Property Platform is a website which can use the inputs from the users to predict the suitable house price for them. This system is built to ease and reduce the users burden of going through the hefty amount of house data in order to find the price trend by using the power of intelligent algorithm. In today's world, owning a house is not an easy task as the price for even resold house has a high price tag. So, to help the community, this system was developed in order to help buyers and seller to find the best price. Data on properties are increasing daily, so to make use of this data, it is used to train the model of property platform in order to find and predict the price trend so users can have an insight of the current price trend.

7.2.1 | Predict the Best House Price for Users using intelligent predictor.

One of the core features of this system is the ability to recommend users the best price available for the house data they input into the system. The system will first take the input from the users and send to the intelligent prediction model within the backend of the system which will then process the data received to make prediction and return the result back to the front-end. Users can input a variety of parameters such as the number of bedroom and bathroom, the square foot of the house and more. With the help of machine learning library such as Scikit-Learn and other libraries such as Panda and NumPy, the model can filter, process, and predict the price way faster compared to a human going through the data and predict it manually. There are two places within the website where user can use this feature, one of them is on the price forecast page and another place is during the uploading of a new property into the system. User can first predict the price using the intelligent predictor before deciding on choosing the price.

7.2.2 | Upload New Properties to website

Users are given the rights to register for an account which can login into the system to both view the available houses that are listed within the website and the houses listed by the user themselves. Besides that, those users who are logged in can upload new properties to the system for the other users to view it and also delete the houses they uploaded. These data are all stored within the database at the backend.

7.2.3 | View Uploaded Properties

` Users are able to view all the houses that are uploaded into the system by navigating to the properties listing page. There is also a filter function which users can filter the listing by the name of the poster. Within the detail page of the house chosen there will be multiple key points for users to view and also the contact email if the user is interested in buying the listed house.

7.3 | Abstract Architecture

This section will mainly talk about the abstract design and architecture of the system developed to give more insight into the planning and design of the system.

7.3.1 | Use Case Diagram

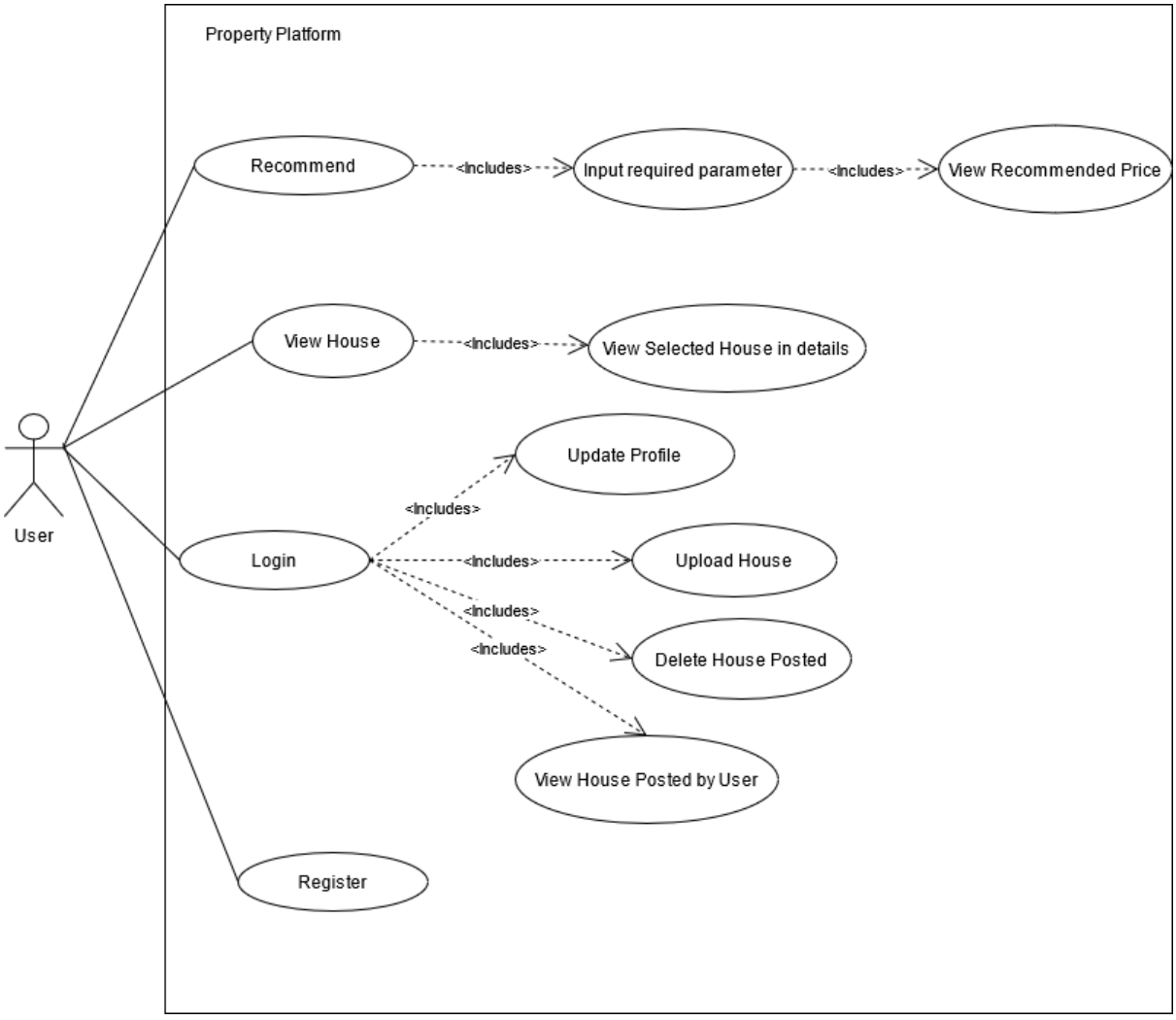


Figure 14 User Case Diagram for proposed system

In this section, an overview of the specifications for the use-cases of the Intelligent Property Platform will be stated as below.

Function Name	Recommend
Description	The system will recommend user the best price for the house data the user has input into the system
Actors	User
Assumptions	The user will receive a numeric result in USD
Default Workflow	Actors input multiple parameters such as bedroom, bathroom, square foot of house and more.

Function Name	View House
Description	The system will allow users to view a list of houses posted by other users within the system
Actors	User
Assumptions	A list of houses will be shown to user
Default Workflow	Actors click on the “Property Listing” page on the navigation bar

Function Name	Login
Description	The system will allow user to login in order to access other functions
Actors	User
Assumptions	User will input the correct username and password
Default Workflow	Actor will navigate to login page and input the correct username and password to login

Function Name	**Upload House**

Description	The system will allow user to upload house that user feel like selling into the website for other users to view
Actors	User
Assumptions	Users will fill in all the required data and system will upload data into database
Default Workflow	Actors need to navigate to "Upload Property" page and fill in the necessary data to upload.

Function Name	Delete House Posted
Description	The system will delete the house in database based on the propertyID user typed in.
Actors	User
Assumptions	User will input the propertyID that he or she want to delete
Default Workflow	Actor will first navigate to "Upload History" page and type the propertyID in the column to delete.

Function Name	View House Posted by User
Description	The system will show all the houses posted by the user only
Actors	User
Assumptions	The system will show a list of houses uploaded by users
Default Workflow	Actors will first need to login and then click on the "Upload History" page on the navigation bar

Function Name	Register
Description	The system will allow user to create new account by registering
Actors	User
Assumptions	User will input appropriate data such as username, password, and email.
Default Workflow	Actors will type in all the necessary data

7.3.2 | Activity Diagram

Below is the diagram of the system activity from Property Platform.

Activity Diagram when logged In

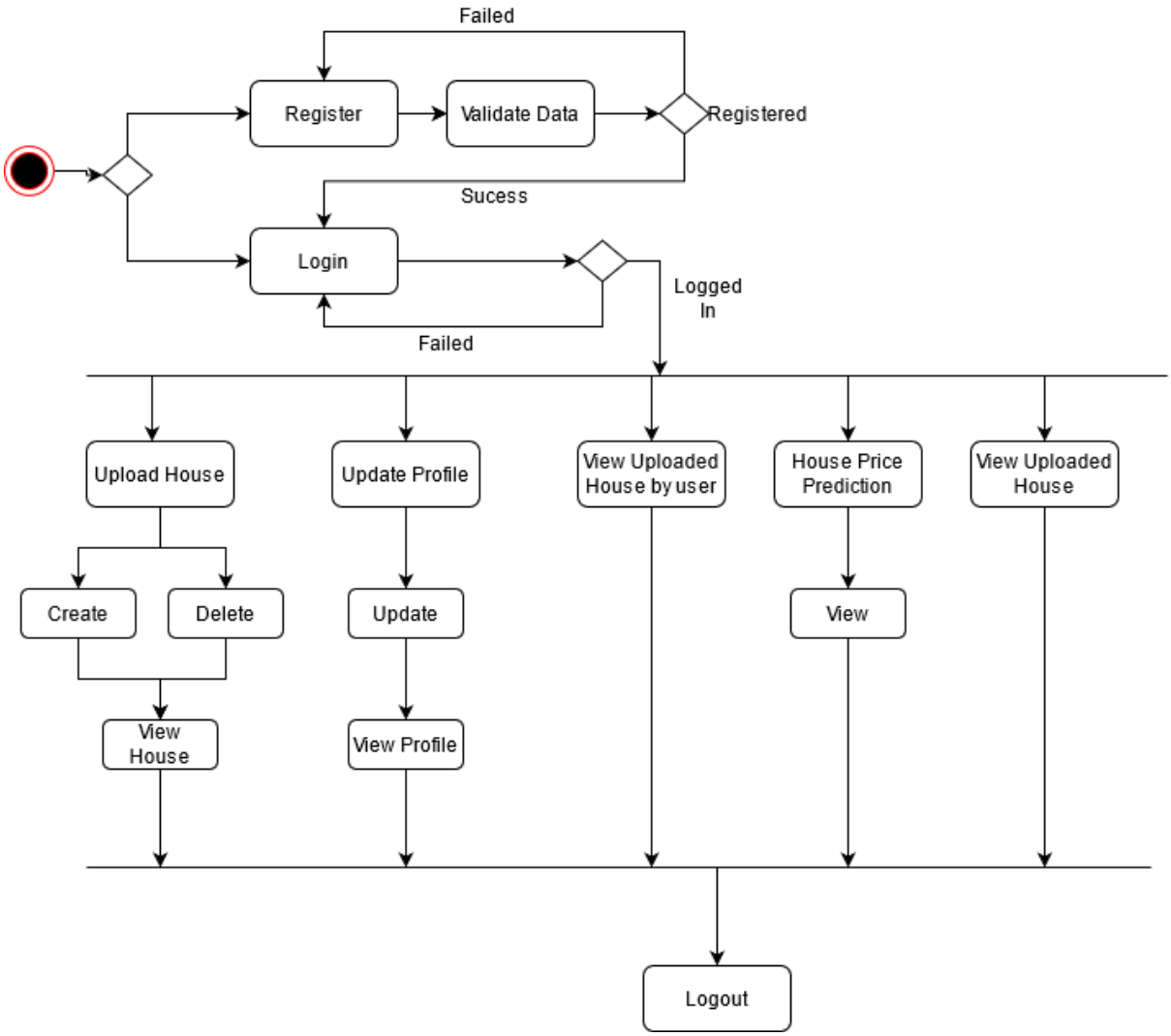


Figure 15 Activity Diagram for user who logged in

Activity Diagram when use as guest

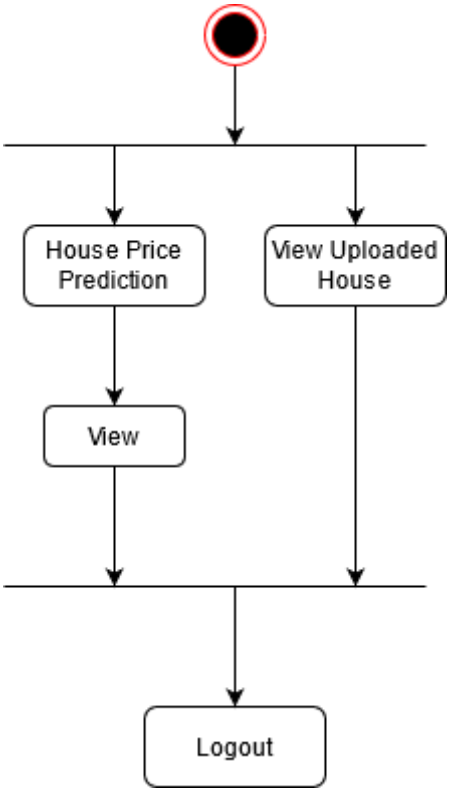


Figure 16 Activity Diagram when used as guest

7.4 | Databases

In this section the database used within the system will be discussed. Database is one of the key components to complete a system as it stores all the data the system will need. Even though the developer has mentioned the usage of MySQL database, due to further research and other benefits from MariaDB, a fork database from MySQL, MariaDB was used. MariaDB is a fork database from MySQL which is faster and also open source compared to its parent project MySQL. It is completely free and has more storage engine compared to MySQL(https://www.guru99.com/mariadb-vs-mysql.html). With the evidence above, it is safe to say MariaDB has a lot of advantages compared to MySQL database.

7.4.1 | ERD

Users	
PK	username
	email
	password

Property	
PK	propertyID
	title
	price
	state
	bedroom
	bathroom
	sqftLiving
	floor
	waterfront
	sqftAbove
	sqftBasement
	yearBuilt
	yearRenovated
	zipcode
	latitude
	longtitude
	logo

As we can see above, there will be two databases within the system, one for the login of users and another one is for storing the data of the houses uploaded by users. The database is hosted in local machine using XAMPP, an open-source web-solutions kit which can help to simplify the process of hosting a database. It is called in the back end using API calls when needed.

7.4.2 | Database Table Structure

User Data Table

Column Name	Description
Username	Unique username for user
Password	Unique password for user
Email	Email of user

Uploaded House Data Table

Column Name	Description
Title	Uploaded house title
price	Total price of house
State	State of house is in
Bedroom	Number of bedrooms
bathroom	Number of bathrooms
sqftLiving	square foot of house
Floor	Number of floors
waterfront	Waterfront view of house
sqftAbove	Square foot of house without basement
sqftBasement	Square foot of house basement
yearBuilt	Year built for house
yearRenovated	Year renovated for house (0 if none)
zipcode	Zipcode of house
latitude	Latitude of house
longtitude	Longtitude of house
user	Username of uploader
propertyID	Unique ID for housse
logo	Pathway for house image

7.5 | Interface Design

In this section, the system's interface design and wireframing are shown here. Both interface design or UI and wireframing phase are key component in software development process as they allow developers to research and create a good UI experience for users which will solve users' problem and meet the system's core business requirements. The screenshots shown below are the low fidelity wireframe for Property Platform.

Home Page/Landing Page

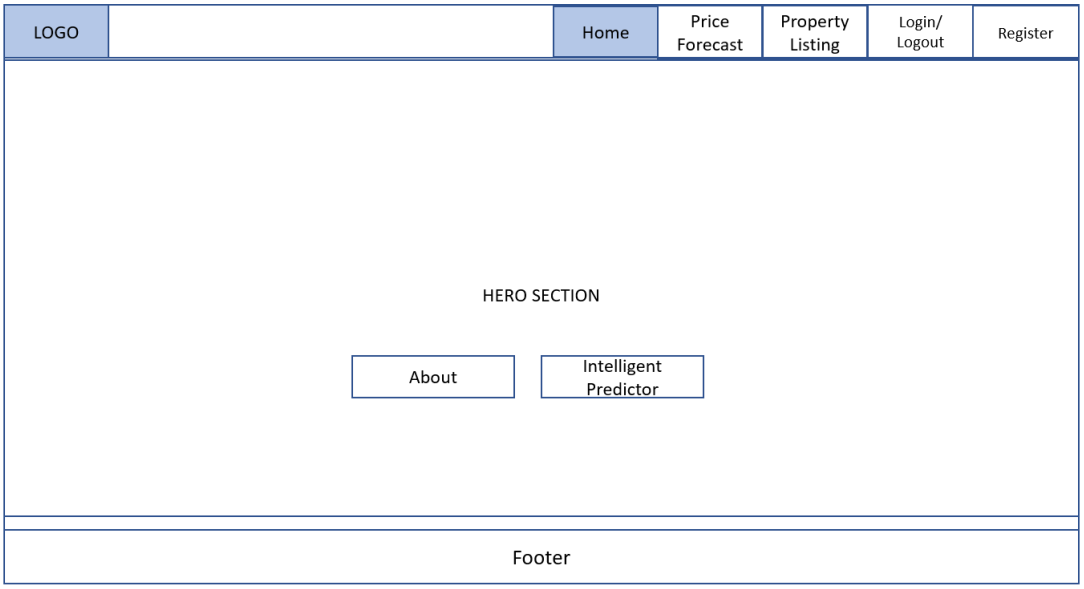


Figure 17 Landing page

Price Forecast

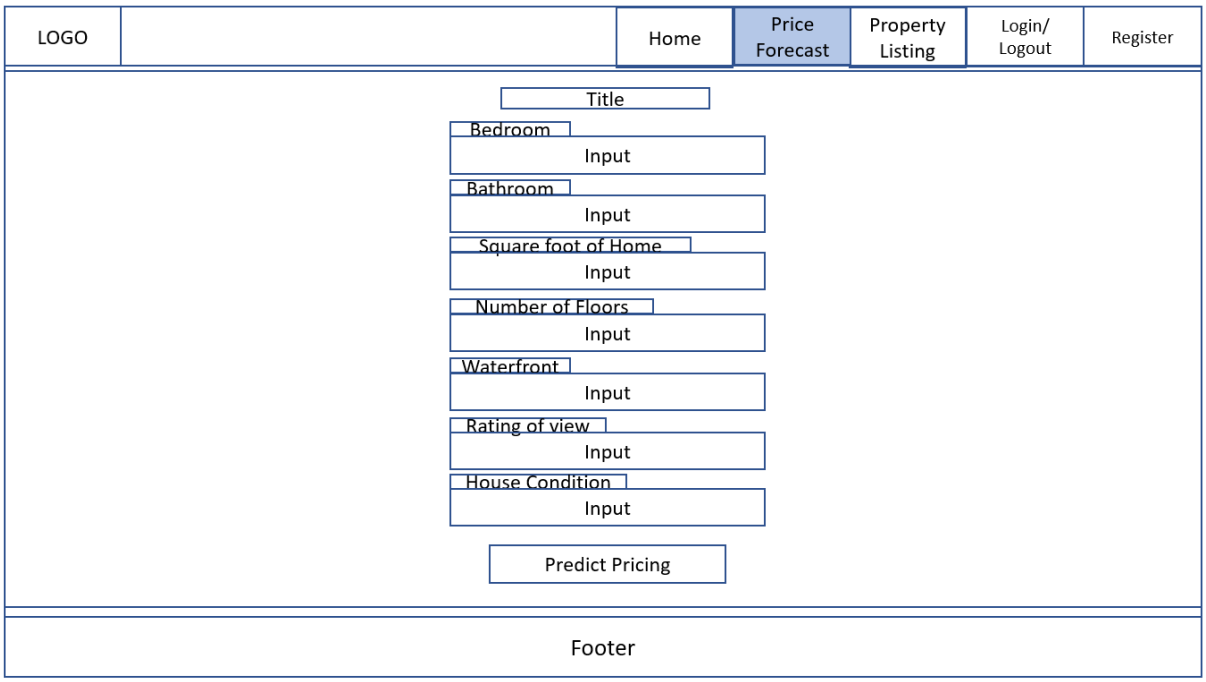
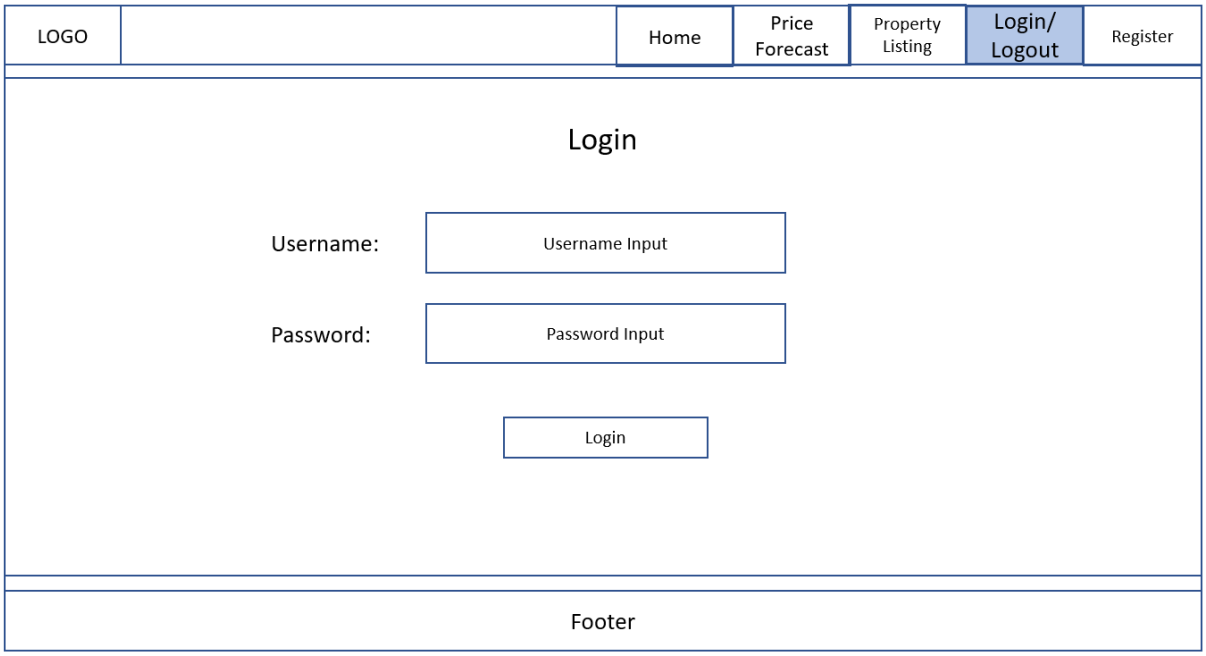


