

**Stock Market Equity Advisory Tool using  
Analytic Hierarchy Process and Single-Layer Perception Neural Network**  
BY  
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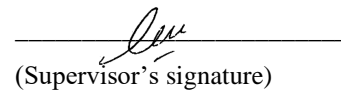
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## **ABSTRACT**

These days, there are a few of application which can help the user to conducting stock comparison and stock rating. However, these applications cannot directly predict the stock trend for the user whether the stock is in an uptrend or downtrend. They also do not allow users to choose their preferred indicators during stock comparisons or predictions. Therefore, this project will deliver a mobile Android application with a dynamic stock prediction model which will be using Analytic Hierarchy Process (AHP) and Artificial Neural Networks (ANN) of Single-Layer Perceptron Neural Network as a combined technique to predict the stock trend. In this application, users can choose multiple or one of their preferred indicators from the fundamental indicator list and technical indicator list which have been provided in the application. The chosen indicators will be used as the input of the stock predictive model in the application and these chosen indicators will become the inputs of AHP and Single-Layer Perception Neural Network algorithm. Through this “Stock Market Equity Advisory Tool”, users can easily know advice on whether it is the right time for them to sell the stock or buy the stock from this tool according to their investment goals. Besides, this application will make the stock prediction process more user-friendly and accessible.

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## LIST OF ABBREVIATIONS

<i>AI</i>	Artificial Intelligence
<i>NSE-India</i>	National Stock Exchange of India
<i>SVM</i>	Support Vector Machine
<i>KNN</i>	K-Nearest Neighbor
<i>GDP</i>	Gross Domestic Product
<i>NLP</i>	Natural Language Processing
<i>AHP</i>	Analytic Hierarchy Process
<i>EPS</i>	Earnings Per Share
<i>IIFL</i>	India Infoline Finance Limited
<i>AVA</i>	Advanced Virtual Assistant
<i>FCF</i>	Free Cash Flow
<i>MACD</i>	Moving Average Convergence Divergence
<i>RSI</i>	Relative Strength Index
<i>CCI</i>	Commodity Channel Index
<i>ATR</i>	Average True Range
<i>STOCHRSI</i>	Stochastic Oscillator
<i>NLP</i>	Natural Language Processing
<i>RNN</i>	Recurrent Neural Network
<i>S&amp;P 500 Index</i>	Standard & Poor's 500 Index
<i>RMSProp</i>	Root Mean Squared Propagation
<i>LSTM</i>	Long Short-Term Memory
<i>DQN</i>	Deep Q-Network
<i>CSV</i>	Comma-Separated Values
<i>IDE</i>	Integrated Development Environment
<i>ANN</i>	Artificial Neural Networks

# CHAPTER 1

## Introduction

### 1.1 Project Inspiration

Stock market equity advisory tool is an investment analysis and stock decision making tool that analyses stocks and advises the users by providing general statistical information about investing in the Malaysia stock market. The target user of this advisory tool is Malaysian who have fresh investors that are troubled in selecting or purchasing a stock. The main purpose of developing this advisory tool is to help these fresh investors to compare stocks in the Malaysia Stock market, so they can make the best decision and get a higher return on money. This tool will be developed into an Android application that has investment knowledge and is equipped with investment data which will be able to provide advice to a new investor in selecting a best suitable stock for them before making a decision. This advisory tool will use Analytic Hierarchy Process (AHP) and Artificial Neural Networks (ANN) of Single-Layer Perceptron Neural Network as a combined stock prediction method for organising, comparing, and analysing the stock decisions by using several maths equations. Finally, this stock advisory tool will generate a stock ranking list for its user to inspect, which stock was more favourable, and which was the least and show the future stock trend whether the stock is in an uptrend or downtrend in the stock ranking list. The whole investment sector worldwide, including institutions like Maybank Investment Bank, Public Investment Bank, and others that serve as a channel between major corporations and investors, will make extensive use of this tool. Once this stock market equity advisory tool has been successfully developed, this advisory tool may be highly beneficial for investors.

### 1.2 Problem Statements

In this project, the “Stock market equity advisory tool” will solve problems that are faced by the investor while using the existing advisory tools. The following are examples of existing stock advisory systems: Trades Ideas, StockRover, Ask IIFL



Chatbot, and AVA Chatbot will face the following problems that could be avoided by “Stock market equity advisory tool”:

### **1.2.1 Some existing stock advisory systems do not have the ability to compare and identify the best stock for the investor.**

Except for Trade Ideas [18] and StockRover [20], some existing stock advisory systems, such as Ask IIFL Chatbot [22], and AVA Chatbot [24] cannot compare stocks based on each company's financial data, rank a company's stock, and choose the best stock according to the user financial ability. In this case, it may be difficult for the user, who is a fresh investor, to select the best stock for them to purchase. Therefore, it is important to have a method that can compare between varieties of stocks based on their performance and potential returns by analysing their financial statements and stock market trends, to make an informed investment decision.

### **1.2.2 There is not a single existing stock advisory system that can be analysing the stock information from the Malaysia Stock Market and giving advice to investor who are interested to invest in Malaysia Stock Market.**

Except for Trade Ideas [18] and StockRover [20], some existing stock advisory systems, such as Ask IIFL Chatbot and AVA Chatbot can only analyse foreign stocks. For instance, the Ask IIFL Chatbot can only analyse the stock information of India stock market, and AVA Chatbot can only analyse stock information from Iberdrola company. In this case, it may be difficult for Malaysia-based new investors to get in touch with stock investment related advice and assistance in determining which stock is the best and most suitable for him to purchase. Therefore, it is important for Malaysia-based new investors to find a stock advisory tool that can provide a wide range of stock information and advice based on Malaysia Stock Market to make an informed decision. On the other hand, seeking advice from a professional financial advisor application or system may also be helpful in this situation.

### **1.2.3 All existing stock advisory systems do not allow the user to choose their own preferences such as fundamental indicator or technical indicator.**

All existing stock advisory systems, such as Trade Ideas [18], StockRover [20], Ask IIFL Chatbot [22], and AVA Chatbot [24] do not allow the user to choose their own preferences such as fundamental indicators or technical indicators to make investment

decisions. This limitation will result in unsatisfactory investment outcomes for users who have specific preferences and investment strategies. Besides, the accuracy and effectiveness of investment decisions will drop due to this problem.

### 1.3 Project Objectives

- **To develop a stock market advisory tool using AHP technique and Artificial Neural Networks (ANN) technique of Single-Layer Perceptron Neural Network that able to help the users to compare and rank the stock's performance based on the company's financial data and stock market trends for the user.** This objective is planned to solve the problem statement of 1.2.1.
- **To develop a stock market advisory tool that can help Malaysian fresh investors who are interested in purchasing stock by analysing the stock information of Malaysia Stock Market and able to provide efficient investment advice and rank the best stock for the user.** The reason for setting this objective is to solve the problem as stated in problem statement 1.2.2, there isn't a stock advisory tool that can focus on analysing stock information and advice the investor who is interested in investing in the Malaysia Stock Market. Therefore, it will be very helpful for Malaysian investors, especially those who are new to the stock market, to have access to a tool that can provide them with valuable insights and stock recommendations based on the analysis of the Malaysia Stock Market data.
- **To develop a stock market advisory tool that allows the user to modify their stock comparison model based on their own preferences such as fundamental indicator or technical indicator of Malaysia companies.** Examples of fundamental indicators or technical indicators included net income, basic EPS, inflation rate, CCI and so on. The accuracy and effectiveness of stock decisions will improve with the existence of this function. This objective is expected to solve the problem statement of 1.2.3.

### 1.4 Project Scope

This project's scope is to develop an interactive stock market equity advisory tool Android application that has the main functionality of helping users to compare and identify the best stock for them. First, this project will create a dynamic model to predict the quality of stock in the stock market. In this dynamic model, the user will be able to **customise the input parameters of the AHP + ANN model** on the stock. The input parameters will include some popular fundamental and technical indicators, which will be available for the user to choose and create their preferred indicator. The user is allowed to choose multiple fundamental and technical indicators at the same time. This functionality is compulsory in this stock advisory tool to allow the user to choose one or more indicators at the same time during the stock decision-making process for the AHP + ANN model. Besides, it allows the user to customise their indicator by combining different fundamental and technical indicators based on their investment strategy and preferences. This functionality can potentially enhance the accuracy and effectiveness of the AHP + ANN model in providing stock recommendations to the user.

Moreover, this stock market equity advisory tool will provide the functionality of **stock decision-making for the stock in Malaysia Stock Market based on the AHP + ANN method**. This stock market equity advisory tool will use the AHP + ANN method to analyse and compare stocks of companies listed on the Malaysia Stock Market based on the user's chosen criteria, such as technical indicators and fundamental indicators. The AHP + ANN method will identify and select the best stock option based on the technical and fundamental indicators of those companies, as well as the importance of each technical and fundamental indicator that users consider. In the first step of the AHP model, for example, at first, this tool will ask the user to select the technical and fundamental indicators of the company that he or she wishes to consider. Then, the user needs to select the intensity of importance for each technical indicator and fundamental indicator, which have been previously selected by the user on the 1 to 9 fundamental scale. Now, the stock market equity tool will automatically make a view of the AHP matrix to calculate the importance weight of each criterion (selected technical indicators and fundamental indicators). After the calculation process for the importance weight has finished, the tool will check the accuracy of the importance weight of each criterion by checking whether the sum of the importance weights for all

criteria is equal to 1 or not. If it is equal to 1, then the tool will proceed to the next step, which is to calculate the total utility of each stock option. After the total utility calculation is complete, the tool will **predict and provide a list of stock rankings and stock trend (buy or sell)** for the user. The stock with the highest total utility value will be ranked first, indicate that it is the most preferable for the user to buy. However, the stock with the lowest total utility value will be ranked last, indicates that it is not recommended for the user to buy. Therefore, the user can view the result and decide which stock is most preferable for him to purchase or invest in based on the AHP + ANN result given by the tool.

Besides, this stock market equity advisory tool application can allow the user to **test and evaluate the AHP + ANN result** by calculate the consistency ratio (CR) to ensure that the consistency of the pairwise comparisons made by the users is acceptable or needs to be adjusted for the pairwise comparison of the AHP matrix. The tool can **show the value of consistency ratio and inform the user whether the AHP + ANN result is acceptable or not**. If consistency ratio's (CR) value is below or equal to 0.1, then the AHP + ANN result is measured acceptable and can be used for decision-making. If consistency ratio's (CR) value is greater than 0.1, we must review and adjust our decisions and the intensity of importance for each criterion as required to improve and lower the consistency ratio of the pairwise comparisons. Lastly, the dataset of stocks that will be used in this stock market equity advisory tool application consists of only 100 stocks in the Malaysia Stock Market. Finally, the user can **save the model that the user had customized** to the Firebase.

### 1.5 Contributions

Nowadays, there are many fresh investors who are unwilling to analyse the Malaysia Stock Market data by themselves, but expert investors are well experienced and have their own preferences for analysing the stock market data. Therefore, this project will be very beneficial for the fresh investor as this project will be mainly focused on developing an interactive stock advisory tool that will assist the fresh investors in making decisions by providing them with real-time market insights and the best stock investment recommendations which are related to the Malaysia Stock Market. Additionally, the stock equity advisory tool can be modified based on the preferences

of expert investors and provide them with clear analytics and insights to aid their stock decision-making process. In general, the stock equity advisory tool of this project will be very appealing as it includes many features, such as giving the stock recommendations of the Malaysia Stock Market that cannot be found in other stock equity advisory tools in Malaysia.

### **1.6 Report Organization**

In the following chapters, the information about this project is detailed. In Chapter 2, some related types of stock prediction techniques, AHP technique, domain applied in AHP, input parameter of technical indicator and fundamental indicator that will be used in criteria of AHP, and the similar system of this project are reviewed. In Chapter 3, the system requirement, design diagram/equation, use case diagram and timeline of this project has been shown in this chapter. Chapter 4, it has shown the architecture diagram and data storage design of this project and the interface design with procedure elaboration of this project's application (Stock Market Equity Advisory Tool). In Chapter 5, it has shown the test plan, the procedure of system testing and the performance measurement of stock prediction models. Chapter 6, it had discussed whether this project's developed application had achieved all the planned objectives or not and it has listed out the system limitations and future improvement of this project's application. Finally, Chapter 7 presents this report's conclusion.

## **CHAPTER 2**

### **Literature Reviews**

#### **2.1 Introduction of Literature Reviews**

This chapter discussed the literature review for the Stock Market Equity Advisory Tool, which includes reviewing the types of stock prediction techniques from other people's research or study and the existing systems related to stock prediction in this project.

#### **2.2 Review Types of Stock Prediction Technique**

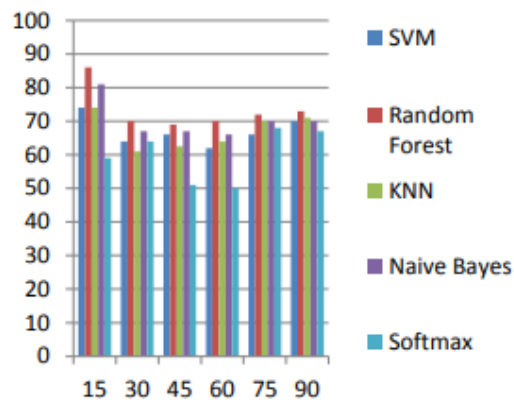
Nowadays, there are many types of techniques for predicting the stocks. This is due to advancements in Basic EPS, increased access to data, and a growing demand for investment insights. New technologies such as machine learning and artificial intelligence have allowed to be faster and more accurate stock predictions that can be used to make better investment decisions. When investing in the stock market, these technologies can help the investors make better decisions because they can provide more accurate information to determine the potential risk of different stocks, allowing investors to make more informed decisions, reducing the risk of loss, and increasing the probability of investment. With these techniques in current Basic EPS, more investors will become interested in stock predictions, as they can provide them with a view of the future stock price in the market. As a result, stock prediction has become a major factor in investment progress, and it has provided investors with a greater level of confidence when it comes to investing their money in the stock market. A stock forecasting tool must be providing different methods of stock forecasting to attract more users to the program. So, what techniques can be used for stock forecasting?

##### **2.2.1 Machine Learning**

From my research, there are many types of stock prediction techniques. Machine Learning is one of the most common techniques that can be used in stock prediction. Machine Learning is a powerful technique when it has been applied in the stock prediction, as it can identify the patterns from large amounts of data and make predictions more quickly and accurately than the traditional techniques. The Machine Learning models can be trained to identify patterns appearing in the data and make

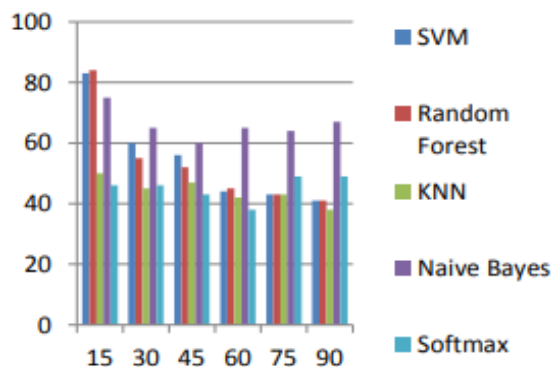
predictions based on that data. In stock prediction, this method will be used to analyse stock prices, company’s financial statements, and many other market factors to provide insight into the potential of certain stocks and their future performance. In finance, machine learning has been applied to various tasks, including stock prediction. Therefore, it will become a very useful tool for investors who wish to make knowledgeable decisions about their investments.

According to [2], the aim of the research is to compare different supervised machine learning algorithms for predicting stock market trends. The researchers had use historical stock market data such as Yahoo Finance, Quandl, National Stock Exchange of India (NSE-India), and YCharts, to train and test in different algorithms, which are Random Forest, Support Vector Machine (SVM), Softmax, Naive Bayes, and, K-Nearest Neighbor (KNN) to compare the performance of supervised machine learning algorithms in predicting stock market trends.



**Figure 2.2.1** Comparison of algorithms for large dataset

Figure 2.2.1 shows the bar chart diagram that compare the accuracy of different algorithms for large dataset.



**Figure 2.2.2** Comparison of algorithms for small dataset

Figure 2.2.2 shows the bar chart diagram that compare the accuracy of different algorithms for small dataset.

The outcome of the research was that the researchers had found that the Random Forest Algorithm was performed the best in terms of accuracy for large dataset of stock market trend prediction, followed by KNN, Naive Bayes, SVM, and the Softmax algorithm was performed the worst in term of accuracy (**Refer Figure 2.2.1**). However, Naive Bayes was performed the best in terms of accuracy for small dataset of stock market trend prediction (**Refer Figure 2.2.2**).

The proposed solution for the research was that the researchers concluded that Random Forest Algorithm are a promising solution for the stock market prediction, as Random Forest Algorithm offer a good accuracy and able to handle a large amount of data. However, the accuracy of the prediction is extremely dependent on the quality of the training data and the size of the training dataset.