Figure 18 Prediction Page

Login



Register

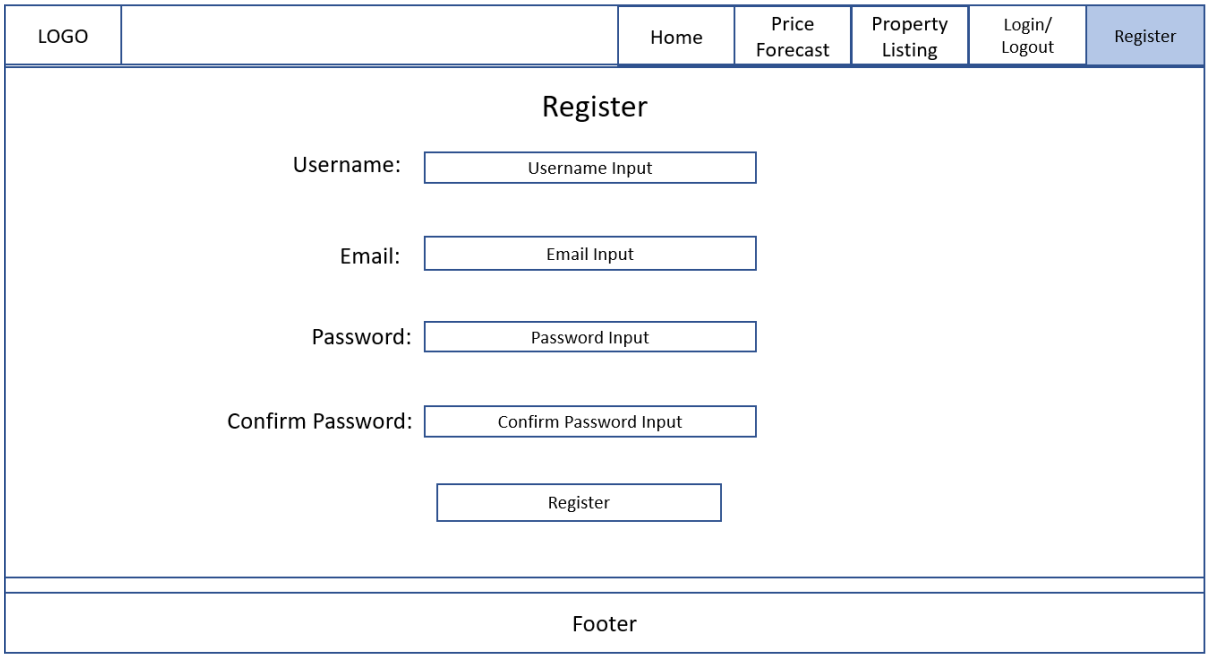


Figure 19 Register Page

Property Listing

Figure 20 House Listing Page

About

Figure 21 About Page

Upload History

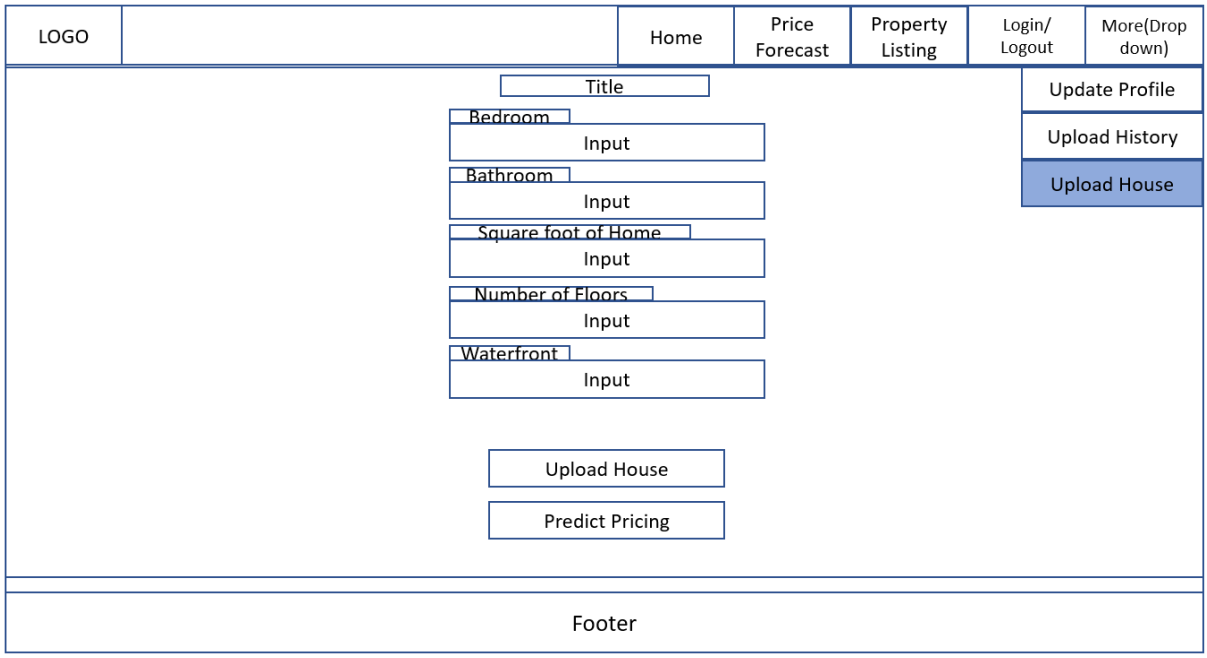


Figure 22 Upload Property Page

House Details Page

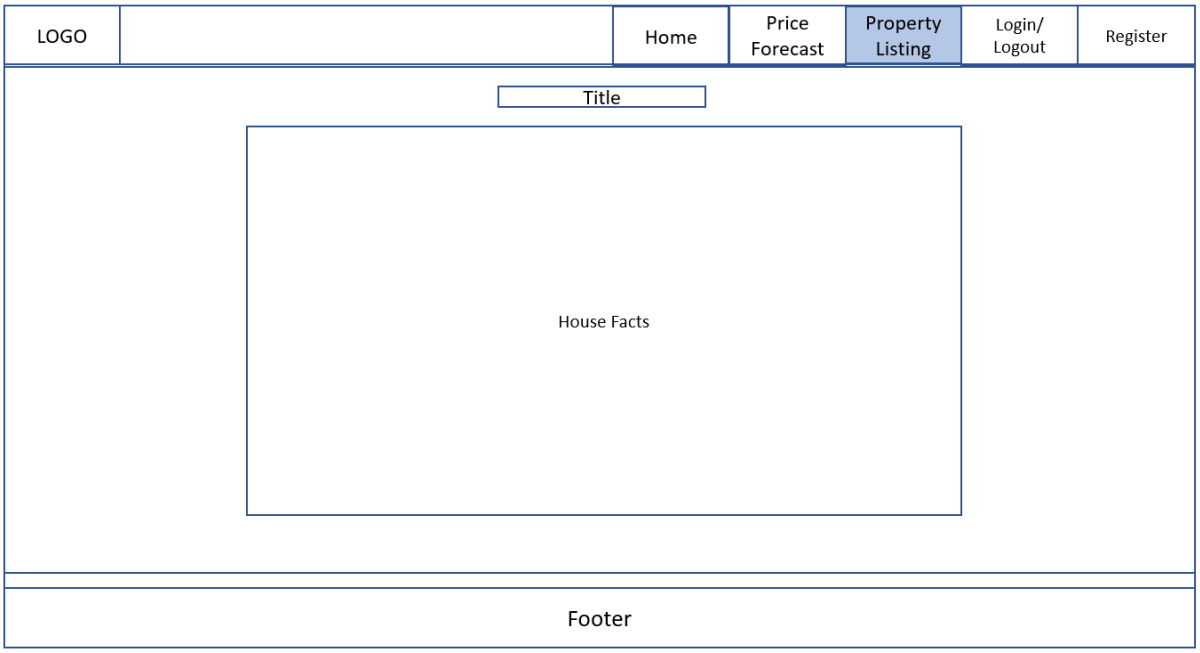


Figure 23 Property details page

Profile

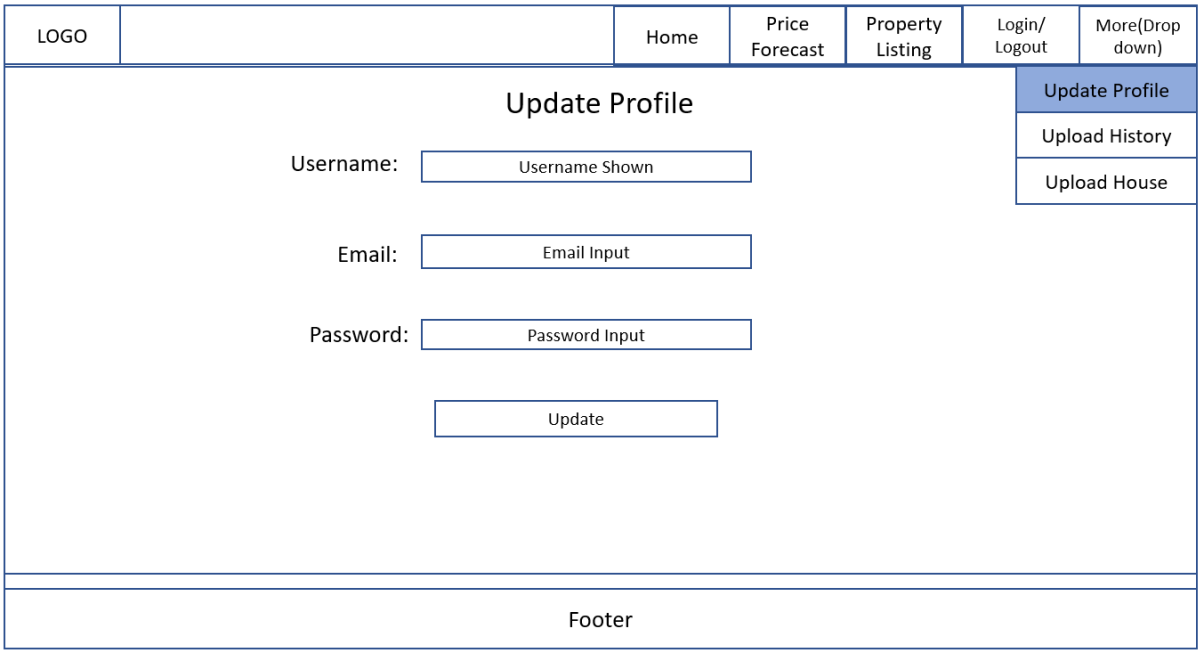


Figure 24 Update Profile Page

Chapter 8: Project Plan

A full released plan for the proposed system will be discuss and shown in this chapter. A detailed project timetable will be provided in the appendix section which utilises the Gantt chart. The project will be release after multiple milestone which were set are met.

8.1 | Release Plan

In this section various version of the proposed system will be discussed. As this system will be develop using the 3-tier architecture for better security, the first version of proposed system will only include the model. Other tiers will be added on the later versions.

8.1.1 | Version 1.0 of proposed system

After a thoroughly technical research on various related domain and various libraries that is required to create the proposed system, the develop then created the release plan for this project. The first version of this proposed system is to be released around the first week of June 2021 will consist of a pre-trained intelligent machine learning model which can accept input from users. Developer will be using the Sci-kit Learn library from Python to develop the Random Forest machine learning model. The development and testing of this version is done within Google Colaboratory. In the version 1.0 release, the model is able to predict the house price using the input typed in by user.

8.1.2 | Version 1.1 of proposed system

The second version which is version 1.1 is released on the second week of June which includes a simple front-end UI that has the ability to allow users to login on top of all the functions in the previous version. This version will also have improved security which uses the 3-tier architecture for building the system. The 3-tier architecture needs three different modules to work which are React, NodeJS and XAMPP. The front-end was created using React framework and NodeJS is the middleware to accept API data sent from front-end to allow the intelligent model to make predictions. The XAMPP which contains database will be added on the next version.

8.1.3 | Version 2.0 of proposed system

This version will include database and other necessary core functions such as connecting to database plus the functions from previous version. Bugs from last version will also be fix.

8.1.4 | Version 3.0 of proposed system

The last and final release for this proposed system will be released on the third week of July which is also the last demo of the proposed system. This version includes database and other functions such as login, register, view houses etc. The system will contain a user-friendly and appealing. Previous detected bugs will also be fixed and improved in this version such as the spacing of button and the validation of inputs. Extra features such as filtering, external websites, manual page, and improvement of graphics are also included.

8.2 | Test Plan

A test plan is one of the important key components to any successful project. With a test plan, we can check the develop system for bugs and to check if it is working. Developer for this project has utilized a test-driven development method in which all working functions and components within the system are checked to make sure it is working before releasing the final version.

Unit testing will be done by developer to make sure they are all working perfectly and producing the expected result. Unit testing for Property Platform will be executed by utilizing a case-by-case unit testing plan. Functional testing will also be done to ensure the feature functions met the functional requirements. The last testing phase will be user acceptance test in which targeted users will be asked to test the proposed system. To pass this phase, the system needs to ensure users are comfortable using and met their requirement while giving outputs that the users expected. All functional and commercial needs of users should also be fulfilled.

8.2.1 | Unit Testing Plan

The table below shows the case-by-case unit testing plan for the system proposed in detail.

8.2.1 | Register New Account

Test ID	Test Description	Test Condition	Expected Result	Actual Output
1.1	Click on “Register” button with missing inputs	Username: “” Email “” Password: ‘” Confirm Password: “”	System display “Please Fill in All Forms”	As expected,

1.2	Click on “Register” button with filled inputs	Username: Kin Email: kin@mail.com Password: 1234 Confirm Password:1234	System display “Register success! Navigate to login to login”	As expected,
1.3	Click on “Register” button with only Username filled	Username: Kin Email “” Password: ‘” Confirm Password: “”	System display “Please Fill in All Forms”	As expected,
1.4	Click on “Register” button with only Email filled	Username: “” Email: “kin@mail.com” Password: ‘” Confirm Password: “”	System display “Please Fill in All Forms”	As expected,
1.5	Click on “Register” button with only password filled	Username: “” Email: “” Password: 1234 Confirm Password: “”	System display “Please Fill in All Forms”	As expected,
1.6	Click on “Register” button with mismatch password and confirm password	Username: Kin Email: kin@mail.com Password: 1234 Confirm Password: abcd	System display “Mismatched passwords try again”	As expected,
1.7	Click on “Register” button with only confirm password filled	Username: “” Email: “” Password: “”	System display	As expected,

		Confirm Password: 1234	“Please Fill in All Forms”	

8.2.2 | Login and Logout

Test ID	Test Description	Test Condition	Expected Result	Actual Output
2.1	Click on “Login” button with filled inputs	Username: Kin Password: 1234	System display “Success! Please navigate to login to login” while redirect user to home page	As expected,
2.2	Click on “Login” button without filled inputs	Username: “” Password: “”	System display “Mismatched password or username try again”	As expected,
2.3	Click on “Login” button with username only	Username: Kin Password: “”	System display “Mismatched password or username try again”	As expected,
2.4	Click on “Login” button with password only	Username: “” Password: 1234	System display “Mismatched password or	As expected,

			username try again”	
2.5	Click on “Logout” button	User logged in	Log out user and redirect to login page	As expected,
2.6	Click on “here” in “Already have an account? Login HERE”	None	Direct user to login page	As expected,

8.2.3 | Intelligent House Price Predictor

Test ID	Test Description	Test Condition	Expected Result	Actual Output
3.1	Click “Predict” button with empty input	Bedroom:”” Bathroom:”” sqftLiving:”” floors:”” waterfront:”” view:”” condition:”” sqftAbove:”” sqftBasement:”” yearBuilt:”” yearRenovated:”” zipcode:”” lat:”” long:””	System display “Invalid input in forms”	As expected,
3.2	Click “Predict” button with filled input	Bedroom:3 Bathroom: 2 sqftLiving:2500	System displays recommended	As expected,

		floors: 2 waterfront: Yes view: 3 condition: 3 sqftAbove:2500 sqftBasement: 200 yearBuilt: 2014 yearRenovated: 0 zipcode: 9800 lat: 22 long: -144	price and price range	
3.3	Click "Predict" button with bedroom only filled	Bedroom:1 Bathroom:"" sqftLiving:"" floors:"" waterfront:"" view:"" condition:"" sqftAbove:"" sqftBasement:"" yearBuilt:"" yearRenovated:"" zipcode:"" lat:"" long:""	System display "Invalid input in forms"	As expected,
3.4	Click "Predict" button with Bathroom only filled	Bedroom:"" Bathroom: 2 sqftLiving:"" floors:"" waterfront:""	System display "Invalid input in forms"	As expected,

		view:”” condition:”” sqftAbove:”” sqftBasement:”” yearBuilt:”” yearRenovated:”” zipcode:”” lat:”” long:””		
3.5	Click “Predict” button with sqftLiving only filled	Bedroom:”” Bathroom:”” sqftLiving: 2000 floors:”” waterfront:”” view:”” condition:”” sqftAbove:”” sqftBasement:”” yearBuilt:”” yearRenovated:”” zipcode:”” lat:”” long:””	System display “Invalid input in forms”	As expected,
3.6	Click “Predict” button with floors only filled	Bedroom:”” Bathroom:”” sqftLiving:”” floors: 2 waterfront:”” view:”” condition:”” sqftAbove:””	System display “Invalid input in forms”	As expected,

		sqftBasement:”” yearBuilt:”” yearRenovated:”” zipcode:”” lat:”” long:””		
3.7	Click “Predict” button with waterfront only filled	Bedroom:”” Bathroom:”” sqftLiving:”” floors:”” waterfront: Yes view:”” condition:”” sqftAbove:”” sqftBasement:”” yearBuilt:”” yearRenovated:”” zipcode:”” lat:”” long:””	System display “Invalid input in forms”	As expected,
3.8	Click “Predict” button with view only filled	Bedroom:”” Bathroom:”” sqftLiving:”” floors:”” waterfront:”” view:3 condition:”” sqftAbove:”” sqftBasement:”” yearBuilt:”” yearRenovated:””	System display “Invalid input in forms”	As expected,

		zipcode:”” lat:”” long:””		
3.9	Click “Predict” button with condition only filled	Bedroom:”” Bathroom:”” sqftLiving:”” floors:”” waterfront:”” view:”” condition: 3 sqftAbove:”” sqftBasement:”” yearBuilt:”” yearRenovated:”” zipcode:”” lat:”” long:””	System display “Invalid input in forms”	As expected,
3.10	Click “Predict” button with sqftAbove only filled	Bedroom:”” Bathroom:”” sqftLiving:”” floors:”” waterfront:”” view:”” condition:”” sqftAbove: 2000 sqftBasement:”” yearBuilt:”” yearRenovated:”” zipcode:”” lat:”” long:””	System display “Invalid input in forms”	As expected,

3.11	Click "Predict" button with sqftBasement only filled	Bedroom:"" Bathroom:"" sqftLiving:"" floors:"" waterfront:"" view:"" condition:"" sqftAbove:"" sqftBasement: 500 yearBuilt:"" yearRenovated:"" zipcode:"" lat:"" long:""	System display "Invalid input in forms"	As expected,
3.12	Click "Predict" button with yearBuilt only filled	Bedroom:"" Bathroom:"" sqftLiving:"" floors:"" waterfront:"" view:"" condition:"" sqftAbove:"" sqftBasement:"" yearBuilt:"" yearRenovated:"" zipcode:"" lat:"" long:""	System display "Invalid input in forms"	As expected,

3.13	Click "Predict" button with yearRenovated only filled	Bedroom:"" Bathroom:"" sqftLiving:"" floors:"" waterfront:"" view:"" condition:"" sqftAbove:"" sqftBasement:"" yearBuilt:"" yearRenovated: 2015 zipcode:"" lat:"" long:""	System display "Invalid input in forms"	As expected,
3.14	Click "Predict" button with zipcode only filled	Bedroom:"" Bathroom:"" sqftLiving:"" floors:"" waterfront:"" view:"" condition:"" sqftAbove:"" sqftBasement:"" yearBuilt:"" yearRenovated:"" zipcode:98000 lat:"" long:""	System display "Invalid input in forms"	As expected,

3.15	Click "Predict" button with lat only filled	Bedroom:"" Bathroom:"" sqftLiving:"" floors:"" waterfront:"" view:"" condition:"" sqftAbove:"" sqftBasement:"" yearBuilt:"" yearRenovated:"" zipcode:"" lat: 22 long:""	System display "Invalid input in forms"	As expected,
3.16	Click "Predict" button with long only filled	Bedroom:"" Bathroom:"" sqftLiving:"" floors:"" waterfront:"" view:"" condition:"" sqftAbove:"" sqftBasement:"" yearBuilt:"" yearRenovated:"" zipcode:"" lat:"" long: -144	System display "Invalid input in forms"	As expected,

8.2.4 | Upload House

Test ID	Test Description	Test Condition	Expected Result	Actual Output
4.1	Click “Upload” button with empty input	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated:””, zipcode:””, lat:””, long: ””	System display “Invalid input in forms”	As expected,
4.2	Click “Upload” button with filled input	Title: Double Story House, Price: 100000, State: Seattle, Bedroom: 3, Bathroom: 2, sqftLiving: 2500, floors: 2, waterfront: No, sqftAbove: 2000, sqftBasement: 500, yearBuilt: 2000, yearRenovated:2013, zipcode: 98000, lat: 22,	System display “Uploaded”	As expected,

		long: -144		
4.3	Click "Upload" button with Title only filled	Title:"", Price:"", State:"", Bedroom:"", Bathroom:"", sqftLiving:"", floors:"", waterfront:"", sqftAbove:"", sqftBasement:"", yearBuilt:"", yearRenovated:"", zipcode:"", lat:"", long: ""	System display "Invalid input in forms"	As expected,
4.4	Click "Upload" button with Price only filled	Title:"", Price:"", State:"", Bedroom:"", Bathroom:"", sqftLiving:"", floors:"", waterfront:"", sqftAbove:"", sqftBasement:"", yearBuilt:"", yearRenovated:"", zipcode:"", lat:"", long: ""	System display "Invalid input in forms"	As expected,

4.5	Click “Upload” button with State only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated:””, zipcode:””, lat:””, long: ””	System display “Invalid input in forms”	As expected,
4.6	Click “Upload” button with Bedroom only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated:””, zipcode:””, lat:””, long: ””	System display “Invalid input in forms”	As expected,
4.7	Click “Upload” button with	Title:””, Price:””, State:””,	System display	As expected,

	Bathroom only filled	Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated:””, zipcode:””, lat:””, long: ””	“Invalid input in forms”	
4.8	Click “Upload” button with sqftLiving only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated:””, zipcode:””, lat:””, long: ””	System display “Invalid input in forms”	As expected,
4.9	Click “Upload” button with floors only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””,	System display “Invalid input in forms”	As expected,

		floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated:””, zipcode:””, lat:””, long: ””		
4.10	Click “Upload” button with waterfront only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated:””, zipcode:””, lat:””, long: ””	System display “Invalid input in forms”	As expected,
4.11	Click “Upload” button with waterfront only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””,	System display “Invalid input in forms”	As expected,

		sqftBasement:””, yearBuilt:””, yearRenovated:””, zipcode:””, lat:””, long: ””		
4.12	Click “Upload” button with sqftAbove only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated:””, zipcode:””, lat:””, long: ””	System display “Invalid input in forms”	As expected,
4.13	Click “Upload” button with sqftBasement only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated:””,	System display “Invalid input in forms”	As expected,

		zipcode:””, lat:””, long: ””		
4.14	Click “Upload” button with yearBuilt only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt: 2000, yearRenovated:””, zipcode:””, lat:””, long: ””	System display “Invalid input in forms”	As expected,
4.15	Click “Upload” button with yearBuilt only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt: 2010, yearRenovated:””, zipcode:””, lat:””, long: ””	System display “Invalid input in forms”	As expected,

4.16	Click “Upload” button with yearRenovated only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated: 2014, zipcode:””, lat:””, long: ””	System display “Invalid input in forms”	As expected,
4.17	Click “Upload” button with zipcode only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated:””, zipcode: 98000, lat:””, long: ””	System display “Invalid input in forms”	As expected,

4.18	Click “Upload” button with lat only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated:””, zipcode:””, lat: 22, long: ””	System display “Invalid input in forms”	As expected,
4.19	Click “Upload” button with long only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated:””, zipcode:””, lat:””, long: -144	System display “Invalid input in forms”	As expected,

8.2.5 | Delete House.

Test ID	Test Description	Test Condition	Expected Result	Actual Output	Pass/Fail
5.1	Click "Update" button with empty input	Property ID: ""	System display "House not found"	As expected,	Pass
5.2	Click "Update" button with filled input	PropertyID: kinSingleStory	System display "House deleted"	As expected,	Pass

8.2.6 | Update Profile

Test ID	Test Description	Test Condition	Expected Result	Actual Output
6.1	Click "Update" button with empty input	Email:"" Password:""	System display "Mismatched passwords try again"	As expected,
6.2	Click "Update" button with filled input	Email: abc@mail.cm Password:1234	System display "Update" and redirect user to home page	As expected,
6.3	Click "Update" button with email only filled	Email: abc@mail.com Password:""	System display "Mismatched passwords try again"	As expected,

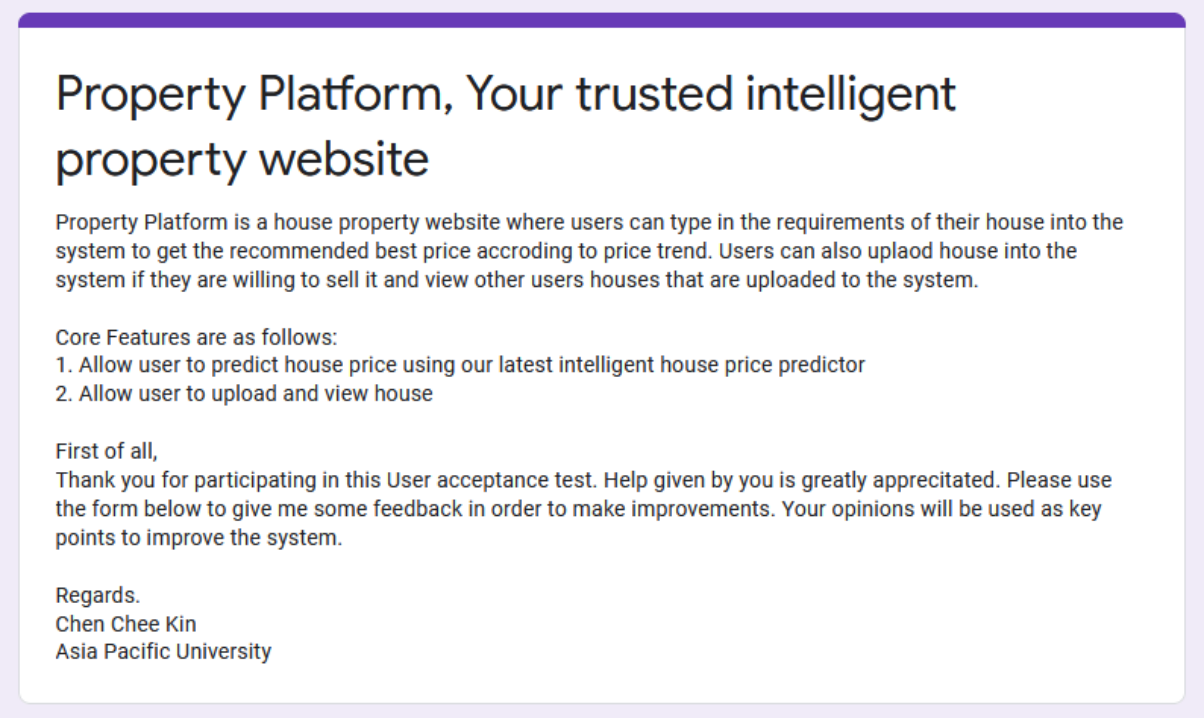
6.4	Click "Update" button with Password only filled	Email:"" Password:1234	System display "Mismatched passwords try again"	As expected,

8.2.7 | Property Listing

Test ID	Test Description	Test Condition	Expected Result	Actual Output	Pass/Fail
7.1	Users navigate to Property Listing page	Data from Database	Show all available house from database	As expected,	Pass

8.3 | User Acceptance Testing Plan

The User Acceptance Testing or UAT for short is one of the testing which is conducted by potential users to validate a proposed system before releasing the final version into the production environment or market. UAT normally is conducted at the near end of testing phase after functional, integration and system testing. As the ongoing movement control order due to recent Covid19 pandemic, instead of meeting the testers face to face, the acceptance testing was done online using online meeting platform such as Microsoft Teams and Google Meet. User input and feedbacks was collected using Google forms. The google form used for collecting feedback is as shown as below.



Property Platform, Your trusted intelligent property website

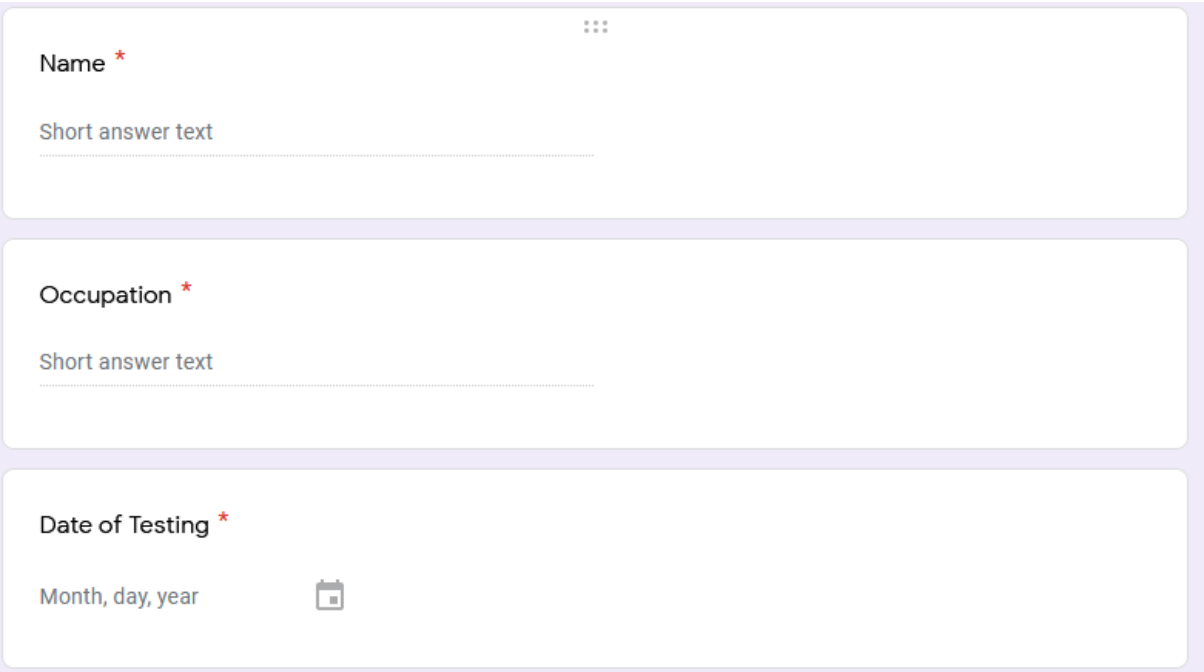
Property Platform is a house property website where users can type in the requirements of their house into the system to get the recommended best price accroding to price trend. Users can also uplaod house into the system if they are willing to sell it and view other users houses that are uploaded to the system.

Core Features are as follows:
1. Allow user to predict house price using our latest intelligent house price predictor
2. Allow user to upload and view house

First of all,
Thank you for participating in this User acceptance test. Help given by you is greatly appreciated. Please use the form below to give me some feedback in order to make improvements. Your opinions will be used as key points to improve the system.

Regards.
Chen Chee Kin
Asia Pacific University

A brief introduction to the system and forms.



Name *

Short answer text

Occupation *

Short answer text

Date of Testing *

Month, day, year

These questions are to get the basic information from testers.

What score will you give to the system? *

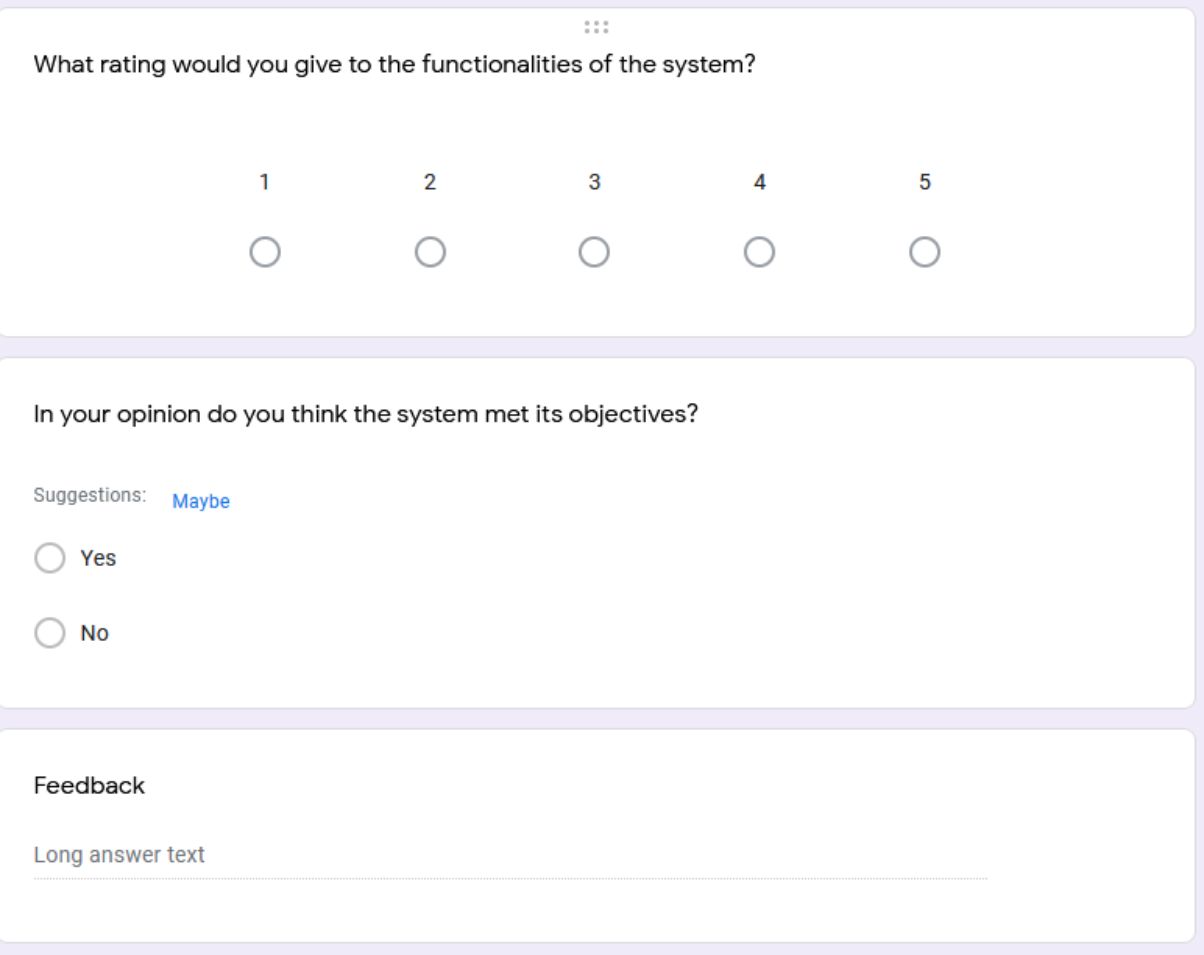
1	2	3	4	5
○	○	○	○	○

How do you find the overall UI?

1	2	3	4	5
○	○	○	○	○

Is the system User friendly?

1	2	3	4	5
○	○	○	○	○



The rest of the questions are to get feedback from testers on the system. All the information collected will be used to improve and validate the system.

Chapter 9: Implementations

In this section, the proposed system's key functions are shown with screenshots and a throughout explanation. Description of code that was used to create the system is also shown in the upcoming section.

9.1 | Screenshots

Home / Landing Page

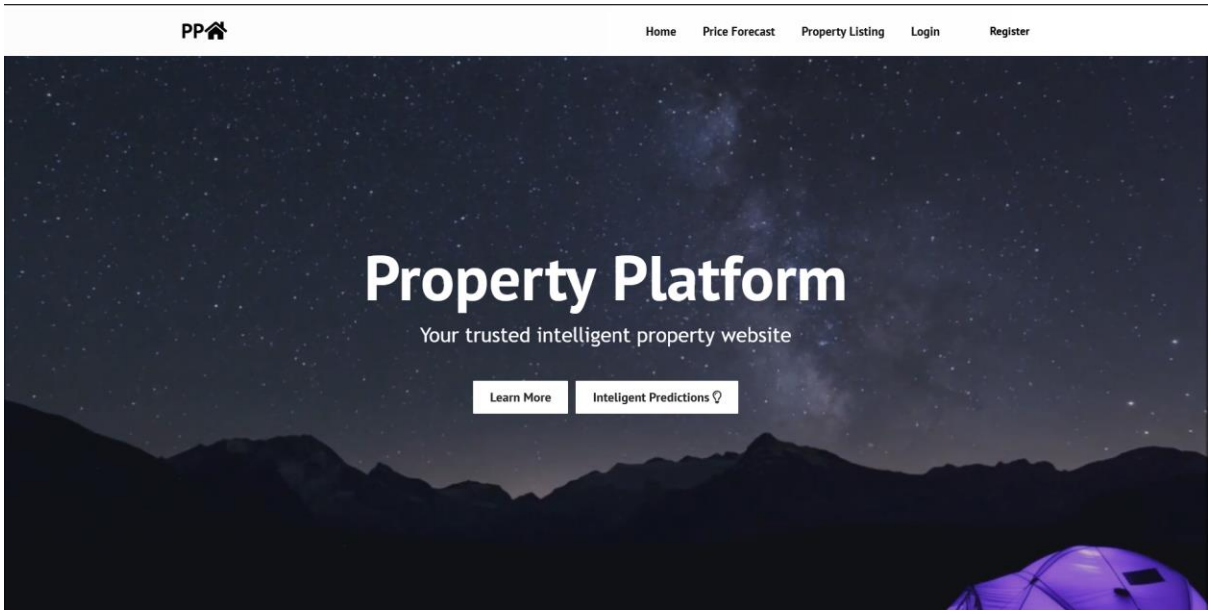


Figure 25 Home Screen

This is the first page where user will see if connect to Property Platform. User can then navigate to other pages using the navigation bar or button within the landing page.

Login

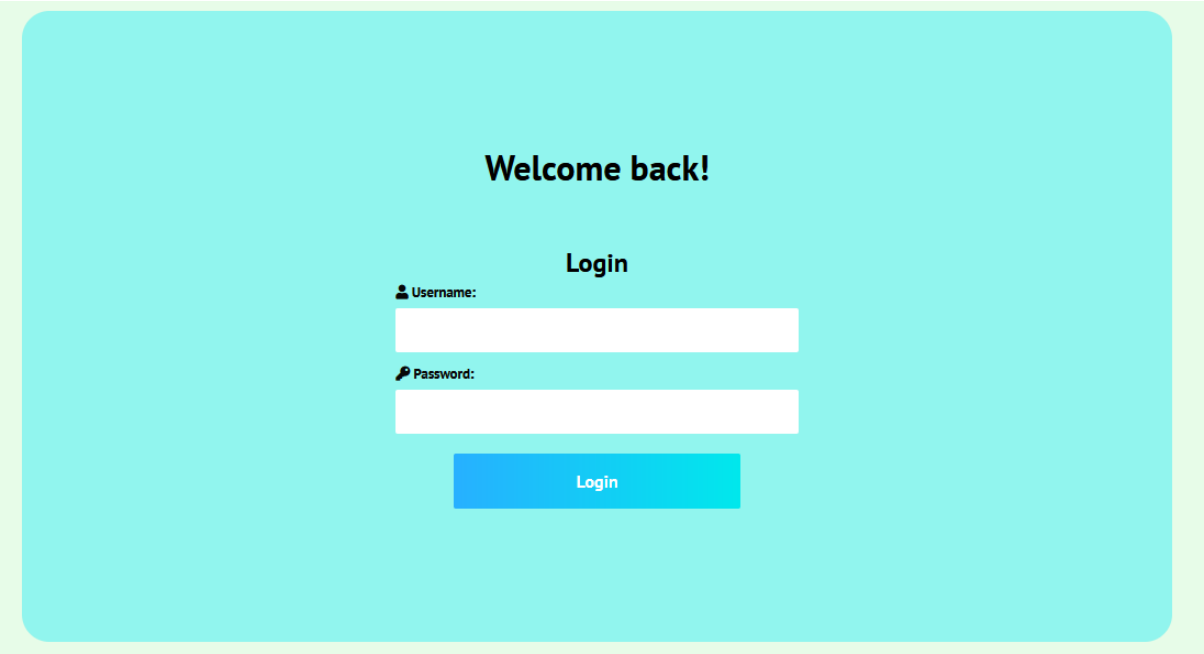


Figure 26 Login Page

As we can see the screenshot above, which shows a login box that require user to fill in all the inputs for verify before allow user to login to the system. If user typed in the correct inputs and login is successful, the system will show a success note within the login box and redirect the user to the home or landing page. If failed to login, a warning will show which wrote" Login Failed", asking user to re-enter their username and password.

Price Forecast

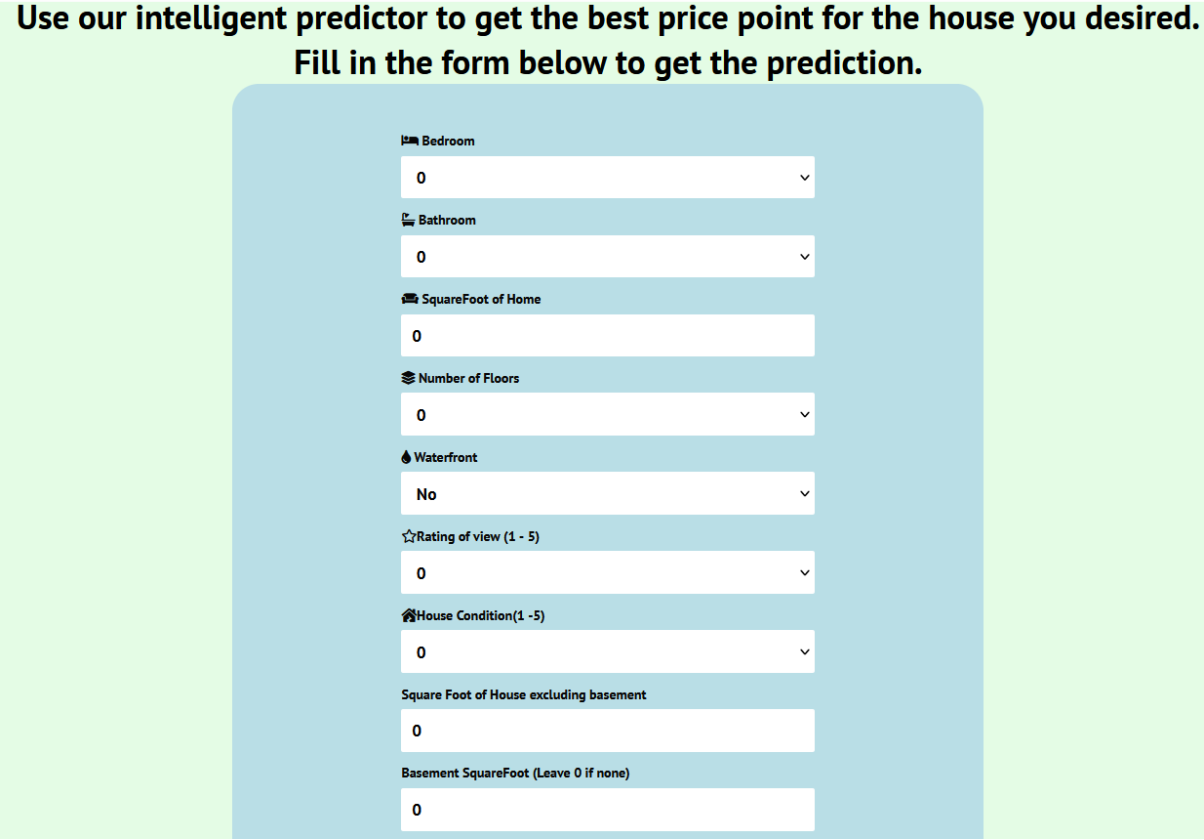


Figure 27 House Price Prediction

This feature can be use with or without login in as this is a public page within the proposed system. This page will require user to fill in the required column in order to predict house price. It will first collect the data received and send to back-end using an API call, the data will then be converted into a JSON file before sending into the intelligent model for prediction. After receiving the result, it will be sent back to the front-end to show the user.

Property Listing

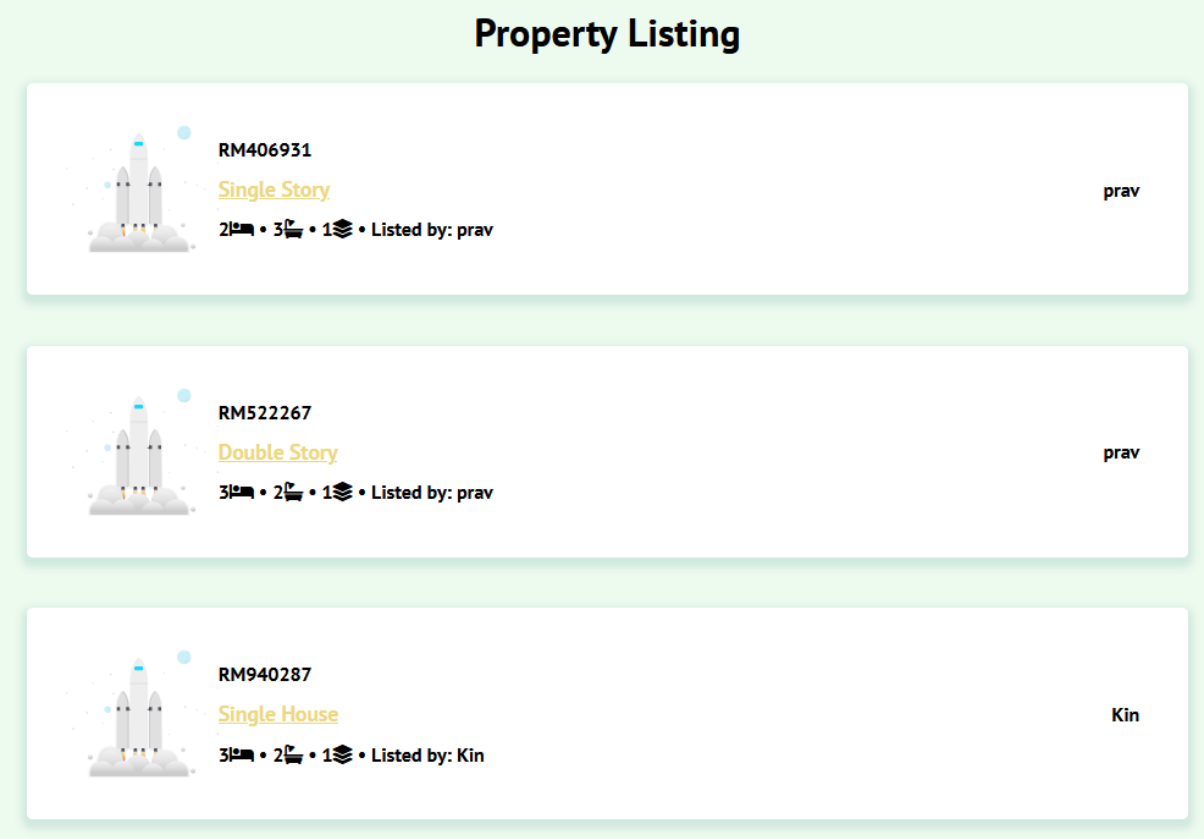


Figure 28 Property Listing

This page will show all the house uploaded by users. When navigate to this page, an API will automatically be called to get all the data from the back-end database to show in the front-end. Users can check for various details on the house listed. A more details page will be directed if user click on the listed property. A filter function is applied in this page. User can filter the listed house by uploader's username.

Register

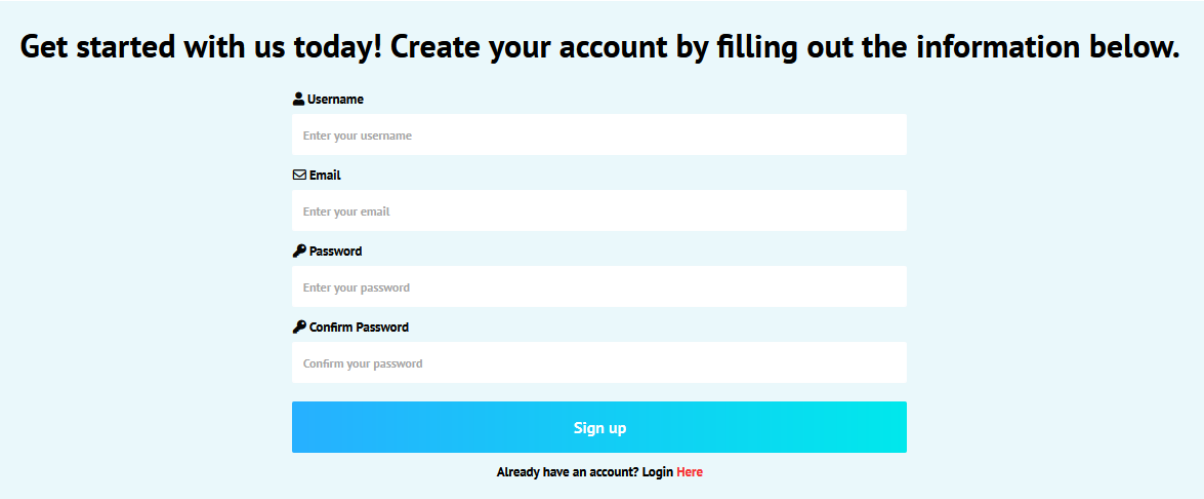


Figure 29 Register Page

This feature allows the registering of new user. As this is a prototype, users only need to input the username, email, and password. There will be verification of password where user need to retype its password on the last column. Validation and error net is done for this function to prevent invalid input and missing input.

Upload House

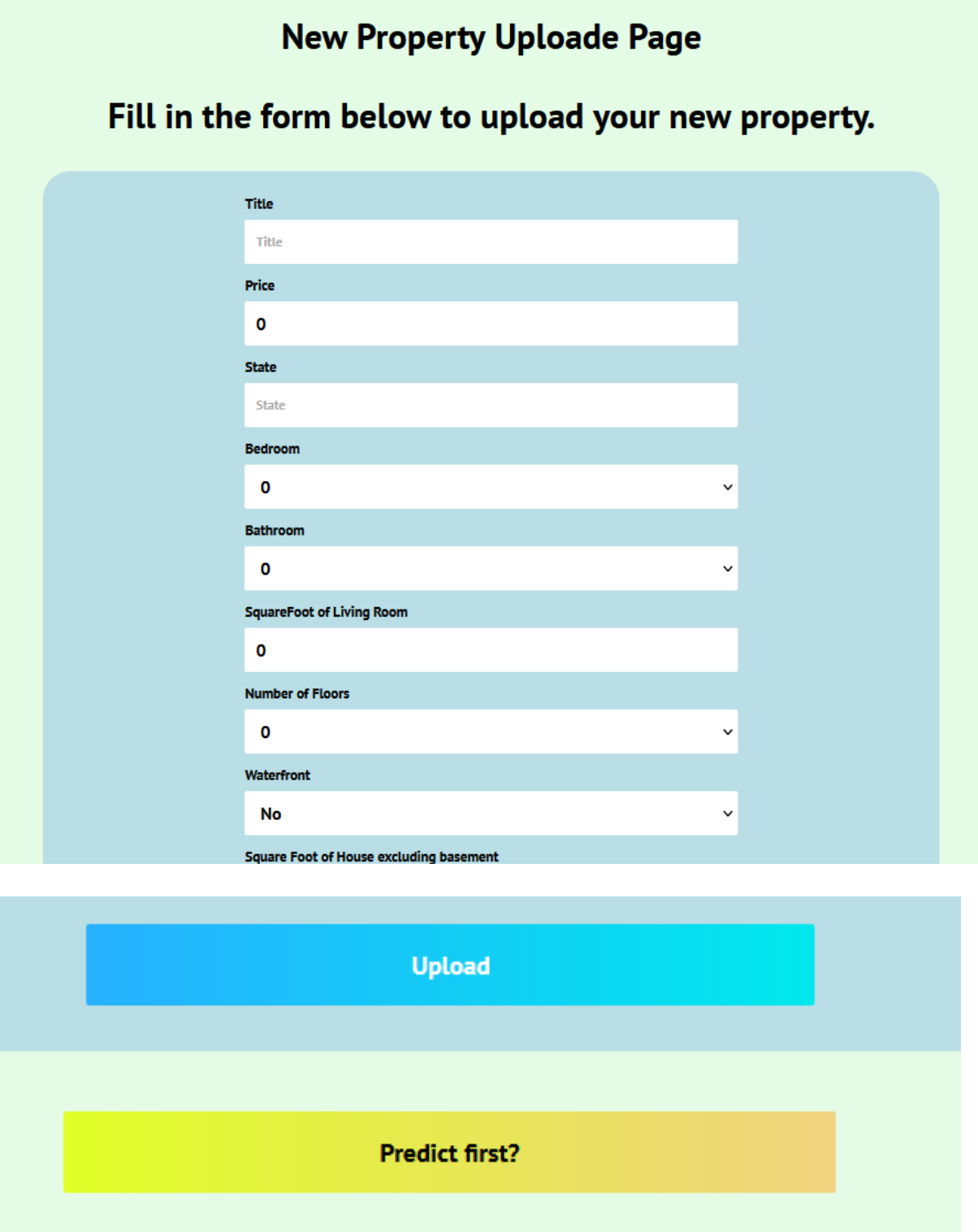


Figure 30 Upload House and Predict House Price

This feature is only accessible by users who logged in. This feature allows users to upload their house data into the system for showing to other users. There will be several inputs to be fill in order to upload. An extra feature where the intelligent house price predictor is also implemented within this page for user to first find the best price before uploading his or her house data with the recommended house price. Validation and error net is also done in this page.