The limitation of the research was that the machine learning did not consider the impact of external factors, such as news and events, on stock market trends. Additionally, the study was limited to a small number of machine learning algorithms, and other algorithms may have performed better or worse.

### **2.2.2 Fundamental Analysis**

The second stock prediction techniques that had been found from my research is the Fundamental Analysis. Fundamental Analysis method is a technique for determining value of an asset based on an examination of its underlying financial and economic factors.

According to [3], the aim of research in fundamental analysis techniques of stock prediction is to provide an estimate of the intrinsic value of a firm's stock, which can be compared to its market price and the firm's financial characteristics such as, its growth prospects, risk profile, and cash flows to determine if the firm's stock is undervalued or overvalued (*The Future Growth Game*). The outcome of this research is providing a systematic approach for investors to evaluate the financial health, future prospects, and intrinsic value of a company, which can be used to make informed investment decisions and determine if a firm's stock is undervalued or overvalued.



The proposed solution of fundamental analysis is the use of financial statements, economic statistics, and other information to assess the financial health and future prospects of a company. This information is used to make predictions about future cash flows, earnings, risk profile and dividends, which are used to determine the intrinsic value of stock for a company.

However, there are also limitations and weaknesses to fundamental analysis. The limitations of this technique is that it depend on the historical data such as a company's financial statements and current economic statistics, which may not accurately reflect future conditions of the company [6]. Additionally, the accuracy of fundamental analysis can be limited by the availability and quality of the company's historical data.

### **2.2.3 Deep Learning**

The third stock prediction technique that had been found from my research is the Deep Learning technique. Deep Learning technique is a subset of machine learning method, which is a neural network with multiple layers.

According to [4], the aim of the research in Deep Learning technique of stock prediction is to compare the different types of neural network models in deep learning technique, such as fully connected, convolutional, and recurrent neural network (RNN) models in term of the performance of predicting the next day of the S&P 500 index based on the inputs which are the index values from the previous 14 days. The S&P 500 index is an index that calculates the total value of the stocks of the Top 500 largest companies based on their market capitalization on the stock market [51]. The outcome of this research is that the researcher found that the RNN models was performed the best accuracy result of S&P 500 index by using RMS optimizer. The result of predicted and actual values of the S&P 500 index is almost overlapping.

The proposed solution for the research was that the researchers concluded that RNN models with RMSprop optimizer are a best solution or method for the stock market prediction, as RNN have the lowest minimum validation and lowest test result compared to others when RNN is using the RMSprop optimizer.

The limitation of this research is that the researcher only uses one stock index (S&P 500 index), which cannot be representative of the performance of the entire stock

market. It may cause the results to be biased and may not accurately reflect the effectiveness of the Deep Learning technique in predicting stock prices for other stocks or indices.

### 2.2.4 Sentiment Analysis

The fourth stock prediction technique that had been found from my research is the Sentiment Analysis. Sentiment Analysis method (Opinion mining) is a Natural Language Processing (NLP) that is used to determine whether a data is positive, negative, or neutral, and analyse public opinion and sentiment on a company, industry, or market to make predictions [1]. This method of stock prediction has the benefit of being able to consider a wider range of factors, such as public sentiment on stocks, industries, or markets.

According to [5], the aim of the research in Sentiment Analysis techniques of stock prediction is to utilize Natural Language Processing and Computational Linguistic techniques to analyse the sentiment expressed in texts, such as stock market reports, news articles, and social media posts, and accurately classify text data into positive, negative, or neutral categories in order to make predictions about stock market trends and to understand the factors that influence stock prices.

For example, the Sentiment Analysis techniques will classify the title of news articles into positive and negative:

- Positive: “Genting Malaysia Reports Strong Earnings for the Quarter”
- Negative: “Genting Malaysia's Debt Load Reaches High Record”

The proposed solutions for the research in Sentiment Analysis techniques of stock prediction include various natural language processing and machine learning algorithms, such as lexicon-based techniques and machine learning-based techniques, or hybrid methods, which combine both lexicon-based techniques and machine learning-based techniques. Lexicon-based techniques find the text's semantic way by using adjectives and adverbs [7]. Instead, machine learning techniques are typically used for binary categorization and forecasting sentiment as either positive or negative.

The limitations of the research in Sentiment Analysis techniques of stock prediction that it might be difficult to identify the sentiment that is being represented in texts that had used sarcasm, irony, or other figurative language. Another limitation is

that since the algorithm may be influenced by the biases included in the training data, the sentiment analysis results may be affected because of the training data used to construct the algorithm.

### **2.2.5 LSTM-based recurrent enhancement of DQN technique**

The fifth stock prediction technique that had been found from my research is the LSTM-based recurrent enhancement of DQN technique. LSTM is used as a pre-processing recurrent network to enhance the performance of DQN in predicting stock prices and making trading decisions in this research.

According to [52], the aim of the research is to strengthen the reliability of agent-based stock trading research by offering a baseline algorithm that uses LSTM to pre-process the data given into the DQN. The outcome of the research is the recurrent enhanced RDQN algorithm had outperformed to two of the other DQN variant algorithms, which are Vanilla DQN and Double DQN, and it also significantly better than the non-RL method in terms of stability, and profitability.

The proposed solution for the research was that the researchers concluded that using the LSTM as a pre-processing recurrent network to boost the DQN algorithm will enhance the stock trading agent's performance.

The limitation of this research is that the researcher only uses a limited number of stocks (3 stocks), which cannot be representative of the performance of the entire stock market. It may cause the results to be biased and may not accurately reflect the effectiveness of the DQN technique in predicting stock prices or profitability of companies.

### **2.2.6 After reviewing different types of Stock Prediction Technique**

First, the main outcome of the research [2] on Machine Learning is that the Random Forest and Naïve Bayes algorithms offered the best accuracy in predicting the stock market trends by using the historical stock market dataset. However, the accuracy of the predictions is dependent on the quality and the size of the dataset. It is recommended that investors use the Random Forest algorithm for stock market prediction as it can offer good accuracy while handling a large-size dataset, but it is

## CHAPTER 2

recommended to use the Naive Bayes algorithm as it can offer good accuracy while handling a small size of the dataset.

To summarise Machine Learning's strength, it has specific techniques that can identify patterns whether the size of the dataset is large or small, allowing it to make predictions quickly and accurately. Besides, its limitations are that it does not consider the impact of external factors, such as news and events, on stock market trends.

Second, the main outcome of the research [3] on Fundamental Analysis is that it has provided a valuable method for evaluating the intrinsic value of stock for a company, which be able to help investors determine whether a stock is undervalued or overvalued.

In conclusion of Fundamental Analysis, its strength is that it can evaluate the financial health, future prospects, and intrinsic value of a company whether its stock is undervalued or overvalued, which can help investors make informed investment decisions. Its limitation is that it relies on historical data, which may not accurately reflect the future conditions of the company.

Third, the main outcome of the research [4] on Deep Learning is that the RNN models with RMSprop optimizer had performed the best in predicting the next day's value of S&P 500 index. Besides, the research also found that the actual values and predicted values of S&P 500 index was almost overlapped.

In conclusion of Deep Learning, its strength is that it can improve the accuracy of stock predictions compared to traditional methods by using different kinds of models, such as RNN and so on. There will be a suitable model for the specific stock prediction task, but the accuracy is still dependent on the quality and quantity of training data.

Fourth, the main outcome of the research [5] on Sentiment Analysis is that it can provide valuable insights into public sentiment on stocks, industries, or markets, which can be used to make predictions about stock market trends.

In conclusion of Sentiment Analysis, its strength is it can consider a wider range of factors than some other techniques for stock prediction. It can consider public sentiment, which can be influenced by a variety of factors such as news events, social

trends, and economic conditions. Its limitation is that identifying sarcasm or other forms of figurative language can be challenging for sentiment analysis techniques.

Sixth, the main outcome of the research [52] on LSTM-based recurrent enhancement of DQN technique is that it outperforms other two DQN variant algorithms, which are the Vanilla DQN and Double DQN, as well as non-RL methods in terms of stability and profitability.

In conclusion of LSTM-based recurrent enhancement of DQN technique, its strength is that it uses LSTM as a pre-processing recurrent network to improve the performance of DQN algorithm, which has been shown to be excellent in predicting stock prices and making profitable trading decisions.

In the overall conclusion, stock prediction is a difficult and complicated process, and there is no one method that able to provide the most accurate predictions. However, investors can gain valuable insights and make informed decisions about their investments by studying and understanding the different techniques and applying them in a smart way.

### **2.3 AHP Technique**

The Analytic Hierarchy Process (AHP) is a multi-criteria decision-making technique which was created by Thomas Saaty for organising and analysing the complex decisions using math and psychology. It is also a mathematical decision-making technique that helps to break complicated decisions into smaller, more manageable parts. It can assist the decision-makers in analysing and comparing alternatives or options based on the criteria. The AHP includes three parts: the goal or problem, all possible solutions or objectives, and a set of alternatives that could be chosen to address the decision problem. AHP also provides a structured way of prioritising criteria in decision-making, which can be very useful in complex decisions where many criteria need to be considered. Furthermore, AHP provides a rational framework for a required decision by enabling the decision-maker to clearly articulate the criteria and alternatives that need to be taken into consideration and to make a decision that is consistent with their personal preferences, objectives, and goals [8]. In

today's world, the AHP has been applied in various fields which are personal, production, education, and organisation [9].

### **2.4 Domain Applied in AHP**

As per the research carried out by [14], the domain that applied Analytic Hierarchy Process (AHP) in the study is the design of enterprise chatbots. In this study, AHP was used to identify and select the design principles that should be considered in the development of enterprise chatbots. The study also used AHP method to calculate the relative importance of different design principles and features by comparing them with each other.

Nowadays as Basic EPS advances, there are many companies had started to develop their own enterprise chatbot. AHP provides a structured and systematic approach to decision-making by breaking down complex decisions into smaller parts to make the decision-makers or companies easier to evaluate the different types of design principles and features of the enterprise chatbot and make informed decisions. For example, although enterprise chatbots differ greatly in their design requirements from more popular and widespread customer service chatbots, but there are only a few studies that especially examine enterprise chatbot designs and provide guidance. This creates a gap in knowledge that needs to be filled to ensure that the design of enterprise chatbots is effective and the design features have met the needs of users. In-depth research on enterprise chatbot design can help the companies' developers to create effective and user-friendly chatbots for business use. Therefore, to address this gap, the researchers can combine and compare the different existing chatbot design features and design knowledge such as the strengths and weaknesses of each design, identify the critical design principles, create a list of 26 design types, which the company will combine and turned them into 6 design principles. Next, the company can use the AHP method to evaluate the list of 26 design types and 6 design principles. After applying the AHP method, the company will see the importance rankings of each design principle and design type and these importance rankings which were provided by the AHP method can provide guidance for the design of the enterprise chatbot and ensure that the chatbot design meets the needs of the enterprise and its users.

## 2.5 Input Parameter (Technical Indicator, Fundamental Indicator)

There are many technical indicator and fundamental indicator which can be cause the condition of a company's stock whether it is in good condition or bad condition, as this indicator can clearly show the company's financial information. Based on the **Table 2.5.1**, there are a total of 23 types of input parameters, which consist of 11 fundamental indicators, 12 technical indicators, and the stock conditions of each indicator. These technical indicator and fundamental indicator will be used as the AHP criteria of the AHP model of this project (Stock Market Equity Advisory Tool). If a stock's condition is better, then it will attract investors, boost the confidence of investors, and drive up the stock price. Therefore, it is important to identify all the input parameters of my AHP method.

**Table 2.5.1** below shows the stock condition of each Input Parameter (Technical Indicator/Fundamental Indicator).

**Table 2.5.1** Input Parameter (Technical Indicator/Fundamental Indicator) Table

<b>Input Parameters (Fundamental Indicators)</b>	<b>Stock Conditions (C = Condition)</b>
Net Income	<p>According to [25], if a company's net income increase, then the stock price will probably increase. Therefore, we can conclude that:</p> <p>C1: The higher its value, the better the stock's condition.</p> <p>C2: The lower its value, the worse the stock's condition.</p> <p>(High: profitable, strong growth potential)</p> <p>(Low: unprofitable, weak growth potential)</p>
Current Debt	<p>According to [27], if a company has a high debt level, then it will cause negatively to the stockholders. Therefore, we can conclude that:</p> <p>C1: The higher its value, the worse the stock's condition.</p>

	<p>C2: The lower its value, the better the stock's condition.</p> <p>(High: high financial risk)</p> <p>(Low: low financial risk)</p>
Total Cash	<p>According to [28], if a company's cash ratio (company's total cash equals to its current liabilities) is high which means that the company has much cash on hand, and this situation makes the company will have a greater ability to pay off and reduce their Current Debts. Then, the reduction of Current Debts will cause positively to the stockholders [27]. Therefore, we can conclude that:</p> <p>C1: The higher its value, the better the stock's condition.</p> <p>C2: The lower its value, the worse the stock's condition.</p> <p>(High: Has the ability to pay its debts)</p> <p>(Low: Do not have the ability to pay its debts)</p>
Total Asset	<p>According to [29], if a company is growing its total asset, then it will negatively affect its stock performance. Therefore, we can conclude that:</p> <p>C1: The higher its value, the worse the stock's condition.</p> <p>C2: The lower its value, the better the stock's condition.</p> <p>(High: high risk of getting no profit return of the asset)</p> <p>(Low: low risk of getting no profit return of the asset)</p>
Total Liabilities	<p>According to [30], total liabilities are the combined debts of a company. If a company has high liabilities, then it indicates that the company has high combined debt. So, the high combined debt</p>



	<p>(current debt) will cause negatively to the stockholders [27]. Therefore, we can conclude that:</p> <p>C1: The higher its value, the worse the stock's condition.</p> <p>C2: The lower its value, the better the stock's condition.</p> <p>(High: high financial risk, greater amount of debt)</p> <p>(Low: low financial risk, lower amount of debt)</p>
Total Stockholders' Equity	<p>According to [31], if the stockholder' equity is high or positive, then it means that company has enough assets to cover its liabilities and liabilities are the debts of a company [30]. So, it also means that the company can cover its debts, and low debt will cause positively to the stockholders [27]. Therefore, we can conclude that:</p> <p>C1: The higher its value, the better the stock's condition.</p> <p>C2: The lower its value, the worse the stock's condition.</p> <p>(High: enough assets to cover the liabilities or debt.)</p> <p>(Low: do not enough assets to cover the liabilities or debt.)</p>
Net cash provided by operating activities (also known as Cash Flow from Operating Activities)	<p>According to [32], net cash provided by operating activities shows the ability of generating cash of a company in its core business activities. If net cash provided by operating activities of a company is high, then the company has generated much cash from its core business activities, and it also will cause the total cash of company increased. So, it also means that the company has much cash on hand, and this situation makes the company will have a greater ability to pay off and reduce their</p>

	<p>Current Debts [28]. Then, the reduction of Current Debts will cause positively to the stockholders [27]. Therefore, we can conclude that:</p> <p>C1: The higher its value, the better the stock's condition.</p> <p>C2: The lower its value, the worse the stock's condition.</p> <p>(High: Company is generating more cash from its business activities)</p> <p>(Low: Company is generating less cash from its business activities)</p>
Free Cash Flow (FCF)	<p>According to [34], the more the free cash flow of a company has, then the better the ability of the company paying down its debt and this situation can get the attraction of the investors. If the free cash flow of a company is high, then the company has enough cash to pay off and reduce their Current Debts [28]. Then, the reduction of Current Debts will cause positively to the stockholders [27]. Therefore, we can conclude that:</p> <p>C1: The higher its value, the better the stock's condition.</p> <p>C2: The lower its value, the worse the stock's condition.</p> <p>(High: A company has enough cash on hand to cover additional expenses like paying dividends or debts.)</p> <p>(Low: A company hasn't enough cash on hand to cover additional expenses like paying dividends or debts.)</p>
Basic EPS (Earning Per Share)	<p>According to [26], an increase in basic EPS could bring a stock price to rise in accordance with a</p>

	<p>company's rising earnings on a per-share basis. Therefore, we can conclude that:</p> <p>C1: The higher its value, the better the stock's condition.</p> <p>C2: The lower its value, the worse the stock's condition.</p> <p>(High: better earnings potential)</p> <p>(Low: worse earnings potential)</p>
P/E Ratio (Price-to-Earnings Ratio)	<p>According to [35], A stock with a high P/E Ratio is expensive, and the stock price may drop in the future. A low P/E Ratio, however, indicates that a stock is undervalued, and the stock price might rise in the future. Therefore, we can conclude that:</p> <p>C1: The higher its value, the worse the stock's condition to buy.</p> <p>C2: The lower its value, the better the stock's condition.</p> <p>(High: stock is expensive to buy, and its price could decrease in the future.)</p> <p>(Low: stock is cheap to buy, and its price could increase in the future.)</p>
P/B Ratio (Price-to-book Ratio)	<p>According to [36], Investors can gain a "margin of safety" by purchasing a stock below its book value, and it means that the stock is safe for the investor to buy. Therefore, we can conclude that:</p> <p>C1: The higher its value, the worse the value and condition of a stock</p> <p>C2: The lower its value, the better the value and condition of a stock.</p> <p>(High: A "margin of safety" for investors cannot be created by purchasing a stock whose price is higher than its book value.)</p>