Upload History

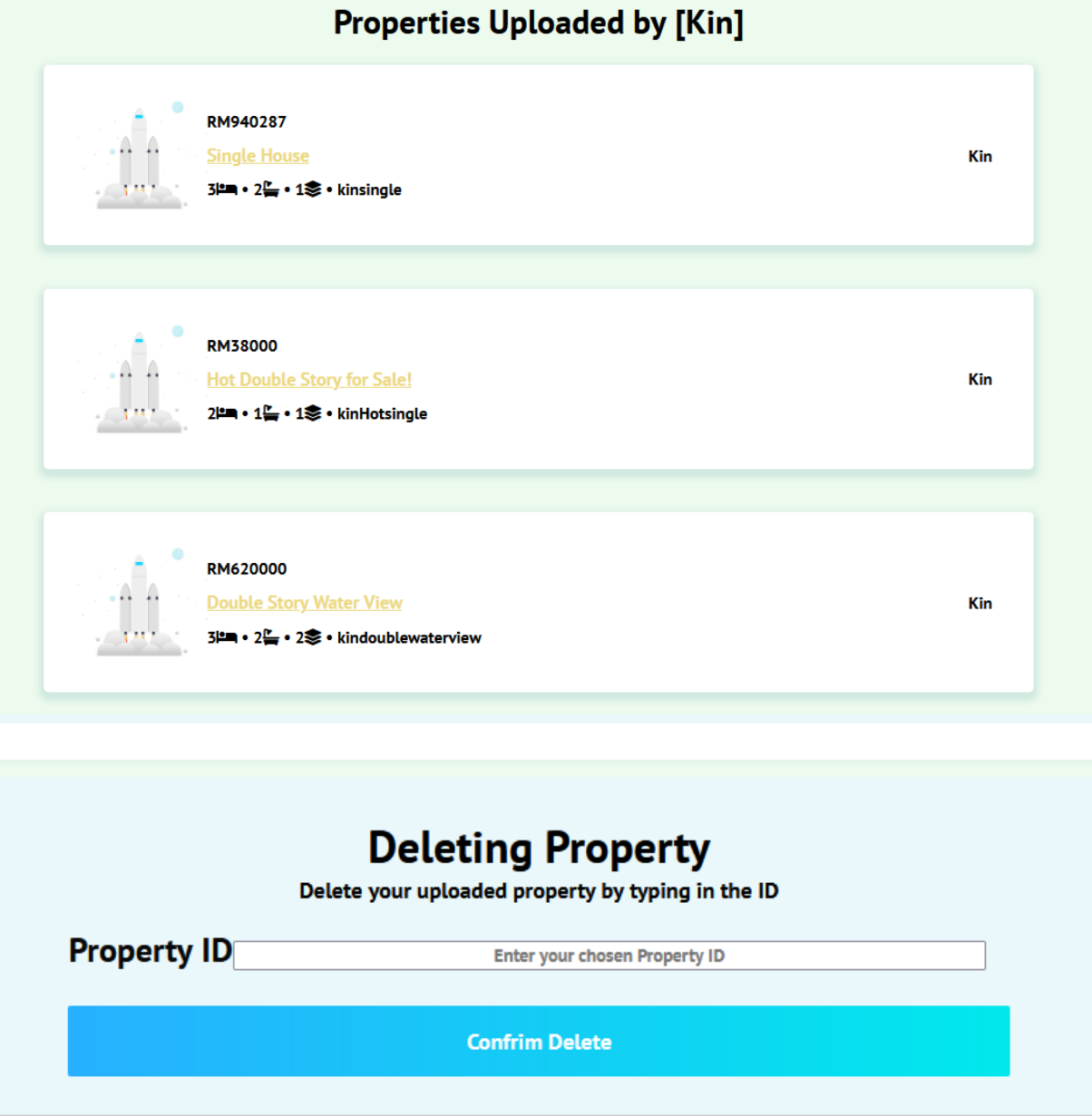


Figure 31 Delete Property

This feature is also only accessible to users who logged in. This is where users check for the house data that uploaded by him or her. Like the previous page all the house data will first be shown as a list and users can delete it by typing the property ID in the delete section.

Update Profile

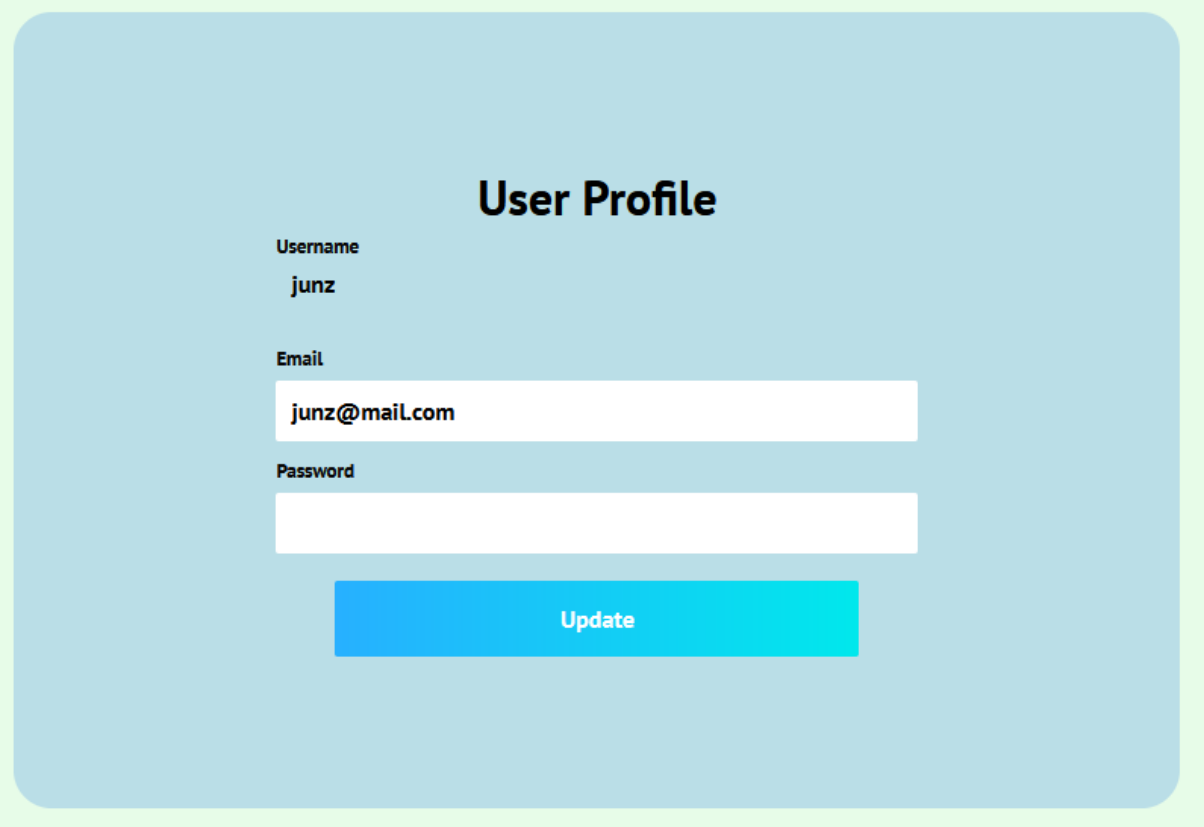


Figure 32 Update Profile

This is where user can update his or her info. User just need to overwrite the desired column and password to update their profile data. After update successfully user will be redirect to home.

About

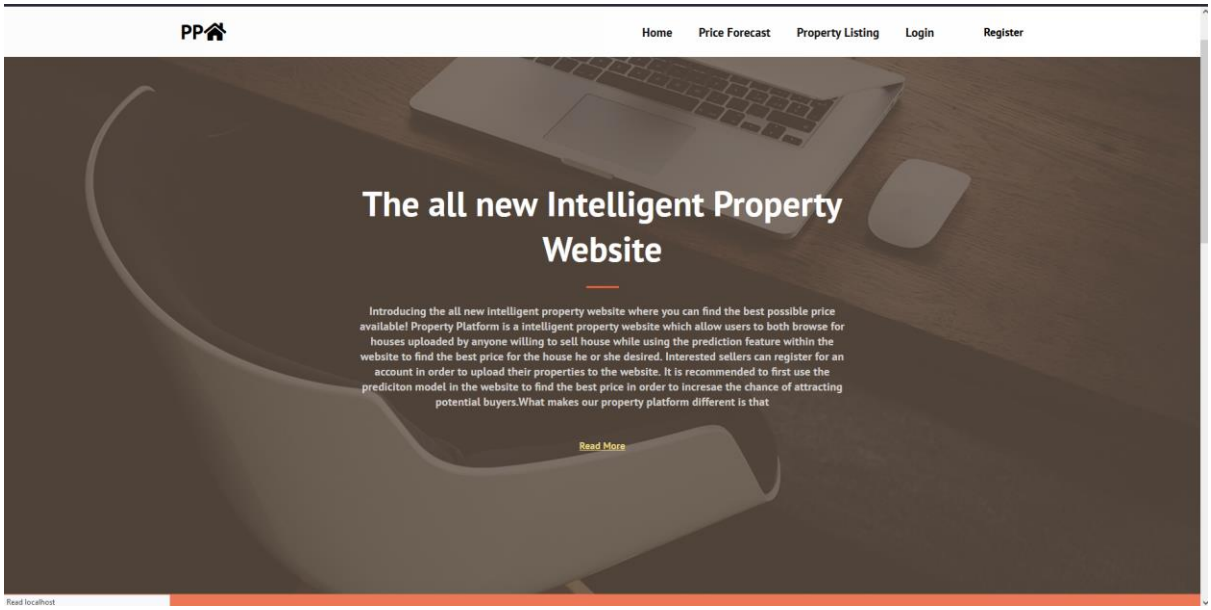


Figure 33 About Page

In this page, a details description of the system will be shown. This page also contains guides on how to use the system to help users navigate and use the proposed system.

House Detail Page

This page shows a details description of one of the houses uploaded by users into the system's database. Users can view all of the data on the selected house and also its uploaded and contact details should the user is interested in buyer the house.

9.2 | Sample Code

9.2.1 | Intelligent House Price Prediction Model

9.2.1.1 | Import required libraries.

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import mpl_toolkits
%matplotlib inline
```

Figure 34 import libraries

Based on the diagram above, required libraries such as NumPy, Pandas, SkLearn are import into the system before doing anything. NumPy is a popular array processing library which provides various tools to work on array data (GeeksforGeeks-1, 2018). Pandas is a library which provides tools to work on data structures efficiently in Python. It is mainly used for the five main steps in processing and analysis data (tutorialspoint - 1, 2021). Matplotlib will be used for data visualization and data representation while Seaborn Is also a library similar to matplotlib. Sklearn, also known as Scikit-Learn is one of the famous open-source machine learning library.

9.2.1.2 | Uploading dataset.

```
#Google Colab read file
from google.colab import files
uploaded = files.upload()
```

Figure 35 Load dataset

This code snipper will allow user to upload data into google colaboratory.

9.2.1.3 | Reading dataset

```
data = pd.read_csv("kc_house_data.csv")
```

Figure 36 Load dataset

This code snippet shows the code to read the data set and display the first 5 row of dataset. This is useful for user to have a look at the dataset.

9.2.1.4 | Check for null values

```
#Find missing values
data.isnull().sum()
```

Figure 37 Check for null values

This code snipper checks for any null values. The code will return the total number of null value if any. For this dataset, there are no missing value after checking with the code above which is a very good indication as the work for data pre-processing can be reduce.

9.2.1.5 | Identify correlation between numeric data.

```
#find relation between features
cor = data.corr()
cor
```

Figure 38 Call for correlation table

This code snipper shows the code for identifying correlation between the available numeric data. The relationship between columns is measure by a score unit range from -1 to 1 which negative value as a negative linear correlation and vice versa. The higher the score is, the stronger the relationship between columns( ).

9.2.1.6 | Visual Representation of Parameters from dataset

```
#finding amount of bedrooms according to each row
data['bathrooms'].value_counts().plot(kind='bar')
plt.title('number of Bathroom')
plt.xlabel('Bathrooms')
plt.ylabel('Count')
sns.despine
```

Figure 39 data visualisalise

The code snipper above shows the code for visual representation of parameters or columns of dataset. This is part of the EDA or exploratory data analysis which is used to analyse the dataset. This code will be used multiple times with different parameters.

9.2.1.7 | Check for outliers

```
#finding outliers
data.boxplot('price')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f98c37a2150>
```

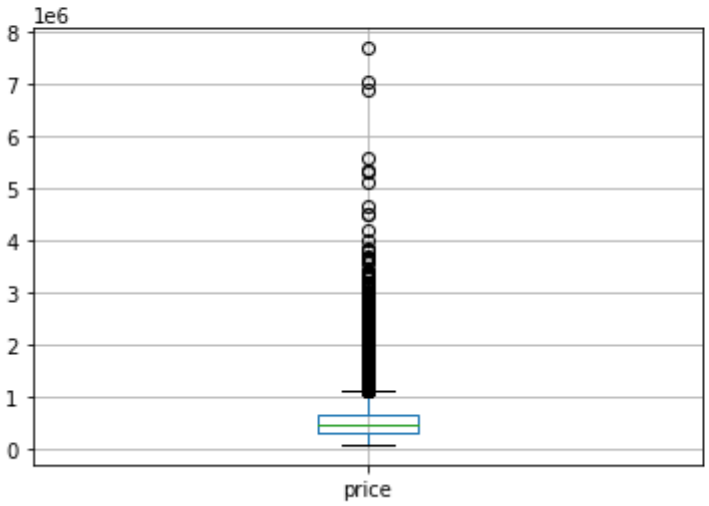


Figure 40 Find for outliers

This code snippet is the code for checking outliers within the dataset. As we can see there are some outliers within the dataset which needs to be remove. Outliers are special data which have values far away from the average value.

9.2.1.8 | Remove of outliers.

```
#Removing outlier using the Interquartile range
#Cleaning the data
data = data[data['price'].between(75000, 6000000)]
Q1 = data['price'].quantile(0.25)
Q3 = data['price'].quantile(0.75)
IQR = Q3 - Q1

#Filtering values between Q1-1.5IQR and Q3+1.5IQR
data_filtered = data.query('(@Q1 - 1.5 * @IQR) <= price <= (@Q3 + 1.5 * @IQR)')
#Get an overview of filtered data
data_filtered.describe().apply(lambda s: s.apply(lambda x: format(x, 'f')))
```

Figure 41 Removing of outliers

This code snipper will be the code to remove outliers. Outliers are removed using the interquartile method in which is a measure of statistical dispersion. This can identify the outliers and remove them. The range of data needs to be in the range of acceptable range, from there, any values outside will be removed( ).

9.2.1.9 | Check for outliers after removing.

```
#boxplot after removing outliers
data_filtered.boxplot('price')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f99cd5a9710>
```

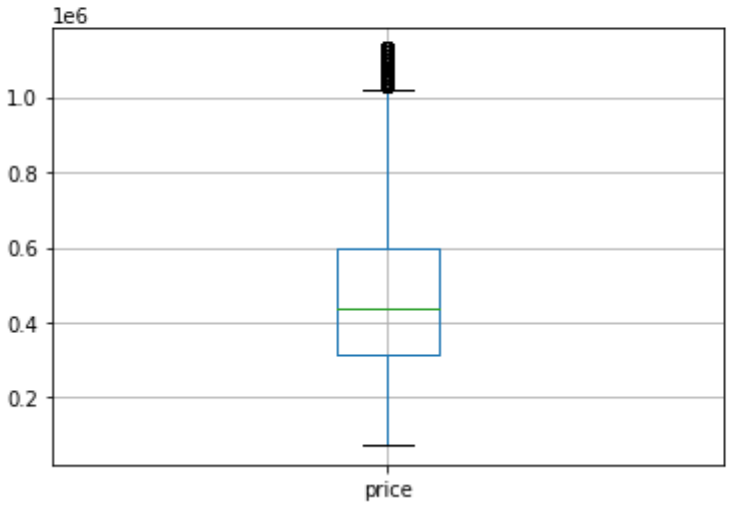


Figure 42 Outliers checking

This code is like the previous one, but this is to check for outliers after processing the data to remove outliers.

9.2.1.10 | Standardization

```
#standardizing data
from sklearn.preprocessing import StandardScaler
s_scaler = StandardScaler()
x_train = s_scaler.fit_transform(x_train.astype(np.float))
x_test = s_scaler.transform(x_test.astype(np.float))
```

Figure 43 Standardization

This section of code standardises all the column within the given dataset to remove any bias.

9.2.1.11 | Transforming year data.

```
#conv date to 0 and 1 , 1 indicate 2015 and above
conv_dates = [1 if values == 2014 else 0 for values in data.date ]
data['date'] = conv_dates
```

These few lines of code will convert year into 0 and 1 in which 0 indicates year 2014 and before while 1 indicates year 2015 and after.

9.2.1.12 | Remove unnecessary features.

```
#drop unecassary features
train1 = data.drop(['id', 'price','sqft_lot','grade','sqft_living15','sqft_lot15'],axis=1)
```

Figure 44 Remove features that are not useful

All unnecessary columns are removed to reduce training time and computational power consumption during training.

9.2.1.13 | Setup parameters for train/test set, splitting of data.

```
#split dataset to 75/25
x_train , x_test , y_train , y_test = train_test_split(train1 , labels , test_size = 0.25,random_state =0)
```

Figure 45 Split dataset

The code snippet above shows the code for splitting of data for train and test. The training and testing set will be split with a ration of 75 and 25. After splitting, the data will be sent to different machine learning model to do the training (Shin, 2020). Random state within the parameter represents the shuffling of data before splitting is applied (Scikit-Learn - 1, 2021).

9.2.1.14 | Linear Regression Model

```
#import sklearn
from sklearn.linear_model import LinearRegression
```

```
reg = LinearRegression()
```

```
#training
reg.fit(x_train,y_train)
```

```
LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None, normalize=False)
```

```
#check for score
from sklearn.metrics import mean_squared_error
y_pred = reg.predict(x_test)

mean_error = sum(abs(y_test - y_pred))/len(y_test)
print("Mean absolute error (MAE) accuracy: ", mean_error)
print("Mean Squared Error: ",mean_squared_error(y_test, y_pred))
print('Root mean square error (RMSE):', np.sqrt(metrics.mean_squared_error(y_test, y_pred)))
print("Overall accuracy: ", reg.score(x_test, y_test))
```

Figure 46 Linear Regression model development

This code snipper is the building of linear regression model. First the model function will be call and then training data will be input into the model for training with the *fit* function before testing the model (Mir, 202). The accuracy, mean absolute error, mean square error and root mean square error will be listed out after the prediction is complete. A graph of actual against predicted result will be shown.

9.2.1.15 | Gradient Boosting Model

```
#import sklearn
from sklearn import ensemble
grad_boost = ensemble.GradientBoostingRegressor(n_estimators = 400, max_depth = 3, min_samples_split = 2,
          learning_rate = 0.1, loss = 'ls')
```

```
#training
grad_boost.fit(x_train, y_train)
```

```
GradientBoostingRegressor(alpha=0.9, ccp_alpha=0.0, criterion='friedman_mse',
                          init=None, learning_rate=0.1, loss='ls', max_depth=3,
                          max_features=None, max_leaf_nodes=None,
                          min_impurity_decrease=0.0, min_impurity_split=None,
                          min_samples_leaf=1, min_samples_split=2,
                          min_weight_fraction_leaf=0.0, n_estimators=400,
                          n_iter_no_change=None, presort='deprecated',
                          random_state=None, subsample=1.0, tol=0.0001,
                          validation_fraction=0.1, verbose=0, warm_start=False)
```

```
#check for score
grad_boost.score(x_test,y_test)
grad_boost_pred = grad_boost.predict(x_test)
mean_error = sum(abs(y_test - grad_boost_pred))/len(y_test)
print("Mean absolute error (MAE) price: ", mean_error)
print("Mean Squared Error:", mean_squared_error(y_test, grad_boost_pred))
print('Root mean square error (RMSE):', np.sqrt(metrics.mean_squared_error(y_test, grad_boost_pred)))
print("Overall accuracy: ", grad_boost.score(x_test, y_test))
```

Figure 47 Gradient Boosting model

The code snipper above is the code for creating a Gradient Boosting model. First the model function will be call and then training data will be input into the model for training with the fit function before testing the model (Mir, 202). The accuracy, mean absolute error, mean square error and root mean square error will be listed out after the prediction is complete. A graph of actual against predicted result will be shown.

9.2.1.16 | Random Forest Model

```
#import and train
from sklearn.ensemble import RandomForestRegressor
random_model = RandomForestRegressor(random_state=1, max_depth=35)
random_model.fit(x_train,y_train)
```

```
RandomForestRegressor(bootstrap=True, ccp_alpha=0.0, criterion='mse',
                      max_depth=35, max_features='auto', max_leaf_nodes=None,
                      max_samples=None, min_impurity_decrease=0.0,
                      min_impurity_split=None, min_samples_leaf=1,
                      min_samples_split=2, min_weight_fraction_leaf=0.0,
                      n_estimators=100, n_jobs=None, oob_score=False,
                      random_state=1, verbose=0, warm_start=False)
```

```
#check for socre
from sklearn.metrics import mean_squared_error
random_pred = random_model.predict(x_test)
print("Mean Squared Error:",mean_squared_error(y_test, random_pred))
print("RMSE:",np.sqrt(mean_squared_error(y_test, random_pred)))
mean_error = sum(abs(y_test - random_pred))/len(y_test)
print("Mean absolute error (MAE) accuracy: ", mean_error)
print("Overall accuracy: ", random_model.score(x_test, y_test))
print("Overall accuracy: ", random_model.score(x_train, y_train))
```

Figure 48 Random Forest Model

This code snipper shows the code for developing the random forest model. The training data will be feed into the model for training before doing testing on the model (Shin,2020). Like the previous model, the accuracy or R2 score, mean square error, root mean square error and mean absolute error will be listed after prediction. A graph will also be drawn. The result or accuracy of Random Forest model is compared with the rest of the machine learning model used which are Linear Regression, Gradient Boosting and Keras Neural Network. Random Forest model will be the chosen model to be implement into the system as it has the best accuracy and lowest error level. Besides that, the other reason is random forest uses less computational power and flexible. It is also simple and straightforward to use. Random forest can be use even with missing data and still give good result. I t can be used to determine the feature importance too (IBM Cloud Education - 1, 2020).

9.2.1.17 | Visualization of comparison between predicted and actual value

```
#ploting actaul vs predicted
plt.figure(figsize=(20,15))

ax = sns.distplot(y_test, hist=False, color="r", label="Actual Value")
sns.distplot(random_pred, hist=False, color="b", label="Fitted Values" , ax=ax)

plt.title('Actual vs Predicted Values for Price')

plt.show()
plt.close()
```

Figure 49 Graph comparison

As stated, before this section of code is to show the comparison between actual and predicted value. Blue line represents the predicted value and red line is the actual values.

9.2.1.18 | Save model for system.