	(Low: A "margin of safety" for investors can be created by purchasing a stock whose price is lower than its book value.)
<b>Input Parameters (Technical Indicators)</b>	<b>Stock Conditions</b>
Open	According to [47], open of a stock means the first price of stock traded when the stock market had just opened.
High	According to [48], high of a stock means the stock's closing price at its highest point during a trading day.
Low	According to [49], low of a stock means the stock's closing price at its lowest point during a trading day.
Volume	<p>According to [46], the volume of a stock means the total number of shares traded in a period. A stock with low volume can be shown there is little buying interest from the market, and it can be difficult for the investor who holds the stock to sell. A stock with high volume can be shown that there is much buying interest from the market and this situation cause the stock to be easier to sell. Therefore, we can conclude that:</p> <p>C1: If its value is higher, then the stock's condition is better to buy.</p> <p>C2: If its value is lower, then the stock's condition is worse to buy.</p> <p>(High: easier to sell)</p> <p>(Low: difficult to sell, as there is little buying interest in the market, quite volatile)</p>
Moving Average Convergence Divergence (MACD)	<p>According to [37], a MACD positive divergence can be seen as a bullish ("bullish" means rising share prices in stock market) signal of stock trading. However, a MACD negative divergence can be seen as a bearish ("bearish" means falling share</p>

	<p>prices in stock market) signal of stock trading.</p> <p>Therefore, we can conclude that:</p> <p>C1: If its value is positive or higher, then the stock's condition is better to buy.</p> <p>C2: If its value is negative or lower, then the stock's condition is worse to buy.</p> <p>(Positive/High: seen as a bullish ("bullish" means rising share prices in stock market) signal of stock trading.)</p> <p>(Negative/Low: seen as a bearish ("bearish" means falling share prices in stock market) signal of stock trading.)</p>
Relative Strength Index (RSI)	<p>According to [39], low RSI levels (below 30) shows the signal of buying for the investor, so investor can buy the stock at this time. However, high RSI (above 70) shows the signal of selling for the investor, so investor can sell their stock at this time, and it is not safe to buy the stock at this time.</p> <p>Therefore, we can conclude that:</p> <p>C1: Low RSI levels (typically below 30), the better the stock to buy.</p> <p>C2: High RSI levels (typically above 70), the better the stock to sell and no encourage to buy it.</p> <p>(Low RSI levels: oversold conditions—generating a potential buy signal)</p> <p>(High RSI levels: overbought conditions—generating a potential sell signal)</p>
Bull/Bear Power	<p>According to [40], bull/bear power is positive (above 0) can be shown as the buy signal for the investor, so investor can buy their stock at this time. However, if the bull/bear power is negative (below 0), then it can be shown as the sell signal for the</p>

	<p>investor and investor can sell their stock at this time. Therefore, we can conclude that:</p> <p>C1: If its value is positive or higher, then the stock's condition is better to buy.</p> <p>C2: If its value is negative or lower, then the stock's condition is worse to buy.</p> <p>(Positive/High: Bulls (buyers) are stronger than the Bears (sellers) in the market.)</p> <p>(Negative/Low: Bears (sellers) are stronger than the in the Bulls (buyers) in the market.)</p>
Average True Range (ATR)	<p>According to [41], a higher ATR will cause the stock to have a higher level of volatility and larger movement of stock prices in the stock market. However, a lower ATR will cause the stock to have a lower level of volatility and smaller movement of stock price in the stock market. Therefore, a lower level of volatility for a stock is safer to buy compared to the higher level of volatility for a stock, and we can be concluded that:</p> <p>C1: If its value is higher, then the stock's condition is worse to buy.</p> <p>C2: If its value is lower, then the stock's condition is better to buy.</p> <p>(High: A stock is more volatile; stock price movements are larger)</p> <p>(Low: A stock is less volatile; stock price movements are smaller.)</p>
Commodity Channel Index (CCI)	<p>According to [42], Buying the stock when the value of CCI moves above 100 and selling the stock when the value of CCI it moves below 100 are the best trading strategy when using the CCI. Therefore, we can be concluded that:</p>

	<p>C1: If its value is above 100 or higher, then the stock's condition is better to buy.</p> <p>C2: If its value is below 100 or lower, then the stock's condition is worse to buy and recommend selling it.</p> <p>(Above 100/High: market is strongly bullish)</p> <p>(Below 100/Low: market is strongly bearish)</p>
Ultimate Oscillator	<p>According to [45], Ultimate Oscillator is similar to RSI. A low RSI levels (below 30) or Ultimate Oscillator (below 30) shows the signal of buying for the investor, so investor can buy the stock at this time. However, high RSI (above 70) or Ultimate Oscillator (above 70) shows the sell signal for the investor, so investor can sell their stock at this time, and it is not safe to buy the stock at this time [39]. Therefore, we can conclude that:</p> <p>C1: Ultimate Oscillator (below 30), the better the stock to buy.</p> <p>C2: Ultimate Oscillator (above 30), the better the stock to sell and no encourage to buy it.</p> <p>(Ultimate Oscillator (below 30): oversold conditions—generating a potential buy signal)</p> <p>(Ultimate Oscillator (above 30): overbought conditions—generating a potential sell signal)</p>
Stochastic Oscillator (STOCHRSI)	<p>According to [44], Stochastic Oscillator is an indicator which showing the oversold signal and overbought signal. If the stochastic oscillator is between 80 and 100, then the stock is overbought signal which generating a selling signal for the investors. However, the stochastic oscillator is between 0 and 79, then the stock is overbought signal which generating a selling signal for the investors. Therefore, we can con conclude that:</p>

	<p>C1: If its value is between 80 and 100, then the stock's condition is worse to buy.</p> <p>C2: If its value is between 0 and 79, then the stock's condition is better to buy.</p> <p>(80 – 100: overbought conditions—generating a potential sell signal)</p> <p>(0 – 79: oversold conditions—generating a potential buy signal)</p>
<p>Inflation Rate</p>	<p>According to [23], an inflation rate (1% - 3%), is consider a healthy and beneficial condition for stocks. However, a high inflation (&gt; 3%) cause uncertainty, and volatility condition of a stock. We can conclude that:</p> <p>C1: If its value is around 1% to 3% per year, then that country's stock market is good to buy.</p> <p>C2: If its value is more than 3%, then that country's stock market is worse to buy.</p> <p>(Inflation Rate (1% - 3%): low-to-moderate inflation, stock market is stable, non-volatile, high consumer spending.)</p> <p>(Inflation Rate (&gt;3%): high inflation, stock market is uncertainty, volatility and slowing consumer spending.)</p>



## 2.6 Review Types of Existing System

### 2.6.1 Trade Ideas

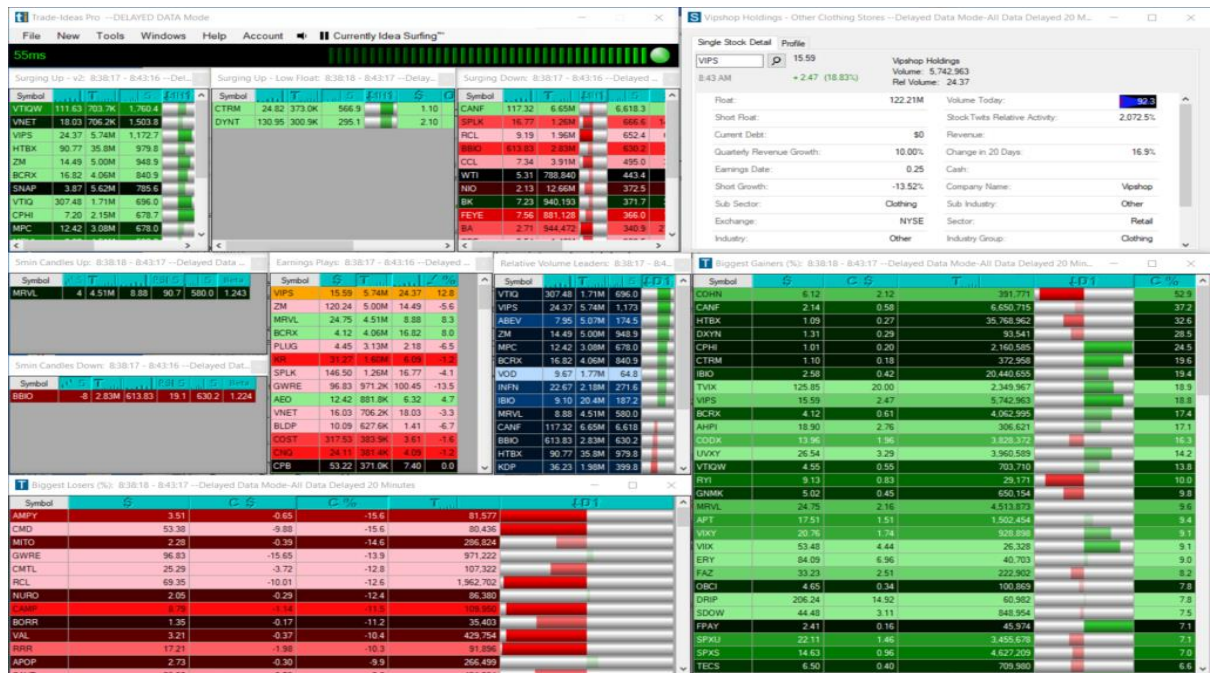


Figure 2.6.1 Screenshot of Trade Ideas Software

Figure 2.6.1 shows the screenshot of Trade Ideas Software interface.

Trade Ideas is a software for active traders that provides real-time stock market data scanning and analysis tools to help the users to identify potential trading opportunities. It offers stock scanning, back testing capabilities, and a community-driven platform for the traders or investors to share and discuss with others [18].

#### Strengths

- Stock Comparison

Trade Ideas software provides the AI-based robo-advisors consist of dozens of advanced algorithms. Once these algorithms have been shown to over a million stock trading scenarios overnight, they will analyse the data from those stock trading scenarios and identify patterns to scan, compare and find the subset with the highest alpha probability of stock for the next trading session. (A higher alpha value means the performance of stock is doing better, while a lower alpha value means the performance of stock is doing worse [17].)

- Real-Time Stock Market Data

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Trade Ideas software provides real-time stock market data from different countries' stock market, which can help investors make timely decisions and capitalize on stock market movements.

- Back Testing

In back testing, Trade Ideas software will use the historical data to determine the validity of stock trends [19].

### Weaknesses

- Lack of comparing stock's ability

Trade Ideas does not have the ability to compare two or more stocks. Therefore, it is hard for a fresh investor to know which stock is the best and most suitable for them.

- Lack of interactive advisory chatbot.

A fresh investor will have difficulty while using Trade Ideas software, as the features and tools are not simplified and there are too many for them. It will be hard for the fresh investor to learn from the beginning how to use this software. If there is an interactive advisory chatbot which willing to help the fresh investor in choosing the stock, then it will be easy for a fresh investor to directly ask for help to the chatbot.

- Lack of offering users the option to select their preferred fundamental or technical indicators.

Trade Ideas does not allow the user to select their preferred fundamental or technical indicators of a company before doing the stock scanning. So, it might be difficult for users who have specific criteria in mind to find the stocks that match their requirements.

### 2.6.2 StockRover

Navigation		Quotes (3 rows)											Quotes (3)		Actions
Views		Sector Weightings	Financial Health	Grades	Growth	Income Statement	Momentum	Per Share	Portfolio Performance	Profile	Profitability	Returns	Returns vs. S&P 500	Valuation	
Ticker ↑	Company	Return on Assets	Return on Equity	ROIC	Greenblatt ROC	Gross Profit / Total Assets	Gross Margin	Operating Margin	Net Margin	EBITDA Margin	Operating Margin vs Industry	Net Margin vs Industry	Profitability Industry Decile		
AAPL	Apple	16.1%	48.8%	24.5%	44.1%	0.3	38.3%	26.6%	22.0%	32.9%	10.2%	7.8%	1		
IBM	IBM	4.7%	31.1%	9.0%	22.0%	0.3	45.9%	15.7%	7.1%	20.6%	3.2%	0.7%	3		
MSFT	Microsoft	6.4%	20.0%	10.4%	17.6%	0.3	65.3%	31.8%	15.0%	44.8%	4.9%	3.8%	2		
<b>Summary</b>		<b>9.1%</b>	<b>33.3%</b>	<b>14.6%</b>	<b>27.9%</b>	<b>0.3</b>	<b>49.8%</b>	<b>24.7%</b>	<b>14.7%</b>	<b>32.8%</b>	<b>6.1%</b>	<b>4.1%</b>	<b>2</b>		

**Figure 2.6.2** Stock Comparison of StockRover

Figure 2.6.2 shows the stocks being compared in the Table.



**Figure 2.6.3** Stock Ratings of StockRover

Figure 2.6.3 shows the stocks being rated in the different type of performance.

StockRover is a software for investors that provides stock comparisons and rating tools that can help them evaluate and compare different stock investment opportunities. It also offers real-time market data and news updates to keep investors informed about the latest developments in the stock market.

**Strengths**

- Stock Comparison  
 StockRover offers a dynamic tool for the stock comparison. (Refer Figure 2.6.2)  
 This tool can compare the stocks based on each company’s financial data and show the 1-10 rank of company’s stock profitability industry decile. (A company will receive a rank of 1 if it has the highest value of Return on Assets and Return on Equity. [20].)

- **Stock Ratings**

StockRover processes the complex historical data of each company to rank the stock's performance relative to its peers in key areas such as growth ratings (Revenue, EPS, Operating Income, Equity), valuation, efficiency, financial strength, quality, earnings, and impulse. It assigns the overall rating to each stock (**Refer Figure 2.6.3**). Therefore, it can allow the investor to easier evaluate and compare different stock investment opportunities [21].

- **Real-Time Stock Market Data**

StockRover software provides real-time stock market data from different countries' stock market, which can help investors make timely decisions and capitalize on stock market movements.

- **Real-Time News**

StockRover software provides real-time company news, which it retrieves from Google News. This feature can help investors get up-to-the-minute information on the companies they are interested in and make informed stock investment decisions based on the latest news and events affecting those companies.

### **Weaknesses**

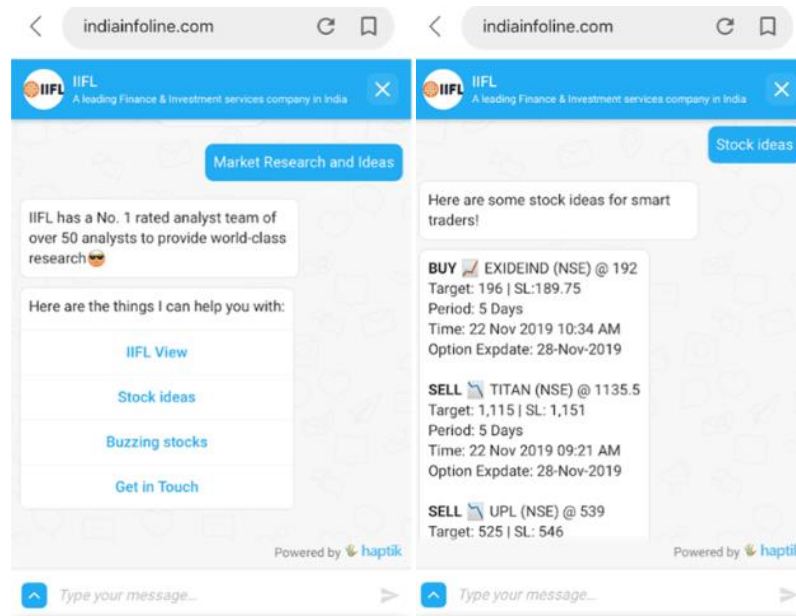
- **Lack of interactive advisory chatbot.**

A fresh investor will have difficulty while using StockRover software, as the features and tools are not simplified and there are too many for them. So, it will be hard for the fresh investor to learn from the beginning how to use this software. If there is an interactive advisory chatbot which willing to help the fresh investor in choosing the stock, then it will be easy for a fresh investor to directly ask for help to the chatbot.

- **Lack of offering users the option to select their preferred fundamental or technical indicators.**

StockRover does not allow the user to select their preferred fundamental or technical indicators of a company before doing the stock comparison process. So, it might be difficult for users who have specific criteria in mind to find the stocks that match their requirements.