```
# save the model to disk
import pickle
filename = 'finalized_model.sav'
pickle.dump(random_model, open(filename, 'wb'))
```

Figure 50 Saving of model

This part of the code shows how to save the chosen model for system. First the code will convert the model into byte stream, with the name of the file as “Finalised_model” with a sav extension (Pythonic,2021). The file will later be loaded in the system using a Python script to do prediction later on in the system.

9.2.1.19 | Feature importance

```
#check for strong relationship
feat_importances = pd.Series(random_model.feature_importances_, index=x_test.columns)
feat_importances.nlargest(5).plot(kind='barh')
plt.show()
```

Figure 51 Feature importance

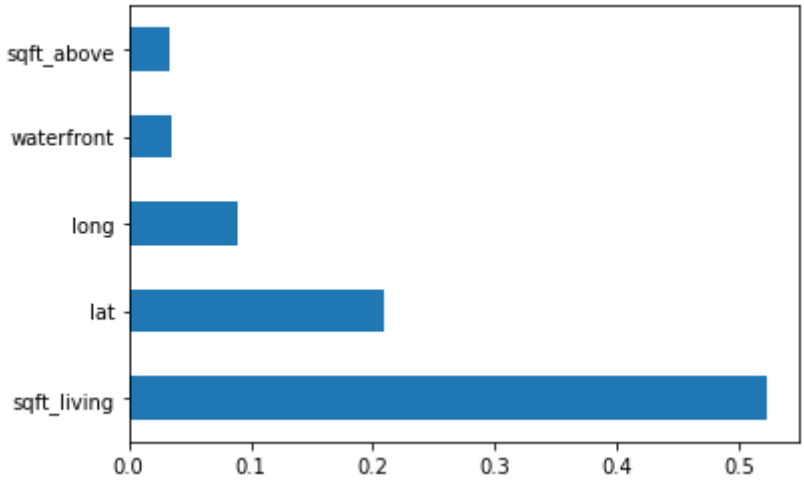


Figure 52 Diferent of all the features importance

The above screenshot is the code for feature importance. Feature importance in another words finds the most important variables or features within the dataset and show it. As we can see, the sqft_living is the most important feature within the dataset. Feature importance is measured by the increasing prediction error of the model after transposing the feature. The feature is key component if randomizing values will increase the model error because model relies on these important features to make prediction.

9.2.1.20 | Backpropagation on Neural Network

```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Activation
from tensorflow.keras.optimizers import Adam
```

```
#19 neuron and 4 layers, optimzer = Adam
model = Sequential()
model.add(Dense(19,activation='relu'))
model.add(Dense(19,activation='relu'))
model.add(Dense(19,activation='relu'))
model.add(Dense(19,activation='relu'))
model.add(Dense(1))

model.compile(optimizer='Adam',loss='mse')
```

```
model.fit(x=x_train,y=y_train,
          validation_data=(x_test,y_test),
          batch_size=128,epochs=400)

model.summary()
```

Figure 53 Development of neural network

The above code snipper shows the code for developing a neural network using the Keras library. The libraries are called before building the model. Sequential model is defined as a stack of layers which each layer will have only one input and output tensor. Backpropagation training method is used to train the model. The layers of model will have to be complied before using(fchollet, 2020). This model uses four hidden layers and one output layer. Dense layer is a densely connected neural network layer. It uses the activation functions which is passed. In this case, relu activation function is used(Keras API Reference - 1, 2021). Adam optimization is used as optimizer to optimize the loss function or mean square error(MSE). It is a stochastic gradient descent method that is based on adaptive estimation(Keras API Reference - 1, 2021). The mode then will be fitted with the dataset and be trained for 400 epochs. The result is compared with other model later on.

9.2.1.21 | Comparison of all trained models

```
from sklearn import metrics
#Comparing accuracy of all model
print('Comparison of Accuracy for all models')
print()

print('---Linear Regression---')
print("Mean absolute error (MAE)($) :", sum(abs(y_test - y_pred))/len(y_test))
print('Mean square error (MSE)      :', metrics.mean_squared_error(y_test, y_pred))
print('Root mean square error (RMSE):', np.sqrt(metrics.mean_squared_error(y_test, y_pred)))
print("Overall accuracy             :", reg.score(x_test, y_test))
print()

print('---Gradient Boosting---')
print("Mean absolute error (MAE)($) :", sum(abs(y_test - grad_boost_pred))/len(y_test))
print('Mean square error (MSE)      :', metrics.mean_squared_error(y_test, grad_boost_pred))
print('Root mean square error (RMSE):', np.sqrt(metrics.mean_squared_error(y_test, grad_boost_pre
print("Overall accuracy             :", grad_boost.score(x_test, y_test))
print()

print('---Random Forest---')
print("Mean absolute error (MAE)($) :", sum(abs(y_test - random_pred))/len(y_test))
print('Mean square error (MSE)      :', metrics.mean_squared_error(y_test, random_pred))
print('Root mean square error (RMSE):', np.sqrt(metrics.mean_squared_error(y_test, random_pred)))
print("Overall accuracy             :", random_model.score(x_test, y_test))
print()

print('---Backpropagation on Neural Network---')
print('Mean absolute error (MAE)    :', metrics.mean_absolute_error(y_test, model_pred))
print('Mean square error (MSE)      :', metrics.mean_squared_error(y_test, model_pred))
print('Root mean square error (RMSE):', np.sqrt(metrics.mean_squared_error(y_test, model_pred)))
print('Variance Score               :',metrics.explained_variance_score(y_test,model_pred))
print()
```

Figure 54 Code for comparison of all model

```
Comparison of Accuracy for all models

---Linear Regression---
Mean absolute error (MAE)($) : 131790.03574606514
Mean square error (MSE)      : 39712944249.905205
Root mean square error (RMSE): 199281.06846839518
Overall accuracy             : 0.6811957452063476

---Gradient Boosting---
Mean absolute error (MAE)($) : 74559.03968563105
Mean square error (MSE)      : 15185800701.263086
Root mean square error (RMSE): 123230.68084394846
Overall accuracy             : 0.8780926983014447

---Random Forest---
Mean absolute error (MAE)($) : 71790.88674634811
Mean square error (MSE)      : 15011164050.200369
Root mean square error (RMSE): 122520.05570599603
Overall accuracy             : 0.8794946318133836

---Backpropagation on Neural Network---
Mean absolute error (MAE)    : 164245.69128262077
Mean square error (MSE)      : 58586095615.98555
Root mean square error (RMSE): 242045.64779393483
Variance Score               : 0.5306628232295967
```

The code above shows the overall score and error for each model trained. The above code and figure shows the comparison of all the result of the four model. We can see that the Random Forest model has the best overall accuracy at 87.9%, followed by Gradient Boosting with 87.8% and linear regression with 68%. Neural network is the lowest with only 53%. Both Random Forest and Gradient Boosting have similar result in both accuracy and error rate. The Random Forest model is chosen to implemented in the system as it has one of the highest accuracy and lowest error. It is also computational friend and straight forward.

MAE is one of the many ways to measure the accuracy of a model by looking at the error rate. MSE is the average difference between the actual and the predicted values (Great Learning Team, 2020). RMSE is the common way of measuring error of a model in predicting data. (Moody, 2019)

9.2.2 | React

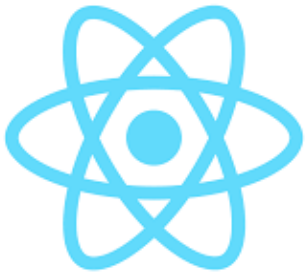


Figure 55 React Logo

React is a front-end framework which helps to create and design of the website. React runs on JavaScript and uses the component block to categories button and other components for reusability (React,2021).

9.2.2.1 | Importing necessary modules.

```
import React from 'react';
import './App.css';//css
import { BrowserRouter as Router, Switch, Route } from 'react-router-dom';//link
```

Figure 56 Import libraries

Necessary modules are downloaded using npm and imported into the JavaScript file. As they are multiple files, each file will import different modules depends on the usage. The most common modules used are React which is the main front-end framework used, react-router-dom, react-router-link for connection between pages. CSS is also import for styling.

9.2.2.2 | Front-end API

```
//Predict API
export const predictData = (data) =>{

    console.log("Predction Requested")

    console.log(data)

      return fetch(`http://localhost:3000/prediction-request/`,{
          method: 'POST',
          headers:{
            'Content-Type': 'application/json',
          },
          body : JSON.stringify(data)
        })
      .then(res=>{
          console.log("Sent from front-end")
          console.log(res)
          return res.json()
      })
    }
```

Figure 57 Prediction API

This section of code is to send data to back-end for further processing or prediction and wait for reply or data from back-end. Besides that, in some situation it will only call and wait for receive data from back-end when the API is called. API stands for application programming interface which a connection between two applications to allow the transfers of data vice versa or letting them “talk” to each other(https://www.mulesoft.com/resources/api/what-is-an-api). This code will be using several times with slightly different parameters and lines of code depends on the situation.

9.2.2.3 | Rendering of HTML

```
  return (
    <>
    <Navbar />
      <HeroSection />
      <Footer />
    </>
  );
}
```

Figure 58 Render of written HTML

This section of code basically renders the skeleton of the website or system. It is written in pure HTML.

9.2.2.4 | Styling

```
.about-content-base {
  height: 80vh;
  width: 100%;
  display: flex;
  flex-direction: column;
  align-items: center;
  box-shadow: inset 0 0 0 1000px rgba(134, 241, 139, 0.2);
  object-fit: contain;

  }

@media (prefers-reduced-motion: no-preference) {
  :root {
    scroll-behavior: smooth;
  }
}
```

Figure 59 CSS

This code is within the CSS file of the system. These codes are basically the styling and design of the website. Each JavaScript file has their corresponding CSS file.

9.2.2.5 | Navigation Bar

```
//whole navbar component
function Navbar() {

  //hooks
  const [click, setClick] = useState(false);
  const [button, setButton] = useState(true);
  const [loginState, setloginState] = useState(true);
  const [loginStateReverse, setloginStateReverse] = useState(false);
  const [dropdown, setDropdown] = useState(false);

  //hooks handler
  const handleClick = () => setClick(!click);
  const closeMobileMenu = () => setClick(false);


  const LogoutFunc = () => {
    UserProfile.setName("");
    UserProfile.setKey("");
  }

  //if size < 960, turn to burger icon
  const showButton = () => {
    if (window.innerWidth <= 960) {
      setButton(false);
    } else {
      setButton(true);
    }
  };
```

Figure 60 Navigation Code

This section of code is a small section navigation bar of the system. User can use this component to navigate to other pages. This code will be called in different pages as component as navigation bar will exist in all pages. useState within the code are used as containers for temporary variables.

9.2.2.6 | Footer

```
function Footer() {
  return (
    <div className='footer-container'>
      <section className='footer-subscription'>
        <p className='footer-subscription-heading'>
          Subscribe to our newsletter for updates.
        </p>
        <p className='footer-subscription-text'>
          You can unsubscribe at any time.
        </p>
        <div className='input-areas'>
          <form>
            <input
              className='footer-input'
              name='email'
              type='email'
              placeholder='Your Email'
            />
            <Button buttonStyle='btn--outline'>Subscribe</Button>
          </form>
        </div>
      </section>
      <div class='footer-links'>
        <div className='footer-link-wrapper'>
          <div class='footer-link-items'>
            <h2>About Us</h2>
            <Link to='/sign-up'>Team</Link>
            <Link to='/'>Careers</Link>
```

Figure 61 Footer Code

This section of code produces the footer of the system. User can navigate to external pages such as LinkedIn of developer, Insta page of proposed system and more. Same as navigation bar, this code will be called in all pages as component.

9.2.2.7 | Login

```
function LoginForm({Login}) {

  const history = useHistory();

    const [details,setDetails] = useState({username:"",password:""});
    const [loginError, setloginError] = useState("");

    const submitHandler = e => {
        e.preventDefault();

        //Send details to Login.js for verification
        Login(details);

        loginData(details)
          .then(
            function (res) {
              console.log("Redirected to homepage")
              if(res.details.password === details.password){
                setloginError("Login Sucess!")
                UserProfile.setName(details.username);
                UserProfile.setKey("Passed");
                history.push('/');}
              else{
                  setloginError("Login Failed")
                }
```

Figure 62 Login Code

This section shows the small section of login function of the system. User will be required to input their username and password for verification. After the system received the data, it will be sent to back-end database for checking via API if the username and password match, user will be logged in successfully and other wise be asked to retype. If user logged in successfully, the system will create a local cookie to keep track of user login. Validation and error catching is done for this section.

9.2.2.8 | Logout

```
const LogoutFunc = () => {
  UserProfile.setName("");
  UserProfile.setKey("");
}
```

Figure 63 Logout Code

This code section will handle the logout. If user clicks the logout button this code will be executed which will clear the local cookie and log user out. It will then redirect user to login page.

9.2.2.9 | Register

```
function SignUpForm({SignUpData,error}) {

  const [details,setDetails] = useState({username:"", email:"",password:"", password2:""});
  const [passwordError, setpasswordError] = useState("");

    const submitHandler = e => {
      e.preventDefault();
      if (details.email === "" || details.password === "" || details.username === "" || details.password2 === ""){
        setpasswordError("Please fill in all forms");
        console.log("Please fill in all forms");
      }

      else{
        if (details.password === details.password2) {
          console.log("Matched");
          //Send details to SignUpData.js for verification
          SignUpData(details);

          registerData(details)
            .then(
              function (res) {
                console.log("User Registered")
                setpasswordError("Sucess! Please navigate to login to login");
              }
              )
            .catch(err => console.log(err))

          console.log("Signed Up");
        }
```

Figure 64 Register code

This code will allow user to register for a new account. As this is a prototype, users only need to input the username, email, and password. There will be verification of password where user need to retype its password on the last column. If success the data will be send to back-end database for storage using API. Validation and error net is done for this function to prevent invalid input and missing input.

9.2.2.10 | Update Profile

```
function PredictionForm({Profile_update}) {

  const history = useHistory();
  const [details,setDetails] = useState({username:"", email:"",password:""});
  const [passwordError, setpasswordError] = useState("");
  const [oldpassword, setOldPassword] = useState({oldPassword:""});


const submitHandler = e => {
  e.preventDefault();
  if (details.password === oldpassword.oldPassword) {
    console.log("Matched");
    //Send details to SignUpData.js for verification
    Profile_update(details);
    updatePersonalData(details)
          .then(
            function (res) {
              setpasswordError("Updated");
              console.log("Updated, API Sent")
              history.push('/');
            }
          )

          .catch(
            err => console.log(err)

          )
      }

  else{
    setpasswordError("Missmatched password try again");
```

Figure 65 Update Profile

This code will allow user to update his or her profile. User just need to overwrite the desired column and password to update their profile data. After update successfully user will be redirect to home. System will first check If the password is match with the database by sending data using API. If match, the update value will be sent to database for update and ask for user to renter password if otherwise.

9.2.2.11 | Price Forecast

```
function PredictionForm({Predict,error}) {

  const [details,setDetails] = useState({bedroom:"0", bathroom :"0",sqftLiving:"0", floors :"0", waterfront  :"0", view  :"0", conditon  :"0", sqftAbove :"0", sqftBas
  const [passwordError, setpasswordError] = useState("");
  const [result, setResult] = useState(0);
  const [floatResult, setfloatResult]  = useState(0);
  const [floatResultMax, setfloatResultMax]  = useState(0);



  const submitHandler = e => {
    e.preventDefault();

    if (details.bedroom === "0" || details.bathroom === "0" || details.sqftLiving === "" || details.floors === "0" || details.waterfront === "" || details.view ===
    {
      setpasswordError("Please fill in all forms");
      console.log("Please fill in all forms");
    }

    else{

        console.log("Prediction Form Filled");
        //Send details to SignUpData.js for verification
        Predict(details);
        setpasswordError("Success! Scroll down to view your result");
        predictData(details)
            .then( res => {
              let resultgotten = res.result.slice(1,-1)
              console.log( res.result.includes("error"))
              if(res.result.includes("error")){
                console.log("User wrong input")
                setpasswordError("Invalid input in forms");
              }
```

Figure 66 Price Forecasting

This code section will require user to fill in the required column in order to predict house price. It will first collect the data received and send to back-end using an API call, the data will then be converted into a JSON file before sending into the intelligent model for prediction. After receiving the result, it will be sent back to the front-end to show the user. At the back if the model receives and error, it will send back an indicator to the front-end to ask user to reinput.

9.2.2.12 | Property Listing

```
const PropertyList = ({ data, setKeywords, keywords }) => {
  console.log(data);
  const [filteredData, setfilteredData] = useState([]);

  const modifiedData = () => {
      if (keywords) {
      const newData = data.details.filter((d) => {
        return keywords.every((key) => {
          return (
            d.user === key

          );
        });
      });
      setfilteredData(newData);
    } else {
      setfilteredData(data);
    }
  };

  useEffect(() => {
    modifiedData();
    // SearchFunc();
  }, [keywords]);

  return (
    <>
    <div className="property">
      <h1 className="property-greet">Property Listing</h1>
      {filteredData.map((d) => {
        return <SingleProperty key={d.id} data={d} setkeywords={setKeywords} />;
```

Figure 67 Property List

When navigate to this page or this JavaScript is called, an API will automatically be called to get all the data from the back-end database to show in the front-end. Users can check for various details on the house listed. A more details page will be directed if user click on the listed property. A filter function is applied in this page. User can filter the listed house by uploader's username. As this is created using React, a total of three files are called in a sequential order. Which are PropertyLising, PropertyList, SingleProperty. Basically, the further the files are called, the smaller the components it is, like a sandwich.

9.2.2.13 | Upload Property

```
function UploadForm({}) {

  const [details,setDetails] = useState({title:"",price:"0",state:"",bedroom:"0", bathroom :"0",sqftLiving:"0", floors :"0", waterfront  :"0", sqftAbove :"0", sqftBasement:"0", yearBuilt :"
  const [passwordError, setpasswordError] = useState("");
  const [result, setResult] = useState(0);
  const [floatResult, setfloatResult]  = useState(0);
  const [floatResultMax, setfloatResultMax]  = useState(0);

  const submitHandler = e => {
    e.preventDefault();
    if (details.title ==="" ||details.price ==="0" ||details.state ==="" || details.bedroom === "0" || details.bathroom === "0" || details.sqftLiving === "0" || details.floors === "0" || de
    {
      setpasswordError("Please fill in all forms");
      console.log("Please fill in all forms");
    }

    else{
        uploadPersonalProperty(details)
            .then(res => console.log("Done Uploaded New Property...From Backend"))
            .catch(err => console.log(err))
        setpasswordError("Success! Uploaded new property");
        console.log("Uploaded New Property");
      }
  }
```

Figure 68 Upload Property

This section of code shows the process on how the system add new house data into the database. There will be several inputs to be fill in order to upload. An extra feature where the intelligent house price predictor is also implemented within this page for user to first find the best price before uploading his or her house data with the recommended house price. Validation and error net is also done in this page. Validation is done for this section also.

9.2.2.14 | Delete Property

```
const deleteProperty = () => {
  let propertyKey = {propertykey: details.propertyID, user: UserProfile.getName()}
  deletePersonalProperty(propertyKey)
            .then(
              function (res) {
                setdeleteError("Property Deleted")
              }

              )
            .catch(function (err) {
              if(err === false){
                setdeleteError("Login Sucess!")}
              else{
                setdeleteError("Login Failed")
                }

              })
}
```

Figure 69 Delete code

This part of code will be handling the deleting of house data. User are required to login in order to access this feature. To delete a property, system need to get the propertyID from the user in order to call API for deletion in the backend.

9.2.3 | NodeJS

NodeJS is the middleware or back-end of the system. It will handle the API request from the front-end and process it, determining if to make query request to database or call model for prediction.

9.2.3.1 | Import required modules.

```
var createError = require('http-errors');
var express = require('express');
var path = require('path');
var cookieParser = require('cookie-parser');
var logger = require('morgan');
const bodyParser = require('body-parser');

const fs = require('fs').promises;
const exec = require("child_process").execSync;

//DB API
const {getLoginData} = require('./algo')
const {newUserRegistration} = require('./algo')
const {ExtractUserData} = require('./algo')
const {UpdateUserData} = require('./algo')
const {ExtractPropertyData} = require('./algo')
const {ExtractPersonalPropertyData} = require('./algo')
const {DeletePersonalPropertyData} = require('./algo')
const {InsertPersonalPropertyData} = require('./algo')
const {extractSpecificProperty} = require('./algo')

var indexRouter = require('./routes/index');
var usersRouter = require('./routes/users');
```

Figure 70 API

Same as the previous file's modules are imported.

9.2.3.2 | Setup necessary functions and connection

```
app.set('port', 9000);
app.use(bodyParser.urlencoded({ extended: 'true' }));
app.use(bodyParser.json());

// CORS (Cross-Origin Resource Sharing) headers to support Cross-site HTTP requests
app.all('*', (req, res, next) => {
  res.header('Access-Control-Allow-Origin', '*');
  res.header('Access-Control-Allow-Headers', 'X-Requested-With');
  res.header('Access-Control-Allow-Headers', 'X-Requested-With, X-HTTP-Method-Override, Content-Type, Accept, AUTHORIZATION');
  res.header('Access-Control-Allow-Methods', 'GET, POST, OPTIONS, PUT, DELETE');
  next();
});
////////////////////////////////////////////////////////////////
```

Figure 71 Setup for backend connection

Connections are set up in order to make connection to the front-end and previous the CORS error.

9.2.3.3 | Prediction API

```
//Prediction API
app.post('/prediction-request/',async(req, res) => {

  // function
  console.log("called [/prediction-request/]")
  // get info from post request
  console.log(req.body)

  let filePath = `D:\\Mats\\fyp_backend\\api\\model\\`

  let writeFile = await fs.writeFile(filePath.concat("predictInfo.json"), JSON.stringify(req.body))

  let path = '"D:\\Mats\\fyp_backend\\api\\model\\Model_call.py"'

  let result = exec('python '+path);

  result = result.toString()

  console.log("Prediction completed.")

  res.send({details : "Data recieved for prediction...sending back result...", result : result});
});
```

Figure 72 Prediction API in backend

This is where the prediction Python Script will be called. First the system need to receive data from front-end via API, after that it will send the data to Python script by compiling the data into a JSON file. Within the Python script it will load the JSON file and process the data before sending data into model for prediction. The result will then send back to front-end via API.

9.2.3.4 | Intelligent predictor Python Scripts

```python
#read data file
with open('D:\\Mats\\fyp_backend\\api\\model\\predictInfo.json') as read_file:
    data = json.load(read_file)
#Process data here
try:
    year           = 1
    bedroom        = int(data['bedroom'])
    bathroom       = float(data['bathroom'])
    sqft_living    = int(data['sqftLiving'])
    floor          = float(data['floors'])
    waterfront     = int(data['waterfront'])
    view           = int(data['view'])
    condition      = int(data['conditon'])
    sqft_above     = int(data['sqftAbove'])
    sqft_basement  = int(data['sqftBasement'])
    year_built     = int(data['yearBuilt'])
    year_renovated = int(data['yearRenovated'])
    zipcode        = int(data['zipcode'])
    latitude       = float(data['lat'])
    longtitude     = float(data['long'])

    #set up array
    predictor = [[year, bedroom, bathroom, sqft_living, floor, waterfront, view, condition, sqft_above, sqft_basement,year_built,year_renovated, zipcode,latitude, longtitude]]
    #sample = [[1,  3,  2,  2400,   2.0,    1,  1 , 3 , 1130 ,  1100    ,1979 , 0   ,98052,     47.6307,    -122.088]]

    # load the model from disk
    loaded_model = pickle.load(open("D:\\Mats\\fyp_backend\\api\\model\\finalized_model(1).sav", 'rb'))

    result = loaded_model.predict(predictor)
    #1125954.29
    print(str(result))
```

Figure 73 Python script for running model

This is the Python code for loading of data and model for prediction. Try Catch net is used to catch error. The system will load the JSON file and convert the data into desired type before send into model. If predict success the result will be result if not the error code will be executed.

9.2.3.5 | Database API

```javascript
//LOGIN API
app.post('/login-request/', async(req, res) => {

  console.log(req.body)

  let serverRes = await getLoginData(req.body)
  console.log(serverRes)

  res.send(serverRes)
});
```

Figure 74 Database API

The code above shows how the system connects to the database to do various activities such as insert, delete, and modify of data. This code will be used multiple time will different parameters and queries.

9.2.3.6 | Setting up database.

```
//setup connection
const mysql = require('mysql');

//database config
const dbConnectConfig = {
  connectionLimit: 50,
  host: 'localhost',
  user: 'root',
  password: '',
  database: 'fyp_login_data'
};

const pool = mysql.createPool(dbConnectConfig);
```

Figure 75 Setup for mysql connection

This code snippet shows how the properties are setup before connecting to database. Instead of using connect function, the create pool function is used to connect to database to increase efficiency. The address and username password are setup before connecting. The code on the lower part is to check connection before query to database.

9.2.3.7 | Database query

```
//login
const getLoginData = async(login_data) => {

  console.log("Recived Login Data:",login_data.username)

  let username = login_data.username

  let query = 'SELECT password FROM `user_data` WHERE username="' + username + '"';


  console.log(query)
  return mysql.query(query, username)
  .then(res => {

    return{
      details : JSON.parse(JSON.stringify (res))[0]
    }
  })
  .catch(err => {
    console.log(err)
    return{

      details : JSON.parse(JSON.stringify (err))
    }
  })

}
```

Figure 76 Database query

This section of code is mainly the database query. If an API is called, the selected API will have specific database query which will be within theses functions.

9.2.4 |PhpMyAdmin

9.2.4.1 | XAMPP

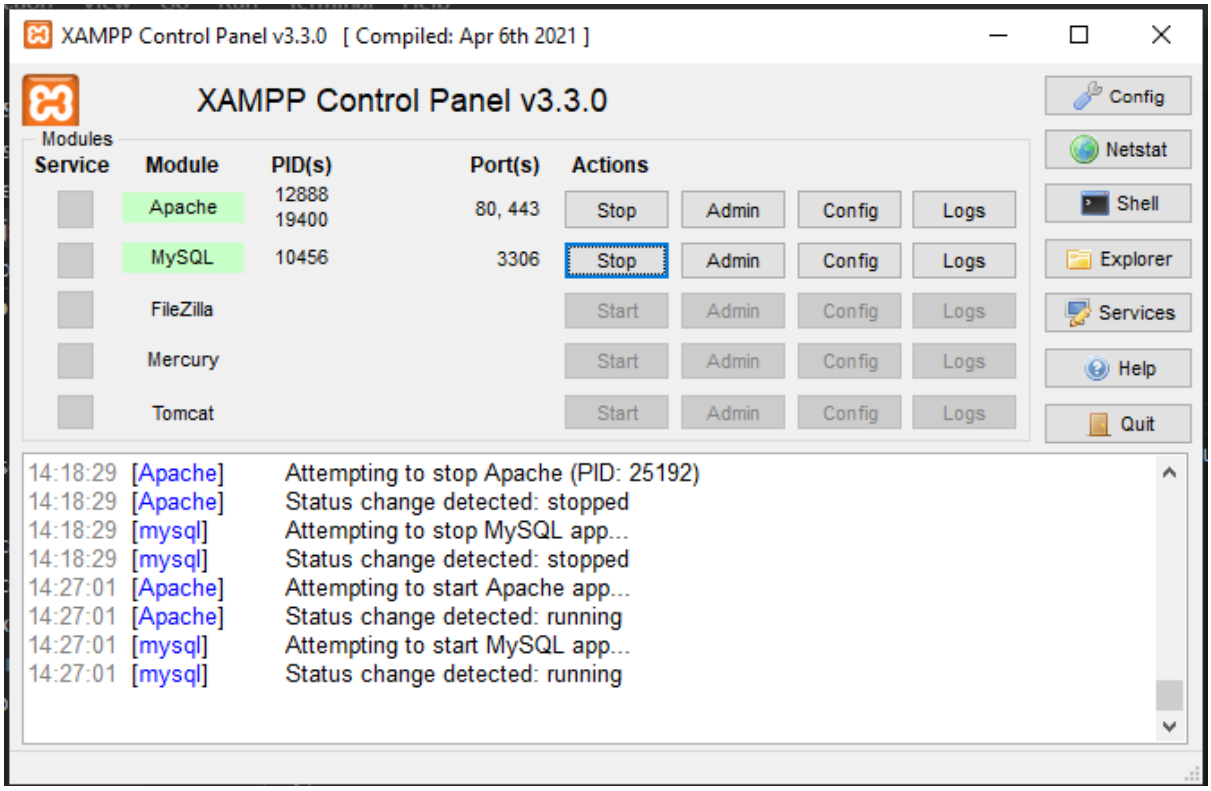
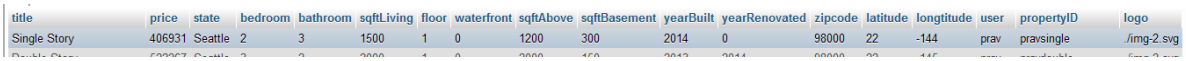


Figure 77 Database host control panel

The diagram above shows the control panel of XAMPP which handles the Apache and Database status. To start both software simply clicks the start button.

9.2.4.2 | Property Database



title	price	state	bedroom	bathroom	sqftLiving	floor	waterfront	sqftAbove	sqftBasement	yearBuilt	yearRenovated	zipcode	latitude	longtitude	user	propertyID	logo
Single Story	406931	Seattle	2	3	1500	1	0	1200	300	2014	0	98000	22	-144	prav	pravsingle	./img-2.svg

The database which stores the data for house. This is accessed using database queries.

9.2.4.3 | User Database

username	email	password
Kin	abcd@mail.com	ancd

The database which stores the data for user. This is accessed using database queries.

Chapter 10: System Validation

10.1 | Unit Testing

10.1.1 | Register New Account

Test ID	Test Description	Test Condition	Expected Result	Actual Output	Pass/Fail
1.1	Click on “Register” button with missing inputs	Username: “” Email “” Password: ‘” Confirm Password: “”	System display “Please Fill in All Forms”	As expected,	Pass
1.2	Click on “Register” button with filled inputs	Username: Kin Email: kin@mail.com Password: 1234 Confirm Password:1234	System display “Register success! Navigate to login to login”	As expected,	Pass
1.3	Click on “Register” button with only Username filled	Username: Kin Email “” Password: ‘” Confirm Password: “”	System display “Please Fill in All Forms”	As expected,	Pass
1.4	Click on “Register” button with only Email filled	Username: “” Email: “kin@mail.com” Password: ‘” Confirm Password: “”	System display “Please Fill in All Forms”	As expected,	Pass
1.5	Click on “Register” button	Username: “” Email: “” Password: 1234	System display	As expected,	Pass

	with only password filled	Confirm Password: “”	“Please Fill in All Forms”		
1.6	Click on “Register” button with mismatch password and confirm password	Username: Kin Email: kin@mail.com Password: 1234 Confirm Password: abcd	System display “Mismatched passwords try again”	As expected,	Pass
1.7	Click on “Register” button with only confirm password filled	Username: “” Email: “” Password: “” Confirm Password: 1234	System display “Please Fill in All Forms”	As expected,	Pass

10.1.2 | Login and Logout

Test ID	Test Description	Test Condition	Expected Result	Actual Output	Pass/Fail
2.1	Click on “Login” button with filled inputs	Username: Kin Password: 1234	System display “Success! Please navigate to login to login” while redirect user to home page	As expected,	Pass
2.2	Click on “Login” button without filled inputs	Username: “” Password: “”	System display “Mismatched password or	As expected,	Pass

			username try again”		
2.3	Click on “Login” button with username only	Username: Kin Password: “”	System display “Mismatched password or username try again”	As expected,	Pass
2.4	Click on “Login” button with password only	Username: “” Password: 1234	System display “Mismatched password or username try again”	As expected,	Pass
2.5	Click on “Logout” button	User logged in	Log out user and redirect to login page	As expected,	Pass
2.6	Click on “here” in “Already have an account? Login HERE”	None	Direct user to login page	As expected,	Pass

10.1.3 | Intelligent House Price Predictor

Test ID	Test Description	Test Condition	Expected Result	Actual Output	Pass/Fail
3.1	Click “Predict” button with empty input	Bedroom:”” Bathroom:”” sqftLiving:”” floors:”” waterfront:”” view:”” condition:””	System display “Invalid input in forms”	As expected,	Pass

		sqftAbove:”” sqftBasement:”” yearBuilt:”” yearRenovated:”” zipcode:”” lat:”” long:””			
3.2	Click “Predict” button with filled input	Bedroom:3 Bathroom: 2 sqftLiving:2500 floors: 2 waterfront: Yes view: 3 condition: 3 sqftAbove:2500 sqftBasement: 200 yearBuilt: 2014 yearRenovated: 0 zipcode: 9800 lat: 22 long: -144	System displays recommended price and price range	As expected,	Pass
3.3	Click “Predict” button with bedroom only filled	Bedroom:1 Bathroom:”” sqftLiving:”” floors:”” waterfront:”” view:”” condition:”” sqftAbove:””	System display “Invalid input in forms”	As expected,	Pass

		sqftBasement:”” yearBuilt:”” yearRenovated:”” zipcode:”” lat:”” long:””			
3.4	Click “Predict” button with Bathroom only filled	Bedroom:”” Bathroom: 2 sqftLiving:”” floors:”” waterfront:”” view:”” condition:”” sqftAbove:”” sqftBasement:”” yearBuilt:”” yearRenovated:”” zipcode:”” lat:”” long:””	System display “Invalid input in forms”	As expected,	Pass
3.5	Click “Predict” button with sqftLiving only filled	Bedroom:”” Bathroom:”” sqftLiving: 2000 floors:”” waterfront:”” view:”” condition:”” sqftAbove:”” sqftBasement:”” yearBuilt:”” yearRenovated:””	System display “Invalid input in forms”	As expected,	Pass

		zipcode:”” lat:”” long:””			
3.6	Click “Predict” button with floors only filled	Bedroom:”” Bathroom:”” sqftLiving:”” floors: 2 waterfront:”” view:”” condition:”” sqftAbove:”” sqftBasement:”” yearBuilt:”” yearRenovated:”” zipcode:”” lat:”” long:””	System display “Invalid input in forms”	As expected,	Pass
3.7	Click “Predict” button with waterfront only filled	Bedroom:”” Bathroom:”” sqftLiving:”” floors:”” waterfront: Yes view:”” condition:”” sqftAbove:”” sqftBasement:”” yearBuilt:”” yearRenovated:”” zipcode:”” lat:”” long:””	System display “Invalid input in forms”	As expected,	Pass

3.8	Click "Predict" button with view only filled	Bedroom:"" Bathroom:"" sqftLiving:"" floors:"" waterfront:"" view:3 condition:"" sqftAbove:"" sqftBasement:"" yearBuilt:"" yearRenovated:"" zipcode:"" lat:"" long:""	System display "Invalid input in forms"	As expected,	Pass
3.9	Click "Predict" button with condition only filled	Bedroom:"" Bathroom:"" sqftLiving:"" floors:"" waterfront:"" view:"" condition: 3 sqftAbove:"" sqftBasement:"" yearBuilt:"" yearRenovated:"" zipcode:"" lat:"" long:""	System display "Invalid input in forms"	As expected,	Pass
3.10	Click "Predict" button with	Bedroom:"" Bathroom:""	System display	As expected,	Pass

	sqftAbove only filled	sqftLiving:”” floors:”” waterfront:”” view:”” condition:”” sqftAbove: 2000 sqftBasement:”” yearBuilt:”” yearRenovated:”” zipcode:”” lat:”” long:””	“Invalid input in forms”		
3.11	Click “Predict” button with sqftBasement only filled	Bedroom:”” Bathroom:”” sqftLiving:”” floors:”” waterfront:”” view:”” condition:”” sqftAbove:”” sqftBasement: 500 yearBuilt:”” yearRenovated:”” zipcode:”” lat:”” long:””	System display “Invalid input in forms”	As expected,	Pass
3.12	Click “Predict” button with yearBuilt only filled	Bedroom:”” Bathroom:”” sqftLiving:”” floors:””	System display “Invalid input in forms”	As expected,	Pass

		waterfront:”” view:”” condition:”” sqftAbove:”” sqftBasement:”” yearBuilt:”” yearRenovated:”” zipcode:”” lat:”” long:””			
3.13	Click “Predict” button with yearRenovated only filled	Bedroom:”” Bathroom:”” sqftLiving:”” floors:”” waterfront:”” view:”” condition:”” sqftAbove:”” sqftBasement:”” yearBuilt:”” yearRenovated: 2015 zipcode:”” lat:”” long:””	System display “Invalid input in forms”	As expected,	Pass
3.14	Click “Predict” button with zipcode only filled	Bedroom:”” Bathroom:”” sqftLiving:”” floors:”” waterfront:”” view:””	System display “Invalid input in forms”	As expected,	Pass

		condition:”” sqftAbove:”” sqftBasement:”” yearBuilt:”” yearRenovated:”” zipcode:98000 lat:”” long:””			
3.15	Click “Predict” button with lat only filled	Bedroom:”” Bathroom:”” sqftLiving:”” floors:”” waterfront:”” view:”” condition:”” sqftAbove:”” sqftBasement:”” yearBuilt:”” yearRenovated:”” zipcode:”” lat: 22 long:””	System display “Invalid input in forms”	As expected,	Pass
3.16	Click “Predict” button with long only filled	Bedroom:”” Bathroom:”” sqftLiving:”” floors:”” waterfront:”” view:”” condition:”” sqftAbove:”” sqftBasement:””	System display “Invalid input in forms”	As expected,	Pass

		yearBuilt:”” yearRenovated:”” zipcode:”” lat:”” long: -144			

10.1.4 | Upload House

Test ID	Test Description	Test Condition	Expected Result	Actual Output	Pass/Fail
4.1	Click “Upload” button with empty input	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated:””, zipcode:””, lat:””, long: ””	System display “Invalid input in forms”	As expected,	Pass
4.2	Click “Upload” button with filled input	Title: Double Story House, Price: 100000, State: Seattle, Bedroom: 3, Bathroom: 2, sqftLiving: 2500,	System display “Uploaded”	As expected,	Pass

		floors: 2, waterfront: No, sqftAbove: 2000, sqftBasement: 500, yearBuilt: 2000, yearRenovated:2013, zipcode: 98000, lat: 22, long: -144			
4.3	Click “Upload” button with Title only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated:””, zipcode:””, lat:””, long: ””	System display “Invalid input in forms”	As expected,	Pass
4.4	Click “Upload” button with Price only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””,	System display “Invalid input in forms”	As expected,	Pass

		sqftBasement:””, yearBuilt:””, yearRenovated:””, zipcode:””, lat:””, long: ””			
4.5	Click “Upload” button with State only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated:””, zipcode:””, lat:””, long: ””	System display “Invalid input in forms”	As expected,	Pass
4.6	Click “Upload” button with Bedroom only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated:””,	System display “Invalid input in forms”	As expected,	Pass

		zipcode:””, lat:””, long: ””			
4.7	Click “Upload” button with Bathroom only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated:””, zipcode:””, lat:””, long: ””	System display “Invalid input in forms”	As expected,	Pass
4.8	Click “Upload” button with sqftLiving only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated:””, zipcode:””, lat:””, long: ””	System display “Invalid input in forms”	As expected,	Pass

4.9	Click "Upload" button with floors only filled	Title:"", Price:"", State:"", Bedroom:"", Bathroom:"", sqftLiving:"", floors:"", waterfront:"", sqftAbove:"", sqftBasement:"", yearBuilt:"", yearRenovated:"", zipcode:"", lat:"", long: ""	System display "Invalid input in forms"	As expected,	Pass
4.10	Click "Upload" button with waterfront only filled	Title:"", Price:"", State:"", Bedroom:"", Bathroom:"", sqftLiving:"", floors:"", waterfront:"", sqftAbove:"", sqftBasement:"", yearBuilt:"", yearRenovated:"", zipcode:"", lat:"", long: ""	System display "Invalid input in forms"	As expected,	Pass
4.11	Click "Upload" button with	Title:"", Price:"", State:"",	System display	As expected,	Pass

	waterfront only filled	Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated:””, zipcode:””, lat:””, long: ””	“Invalid input in forms”		
4.12	Click “Upload” button with sqftAbove only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated:””, zipcode:””, lat:””, long: ””	System display “Invalid input in forms”	As expected,	Pass
4.13	Click “Upload” button with sqftBasement only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””,	System display “Invalid input in forms”	As expected,	Pass

		floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated:””, zipcode:””, lat:””, long: ””			
4.14	Click “Upload” button with yearBuilt only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt: 2000, yearRenovated:””, zipcode:””, lat:””, long: ””	System display “Invalid input in forms”	As expected,	Pass
4.15	Click “Upload” button with yearBuilt only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””,	System display “Invalid input in forms”	As expected,	Pass

		sqftBasement:””, yearBuilt: 2010, yearRenovated:””, zipcode:””, lat:””, long: ””			
4.16	Click “Upload” button with yearRenovated only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated: 2014, zipcode:””, lat:””, long: ””	System display “Invalid input in forms”	As expected,	Pass
4.17	Click “Upload” button with zipcode only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””,	System display “Invalid input in forms”	As expected,	Pass

		yearRenovated:””, zipcode: 98000, lat:””, long: ””			
4.18	Click “Upload” button with lat only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated:””, zipcode:””, lat: 22, long: ””	System display “Invalid input in forms”	As expected,	Pass
4.19	Click “Upload” button with long only filled	Title:””, Price:””, State:””, Bedroom:””, Bathroom:””, sqftLiving:””, floors:””, waterfront:””, sqftAbove:””, sqftBasement:””, yearBuilt:””, yearRenovated:””, zipcode:””, lat:””,	System display “Invalid input in forms”	As expected,	Pass

		long: -144			

10.1.5 | Delete House.

Test ID	Test Description	Test Condition	Expected Result	Actual Output	Pass/Fail
5.1	Click "Update" button with empty input	Property ID: ""	System display "House not found"	As expected,	Pass
5.2	Click "Update" button with filled input	PropertyID: kinSingleStory	System display "House deleted"	As expected,	Pass

10.1.6 | Update Profile

Test ID	Test Description	Test Condition	Expected Result	Actual Output	Pass/Fail
6.1	Click "Update" button with empty input	Email:"" Password:""	System display "Mismatched passwords try again"	As expected,	Pass
6.2	Click "Update" button with filled input	Email: abc@mail.cm Password:1234	System display "Update" and redirect user to home page	As expected,	Pass
6.3	Click "Update" button with email only filled	Email: abc@mail.com Password:""	System display	As expected,	Pass

			"Mismatched passwords try again"		
6.4	Click "Update" button with Password only filled	Email:"" Password:1234	System display "Mismatched passwords try again"	As expected,	Pass

10.1.7 | Property Listing

Test ID	Test Description	Test Condition	Expected Result	Actual Output	Pass/Fail
7.1	Users navigate to Property Listing page	Data from Database	Show all available house from database	As expected,	Pass

10.2 | User Acceptance Testing

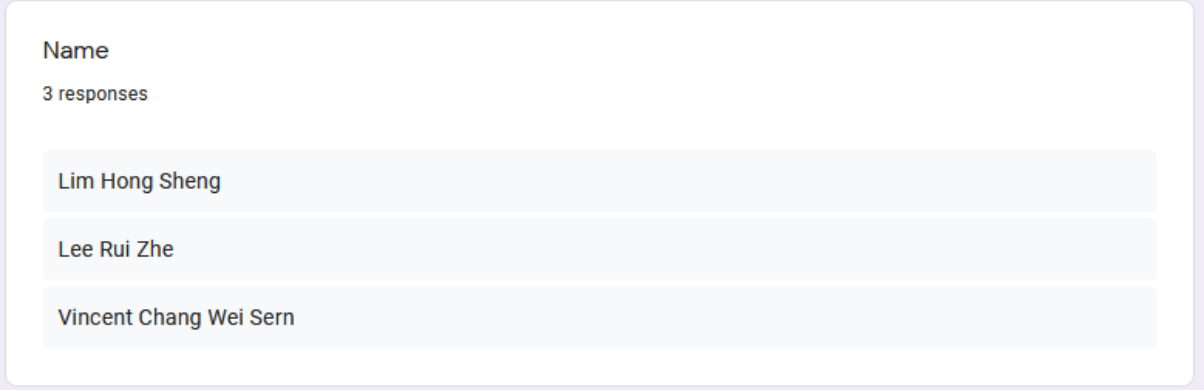


Figure 78 Participants

These are the three testers' name that participated in the UAT or user acceptance testing.

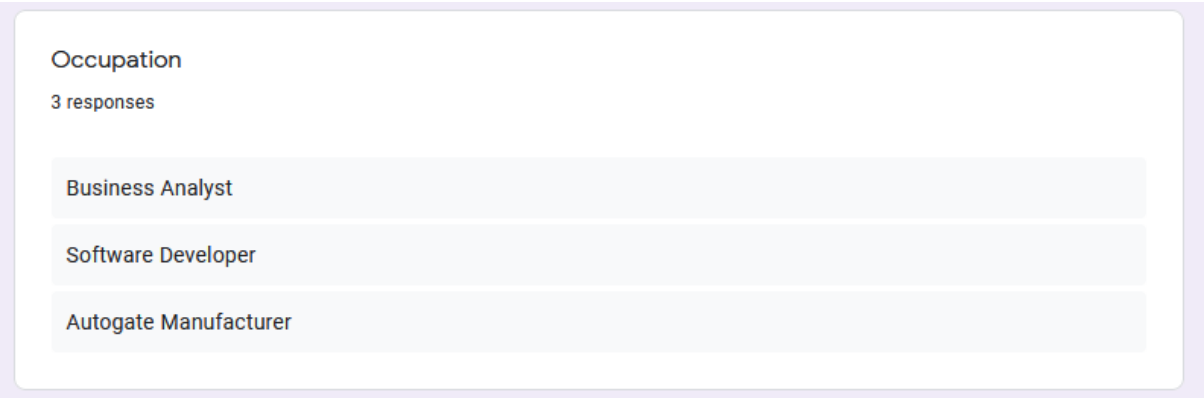


Figure 79 Participants' occupation

These are the three testers' occupations that too part in the UAT for the Property Platform.

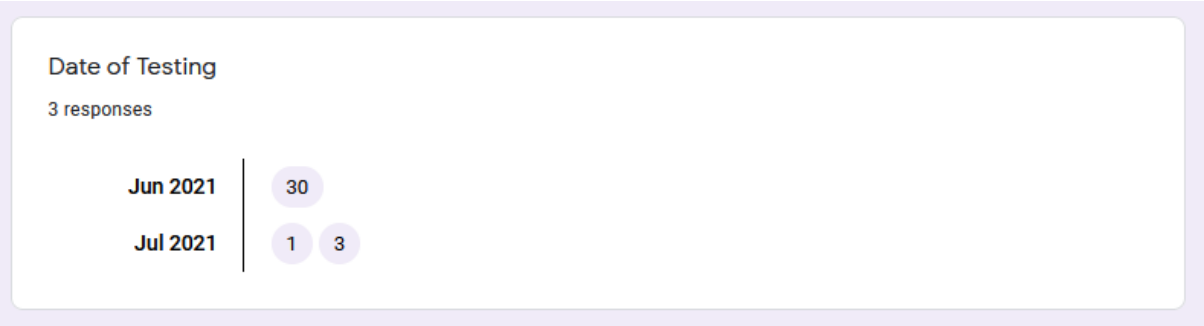
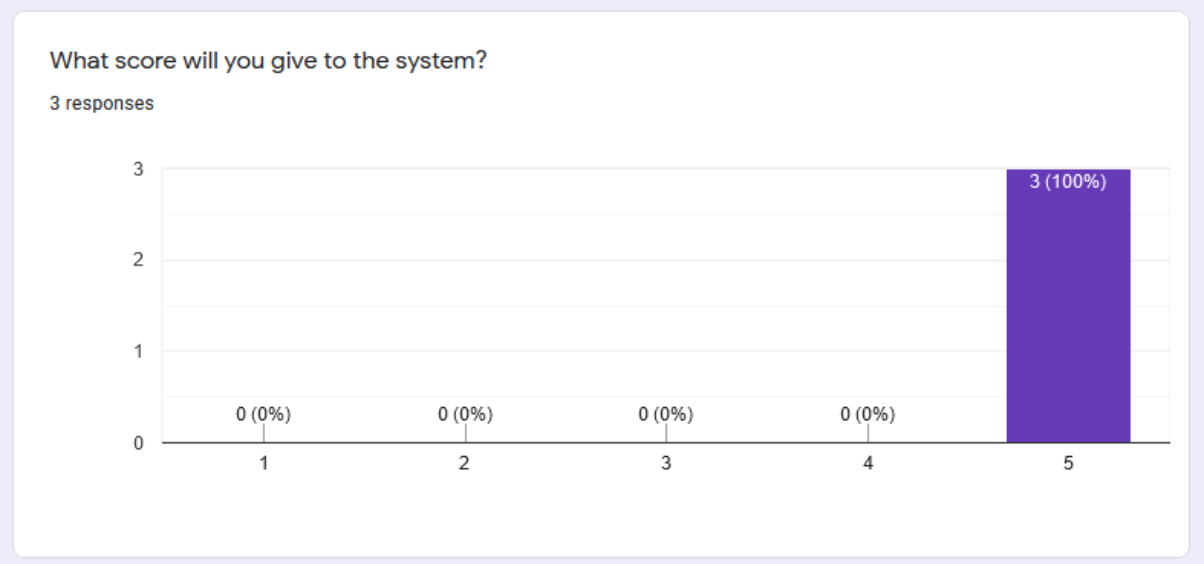


Figure 80 Date

Each participant conducted the testing in separate days.



As we can see the figure above, we can see that the feedback from the 3 testers are good as all of them gave high score for the overall system. With this, we can say that the system is accepted.

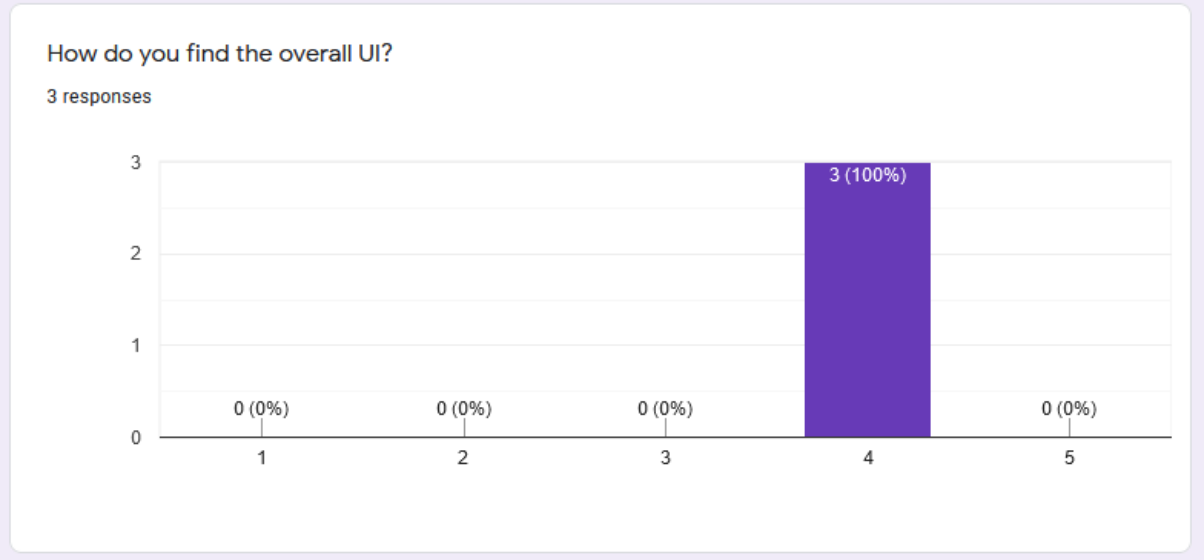
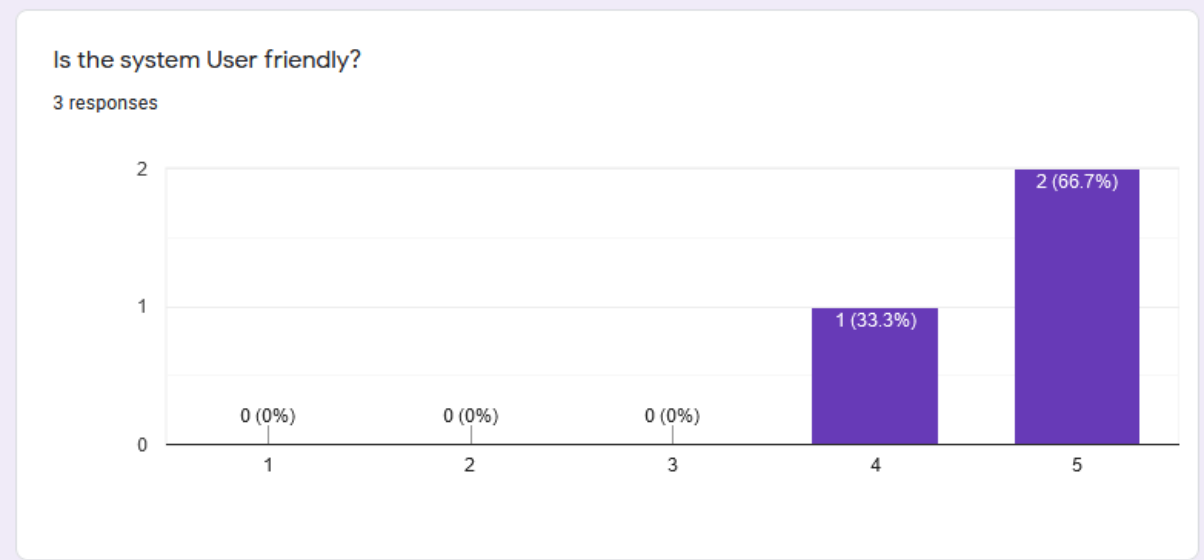


Figure 81 Overall UI score

The figure above shows the rating the testers gave in terms of UI. All of them gave a 4 rating which indicates that the UI have space to improve. Overall it is still accepted.



The above figure shows the feedback on the user friendliness of the system. As we can see the rating is between 4 and 5 which indicates that there is space to improve the system.

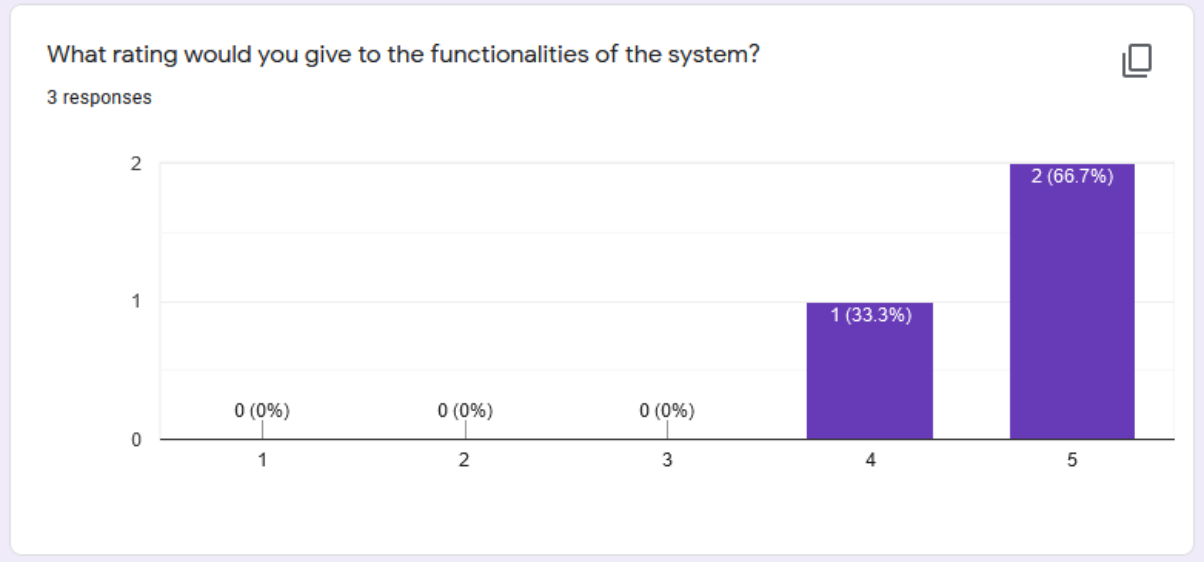


Figure 82 Rating of features in system

The above figure shows that the functionalities within the proposed is system is sufficient but can be more as the rating falls between 4 and 5. More research can be done in other to add more features.

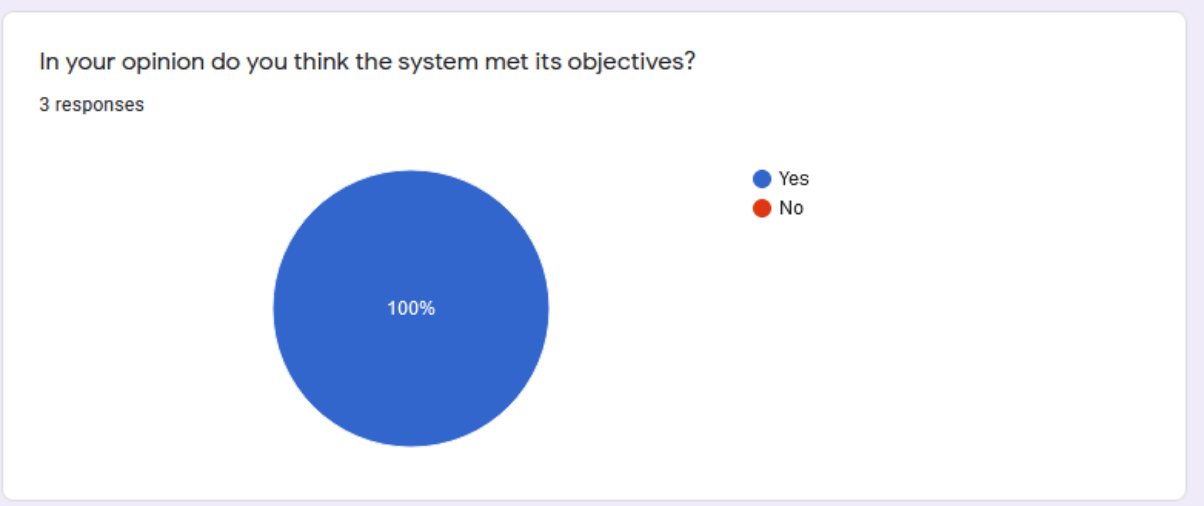


Figure 83 Overall satisfaction

The above pie chart shows the overall acceptance rate from the testers. As we can see all of the testers agreed that the system has met its objectives.

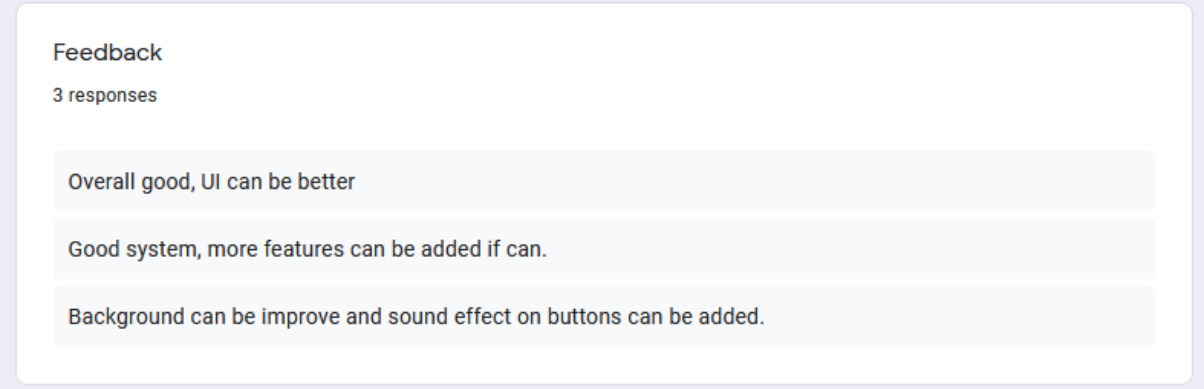


Figure 84 Feedback from participants

Personal opinion and feedback is given by testers on the system. These information will be collected and be used for improvement of the system.

10.3 | Summary

The main objective of unit testing and user acceptance testing is to make sure that the proposed system meet all requirements and can function without any bugs or problem. The proposed system has passed the test as no bugs were found. For the user acceptance test, a quick demonstration has been done with three potential users to get their feedbacks. All of the testers are satisfied, and the system met all requirements. The result of user acceptance test shown have good feedback from them. The testers stated that the system is satisfying but improvements can be done. All in all, it is safe to say that the Property Platform has passed the testing phase.

Chapter 11: Conclusion and Reflections

This will be the final chapter of this report. In this section, conclusion will be drawn, and critical reviews will be provided here. This chapter will also include the researcher's opinion, future work and intentions for this particular project and study.

11.1 Critical Evaluation

In this section summary on the researcher's ideas and critical evolution of the proposed system will be stated. Research will compile his opinion on objectives and benefits of this project and how are they fulfilled, evaluation on the chosen methodology, reflects on the implementation and the challenges and evaluate the effectiveness of the solution.

11.1.1 Objectives and Benefits of the project

The main objective for this very project is to develop a system in which based on the user's input, predicts the most suitable house price for the house the user desired to save them time from filtering through house market data manually and to get maximum profit.

11.1.2 | Methodology

The reason of have a methodology in any project is to have a planned and structured approach when solving the problem. It is one of the essential factor that contribute to a project's success. Having a planned approach can help the developer in completing in task within the time schedule as the methodology provides guides in developing the proposed system. For this project popular data scient methodology CRISP-DM and RAD was used. CRISP-DM was used to during the development of the intelligent model while the structured methodology RAD was used in web development. These two methodologies helped the developer to create the proposed system within the time schedule, helping developer to meet each milestone. Overall, the researcher is very satisfied with the methodologies that we chose and used in this project.

11.1.3 | Implementation evaluation and challenges

Multiple programming languages have been used in this project. Program languages such as Python, JavaScript and Markup Language are used to both create the machine learning model and the website. Python language was use to develop the model as developer has prior knowledge on it and the ease of usage of Python compared to other languages discuss in previous chapters. Another reason is that Python community provides a lot of machine learning libraries which are open source and have support from the community if needed. For the other

languages, even though developer do not have much knowledge on it, much effort have been contribute to learn and use the chosen programming language as programming languages such as JavaScript is one of the efficient way of developing a website. With the help of framework such as REACT, the website is able to be develop and combine with backend using NodeJS, another JavaScript framework. Developer has faced many challenges during the developing of proposed system. With online guides, articles and the broad coding community as will as help from the researcher's mentor and university lecturers, solutions for these challenges are found and the final proposed system was developed.

11.1.4 | Target User Evaluation

During the user acceptance test of the proposed system, the potential users and testers are very satisfied with the solution developed. This takes into account the academic nature of this project and the current pandemic we are all in. Users were very amazed with the UI and user-friendly UX of the proposed system as Property Platform do not require much effort to learn and use. On the other side, the testers did give feedback and advise on the accuracy and limitations of the system and how to prepare it for the real-world market. All in all, testers were happy with the project's achievements, and it is in the correct direction for developing a system that can deploy in the real ever competitive market.

11.1.5 Evaluation Summary

The section above discussed on the critical evaluation of this project according to the developer's perspective and feedback obtained from potential users and project supervisor during the research, developing and testing of proposed system. Further reflections and limitation of the proposed system will be discussing and written in the following section.

11.2 | Conclusion

This research paper is written as a part of an academic project and developed with the aid from project supervisor and lecturers who provided immense support and guidance throughout the development of this project. In the first chapter of the research, the project's background is discuss, same as the problem context, benefits, aim and objectives and deliverables of the project. After that the researcher conduct a detailed literature reviews on related domain and research similar systems that are available in the market now. After that, a technical research is conducted to identify the best technical resources that can be used for this project. The methodologies are research and choose for this project after that. An analysis Is