### 2.6.3 Ask IIFL Chatbot



**Figure 2.6.4** Screenshot of Ask IIFL Chatbot

Figure 2.6.4 shows the screenshot of Ask IIFL Chatbot interface.

Ask IIFL Chatbot is a financial advisory tool that provides instant assistance and guidance to users on various financial products and services offered by IIFL. It is designed to deliver stock investing tips from its real-time stock market data to the users and this feature can help the users make informed decisions about their investments [22].

#### Strengths

- Deliver stock investing tips.  
Ask IIFL Chatbot can provide today's stock investing tips to users. For example, the user can ask the Ask IIFL Chatbot about investing tips by typing "Stock Ideas", and the chatbot will provide a bunch of potential stocks to invest in based on market trends and analysis.
- Real-Time Stock Market Data  
Ask IIFL Chatbot can provide real-time stock market data, which can help investors make timely decisions and capitalize on stock market movements.

#### Weaknesses

- Limited to India Stock Market

Ask IIFL Chatbot is designed to provide stock investment advice and support to the Indian investors only and it is only focusing on analysing the Indian stock market.

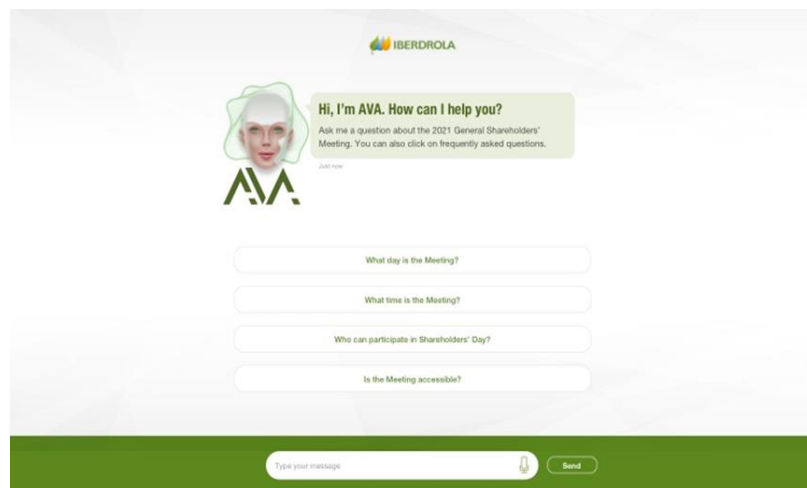
- Lack of comparing stock's ability

Ask IIFL Chatbot does not have the ability to compare two or more stocks. Therefore, it is hard for a fresh investor to know which stock is the best and most suitable for them.

- Lack of offering users the option to select their preferred fundamental or technical indicators.

Ask IIFL Chatbot does not allow the user to select their preferred fundamental or technical indicators of a company before the Ask IIFL Chatbot provides the stock investing tips for them. So, it might be difficult for users who have specific criteria in mind to find the stocks ideas and tips that match their requirements.

#### 2.6.4 AVA Chatbot



**Figure 2.6.5** Screenshot of AVA Chatbot

Figure 2.6.5 shows the screenshot of AVA Chatbot interface.

AVA Chatbot is a financial advisory tool that helps the Iberdrola company handle questions from its investors. The chatbot gives investors of Iberdrola customised replies using NLP technique and machine learning technique. [24].

#### Strengths

- Handle different type of financial investment questions.











AVA chatbot can handle the customers questions in financial investment service of Iberdrola such as get to know on how to buy stocks, the stock price of Iberdrola, taxation regarding stocks, questions about the quarterly results of Iberdrola, the total earning per stock, return on investment, status of and changes in stock price dividend history and dividend yield of the Iberdrola company.

### Weaknesses

- Lack of comparing stock's ability  
AVA Chatbot does not have the ability to compare the Iberdrola stock with another two or more stocks. Therefore, it is hard for a fresh investor to know how good the Iberdrola stock in today's market is.
- Limited to Iberdrola company  
The user of the AVA Chatbot can only ask for the stock information of Iberdrola company. If a customer wishes to ask the stock information other than the Iberdrola company, then the chatbot will not be able to reply.
- Lack of offering users the option to select their preferred fundamental or technical indicators.  
AVA Chatbot does not allow the user to select their preferred fundamental or technical indicators of Iberdrola company before doing the stock scanning. So, it might be difficult for users who have specific criteria in mind to find the stocks that match their requirements.

### 2.6.5 Comparisons between Existing Systems

System Name	Stock Comparison	Advisory Chatbot	Real-Time Stock Market Data	Type of Stock Market	Option of selecting indicators	Stock Ratings/Rankings
Trade Ideas	✓	✗	✓	Global Stock Market	✗	✓
StockRover	✓	✗	✓	Global Stock Market	✗	✓

Ask IIFL Chatbot				India stock market		
AVA Chatbot				Stock information of Iberdrola company only		

**Table 2.6.1** Comparison on the functionalities for the existing systems

Table 2.6.1 shows the comparison of the differences between the four existing systems in terms of their functionalities.

After reviewing the four existing systems, which consists of 2 types of the existing system which are 2 of the existing system that can do stock prediction and 2 the existing chatbot system that is related to stock advisory, **Table 2.6.1** can be seen that the stock prediction software such as Trade Ideas and Stock Rover have the function of stock comparison and stock rankings, but it is lack of advisory chatbot inside the software, so it will be hard for a fresh investor to use both of this software, as the features and tools are not simplified and there is no anyone can give advice or guide them, so, it will be hard for them to use this software and this will become one of the problem statements of this project.

From **Table 2.6.1**, the Ask IIFL Chatbot and AVA Chatbot can have interactive stock-related conversations with the user, but they did not have the ability to compare and identify the best stock for the user and this will become one of the problem statements of this project. Besides, four of these existing systems are not focused on the Malaysia Stock Market, so it might not be user-friendly for the investor who wishes to invest in the Malaysia Stock Market. This will become one of the problem statements of this project. On the other hand, these existing systems can provide real-time stock market data. However, four of these existing systems don't have the options for the users to select their preferences for the fundamental indicators or technical indicators, so it will be hard for the investor who has special needs to select the best stock based on the performance of the preferred fundamental indicators and technical indicators of a company and this will become one of the problem statements of this project.



## CHAPTER 2

In conclusion, each existing system has its own strengths and weaknesses and the ideal tool for a particular investor is depending on their specific needs and preferences. Therefore, if there is a solution for all of the weaknesses found in these existing systems by developing a stock advisory tool which also can compare stocks, allow the user to choose their preferences for the indicators and provides a list of stock rankings in these existing systems.

# CHAPTER 3

## Proposed Method/Approach

### 3.1 Project Methodology

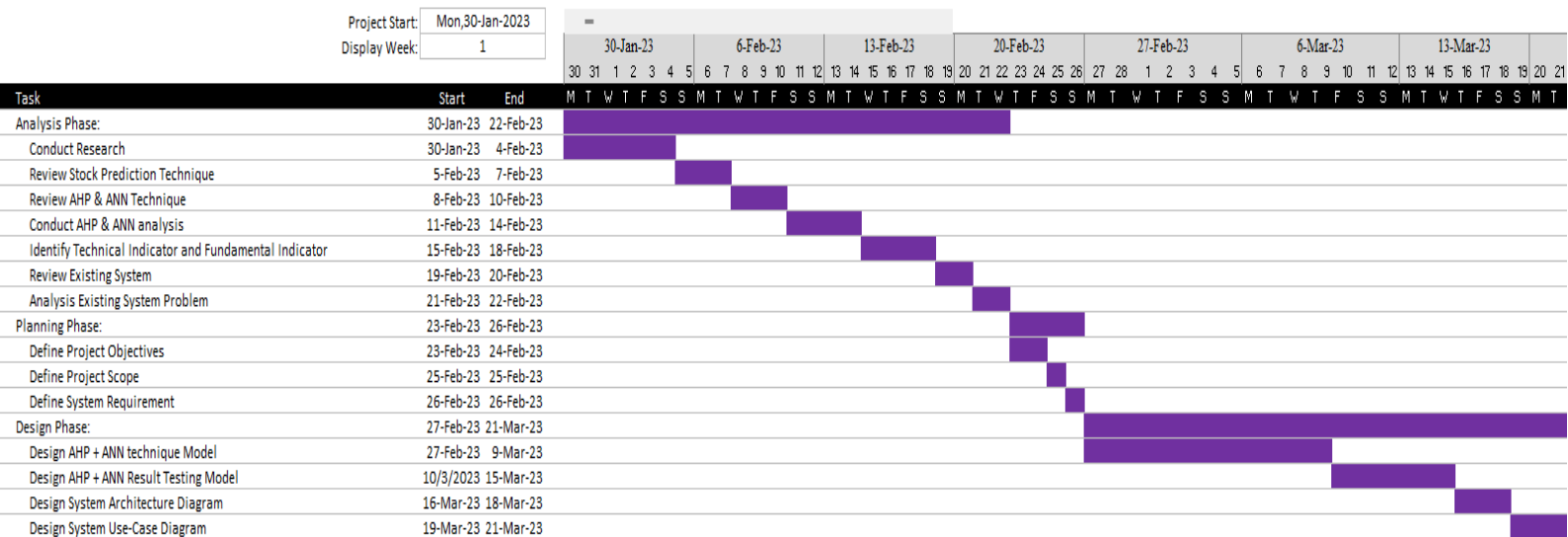


Figure 3.1.1 Gantt Chart Part 1 of FYP 1

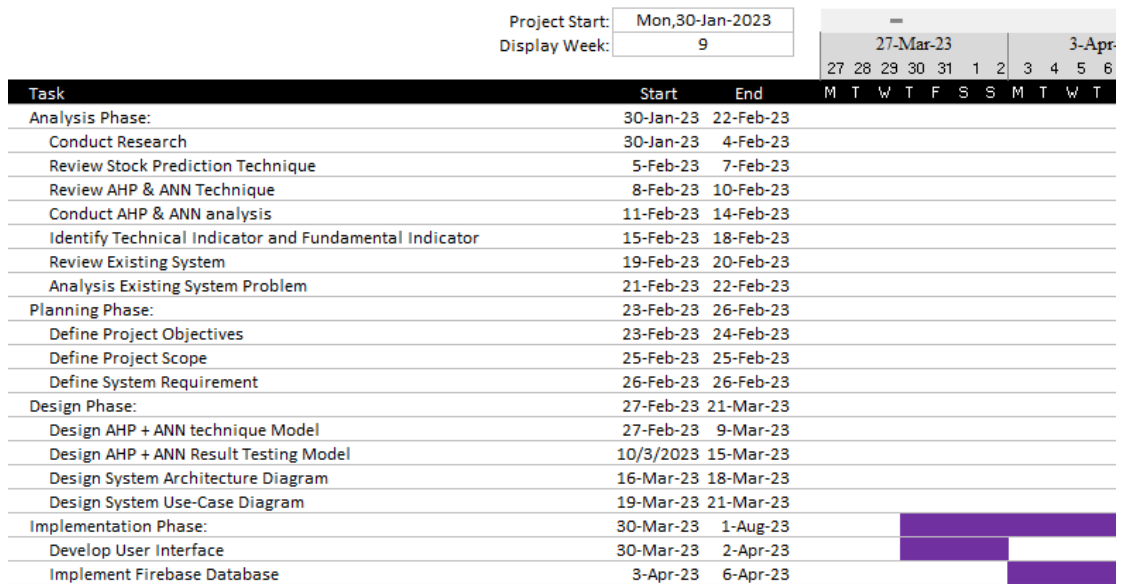
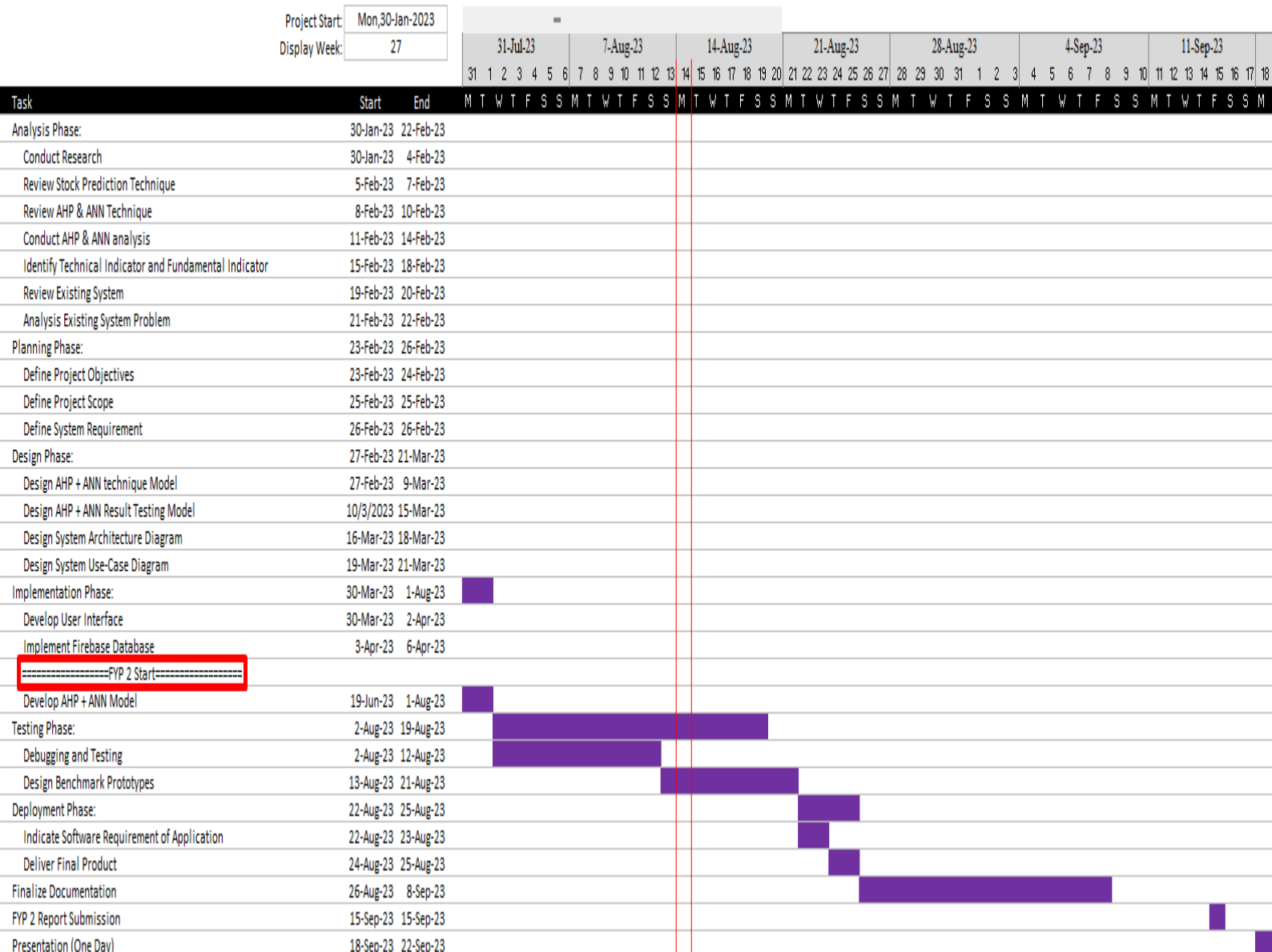


Figure 3.1.2 Gantt Chart Part 2 of FYP 1

Figure 3.1.1 and Figure 3.1.2 show the Gantt Chart, which represents the project schedule and the planned timeline for completing various tasks of this Final Year Project 1 (FYP 1).

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**Figure 3.1.3** Gantt Chart of FYP 2

Figure 3.1.3 shows the Gantt Chart, which represents the project schedule and the planned timeline for completing various tasks of this Final Year Project 2 (FYP 2).

In this project, it will be using waterfall development to complete it. The processes of waterfall development were categorised into different phases, which were analysis, planning, design, implementation, testing, and development.