done after that in order to validate the proposed solution. After this, the details about the system architecture and release plan of project is stated, followed by guides on how the project will be implemented. At the end, the paper discussed the testing and validation test conducted and an evaluation to conclude the research.

11.2.1 | System Limitation

Although the system has met all aims and objectives, there are sill limitations and drawbacks within the proposed system. Firstly, the system uses USA dataset as demonstrations for the house price predictions. This is due to the insufficient data within Malaysia. The second one is the limitation of real time data and real time learning of model. Currently the system does not have ways to obtain daily real time data for external sites due to insufficient funding and insufficient sources. Besides that, retraining of model real time require intensive computational power which developer's machine could not handle. Another one is that proposed system currently runs on local host which is the developer's machine.

11.2.2 | Research Limitation

As there is a strict timeframe for this research and other academic assignments, there were limitations in the research. More data could be collected from analysis to provide a more solid validation and getting a better understanding of the problem. And also due to the pandemic, restrictions were further increases which further reduce the chances of data gathering and research process.

11.2.3 | Future Enhancement Plans

The developers plan to further improve his work beyond the current boundaries of the project to improve the system and fix any limitations that are found. The researcher plans to further this work on the field of machine learning to further understand its working and how it can be implemented in the real-world use cases.

On the system side, developer tend to include more features such as 360 virtual tour, intelligent chatbot and better interactive website to the system in order to make the website better and more interesting. The intelligent of house price can further be improve if more data and better knowledge is obtained.

11.2.4 | Personal Reflections

This research project gave author a chance to improve and develop his research and technical skills that will be very valuable in the related industry. The nature of the project and

strict time schedules have helped the author to manage time well and making a good plan and research are highly valuable skill obtained. Author have plans to continue working in this field and further the research in the field of Artificial Intelligence (AI) to find solutions to solve the difficult problems in the world to contribute to the community.

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Appendices

Library Form

First Name: Chen
Middle Name (only if applicable) :
Last Name: Chee Kin
Title of the Final Year Project / Dissertation / Thesis : "Property Platform" – Your trusted property platform
Abstract : This research project will conduct multiple researches on the affordability of house within Malaysia. A system equipped with intelligent house price prediction model is introduced to help with the prediction of house price to help buyers and seller to have a general view of current market price and the trend.
A few keywords associated with the work : Machine Learning, Regression, House Price Prediction
General Subject: Machine Learning, Prediction

Date of Submission : 14th July 2021

Confidentiality Document

DECLARATION OF THESIS CONFIDENTIALITY

Author's full name: **CHEN CHEE KIN**

IC No./Passport No.: **990430146743**

Thesis/Project title: **PROPERTY PLATFORM, YOUR TRUSTED INTELLIGENT PLATFORM**

I declare that this thesis is classified as:

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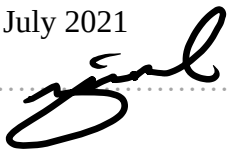
Author's Signature: *chen*

Date: 1 July 2021

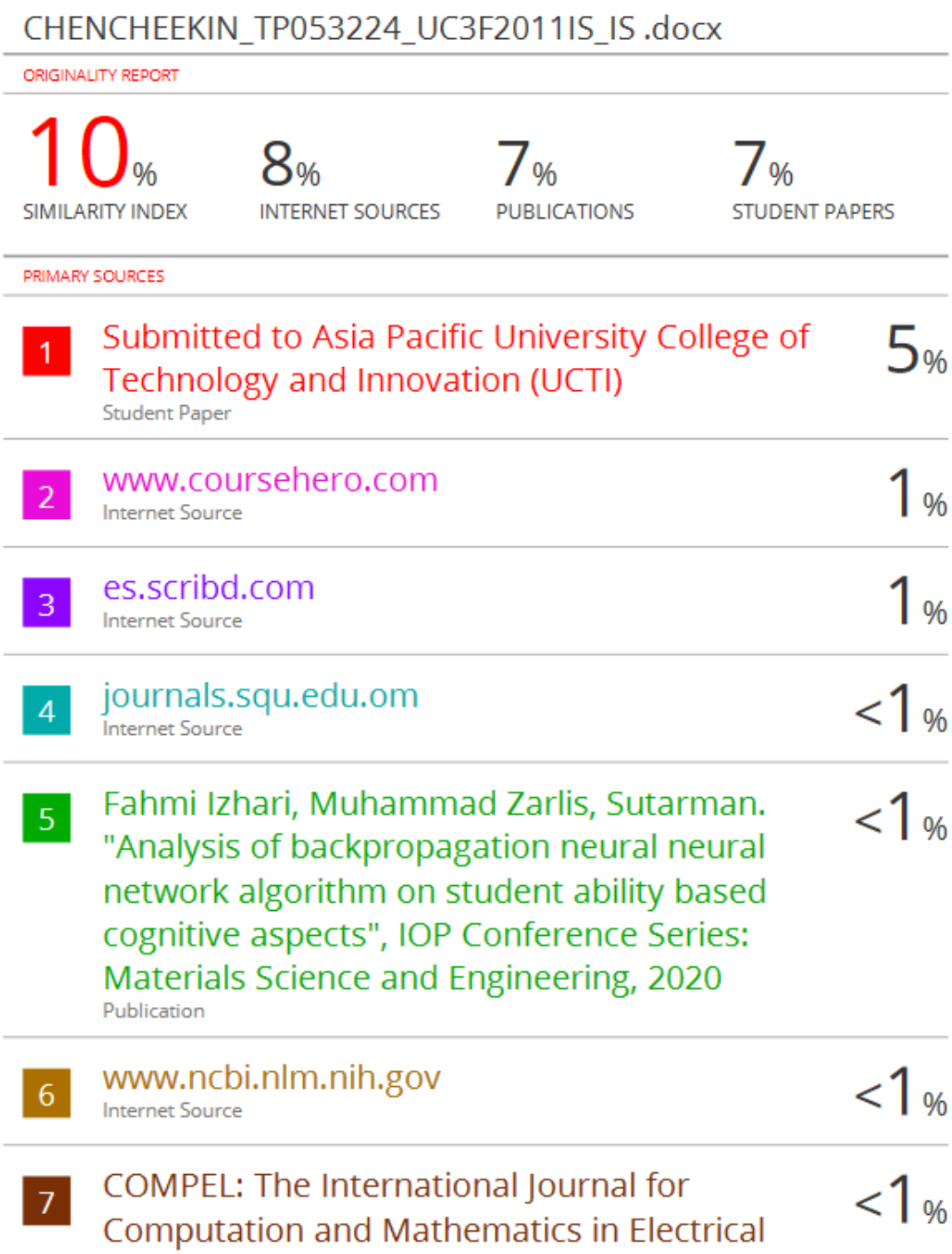
Supervisor's Name: Mr. ZAILAN ARABEE BIN ABDUL SALAM

Date: 13 July 2021

Signature: .....



Turnitin Report



CHENCHEEKIN_TP053224_UC3F2011IS_IS .docx

ORIGINALITY REPORT

10%	8%	7%	7%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Asia Pacific University College of Technology and Innovation (UCTI) Student Paper	5%
2	www.coursehero.com Internet Source	1%
3	es.scribd.com Internet Source	1%
4	journals.squ.edu.om Internet Source	<1%
5	Fahmi Izhari, Muhammad Zarlis, Sutarman. "Analysis of backpropagation neural neural network algorithm on student ability based cognitive aspects", IOP Conference Series: Materials Science and Engineering, 2020 Publication	<1%
6	www.ncbi.nlm.nih.gov Internet Source	<1%
7	COMPEL: The International Journal for Computation and Mathematics in Electrical	<1%

FYP Poster

PROPERTY PLATFORM

Your Intelligent Property Website

A·P·U
ASIA PACIFIC UNIVERSITY
OF TECHNOLOGY & INNOVATION

INTRODUCTION

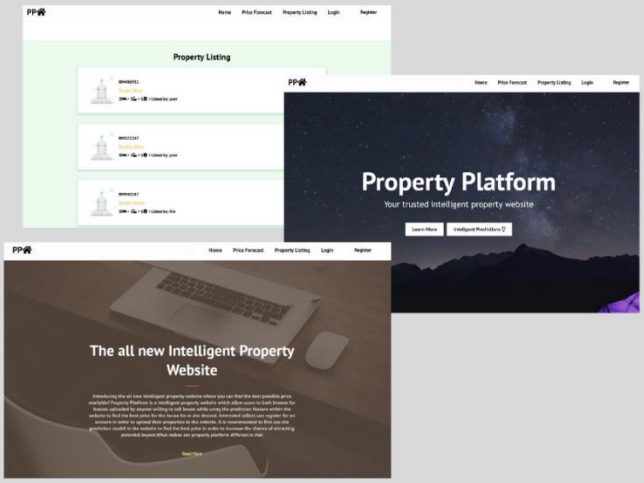
Property is defined as anything that a person owns in which he or she has legal title over item. In here, we describe property as house that a person owns. For a person to own a house in Malaysia, one's Central Credit Reference Information System (CCRIS) and CTOS score needs to be in good condition to apply loan from banks. But in current days owning a house require much preparation, primary cash flow. To help with this problem, developer has come out with a new system to help people to find the best price and reduce their burdens.

PROBLEM

Based on the data provided by Department of Statistics, Malaysia, and Bank Negara Malaysia estimates, most of the household's owner by income are centre between the RM2000 to RM5999 bracket. Their maximum affordable house price is RM247200 for the RM2000 to RM3999 bracket while RM354100 for the RM4000 to RM5999 bracket. These maximum affordable house prices are only below and slightly above the actual median house price. With all these evidence provided, we can see that if a person wants to buy a house, he or she need to know the best price range so they can plan in advance to buy their desired house.

OBJECTIVE

- Conduct analysis to identify house price trend using data received.
- To build a machine learning predictive model to predict house price.
- Provide a platform for users to browse houses upload by sellers.
- Allow users to predict the house price.



HOW IT WORKS?

- User first can use the Intelligent house price predictor to help to get the best price
- User can also upload new house data into the system using the recommended house price.
- Besides that, user can browse through houses posted by other users or their own
- If there are any more inquiries, user can navigate to about page for more info

CONCLUSION

After multple domian researches, the developer found out that people have a hard time trying to find out the perfect prce point for both buying and selling. With this in mind, a property website called Property Platform was developed to tackle this problem. Property Platform is a property website which is equipped with intelligent house price predictor that can save people hours of going through piles of house data to find the perfect price.

Created by
Chen Chee Kin
TP053224
BSc (Hons) in Intelligence System
UC3F2011IS

Supervisor:
Mr. ZAILAN ARABEE BIN ABDUL SALAM
Dr. VINOTHINI KASINATHAN

Project Log Sheet 1

(APU: Serial Number)

PLS V1.0

Project Log Sheet – Supervisory Session

Notes on use of the project log sheet:

1. This log sheet is designed for meetings of more than 15 minutes duration, of which there must be at minimum SIX (6) during the course of the project (SIX mandatory supervisory sessions).
2. The student should prepare for the supervisory sessions by deciding which question(s) he or she needs to ask the supervisor and what progress has been made (if any) since the last session, and noting these in the relevant sections of the form, effectively forming an agenda for the session.
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7. The log sheet is an important deliverable for the project and an important record of a student's organisation and learning experience. The student **must** hand in the log sheets as an appendix of the final year documentation, with sheets dated and numbered consecutively.

Student's name: ……Chen Chee Kin…….. **Date:…..18/12/2020……Meeting No: ……1...**

Project title: …Forecasting Housing Price with Machine Learning…**Intake:**……UC3F2011IS…

Supervisor's name: …Zailan Arabee Bin Abdul Salam……. . **Supervisor's signature:** ……..…..

Items for discussion (noted by student before mandatory supervisory meeting):

1. Difference between Matlab and available ML library provided online(Tensorflow, PyTorch, etc.)
2. Guide on how complete a system needs to be done, for example, what should be included in a complete working system
3. Enquiry on amount of data sets need to gather, its sources and validation of data
4. Verification of proposed title and seek advice on what data to gather.

Record of discussion (noted by student during mandatory supervisory meeting):

1. Got a better understanding of the difference of each available tools for both machine learning and data gathering.
2. System needs to be useful in order to be qualified as a good system. It needs to solve the main problem statement.
3. A better understanding of what needs to be done and what needs to gather in order to complete the FYP. A clearer picture of objective and problem.
4. Various research need to be done in order to fully understand the chosen field of research.

Project Log Sheet

Action List (to be attempted or completed by student by the <u>next</u> mandatory supervisory meeting):

1. Research on which machine learning method to choose, preferably neural network.

2. Research to be done on what data, parameters to feed into chosen machine learning algorithm for forecasting housing prices.

3. Setup all required tools, platform and materials for creation of system such as programming language to use, platform for model training and data sets.

5. Begin PSF and IR for next FYP phase.

Note: A student should make an appointment to meet his or her supervisor (via the consultation system) at least ONE (1) week prior to a mandatory supervisor session – please see document on project timelines. In the event a supervisor could not be booked for consultation, the project manager should be informed ONE (1) week prior to the session so that a meeting can be subsequently arranged.

Project Log Sheet

Project Log Sheet 2

(APU: Serial Number)

PLS V1.0

Project Log Sheet – Supervisory Session

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Student's name: ……Chen Chee Kin…….. **Date: …15/1/2020…Meeting No: ……2...**

Project title: ……Forecasting Housing Price with Machine Learning……**Intake:** …UC3F2011IS

Supervisor's name: ……Zailan Arabee Bin Abdul Salam…. **Supervisor's signature:** ……

Items for discussion (noted by student before mandatory supervisory meeting):

1. Update on currently status and next phase of FYP.
2. Question on datasets to use.
3. Features to add into website.
4. Viable features to add into website

Record of discussion (noted by student during mandatory supervisory meeting):

1. Decided on what datasets to use, which region to use.
2. Have a better view on what features to focus.
3. Update mentor on currently status of FYP
5. Literature review needs to be done on multiple fields of study.
6. Surveys and interview need to be prepared and done

Action List (to be attempted or completed by student by the next mandatory supervisory meeting):

1. Proceed with Investigation Report (IR)
2. Literature Review on multiple fields of studies
3. Continue research on coding and technical stuff.
4. Surveys and interview

Project Log Sheet

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Project Log Sheet

Project Log Sheet 3

(APU: Serial Number)

PLS V1.0

Project Log Sheet – Supervisory Session

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Student's name: …… Chen Chee Kin …….. **Date: 23/02/2021…Meeting No: …3…...**

Project title: Forecasting Housing Price with Machine Learning ……**Intake:** UC3F2011IS

Supervisor's name: Zailan Arabee Bin Abdul Salam **Supervisor's signature:** ……..…..

Items for discussion (noted by student before mandatory supervisory meeting):

1. Update on going status and what to do next for FYP
2. Verify if requirement validation has enough method
3. Ask questions on Literature Review
4. Questions on the number of programming languages required to write in IR report

Record of discussion (noted by student during mandatory supervisory meeting):

1. Better understanding on Literature review
2. Improvement of current literature review
3. Chosen programming language for FYP

Action List (to be attempted or completed by student by the next mandatory supervisory meeting):

1. Modify IR report
2. Continue to finish IR report

Note: A student should make an appointment to meet his or her supervisor (via the consultation system) at least ONE (1) week prior to a mandatory supervisor session – please see document on project timelines. In the event a supervisor could not be booked for consultation, the project manager should be informed ONE (1) week prior to the session so that a meeting can be subsequently arranged.

Project Log Sheet

Project Log Sheet 4

(APU: Serial Number)

PLS V1.0

Project Log Sheet – Supervisory Session

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Student's name: …… Chen Chee Kin …….. **Date: 19/05/2021…Meeting No: …4…...**

Project title: Forecasting Housing Price with Machine Learning ……**Intake:** UC3F2011IS

Supervisor's name: Zailan Arabee Bin Abdul Salam **Supervisor's signature: ……..…**

Items for discussion (noted by student before mandatory supervisory meeting):

1. Updates on going status and what to do next for FYP
2. Present pre-trained model
3. Ask questions on GUI and model

Record of discussion (noted by student during mandatory supervisory meeting):

1. Check if the model is working as intended
2. Designing of GUI

Action List (to be attempted or completed by student by the next mandatory supervisory meeting):

1. Developing of GUI
2. Developing of database and API to connect all together

Note: A student should make an appointment to meet his or her supervisor (via the consultation system) at least ONE (1) week prior to a mandatory supervisor session – please see document on project timelines. In the event a supervisor could not be booked for consultation, the project manager should be informed ONE (1) week prior to the session so that a meeting can be subsequently arranged.

Project Log Sheet

Project Log Sheet 5

(APU: Serial Number)

PLS V1.0

Project Log Sheet – Supervisory Session

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Student's name: …… Chen Chee Kin …….. **Date: 22/06/2021…Meeting No: …5…...**

Project title: Forecasting Housing Price with Machine Learning ……**Intake:** UC3F2011IS

Supervisor's name: Zailan Arabee Bin Abdul Salam **Supervisor's signature:** ……

Items for discussion (noted by student before mandatory supervisory meeting):

1. Updates on going FYP progress
2. Check if website is good enough
3. Ask questions on GUI

Record of discussion (noted by student during mandatory supervisory meeting):

1. Check if the website is working
2. Modification of GUI

Action List (to be attempted or completed by student by the next mandatory supervisory meeting):

1. Finishing of website
2. Writing of documentation

Note: A student should make an appointment to meet his or her supervisor (via the consultation system) at least ONE (1) week prior to a mandatory supervisor session – please see document on project timelines. In the event a supervisor could not be booked for consultation, the project manager should be informed ONE (1) week prior to the session so that a meeting can be subsequently arranged.

Project Log Sheet

Project Log Sheet 6

(APU: Serial Number)

PLS V1.0

Project Log Sheet – Supervisory Session

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7. The log sheet is an important deliverable for the project and an important record of a student's organisation and learning experience. The student **must** hand in the log sheets as an appendix of the final year documentation, with sheets dated and numbered consecutively.

Student's name: …… Chen Chee Kin …….... **Date: 30/06/2021…Meeting No: …6…...**

Project title: Forecasting Housing Price with Machine Learning ……**Intake:** UC3F2011IS

Supervisor's name: Zailan Arabee Bin Abdul Salam **Supervisor's signature:** ……

Items for discussion (noted by student before mandatory supervisory meeting):

1. Updates on going FYP progress
2. Show final developed system
3. Ask for advise

Record of discussion (noted by student during mandatory supervisory meeting):

1. Ask for comments on system
2. Writing of report

Action List (to be attempted or completed by student by the next mandatory supervisory meeting):

1. Finishing of report
2. Writing of documentation

Note: A student should make an appointment to meet his or her supervisor (via the consultation system) at least ONE (1) week prior to a mandatory supervisor session – please see document on project timelines. In the event a supervisor could not be booked for consultation, the project manager should be informed ONE (1) week prior to the session so that a meeting can be subsequently arranged.

Project Log Sheet

Project Proposal Form (PPF)

FYP Title

Forecasting Housing Prices using Machine Learning method

Introduction

In this globalization era, our technology knowledge has enabled us to create both massive and amazing houses. Houses in today's era compared to the older days wooden house are like day and night. With that said, the pricing for each house also varies a lot compared to the older days. Clients who wanted to buy a house should consider the house location and other factors to find the best price. To find the best price, much research needs to be done in order to find the right price. Even we can easily obtain data for these areas from the web, often there are too many data and statistic that will confuse the researcher. With this in mind, a software to forecast the housing prices as a solution to the mentioned problem was born.

Problem Statement

1. Human Limitation

The main tools we have to predict house price is us human ourselves. To predict house prices, we would need to obtain data from different source, filter it and compile it in order to generate a result or prediction. As time goes on, our technology skill increases, more buildings are built which generated more and more data. This will cause problems for us human to process all these data as our human brain could not keep up to the demanding of needs in today's world to do the prediction ourselves (Brian&Hokyoung, 2007).

a. Manual Processing of data to predict housing prices is too slow.

Manual filter, processing of data takes a good amount of time for a human to complete it compared to human. To overcome this, machine can be used as an alternative to overcome this problem.

b. Manual Processing of data to predict housing prices is not accurate.

Sometime when processing data, a human might miscalculate, or other human factor will also lead to inaccuracy of prediction. This will not be a problem when processing small amount of data but when the data increases, it might cause human error such as calculating the number

using the wrong variable or amount which will reduce accuracy of the result (Jaeyoung&Howard etc.,2013).

c. Too much data for a human to process.

Human has limited capabilities on process large amount of data compare to machine. This has no problem to machine as there are capable to process large amount of repeating task. Other than that, machine has also proved to be more efficient at processing these data (Brian&Hokyoung, 2007).

Project Aim

To reduce burden of human by processing all data required to predict future housing prices.

Project Objectives

1. To process data from difference source to identify current housing market.
2. To reduce burden of human by helping them to process all the housing market data.
3. To overcome human limitation by using machine
4. To use processed data to predict future housing prices.

Literature Review

Based on the report "House Price Prediction " by Ahmad Abdulal and Nawar Aghi in 2020, they have tried to using machine learning regression algorithms and Artificial Neural Network (ANN) to predict the house price and found out that lasso method which is under the regression algorithm category has a better performance (Ahmad&Nawar, 2020).

In another research paper done by QuangTruong and his team, they found out that the existing house price predictors are based on House Price Index (HPI) and other common factors such as area, population but these predictors use traditional machine learning method, and they also

did not put much attention to the performance of individual models and neglect the less popular yet complex models (Quang&Bo etc.2020).

Deliverables

A fully functional robot advisor equipped with machine learning model where it is used to predict housing prices for certain areas that will be chosen by user.

Project Specification Form (PSF)