As shown in the Gantt Chart of FYP 1, which is shown in Figure 3.1.1 and Figure 3.1.2, it had conducted some research from online journals and websites to gather relevant information for the analysis phase, review different types of techniques that can be used in stock prediction, review AHP and ANN techniques, which are

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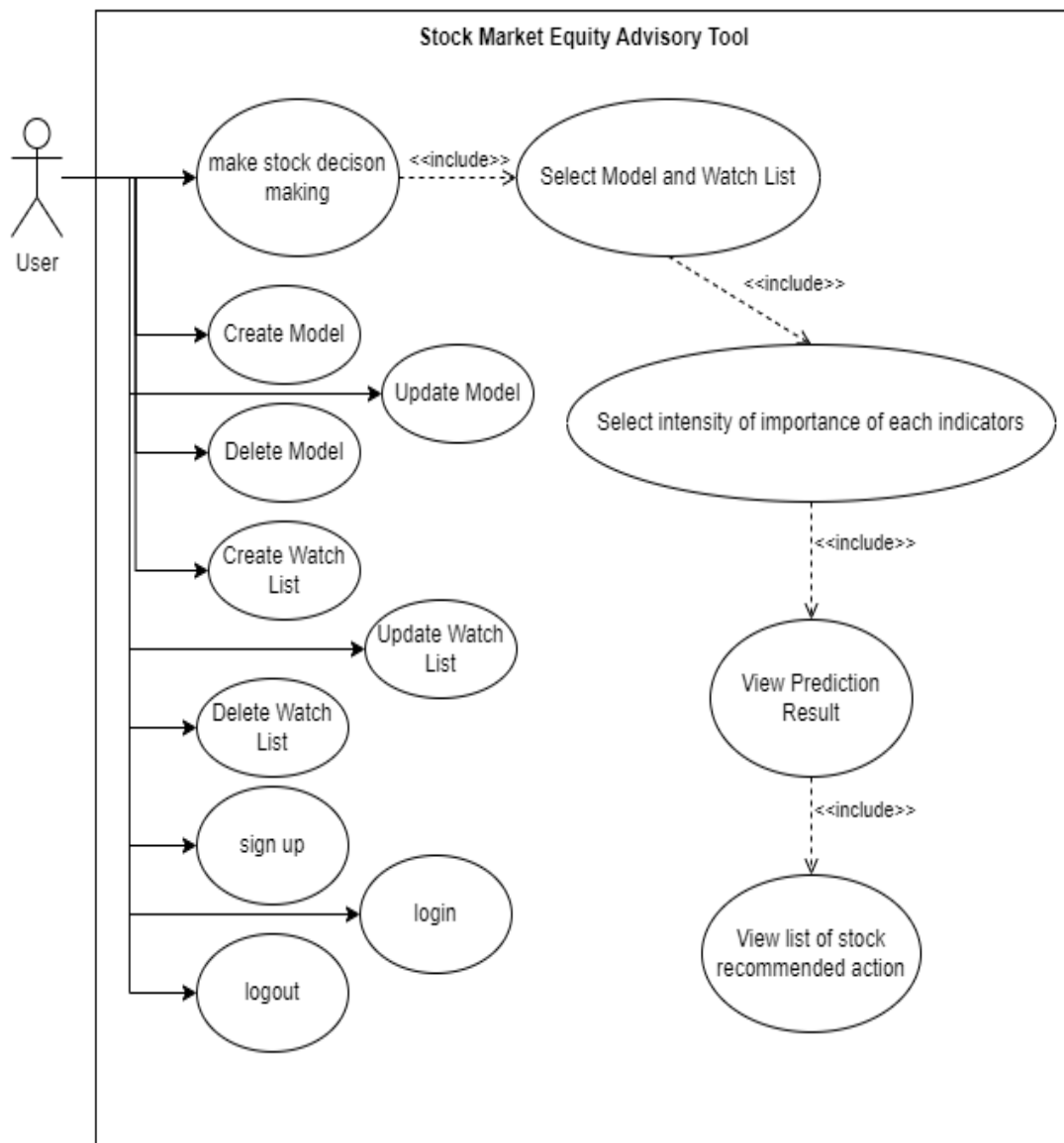
shown in Figure 3.1.1 and Figure 3.1.2, it had conducted some research from online journals and websites to gather relevant information for the analysis phase, review different type of technique which can be used in stock prediction, review AHP & ANN Techniques which are the main methods that will be used in this project, conduct AHP & ANN analysis, identify the technical indicator and fundamental indicator which will be used as the criteria of AHP & ANN, review the existing system and analysis the problem of the existing system in the analysis phase. After that, in the planning phase, it had done some planning for this project by defining the project objectives based on the problem statement that had been found in the existing system, defining the project scope and system requirements. Next, the design phase had been started to design the AHP + ANN technique as a model that will be used in making the stock decision for the user to achieve the main objective of this tool, design the AHP + ANN Result Testing model, design the system architecture diagram, and design the system use-case diagram of the stock market equity advisory tool. Thereafter, in the implementation phase, it started to develop the user interface of the stock market equity advisory tool, implement it, and connect the Firebase Realtime Database to the application.

As shown in the Gantt Chart of FYP 2, which is shown in Figure 3.1.3, FYP 2 had continued with the incomplete task of the implementation phase, which is to develop the AHP and ANN model for the stock market equity advisory tool. After that, in the testing phase, it had done some debugging and testing progress for the stock market equity advisory tool to make sure that the application did not have bugs before being delivered or published to the user, and it also designed and conducted several tests such as benchmark prototypes to simulate the performance of stock prediction by comparing among the ANN model, the AHP model, and the AHP+ANN model. If there is a bug, then it will conduct the bug-fixing process. Moreover, the next phase is the deployment phase, which will indicate the requirements of the application, such as that it is compatible with the Android OS version only and that it needs internet access while using it. Next, it will be finalising the documentation of this project from 26 August 2023 until 8 September 2023. After that, the submission of this report of final year project 2 will be on time which is on 15 September 2023 and the presentation will be conducted on one of the days between 18 September 2023 and 22 September 2023.

### 3.2 Overview Design for the Stock Market Equity Advisory Tool

The overall stock market equity advisory tool system will be designed using the AHP Model and ANN Model Framework to help investors make informed decisions by considering multiple criteria and their relative importance. The result of the AHP Model and ANN Model Framework will provide a more comprehensive analysis of the stock market whether which stock is the best option to buy and potentially lead to better investment outcomes.

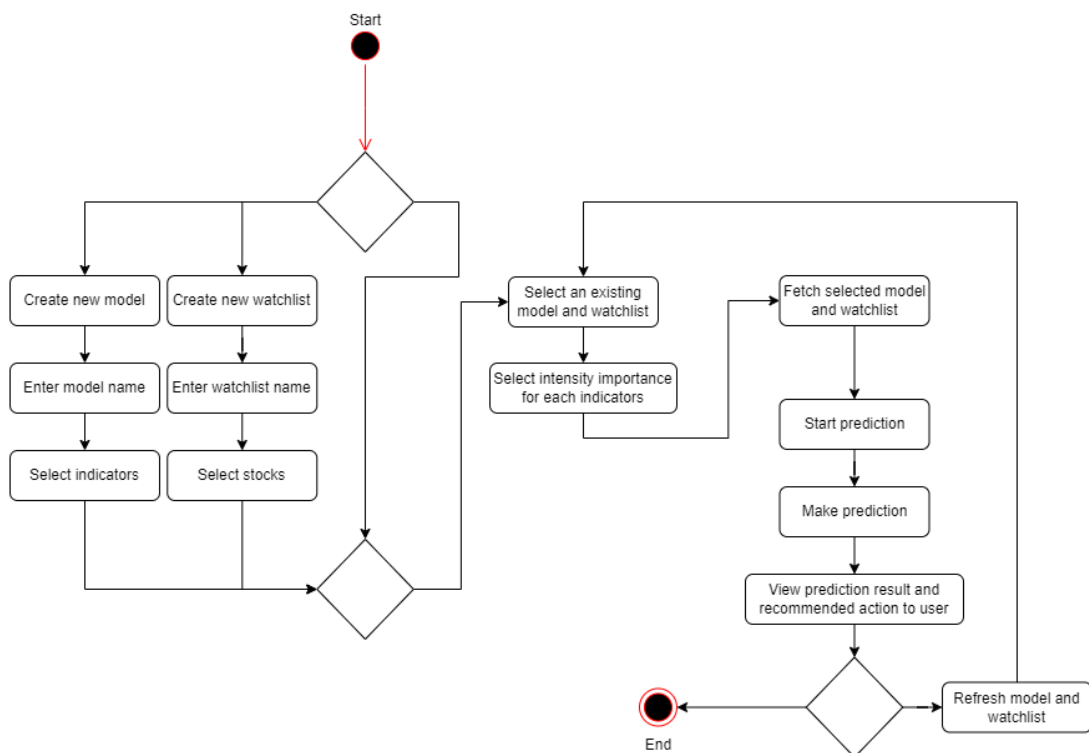
#### 3.2.1 System Functionalities of Stock Market Equity Advisory Tool



**Figure 3.2.1** System Functionalities of Stock Market Equity Advisory Tool

Figure 3.2.1 shows the System Functionalities of Stock Market Equity Advisory Tool. The user can sign up, login or log out of his account in this application. The user can make stock decision-making in AHP + ANN model by selecting the created model and watch list. Then, the user also needs to select the intensity of importance of each indicator before the stock prediction process starts. Besides, the user can create, update, and delete the model. The available indicators that allow the user to choose during the creation or update of the model are shown in **Table 3.4.1**. The user also can create, update, and delete the watch list. After the stock prediction process had done, the user can view the prediction result and view the list of stock recommended actions provided by the tool.

### 3.2.2 Design of Stock Prediction Procedure for the Stock Market Equity Advisory Tool

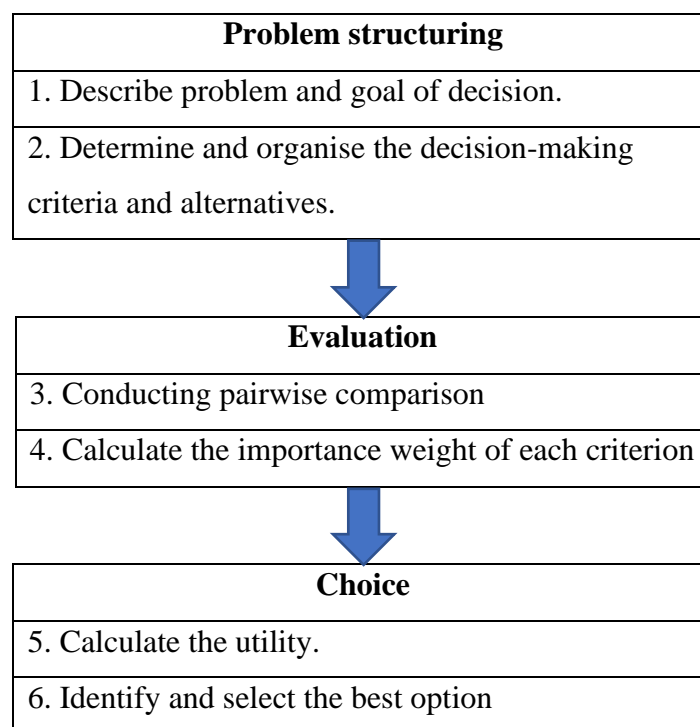


**Figure 3.2.2** The process of stock prediction procedure for Stock Market Equity Advisory Tool

In the stock prediction procedure of the Stock Market Equity Advisory Tool, the user can create a new model and a new watch list. Firstly, the user needs to enter a name for the model and watch list. The user also needs to select their favourite

indicators for the model and their preferred stocks for the watch list. If the user had created a model and watch list before, then they can directly go to select an existing model and an existing watch list to conduct the stock prediction. After selecting the model and watch list, the user needs to select the intensity importance for each indicator based on the model chosen. After that, the system will fetch the data of the selected model and watch list from the CSV file and now the system will start to conduct or make the prediction for the stock of the selected watch list. Once the prediction is done, the system will view the prediction result and recommend action for each stock to the user. Then, the user can choose whether to end the prediction process or refresh the model and watchlist to conduct the prediction for another model and watchlist.

### 3.2.3 AHP + ANN Model Framework



**Table 3.2.3.1** AHP + ANN Model Framework

Based on **Table 3.2.3.1** [11], AHP + ANN framework consists of the following steps:

**Step 1 (AHP + ANN Model Framework): Describe problem and goal of decision.**

To describe the problem and goal of decision in Step 1 of the Analytic Hierarchy Process (AHP) + Artificial Neural Networks (ANN) framework, it is needed to identify the decision problem and the goals that one wants to achieve.

First, it is needed to start by clearly stating the decision problem. This should be a clear description of the problem that needs to be solved. For example, there will be **stated the decision problem which is, it is hard for us to choose the best stock in Malaysia Stock Market**. Next, we must identify the criteria that can be used to evaluate the alternatives, or the options and these criteria is important and able to help us to achieve our goals. On the other hand, we are needed to identify the goals that we want to achieve, and these goals should be SMART goals/criteria [12], S means specific, M means measurable, A means achievable, R means relevant, and T means time bound. They should also be consistent with our mission and values. Lastly, for the Step 1 of the AHP method, we must focus on the objectives based on their importance because it will help us to focus on the most critical objectives and make better decisions.

**Step 2 (AHP + ANN Model Framework): Determine and organise the decision-making criteria and alternatives.**

Step 2 of the Analytic Hierarchy Process (AHP) + Artificial Neural Networks (ANN) framework is identifying and structuring decision criteria and alternatives. Step 2 is one of the important steps in AHP, as it sets the stage for the rest of the AHP method and helps to ensure that all the relevant factors and alternatives that we are considering to are related to the decision.

First, we must first identify and decide which alternatives we want to evaluate, which must be specific, well-defined, and relevant to our decision problem. In this step, the stock advisory tool will allow the user to choose the Malaysia company names from the list of Malaysia company name of constituents (**Refer Appendix A**) which will be provided for the user. There will be a total of 100 companies' name for the user to choose from. These companies' name is got from **Appendix A**. Once the user had selected their preferred Malaysia company, these selected Malaysia company will use as the alternative for the AHP model to do the stock decision-making.

For example, **we must identify and decide which of our top three best options of Malaysia Stock (Stock A – Tenaga Nasional Bhd, Stock B - Genting Bhd, or Stock C - Maxis Bhd) is the best for us to buy?** [11]. Once we had understood the question, we can proceed to the next step which is identifying and deciding which criteria to consider and relevant to the decision we are currently making, which must be specific, measurable, and relevant to our decision problem. In this step, the stock



advisory tool will allow the user to choose the fundamental indicators and technical indicators (except for the Open, High, Low) from the list of indicators (**Refer Table 3.2.1**) which will be provided for the user. There will be a total of 11 fundamental indicators and 9 technical indicators for the user to choose from. Once the user had selected their preferred indicators, these selected indicators will use as the criteria for the AHP model to do the stock decision-making.

For example, the three most important criteria for the user are **finding a Malaysian Company's Stock that is the Current Debt, Net Income, and Basic EPS (Earnings Per Share) of that company, then the user will choose "Current Debt", "Net Income", and "Basic EPS" from the indicators list provided by the stock advisory tool.** Once the criteria are identified, we need to organize them into a ranking structure, as this will help us see how the criteria relate to each other and how they influence the overall decision. After that, we need to evaluate each alternative based on each of the criteria. Using a rating scale (a scale from 1 to 9 or an index scale) by allowing the user to select the 1 to 9 from the dropdown list from the application, we can indicate the relative importance and strength of each criterion for each alternative [10]. Higher values on the 1–9 scale and the indicator scale indicate higher importance of the alternative's criteria.

### **Step 3 (AHP + ANN) Model Framework): Conducting pairwise comparison.**

Step 3 of the Analytic Hierarchy Process (AHP) + Artificial Neural Networks (ANN) framework is conducting pairwise comparison. Step 3 is one of the important steps in AHP. In this step, we can conduct pairwise comparisons to help us to determine which alternative is the most suitable option based on the decision criteria. Pairwise comparisons concept is the process of comparing two criteria at a time instead of comparing several criteria at once.

First, according to [11], we can organize the important criteria that had identified by me in the previous step of AHP + ANN Framework into matrices. The matrix is a grid array of information such as the presentive symbol of criteria arranged in rows and columns. Each criteria have its own row and column in AHP matrix. **Figure**

3.2.3.1 below shows the resulting square matrices are allowed pairwise comparisons of all possible sets of criteria in AHP matrix.

A	Crit. 1	Crit. 2	Crit. 3
Crit. 1	$x_{11}$	$x_{12}$	$x_{13}$
Crit. 2	$x_{21}$	$x_{22}$	$x_{23}$
Crit. 3	$x_{31}$	$x_{32}$	$x_{33}$

**Figure 3.2.3.1** AHP Matrix

**Figure 3.2.3.1** above shows how the important criteria assign in the AHP matrix of pairwise comparisons and references using subscripts [11]. For example,  $x_{13}$  refers to grid area of the first row and third column.

Intensity of importance	Definition
1	Equivalent importance
2	Low importance
3	Average importance
4	Average plus importance
5	High importance
6	High plus importance
7	Very high importance
8	Very, very high importance
9	Extremely importance

**Table 3.2.3.2** The 1 to 9 fundamental scale [13]

In pairwise comparisons, we will allow the user to assign and select a number from each dropdown list into each grid area based on the intensity of importance in the 1 to 9 fundamental scale table (**Table 3.2.3.2**) and this number is represented the relative importance between both criteria. For instance, a score of 1 for the AHP matrix indicates that both criteria are equally important, as both criteria are the same and they

are evaluated on its own. A higher score for a criterion, number 9 in the AHP matrix, indicates that that criterion is more important than others that score lower than it.

	<b>Current Debt</b>	<b>Net Income</b>	<b>Basic EPS</b>
<b>Current Debt</b>	1	5	4
<b>Net Income</b>	1/5	1	1/2
<b>Basic EPS</b>	1/4	2	1

**Table 3.2.3.3** AHP Matrix of Stock's Company (Stock A – Tenaga Nasional Bhd, Stock B - Genting Bhd, and Stock C - Maxis Bhd)

Table 3.2.3.3 above shows the AHP matrix of stock's company. This AHP matrix is a 3 x 3 matrix, and it contains three criteria of Malaysia Stock Decision including Current Debt, Net Income and Basic EPS (Basic Earnings Per Share) of the Malaysian Company, and it has assigned the number of intensities of importance inside each grid area.

In **Table 3.2.3.3**, we will put the number of intensities of importance for each criterion. The **Table 3.2.3.3**, we can see that there are three grid area which can be given a score of 1, as those criteria of the three-grid area (Current Debt, Current Debt) & (Net Income, Net Income) & (Basic EPS, Basic EPS) are compared by themselves, and it means that both criteria are equally important, and the relative importance will be 1. In the first row of **Table 3.2.3.3**, Current Debt of the stock's company is five times as important ( $x_{12} = 5$ ) as Net Income, and Current Debt is four times as important ( $x_{13} = 4$ ) as Basic EPS. Because of Current Debt is five times as important as Net Income, so we can say that Net Income is 1/5 important as Current Debt ( $x_{21} = 1/5$ ). Similarly, since Current Debt is four times as important as Basic EPS, then Basic EPS must be 1/4 as important as Current Debt ( $x_{31} = 1/4$ ). Besides, because of Current Debt of the stock's company is five times as important ( $x_{12} = 5$ ) as Net Income and Current Debt is four times as important ( $x_{13} = 4$ ) as Basic EPS, then Basic EPS will be  $5/4$  or  $(5-4+1 = 2)$  2 times as important as Net Income. Similarly, Net Income will be 1/2 times as important as Basic EPS.

**Step 4 (AHP + ANN Model Framework): Calculate the importance weight of each criterion.**

In **Step 4 of the AHP + ANN framework**, we need to **calculate importance weights based on the completed matrix (Table 3.2.3.3)** and we will know to what extent each criterion will be considered in our decision. AHP evaluates the results of each pairwise comparison using linear algebra. The importance weight of each criterion is different. The more important and impactful a criterion is for the final decision, the higher its weight.

The First step in calculating the importance weights is to find geometric mean (V) of each row for AHP matrix. To find the geometric mean (V), we need to find the cube root of multiplying all the related scores by each row (x) [11] (**Refer Figure 3.2.3.2**).

**Figure 3.2.3.2** below shows the example of an equation for calculating the geometric mean(V) of a criterion of the 3x3 matrix:

$$V1 = \sqrt[3]{X_{11} * X_{12} * X_{13}}$$

**Figure 3.2.3.2** Equation for calculating Geometric Mean(V) of a criterion of 3x3 matrix

where

- $V_1$  : Geometric Mean of Criterion 1 (Row 1 of Matrix)
- $\sqrt[3]{}$  : Cube Root
- $X_{11}$  : Refers to grid area (3x3 matrix) of the first row and first column (**Figure 3.2.3.1**)
- $X_{12}$  : Refers to grid area of the first row and second column (**Figure 3.2.3.1**)
- $X_{13}$  : Refers to grid area of the first row and third column (**Figure 3.2.3.1**)
- \* : Multiply

Next, the Second step in determining the importance weights is to find the weight (W) of the criterion. We must divide the geometric mean of the criterion by total number of geometric means of all criteria in order to get the weight (W) of the criterion. (**Refer Figure 3.2.3.3**).

$$W_1 = \frac{V_1}{V_1 + V_2 + V_3}$$

**Figure 3.2.3.3** Equation for calculating Importance Weights(W) of a criterion of 3x3 matrix

where

- $W_1$  : Weight of Criterion 1 (Row 1 of Matrix)
- $V_1$  : Geometric Mean of Criterion 1 (Row 1 of Matrix)
- $V_2$  : Geometric Mean of Criterion 2 (Row 2 of Matrix)
- $V_3$  : Geometric Mean of Criterion 3 (Row 3 of Matrix)

**Example of calculating Importance Weights(W):**

We use **Table 3.2.3.3** as the example for Calculation of Importance Weights:

	<b>Current Debt</b>	<b>Net Income</b>	<b>Basic EPS</b>
<b>Current Debt</b>	1	5	4
<b>Net Income</b>	1/5	1	1/2
<b>Basic EPS</b>	1/4	2	1

**Table 3.2.3.3** AHP Matrix of Stock's Company (Stock A – Tenaga Nasional Bhd, Stock B - Genting Bhd, and Stock C - Maxis Bhd)

**1. First Step: Calculation of Geometric Mean for criterion from each row of AHP matrix**

(1a) Find **Geometric Mean of Current Debt (V1):**

$$V_1 = \sqrt[3]{X_{11} * X_{12} * X_{13}}$$

$$V_1 = \sqrt[3]{1 * 5 * 4}$$

$$V_1 = \sqrt[3]{20}$$

$$V_1 (\text{Current Debt}) = 2.71 \text{ (rounded off to 2 decimal places)}$$

(1b) Find **Geometric Mean of Net Income (V2):**

## CHAPTER 3

$$V_2 = \sqrt[3]{X_{21} * X_{22} * X_{23}}$$

$$V_2 = \sqrt[3]{\frac{1}{5} * 1 * \frac{1}{2}}$$

$$V_2 = \sqrt[3]{\frac{1}{10}}$$

$$V_2 \text{ (Net Income)} = 0.46 \text{ (rounded off to 2 decimal places)}$$

(1c) Find **Geometric Mean of Basic EPS (V3)**:

$$V_3 = \sqrt[3]{X_{31} * X_{32} * X_{33}}$$

$$V_3 = \sqrt[3]{\frac{1}{4} * 2 * 1}$$

$$V_3 = \sqrt[3]{\frac{1}{2}}$$

$$V_3 \text{ (Basic EPS)} = 0.79 \text{ (rounded off to 2 decimal places)}$$

### **2. Second Step: Calculation of Importance Weight**

(2a) Find **Importance Weight of Current Debt (W1)**:

$$W_1 \text{ (Current Debt)} = \frac{V_1}{V_1 + V_2 + V_3}$$

$$W_1 \text{ (Current Debt)} = \frac{2.71}{2.71 + 0.46 + 0.79}$$

$$W_1 \text{ (Current Debt)} = \frac{2.71}{3.96}$$

$$W_1 \text{ (Current Debt)} = 0.68 \text{ (rounded off to 2 decimal places)}$$

(2b) Find **Importance Weight of Net Income (W2)**:

## CHAPTER 3

$$W_2 (\text{Net Income}) = \frac{V_2}{V_1 + V_2 + V_3}$$

$$W_2 (\text{Net Income}) = \frac{0.46}{2.71 + 0.46 + 0.79}$$

$$W_2 (\text{Net Income}) = \frac{0.46}{3.96}$$

$$W_2 (\text{Net Income}) = 0.12 \text{ (rounded off to 2 decimal places)}$$

(2a) Find **Importance Weight of Basic EPS (W3)**:

$$W_3 (\text{Basic EPS}) = \frac{V_3}{V_1 + V_2 + V_3}$$

$$W_3 (\text{Basic EPS}) = \frac{0.79}{2.71 + 0.46 + 0.79}$$

$$W_3 (\text{Basic EPS}) = \frac{0.79}{3.96}$$

$$W_3 (\text{Basic EPS}) = 0.20 \text{ (rounded off to 2 decimal places)}$$

### **3. Third Step: Checking the correctness of Importance Weight Calculation**

The sum of importance weight of three criterion must be equal to 1.

$$0.68 + 0.12 + 0.20 = 1$$

### **Conclusion of Importance Weight Calculation of Table 3.2.3.3 – AHP Matrix of Car**

After finished calculating all the Importance Weight of three criterion (Current Debt, Net Income, Basic EPS), the result tells us that:

- Current Debt accounts for 68% of the overall decision of which Malaysian Company's stock to buy (**The most important criteria**).
- Net Income accounts for 12% of the overall decision of which Malaysian Company's stock to buy (**The second important criteria**).

- Basic EPS accounts for 20% of the overall decision of which Malaysian Company's stock to buy (**The least important criteria**).

**Step 5 (AHP + ANN Model Framework): Calculate the utility of ANN Technique.**

In **Step 5 of the AHP + ANN framework**, we need to **calculate and determine the utility based on the completed matrix** and we will the numerical value of utility to get the useful information which can help us to select the best option/choice of stock. The higher the value of that criterion's utility, the more beneficial that criterion.

**Example of calculating Total Utility:**

We use **Table 3.2.3.3** as the example for Calculation of Importance Weights:

	<b>Current Debt</b>	<b>Net Income</b>	<b>Basic EPS</b>
<b>Current Debt</b>	1	5	4
<b>Net Income</b>	1/5	1	1/2
<b>Basic EPS</b>	1/4	2	1

**Table 3.2.3.3** AHP Matrix of Stock's Company (Stock A – Tenaga Nasional Bhd, Stock B - Genting Bhd, and Stock C - Maxis Bhd)

**Calculation of Total Utility for each alternative (Stock A – Tenaga Nasional Bhd, Stock B - Genting Bhd, or Stock C - Maxis Bhd) of Table 3.2.3.3:**

**1. First Step: Identifying the Importance Weight of each criterion**

From previous calculation (Step 4 of AHP Framework), we have the Importance Weight of each criterion (Current Debt, Net Income, Basic EPS)

Importance Weight of Current Debt = 0.68

Importance Weight of Net Income = 0.12

Importance Weight of Basic EPS = 0.20



## **2. Second Step: Calculation of Score for each criterion**

In this step, we need to calculate the score for each criterion (Current Debt, Net Income, Basic EPS) for each stock (Stock A – Tenaga Nasional Bhd, Stock B - Genting Bhd, or Stock C - Maxis Bhd).

### **Example:**

Suppose we list down each fundamental indicator of the companies which are found from the financial statement of each company:

(a) Stock A – Tenaga Nasional Bhd

Current debt: RM 6,992,500, Net Income: RM 3,661,800, Basic EPS: 0.64

(b) Stock B - Genting Bhd

Current debt: RM 2,767,900, Net Income: RM -1,369,700, Basic EPS: -0.36

(c) Stock C - Maxis Bhd

Current debt: RM 1,772,000, Net Income: RM 1,308,000, Basic EPS: 0.17

## **3. Third Step: Normalization of score for each criterion:**

Based on the fundamental indicator of those companies above, to calculate the total utility of each stock, we need to first normalize the values of each criterion for each stock using the formula based on different condition or situation of indicators (**Table 2.5.1 Input Parameter (Technical Indicator/Fundamental Indicator)**):

### **2.5.1 Input Parameter (Technical Indicator/Fundamental Indicator):**

(a) **Condition 1:** The higher the value of that fundamental indicator, the best the score of that company's stock. Then, we will use this formula:

$$\text{Normalized value} = \frac{(\text{Actual value} - \text{Minimum value})}{(\text{Maximum value} - \text{Minimum value})}$$

(b) **Condition 2:** The higher the value of that fundamental indicator, the bad the score of that company's stock, then we need to invert the normalized value by subtracting it from 1. Then, we will use this formula:

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$$\text{Normalized value} = 1 - \frac{(\text{Actual value} - \text{Minimum value})}{(\text{Maximum value} - \text{Minimum value})}$$

We will find out the maximum value and minimum value of each criterion.

Current Debt (max) = RM 6,992,500, Current Debt (min) = RM 1,772,000

Net Income (max) = RM 3,661,800, Net Income (min) = RM -1,369,700

Basic EPS (max) = 0.64, Basic EPS (min) = -0.36

Once we had found out the maximum value and minimum value of each criterion, then we can start to normalize the values of each criterion for each stock and calculate the total utility of each stock:

(a) For Net Income and Basic EPS, since the higher the value of the criterion, the better the score of that company's stock, we can use the normal formula to calculate the normalized values.

(b) For Current Debt, since the higher the value of current debt, the bad the score of that company's stock, we need to invert the normalized value by subtracting it from 1.

Stock A – Tenaga Nasional Bhd:

$$X_{(\text{Normalized Current Debt}-\text{Stock A})} = 1 - \frac{6,992,500 - 1,772,000}{6,992,500 - 1,772,000}$$

$$X_{(\text{Normalized Current Debt}-\text{Stock A})} = 1 - \frac{5,220,500}{5,220,500}$$

$$X_{(\text{Normalized Current Debt}-\text{Stock A})} = 1 - 1$$

$$X_{(\text{Normalized Current Debt}-\text{Stock A})} = 0$$

$$X_{(\text{Normalized Net Income}-\text{Stock A})} = \frac{3,661,800 - (-1,369,700)}{3,661,800 - (-1,369,700)}$$

$$X_{(\text{Normalized Net Income}-\text{Stock A})} = \frac{5,031,500}{5,031,500}$$

$$X_{(\text{Normalized Net Income}-\text{Stock A})} = 1$$

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$$X_{(\text{Normalized Basic EPS}-\text{Stock A})} = \frac{0.64 - (-0.36)}{0.64 - (-0.36)}$$

$$X_{(\text{Normalized Basic EPS}-\text{Stock A})} = \frac{1}{1}$$

$$X_{(\text{Normalized Basic EPS}-\text{Stock A})} = 1$$

### Stock B - Genting Bhd:

$$X_{(\text{Normalized Current Debt}-\text{Stock B})} = 1 - \frac{2,767,900 - 1,772,000}{6,992,500 - 1,772,000}$$

$$X_{(\text{Normalized Current Debt}-\text{Stock B})} = 1 - \frac{995,900}{5,220,500}$$

$$X_{(\text{Normalized Current Debt}-\text{Stock B})} = 0.81 \text{ (rounded off to 2 decimal places)}$$

$$X_{(\text{Normalized Net Income}-\text{Stock B})} = \frac{-1,369,700 - (-1,369,700)}{3,661,800 - (-1,369,700)}$$

$$X_{(\text{Normalized Net Income}-\text{Stock B})} = \frac{0}{5,031,500}$$

$$X_{(\text{Normalized Net Income}-\text{Stock B})} = 0$$

$$X_{(\text{Normalized Basic EPS}-\text{Stock B})} = \frac{-0.36 - (-0.36)}{0.64 - (-0.36)}$$

$$X_{(\text{Normalized Basic EPS}-\text{Stock B})} = \frac{0}{1}$$

$$X_{(\text{Normalized Basic EPS}-\text{Stock B})} = 0$$

### Stock C - Maxis Bhd

$$X_{(\text{Normalized Current Debt}-\text{Stock C})} = 1 - \frac{1,772,000 - 1,772,000}{6,992,500 - 1,772,000}$$

$$X_{(\text{Normalized Current Debt}-\text{Stock C})} = 1 - \frac{0}{5,220,500}$$

$$X_{(\text{Normalized Current Debt}-\text{Stock C})} = 1$$

## CHAPTER 3

$$X_{(\text{Normalized Net Income}-\text{Stock C})} = \frac{1,308,000 - (-1,369,700)}{3,661,800 - (-1,369,700)}$$

$$X_{(\text{Normalized Net Income}-\text{Stock C})} = \frac{2,677,700}{5,031,500}$$

$$X_{(\text{Normalized Net Income}-\text{Stock C})} = 0.53 \text{ (rounded off to 2 decimal places)}$$

$$X_{(\text{Normalized Basic EPS}-\text{Stock C})} = \frac{0.17 - (-0.36)}{0.64 - (-0.36)}$$

$$X_{(\text{Normalized Basic EPS}-\text{Stock C})} = \frac{0.53}{1}$$

$$X_{(\text{Normalized Basic EPS}-\text{Stock C})} = 0.53 \text{ (rounded off to 2 decimal places)}$$

### **4. Fourth Step: Calculation of Total Utility for each stocks**

After we have the importance weight and normalized score of each criterion (Current Debt, Net Income, Basic EPS) for each stock (Stock A – Tenaga Nasional Bhd, Stock B - Genting Bhd, and Stock C - Maxis Bhd), we can calculate the total utility for each stock by multiplying the importance weight for each criterion by the normalized data for that criterion, and then sum up these values across all criteria.