FYP Title

Forecasting Housing Prices using Machine Learning method

Brief description on project background

Problem Context

Malaysia, a country with GDP of 6.0 and labelled as a developing country by the International Monetary Fund , have been rapidly developing its land with various breath-taking building and residential housing. an essential for us humans. The improving of lifestyle of Malaysian has increase in demand for residential houses. For people for are new to purchasing households or new to a particular area, they often do not have the knowledge on the price range for house in different areas. This will cause seller to setup prices they want without being verified by anyone which, in turn will disrupt the average price range of household for that area. On the other hand, new seller who want to sell house will not have the knowledge on the current price range and has no idea how to set a sui price. If the price is set too high, no buyers will show up while putting to low will cause the seller to loss some of his or her property value. For those who are experience, they still need to go through many data from many different sources in other to process and filter the data they want to find out the average price range. Besides that, human also make mistakes which will greatly reduce the accuracy of the price. Furthermore, it will take a lot of manpower to process large amount of data which compare to machine, is a very simply task. Although there are many Malaysia property website available on the internet today, there are still no platform which contains a robot advisor to both advise the seller what price to put to gain maximum profit and to tell the buyer what the best price is he or she can get in a specific area. Furthermore, most property website only provide image of the property. This sometimes discourage buyers from gaining interest as they cannot have a 360 view of the house. 360 camera views can be implemented to solve this problem.

Rationale

As the problem stated above, a property platform equipped with artificial intelligence robot advisor will be a standalone web application which allow both buyers and sellers to post houses that are for sold and buying. Robot advisor integrated with machine learning and 360 view camera features can be included on the website to give users a better experience. Users can make use of the robot advisor on the website to check the best price for the house of their choice in a specific area or just to get to know the fundamental of buying or selling property. The advantage will prevent new users from buying or selling houses at disadvantages and the robot advisor can advise them on how to sell or buy to gain maximum profit. Besides that, the website can also be a platform for sellers and buyers to communicate and have a view of the houses they are interested since the pandemic recently has cause inconvenient for travelling.

Tangible Benefits:

- Cost saving, resources can be saved as users do not required to drive or take any transportation to the house he or she are interested as they can view the house using the picture posted by seller.
- Reduce workload from people who are doing the processing of household data.
- Cost and time efficient as it reduces the cost for hiring people to process the data and reduce time required to filter and process the data as machine can do it faster and better.
- Allow users to have a fundamental of selling or buying property to prevent fraud or miscommunication.

Intangible Benefits:

- A greener environment as this website can help to reduce the use of transportation, this makes the user happier for contributing to help the environment.
- Regulate the average price for houses as the robot advisor can help to suggest the best price at a specific timeline in a specific location.

Nature of Challenge

Firstly, the user browsing experience is the priority I need to fulfil as they website will be used by different users, and they will view the website in different screen resolution, browser, and

devices. Furthermore, if a user is using his or her smartphone to browse the website, a micro site will need to be created which will be a great challenge. Another important and difficult challenge will be the security of the website. Prevention SQL injection, and encryption of the user's information will be some of the methods taken consideration to increase the level of security of the website. Backend server and will need to be develop and maintain to ensure the website is up 24/7.

Brief description of project objectives

Deliverables

Property Platform – Your trusted property platform allows users to buy, sell houses while being assist by a machine learning integrated robot advisor. This website can predict the house price for a particular area in particular time and inform the user about the predicted price range. Users can then use this info to setup selling price or buy the house within the price range to maximise their profit. This can help to reduce burden of the users from going through all the raw data to filter and process the data themselves to know the price range for a house.

Below are functions and aim of the system which need to be accomplished before delivering.

For all end-users:

- Allow end-users to register, login and logout from the website.
- Allow end-users to use the platform to communicate with each other.
- Allow end-users to browse the houses uploaded to the website.
- Allow end-users to view the image posted by sellers.
- Inform users about the price range of the house they choose.
- Allow users to take advantage of robot advisor to teach the fundamental of house prices to new users.
- Allow sellers to upload diagram to website for advertising.

Besides that, the additional features of the system are as follows.

- Robot advisor integrated with machine learning to predict house prices

- Guide users to use the website with robot advisor
- Allow users to chat on the website
- Reminder on house price changes

Apart from that, the special features of the system will be added if there is any extra time.

- 360 image views of the house
- Friend list for users to use.
- Allow email notification on new house advertisement being setup
- Allow SMS notification of new house or house price changes

Brief description of the resources needed by the proposal.

Hardware

The minimum requirements of hardware to meet the objectives of the systems and maintain the website are as follows:

- Keyboard and Mouse
- Router
- Working Personal Computer or Laptop

Software

Minimum software requirement for the development, maintenance, use and execution of the project are as below:

Code Editor and Database Management System (DBMS)

- Notepad++
- Visual Code 2019
- MySQL Version 8.0.22 or phpMyAdmin 8.0.1

Server-Side Scripting, Web Server, and File Transfer Protocol (FTP) Software

- PHP 8.0.1

- Apache 2.4

Documentation and Planning

- Microsoft word 2019
- Microsoft project 2019
- Microsoft excel 2019.
- Google Drive

Access to information / expertise

Developing phase of the website will require aid and guide from IT experts from multiple fields such as web application, website security, machine learning and a few more. Information can also be gather using interviews and surveys from multiple departments such as the students, staff, and lectures of APU.

User Involvement

People who will be involved are those who are interested in buying or selling houses and more importantly those who are interested in the price of houses for a specific area at a specific time. Interviews and surveys will be done to those who are interested in house prices and those who are interested in selling or buying houses. These users will also be asked to participate in usability testing.

Academic research being carried out and other information, techniques being learned.

To carry out deliverables, the books and web pages I will study are as follows,

Books

- Name: CSS: The Missing Manual

  Author: David Sawyer McFarland

  Publisher: Reilly Media

- Name: Learning PHP 5

Author: David Sklar

Publisher: OReilly Media

- Name: HTML5: Up and Running

Author: Mark Pilgrim

Publisher: OReilly Media

- Name: JavaScript, A Beginners Guide, Third Edition (Beginners Guide (Osborne Mcgraw Hill))

Author: John Pollock

Publisher: McGraw-Hill Osborne Media

- Name: Learning React: Functional Web Development with React and Redux

Author: Alex Banks and Eve Porcello

Publisher: OReilly Media

Online Resources (Journals)

- Truong, Q., Nguyen, M., Dang, H. & Mei, B. (2020). Housing Price Prediction via Improved Machine Learning Techniques. Procedia Computer Science. 174. pp. 433-442. Available from: [Accessed: 13 January 2020].

- Abdul Rahman, M. & Ridzuan, A. (2020). Factors that Determine House Price Index in Malaysia. International Journal of Academic Research in Accounting, Finance and Management Sciences. 10 (1). Available from: [Accessed: 10 January 2020].

• Abhishek, K., Singh, M., Ghosh, S. & Anand, A. (2012). Weather Forecasting Model using Artificial Neural Network. Procedia Technology. 4. pp. 311-318. Available from: [Accessed: 10 January 2020].

• Baboo, S. & Shereef, I. (2010). An Efficient Weather Forecasting System using Artificial Neural Network. International Journal of Environmental Science and Development. pp. 321-326. Available from: [Accessed: 12 January 2020].

Brief description of the development plan for the proposed project.

System Development Methodology

System development is defined as the task of defining, design, test and implementing a software application (Systems Development Methods and Tools, 2013). There are many different system development methods and each of them have different number and type of phases. The most sui methodology for this project will be the RAD methodology or Rapid Application Development Methodology. This methodology is considered one of the agile project management strategy in software development. The key benefit of RAD is fast project turnaround which is sui in a fast-paced environment like software development . In RAD there are 4 phases, planning, designing, constructing and cutover. These phases are key component in RAD to achieve smooth and fast software development. In planning phase, aim and objectives will be confirmed, and setup, workflow and schedule will be created for smooth developing phase. Design phase is the bread and butter of the RAD methodology which set apart other methodology. In this phase, clients work together with developers to discuss with the clients their needs on the design process. Which in this project will be the users who agreed to do the usability testing? The next phase is the construction phase which is the coding phase. The task in the phase will be break down multiple steps such as coding and system testing. The last phase will be implementation phase which the multiple users will be asked to conduct the usability testing.

Brief description of the evaluation and test plan for the proposed project

Success Criteria

The objective of Property Advisor property platform Is to create a platform for multiple users which include a house price predictor and a robot assistant to educate new users. Besides that, this platform is for people who are interested in selling and buying property but with a new feature where a robot advisor is included to recommend the best price. A few users are selected to conduct the stated testing to make sure the system is working.

Unit Testing

For unit testing, the software will be broken down several units to conduct the testing. This is to ensure the tested unit lines up with the deliverables. Units such as login page, register page, interacting with robot advisor will be tested separately. For example, when register, user should have a username contain characters from 5-10. All these units must be tested before implementing the real system.

Integration Testing

For integration testing, multiple tested units from unit testing phase will be combined a component. For example, a user can register using the registration page which will send the data to backend and login using the login page which will take the data from backend to the frontend. Dummy data will be used in this testing to check for the functionality of the units and make sure they align with the deliverables.

Usability Testing

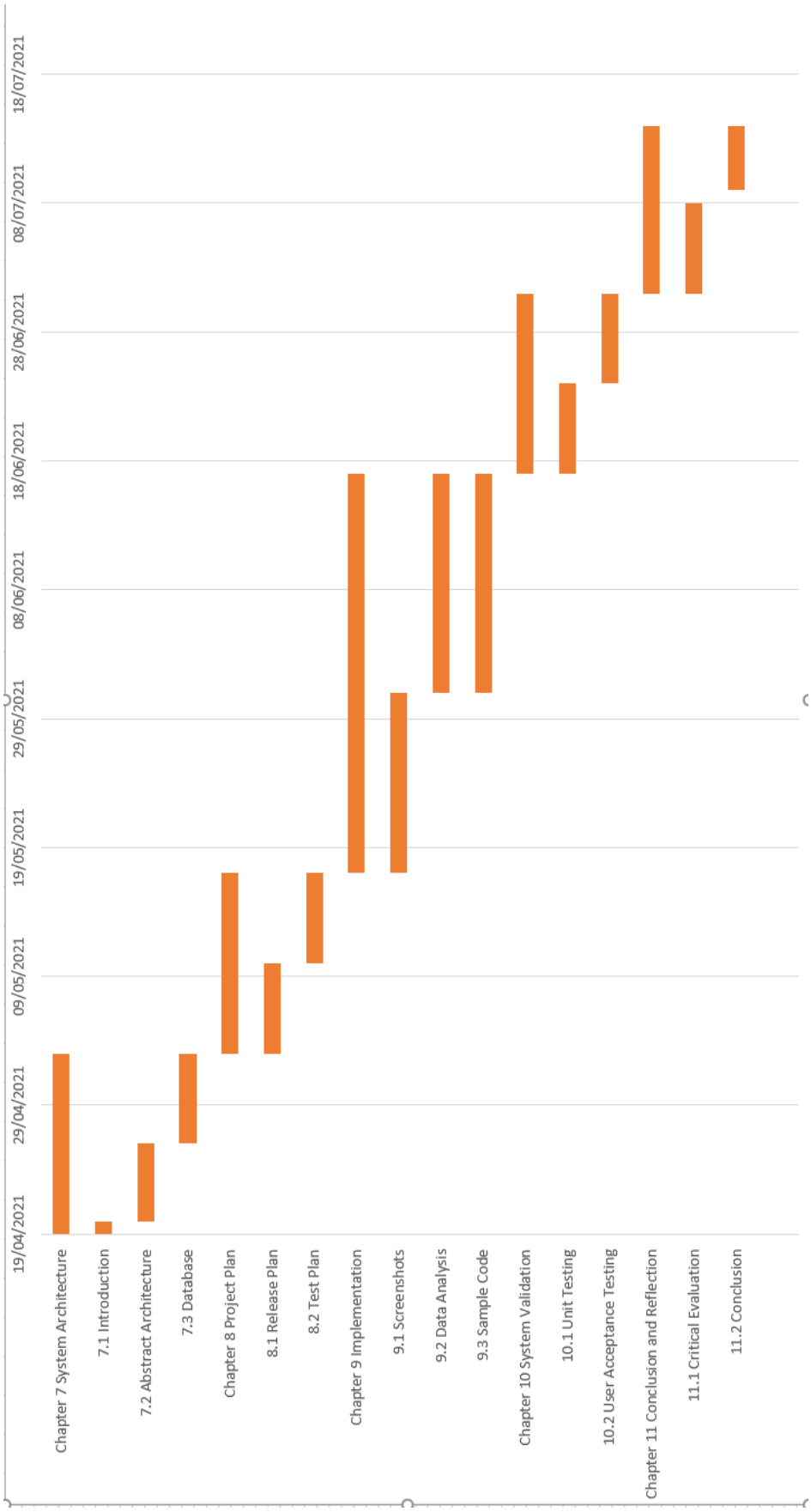
In usability testing, the main priority is the satisfaction level of the users. Actual data will need to be by participates during this testing phase to use the system. Evaluation on the system based on multiple factors will be done. Some of the factors are the graphical user interface of the website, the accessibility of the website and the font size or font colour. Modification will be done according to the feedback given by the participant after the testing phase.

Gantt Chart

Semester 1

Task \Time	January		February				March	
	20 Jan 2021	24 Jan 2021	25 Jan 2021	10Feb 2021	11 Feb 2021	15 Feb 2021	16 Feb 2021	28 Feb 2021
Introduction to the study								
Literature Review								
Technical Research								
System Development Methodology								
Research Methods								
Requirements Validation								
Conclusion and Reflections								

Semester 2


19/04/2021
29/04/2021
09/05/2021
19/05/2021
29/05/2021
08/06/2021
18/06/2021
28/06/2021
08/07/2021
18/07/2021
Chapter 7 System Architecture
7.1 Introduction
7.2 Abstract Architecture
7.3 Database
Chapter 8 Project Plan
8.1 Release Plan
8.2 Test Plan
Chapter 9 Implementation
9.1 Screenshots
9.2 Data Analysis
9.3 Sample Code
Chapter 10 System Validation
10.1 Unit Testing
10.2 User Acceptance Testing
Chapter 11 Conclusion and Reflection
11.1 Critical Evaluation
11.2 Conclusion

Fast Track Ethical Approval Form

Office Record	Receipt – Fast-Track Ethical Approval
Date Received:	Student name: Student number:
Received by whom:	Received by: Date:

APU / APIIT FAST-TRACK ETHICAL APPROVAL FORM (STUDENTS)

Tick one box (level of study):
- ☐ POSTGRADUATE (PhD / MPhil / Masters)
- ✔ UNDERGRADUATE (Bachelors degree)
- ☐ FOUNDATION / DIPLOMA / Other categories

Tick one box (purpose of approval):
- ✔ Thesis / Dissertation / FYP project
- ☐ Module assignment
- ☐ Other: _____

Title of Programme on which enrolled … BSc(Hons) in Intelligence Systems… …

Tick one box: ✔ Full-Time Study or ☐ Part-Time Study

Title of project / assignment … Property Platform – "Your trusted intelligent property website"

Name of student researcher … … … Chen Chee Kin … … … … … … … …

Student Researchers- please note that certain professional organisations have ethical guidelines that you may need to consult when completing this form.

Supervisors/Module Lecturers - please seek guidance from the Chair of the APU Research Ethics Committee if you are uncertain about any ethical issue arising from this application.

		YES	NO	N/A
1	Will you describe the main procedures to participants in advance, so that they are informed about what to expect?	✔		
2	Will you tell participants that their participation is voluntary?	✔		
3	Will you obtain written consent for participation?	✔		
4	If the research is observational, will you ask participants for their consent to being observed?	✔		
5	Will you tell participants that they may withdraw from the research at any time and for any reason?			✔
6	With questionnaires and interviews will you give participants the option of omitting questions they do not want to answer?	✔		
7	Will you tell participants that their data will be treated with full confidentiality and that, if published, it will not be identifiable as theirs?	✔		
8	Will you give participants the opportunity to be debriefed i.e. to find out more about the study and its results?			✔

If you have ticked **No** to any of Q1-8 you should complete the full Ethics Approval Form.

		YES	NO	N/A
9	Will your project/assignment deliberately mislead participants in any way?		✔	
10	Is there any realistic risk of any participants experiencing either physical or psychological distress or discomfort?		✔	
11	Is the nature of the research such that contentious or sensitive issues might be involved?		✔	

If you have ticked **Yes** to 9, 10 or 11 you should complete the full Ethics Approval Form. In relation to question 10 this should include details of what you will tell participants to do if they should experience any problems (e.g. who they can contact for help). You may also need to consider risk assessment issues.

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			YES	NO	N/A
12	Does your project/assignment involve work with animals?			✔	
13	Do participants fall into any of the following special groups? **Note that you may also need to obtain satisfactory clearance from the relevant authorities**	Children (under 18 years of age)			
		People with communication or learning difficulties		✔	
		Patients			
		People in custody			
		People who could be regarded as vulnerable			
		People engaged in illegal activities (eg drug taking)			
14	Does the project/assignment involve external funding or external collaboration where the funding body or external collaborative partner requires the University to provide evidence that the project/assignment had been subject to ethical scrutiny?			✔	

If you have ticked **Yes** to 12, 13 or 14 you should complete the full Ethics Approval Form. There is an obligation on student and supervisor to bring to the attention of the APU Research Ethics Committee any issues with ethical implications not clearly covered by the above checklist.

STUDENT RESEARCHER
Provide in the boxes below (plus any other appended details) information required in support of your application, THEN SIGN THE FORM.

	Please Tick Boxes
I consider that this project/assignment has no significant ethical implications requiring a full ethics submission to the APU Research Ethics Committee.	✔
Give a brief description of participants and procedure (methods, tests used etc) in up to 150 words. Participants will be asked to fill in a questionnaires consist of about 14 questions. After that, a prototype will be shown to participants and asked to follow some steps for the purpose of testing the usability of prototype.	
I also confirm that: i) All key documents e.g. consent form, information sheet, questionnaire/interview are appended to this application.	✔
Or ii) Any key documents e.g. consent form, information sheet, questionnaire/interview schedules which need to be finalised following initial investigations will be submitted for approval by the project/assignment supervisor/module lecturer before they are used in primary data collection.	✔

E-signature... Chen ... ... Print Name.....Chen Chee Kin ... ... Date... 21/02/2021
(Student Researcher)

Please note that any variation to that contained within this document that in any way affects ethical issues of the stated research requires the appending of new ethical details. New ethical consent may need to be sought.

The completed form (and any attachments) should be submitted for consideration by your Supervisor/Module Lecturer

SUPERVISOR/MODULE LECTURER
PLEASE CONFIRM THE FOLLOWING:

	Please Tick Box
I consider that this project/assignment has no significant ethical implications requiring a full ethics submission to the APU Research Ethics Committee	✓
i) I have checked and approved the key documents required for this proposal (e.g. consent form, information sheet, questionnaire, interview schedule) Or	✓
ii) I have checked and approved draft documents required for this proposal which provide a basis for the preliminary investigations which will inform the main research study. I have informed the student researcher that finalised and additional documents (e.g. consent form, information sheet, questionnaire, interview schedule) must be submitted for approval by me before they are used for primary data collection.	

SUPERVISOR AND SECOND ACADEMIC SIGNATORY

STATEMENT OF ETHICAL APPROVAL (please delete as appropriate)

1) **THIS PROJECT/ASSIGNMENT HAS BEEN CONSIDERED USING AGREED APU/SU PROCEDURES AND IS NOW APPROVED**

2) **THIS PROJECT/ASSIGNMENT HAS BEEN APPROVED IN PRINCIPLE AS INVOLVING NO SIGNIFICANT ETHICAL IMPLICATIONS, BUT FINAL APPROVAL FOR DATA COLLECTION IS SUBJECT TO THE SUBMISSION OF KEY DOCUMENTS FOR APPROVAL BY SUPERVISOR (see Appendix A)**

E-signature... ... ... Print Name Zailan Arabee Bin Abdul Salam... Date... 22/2/21
(Supervisor/Lecturer)

E-signature... ... ... Print Name... ... ... Date... ... ...
(Second Academic Signatory)

Office Record	Receipt – Appendix A(Fast-Track Ethics Form)
Date Received:	Student name:
	Student number:
Received by whom:	Received by:
	Date:

APPENDIX A
AUTHORISATION FOR USE OF KEY DOCUMENTS

Completion of Appendix A is required when for good reasons key documents are not available when a fast track application is approved by the supervisor/module lecturer and second academic signatory.

I have now checked and approved all the key documents associated with this proposal e.g. consent form, information sheet, questionnaire, interview schedule

Title of project/assignment... ... ...

... ...

Name of student researcher ... ...

Student ID: .... Intake: ... ...

E-signature... ... ... Print Name... ... ... Date... ... .
(Supervisor/Lecturer)

Fast-Track Ethical Approval Form ver. 3.0 (Dec 2015) Page 4 of 4