#### **Formula of Total Utility:**

*Total Utility*

$$\begin{aligned} &= (\text{Weight of Criterion 1} * \text{Normalized Score of Criterion 1}) \\ &+ (\text{Weight of Criterion 2} \\ &* \text{Normalized Score of Criterion 2}) + \dots + (\text{Weight of Criterion } n \\ &* \text{Normalized Score of Criterion } n) \end{aligned}$$

(3a) Find **Total Utility for Stock A – Tenaga Nasional Bhd:**

$$\begin{aligned} \text{Total utility (Stock A – Tenaga Nasional Bhd)} \\ &= (0.68 \times 0) + (0.12 \times 1) + (0.20 \times 1) = 0.32 \end{aligned}$$

(3b) Find **Total Utility for Stock B - Genting Bhd:**

*Total utility (Stock B – Genting Bhd)*

$$= (0.68 \times 0.81) + (0.12 \times 0) + (0.20 \times 0) = 0.5508$$

(3c) Find **Total Utility for Stock C - Maxis Bhd:**

*Total utility (Stock C – Maxis Bhd)*

$$= (0.68 \times 1) + (0.12 \times 0.53) + (0.20 \times 0.53) = 0.8496$$

**Step 6 (AHP + ANN Model Framework): Identify and rank best option of stocks.**

**Conclusion of Total Utility Calculation for each alternative of stock (Stock A – Tenaga Nasional Bhd, Stock B - Genting Bhd, and Stock C - Maxis Bhd) of Table 3.2.3.3**

After finished calculating all the Total Utility Calculation for each alternative (Stock A – Tenaga Nasional Bhd, Stock B - Genting Bhd, and Stock C - Maxis Bhd), the result tells us that:

- Total utility score for Stock A (Tenaga Nasional Bhd) is 0.32
- Total utility score for Stock B (Genting Bhd) is 0.5508
- Total utility score for Stock C (Maxis Bhd) is 0.8496

From the above result, we see that Stock C (Maxis Bhd) has the highest total utility of 0.8496, followed by Stock B (Genting Bhd) with the total utility of 0.5508, and Stock A (Tenaga Nasional Bhd) with the total utility of 0.32. So, we can say that the best choice for us to buy the stock in Malaysian Stock Market is Stock C (Maxis Bhd) which is ranked the First Place of stock ranking list, followed by Stock B (Genting Bhd) which is ranked at the Second Place of stock ranking list and at last is Stock A (Tenaga Nasional Bhd) which is ranked the Third Place of stock ranking list.

**Stock Trend**

(0.0000 – 0.4999 = Downtrend of Stock, 0.5000 – 1.0000 = Uptrend of Stock)

<b>Rank</b>	<b>Stock Name</b>	<b>Total utility score</b>	<b>Stock Trend</b>
1st	Stock C (Maxis Bhd)	0.8496	Uptrend

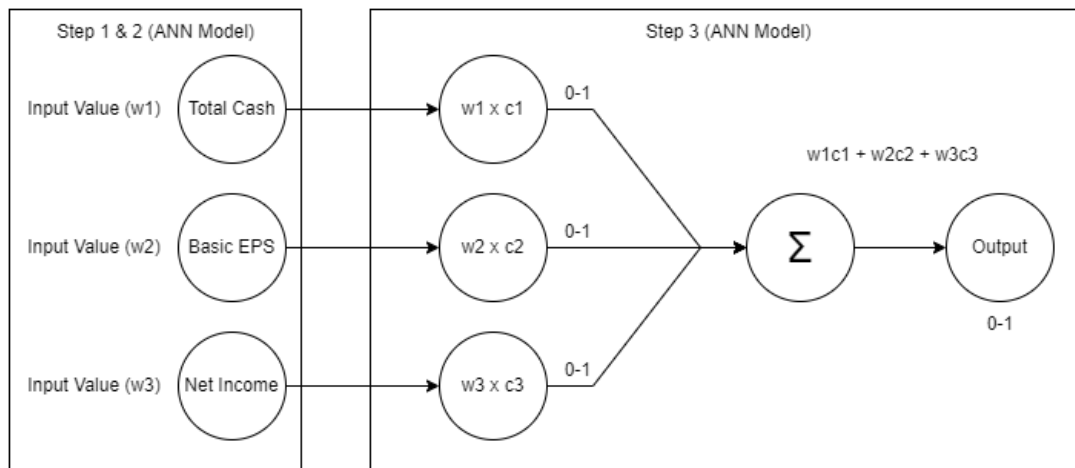
2nd	Stock B (Genting Bhd)	0.5508	Uptrend
3rd	Stock A (Tenaga Nasional Bhd)	0.32	Downtrend

**Table 3.2.3.4** Stock Ranking Table of AHP + ANN Model

Table 3.2.3.4 above shows the Stock Ranking Table of AHP + ANN Model. The higher the total utility score of stock, the higher the ranking of the stock will be in the stock ranking table of AHP + ANN model.

### 3.2.3.1 ANN Model Framework

ANN model can be used for conducting stock prediction process. The goal of stock prediction for the ANN model is to predict whether the performance for the stock price of three companies will decrease (0) or increase (1) or the recommended action for the stock of three companies is strongly sell (0) or strongly buy (1) based on the input indicators preferred by the user.



**Figure 3.2.3.1.1** Architecture Diagram of ANN Model

Figure 3.2.3.1.1 shows the architecture of the Artificial Neural Network (ANN) model employed in the stock prediction process. The explanation of the diagram of ANN model is presented below:

#### **Step 1 (ANN Model Framework): Define Inputs and Weights.**

Assume that the user had selected 3 indicators (Total Cash, Net Income, Basic EPS) and 3 company's stocks (Stock A – Tenaga Nasional Bhd, Stock B - Genting Bhd, and Stock C - Maxis Bhd) to predict their performance and recommended action.

(a) Let's assign the value of weights to selected indicators:

Weight for Current Debt ( $w_1$ ): 0.3

Weight for Net Income ( $w_2$ ): 0.5

Weight for Basic EPS ( $w_3$ ): 0.2

(b) Let's assign the input value to selected indicators for Stock A – Tenaga Nasional Bhd:

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Current Debt: 6,992,500

Net Income: 3,661,800

Basic EPS: 0.64

(c) Let's assign the input value to selected indicators for Stock B - Genting Bhd:

Current Debt: 2,767,900

Net Income: -1,369,700

Basic EPS: -0.36

(d) Let's assign the input value to selected indicators for Stock C - Maxis Bhd:

Current Debt: 1,772,000

Net Income: 1,772,000

Basic EPS: 0.17

### **Step 2 (ANN Model Framework): Normalization of score for each stock:**

Based on the indicator of those companies above, to calculate the weighted sum of each stock, we need to first normalize the input values of each stock by using the formula based on different condition or situation of indicators:

**(a) Condition 1:** The higher the value of that indicator, the best the score of that company's stock. Then, we will use this formula:

$$\text{Normalized input value} = \frac{(\text{Actual value} - \text{Minimum value})}{(\text{Maximum value} - \text{Minimum value})}$$

**(b) Condition 2:** The higher the value of that indicator, the bad the score of that company's stock, then we need to invert the normalized value by subtracting it from 1. Then, we will use this formula:

$$\text{Normalized input value} = 1 - \frac{(\text{Actual value} - \text{Minimum value})}{(\text{Maximum value} - \text{Minimum value})}$$

We will find out the maximum value and minimum value of each indicator.

Current Debt (max) = RM 6,992,500, Current Debt (min) = RM 1,772,000



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Net Income (max) = RM 3,661,800, Net Income (min) = RM -1,369,700

Basic EPS (max) = 0.64, Basic EPS (min) = -0.36

Once we had found out the maximum value and minimum value of each criterion, then we can start to normalize the input values of each stock and calculate the weighted sum of each stock:

(a) For Net Income and Basic EPS, since the higher the value of the indicator, the better the score of that company's stock, we can use the normal formula to calculate the normalized input values.

(b) For Current Debt, since the higher the value of current debt, the bad the score of that company's stock, we need to invert the normalized input value by subtracting it from 1.

### Stock A – Tenaga Nasional Bhd:

$$X_{(Normalized\ Current\ Debt-Stock\ A)} = 1 - \frac{6,992,500 - 1,772,000}{6,992,500 - 1,772,000}$$

$$X_{(Normalized\ Current\ Debt-Stock\ A)} = 1 - \frac{5,220,500}{5,220,500}$$

$$X_{(Normalized\ Current\ Debt-Stock\ A)} = 1 - 1$$

$$X_{(Normalized\ Current\ Debt-Stock\ A)} = 0$$

$$X_{(Normalized\ Net\ Income-Stock\ A)} = \frac{3,661,800 - (-1,369,700)}{3,661,800 - (-1,369,700)}$$

$$X_{(Normalized\ Net\ Income-Stock\ A)} = \frac{5,031,500}{5,031,500}$$

$$X_{(Normalized\ Net\ Income-Stock\ A)} = 1$$

$$X_{(Normalized\ Basic\ EPS-Stock\ A)} = \frac{0.64 - (-0.36)}{0.64 - (-0.36)}$$

$$X_{(Normalized\ Basic\ EPS-Stock\ A)} = \frac{1}{1}$$

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$$X_{(\text{Normalized Basic EPS}-\text{Stock A})} = 1$$

### Stock B - Genting Bhd:

$$X_{(\text{Normalized Current Debt}-\text{Stock B})} = 1 - \frac{2,767,900 - 1,772,000}{6,992,500 - 1,772,000}$$

$$X_{(\text{Normalized Current Debt}-\text{Stock B})} = 1 - \frac{995,900}{5,220,500}$$

$$X_{(\text{Normalized Current Debt}-\text{Stock B})} = 0.81 \text{ (rounded off to 2 decimal places)}$$

$$X_{(\text{Normalized Net Income}-\text{Stock B})} = \frac{-1,369,700 - (-1,369,700)}{3,661,800 - (-1,369,700)}$$

$$X_{(\text{Normalized Net Income}-\text{Stock B})} = \frac{0}{5,031,500}$$

$$X_{(\text{Normalized Net Income}-\text{Stock B})} = 0$$

$$X_{(\text{Normalized Basic EPS}-\text{Stock B})} = \frac{-0.36 - (-0.36)}{0.64 - (-0.36)}$$

$$X_{(\text{Normalized Basic EPS}-\text{Stock B})} = \frac{0}{1}$$

$$X_{(\text{Normalized Basic EPS}-\text{Stock B})} = 0$$

### Stock C - Maxis Bhd

$$X_{(\text{Normalized Current Debt}-\text{Stock C})} = 1 - \frac{1,772,000 - 1,772,000}{6,992,500 - 1,772,000}$$

$$X_{(\text{Normalized Current Debt}-\text{Stock C})} = 1 - \frac{0}{5,220,500}$$

$$X_{(\text{Normalized Current Debt}-\text{Stock C})} = 1$$

$$X_{(\text{Normalized Net Income}-\text{Stock C})} = \frac{1,308,000 - (-1,369,700)}{3,661,800 - (-1,369,700)}$$

$$X_{(\text{Normalized Net Income}-\text{Stock C})} = \frac{2,677,700}{5,031,500}$$

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$$X_{(\text{Normalized Net Income}-\text{Stock C})} = 0.53 \text{ (rounded off to 2 decimal places)}$$

$$X_{(\text{Normalized Basic EPS}-\text{Stock C})} = \frac{0.17 - (-0.36)}{0.64 - (-0.36)}$$

$$X_{(\text{Normalized Basic EPS}-\text{Stock C})} = \frac{0.53}{1}$$

$$X_{(\text{Normalized Basic EPS}-\text{Stock C})} = 0.53 \text{ (rounded off to 2 decimal places)}$$

### **Step 3 (ANN Model Framework): Calculate the Weighted Sum for each stock**

Formula of calculating the weighted sum:

$$(w1 \times c1) + (w2 \times c2) + (w3 \times c3)$$

where

- w1: weight of first indicator
- w2: weight of second indicator
- w3: weight of third indicator
- c1: Normalized input value of first indicator
- c2: Normalized input value of second indicator
- c3: Normalized input value of third indicator

(a) Weighted Sum of Stock A – Tenaga Nasional Bhd

$$(w1 \times c1) + (w2 \times c2) + (w3 \times c3)$$

$$= (0.3 \times 0) + (0.5 \times 1) + (0.2 \times 1)$$

$$= 0 + 0.5 + 0.2$$

$$= 0.7$$

(b) Weighted Sum of Stock B - Genting Bhd

$$(w1 \times c1) + (w2 \times c2) + (w3 \times c3)$$

$$= (0.3 \times 0.81) + (0.5 \times 0) + (0.2 \times 0)$$

$$= 0.243 + 0 + 0$$

$$= 0.243$$

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(a) Weighted Sum of Stock C - Maxis Bhd

$$(w_1 \times c_1) + (w_2 \times c_2) + (w_3 \times c_3)$$

$$= (0.3 \times 1) + (0.5 \times 0.53) + (0.2 \times 0.53)$$

$$= 0.3 + 0.265 + 0.106$$

$$= 0.671$$

### **Step 4 (ANN Model Framework): Identify and rank best option of stocks.**

After finished calculating all the weighted sum for each alternative (Stock A – Tenaga Nasional Bhd, Stock B - Genting Bhd, and Stock C - Maxis Bhd), the weighted sum also means that it is the output value of each stock in the ANN model, the result tells us that:

- Output value for Stock A (Tenaga Nasional Bhd) is 0.7
- Output value for Stock B (Genting Bhd) is 0.243
- Output value for Stock C (Maxis Bhd) is 0.671

From the above result, we see that Stock A (Tenaga Nasional Bhd) has the highest output value of 0.7, followed by Stock C (Maxis Bhd) with the output value of 0.671, and Stock B (Genting Bhd) with the output value of 0.243. So, we can say that the most recommended choice for us to buy the stock in Malaysian Stock Market is Stock A (Tenaga Nasional Bhd) which is ranked the First Place of stock ranking list, followed by Stock C (Maxis Bhd) which is ranked at the Second Place of stock ranking list and at last is Stock B (Genting Bhd) which is ranked the Third Place of stock ranking list.

<b>Rank</b>	<b>Stock Name</b>	<b>Total utility score</b>
1st	Stock A (Tenaga Nasional Bhd)	0.7
2nd	Stock C (Maxis Bhd)	0.243
3rd	Stock B (Genting Bhd)	0.671

**Table 3.2.3.1.1** Stock Ranking Table of ANN Model

Table 3.2.3.1.1 above shows the Stock Ranking Table of ANN Model. The higher the output value of stock, the higher the ranking of the stock will be in the stock ranking table of ANN model.

### 3.3 Hardware and Software Requirement

#### 3.3.1 Hardware

The hardware involved in this project is a computer and mobile device. The computer will be used for the coding part of the Stock Market Equity Advisory Tool in the development stage. The mobile device will be used for the testing of the function and flow of the application to ensure that the application can run smoothly without being stuck or having any bugs.

Descriptions	Specifications
Model	Acer Aspire E 14 (E5-476G-81VA)
Processor	Intel® Core i7-8550U
Operating System	Windows 11 Home Single Language
Graphic	NVIDIA GeForce MX150 2GB of dedicated GDDR5 VRAM
Memory	12GB DDR4 RAM
Storage	1TB SSD + 1TB SATA HDD

**Table 3.3.1.1** – Specifications of Laptop

**Table 3.3.1.1** shows the specifications of the laptop that will be used in the development stages of this project.

Descriptions	Specifications
Model	Redmi Note 11
Processor	Qualcomm SM6225 Snapdragon 680
Operating System	Android 12
Memory	6GB
Storage	128GB

**Table 3.3.1.2** – Specifications of Mobile Device

**Table 3.3.1.2** shows the specifications of the mobile device that will be used in the testing stage of this project.

### 3.3.2 Software

There is one software that must be installed on the laptop before beginning with developing the stock market equity advisory tool:

#### 1. Android studio

Android Studio is the official IDE that enables users from all around the globe to create custom Android applications. Additionally, Android Studio offers extra capabilities that increase productivity while creating Android applications [5]. Java and Kotlin are the two programming languages that may be used in the Android Studio coding section.

In terms of stability, Versions of Java like Java 8 and Java 11 are supported for a very long time, and if something goes wrong, a patch may be released to correct it. Besides, in term of library, Java has more library than Kotlin that can be used by me. Moreover, compared to Java, Kotlin is still a newer language, and as of this writing, none of its versions are supported long-term. [6]. Therefore, it will be choosing Java as the programming language for this project while developing the Stock Market Equity Advisory Tool in Android Studio.

### 3.4 Information Gathering

The required data of the AHP + ANN model is the stock details in the Malaysia Stock Market. There will be having only 100 stocks in the Malaysia Stock Market that will be used for the decision making of AHP + ANN model. These stocks are got from the list of FTSE Bursa Malaysia 100 Index Constituents [53] & [54] which has shown in the **Appendix A**. The information of the stocks and the company's fundamental and technical indicators (**Refer Table 3.4.1**), such as net income, current debt, RSI and so on is needed to be collect because it will be provided for the user while the user wants to select the criteria of this AHP model in Stock Market Equity Advisory Tool. These information of the stocks and the company's fundamental and technical indicators will be gotten from the websites of Investing.com [55], Yahoo Finance [56], and Bursa Malaysia [57] and used as the dataset of AHP + ANN model in Stock Market Equity Advisory Tool.

<b>Fundamental Indicator</b>	<b>Description</b>
Net Income	The net income of Stock's company
Current Debt	The current debt of Stock's company
Total Cash	The total cash of Stock's company
Total Asset	The total asset of Stock's company
Total Liabilities	The total liabilities of Stock's company
Total Stockholders' Equity	The total stockholders' equity of Stock's company
Net Cash Operating	The net cash generated by the operating activities of Stock's company
Free Cash Flow	The free cash flow of Stock's company
Basic EPS	The basic earnings per share of Stock's company
P/E Ratio	The price-to-earnings ratio of Stock's company
P/B Ratio	The price-to-book ratio of Stock's company
<b>Technical Indicator</b>	<b>Description</b>
Volume	The volume of the Stock

MACD	The moving average convergence divergence of the Stock
RSI	The relative strength index of the Stock
Bull/Bear Power	The bull/bear power of the Stock
ATR	The average true range of the Stock
CCI	The commodity channel index of the Stock
Ultimate Oscillator	The ultimate oscillator of the Stock
Stochastic Oscillator	The stochastic oscillator of the Stock
Inflation Rate	The inflation rate of Malaysia

**Table 3.4.1** List of indicators provides for the user

**Table 3.4.1** shows the list of indicators which will be provided for the user while the user wants to select the criteria of this AHP + ANN model in Stock Market Equity Advisory Tool.

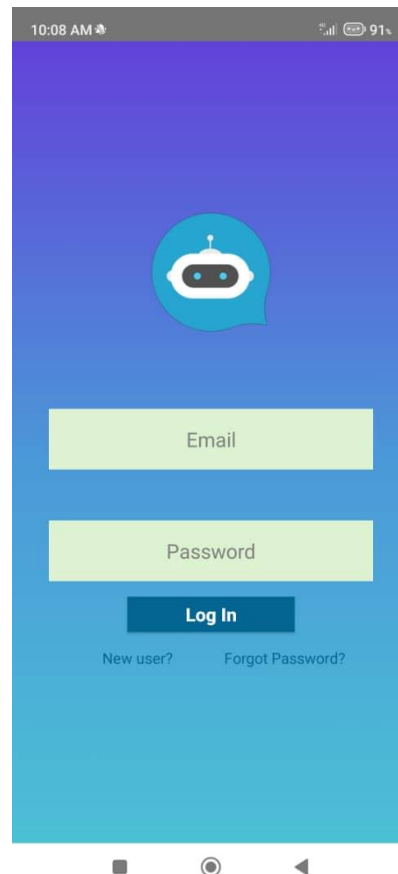


## CHAPTER 4

### Design of Proposed System

#### 4.1 Graphical User Interface Design

##### 4.1.1 Login Page

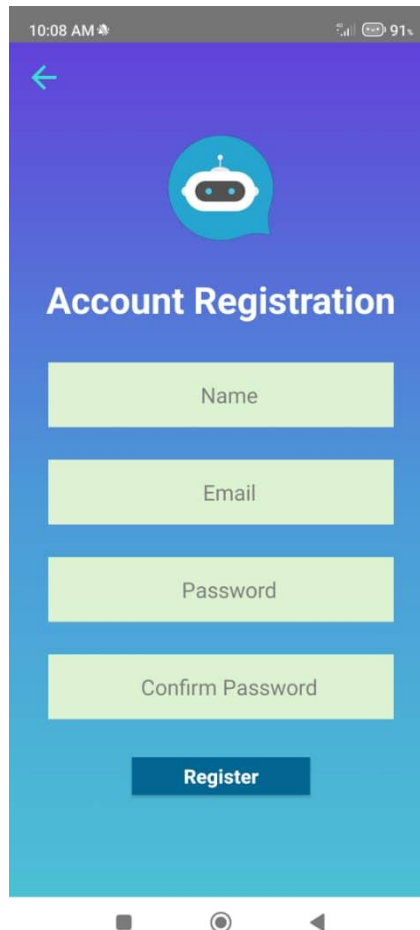


**Figure 4.1.1.1** Login Page of Stock Advisory Tool

Figure 4.1.1.1 above shows the Login Page of the Stock Advisory Tool mobile application. This Login Page allows users to access their Stock Advisory Tool accounts by entering their email and password in the text box of 'Email' and 'Password' respectively. The 'New user?' button is located below the 'Log In' button, and it allows users to enter the Account Registration page of Stock Advisory Tool. If the users don't have a Stock Advisory Tool account before, then they need to press the 'New user?' button to get an account in this app. The 'Forgot Password?' button is found on the right side of the 'New User?' button. If the users have forgotten their account's

password, then they need to press the ‘Forgot Password?’ button to enter the Reset Password page of this app.

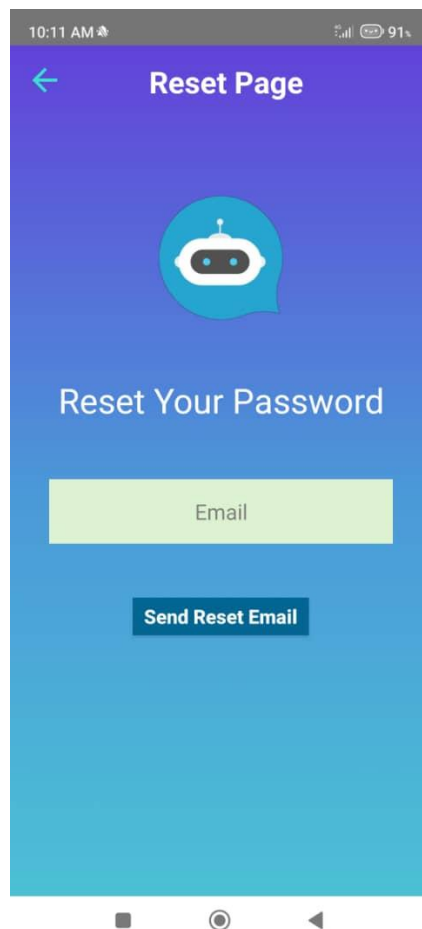
#### 4.1.2 Account Registration Page



**Figure 4.1.2.1** Account Registration Page of Stock Advisory Tool

Figure 4.1.2.1 above shows the Account Registration Page of the Stock Advisory Tool mobile application. This Account Registration Page allows users to create an account by providing their personal information, such as name, email address, and password. All the inputted personal information will be saved inside the Firebase of this app. Once the users have pressed the ‘Register’ button and the account registration process is successful, then they can access the exclusive features of the Stock Advisory Tool. On the top left side of this page, there is a light blue left arrow button which allows users to navigate back to the Login page.

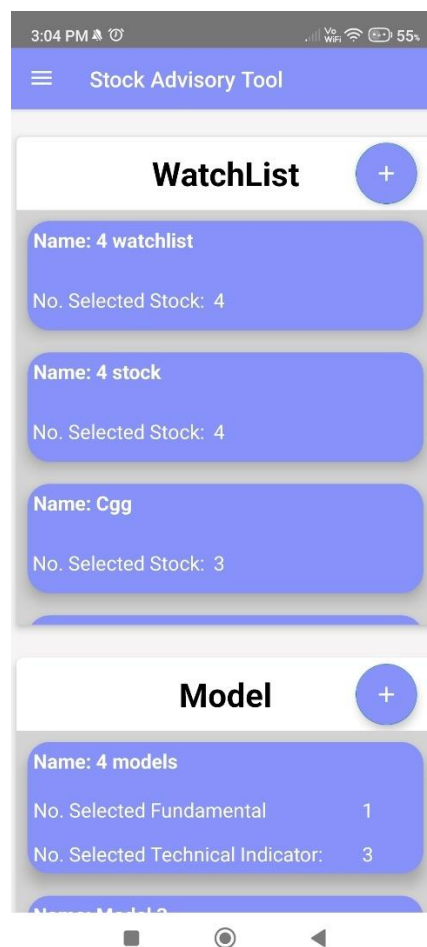
### 4.1.3 Reset Password Page



**Figure 4.1.3.1** Reset Password Page of Stock Advisory Tool

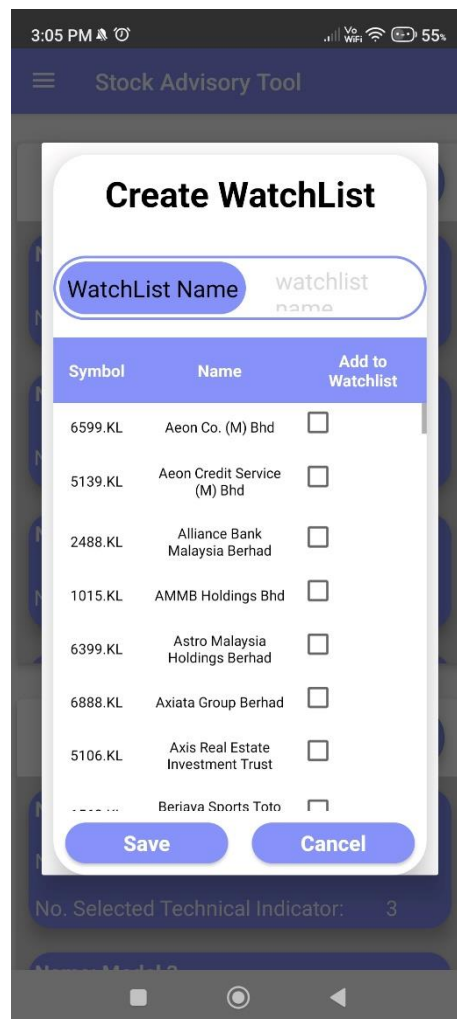
Figure 4.1.3.1 above shows the Reset Password Page of the Stock Advisory Tool mobile application. The Reset Password Page allows users to reset their forgotten passwords by providing the email address associated with their Stock Advisory Tool account. Once the users have submitted the required email address by pressing the 'Send Reset Email' button, they will receive an email requesting them to reset their password in their email inbox. On the top left side of this page, there is a light blue left arrow button which allows users to navigate back to the Login page.

#### 4.1.4 Home Page



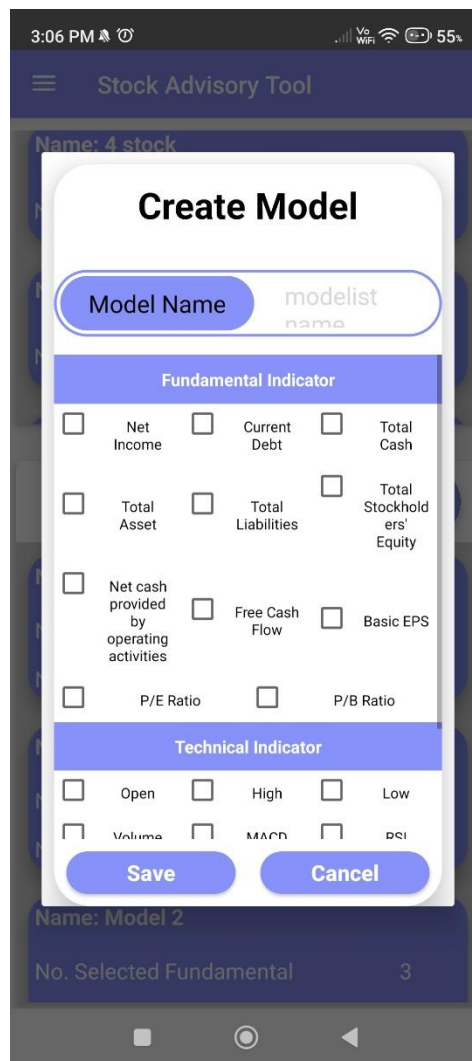
**Figure 4.1.4.1** Home Page of Stock Advisory Tool

Figure 4.1.4.1 above shows the home page of the Stock Advisory Tool mobile application. The Home page will show the list of watch lists and models that were previously created by the user. Each watch list will show their name, the number of selected stocks, and each model will show the number of selected fundamental and technical indicators. This feature enhances user convenience and allows for easy access to update or view their saved watch lists and models on the home page. Besides, the user can press the '+' floating button at the watch list section to open the pop-up window of the watch list creation form (**Figure 4.1.4.2**) and press the '+' floating button at the model section to open the pop-up window of the model creation form (**Figure 4.1.4.3**).



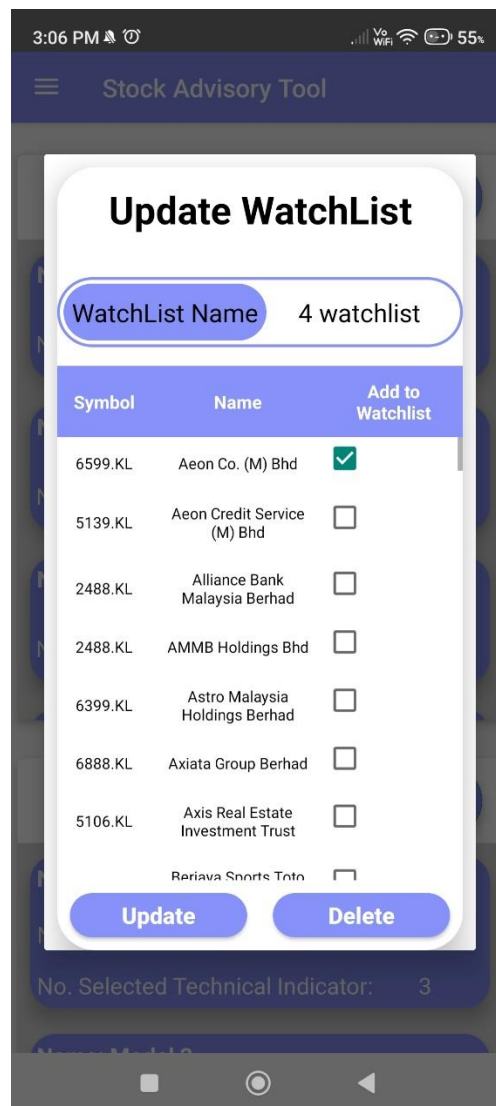
**Figure 4.1.4.2** Pop-Up Window of Watch List Creation Form

Figure 4.1.4.2 above shows pop-up window of watch list creation form after the user had pressed the ‘+’ floating button at the watch list section in the home page of Stock Advisory Tool mobile application. This watch list creation form allows users to create a watch list by providing a name for the watch list and select at least 3 stocks and at most 4 stocks from 100 stocks by ticking the checkboxes besides each stock. Once the user has pressed the ‘Save’ button, the inputted name and selected checkboxes of stocks will be saved inside the Firebase Real-time of this application. The user can press the ‘Cancel’ button if they wish to close the pop-up window.



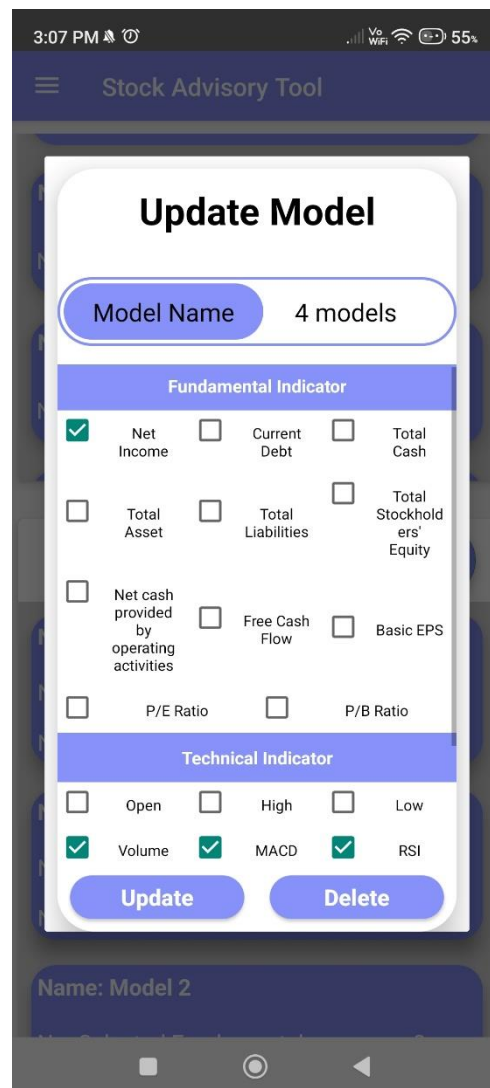
**Figure 4.1.4.3** Pop-Up Window of Model Creation Form

Figure 4.1.4.3 above shows pop-up window of model creation form after the user had pressed the '+' floating button at the model list section in the home page of Stock Advisory Tool mobile application. This model creation form allows users to create a model by providing a name for the model and select at least 3 indicators and at most 4 indicators from 23 indicators by ticking the checkboxes besides each indicator. Once the user has pressed the 'Save' button, the inputted name and selected checkboxes of indicators will be saved inside the Firebase Real-time of this application. The user can press the 'Cancel' button if they wish to close the pop-up window.



**Figure 4.1.4.4** Pop-Up Window of Watch List Update Form

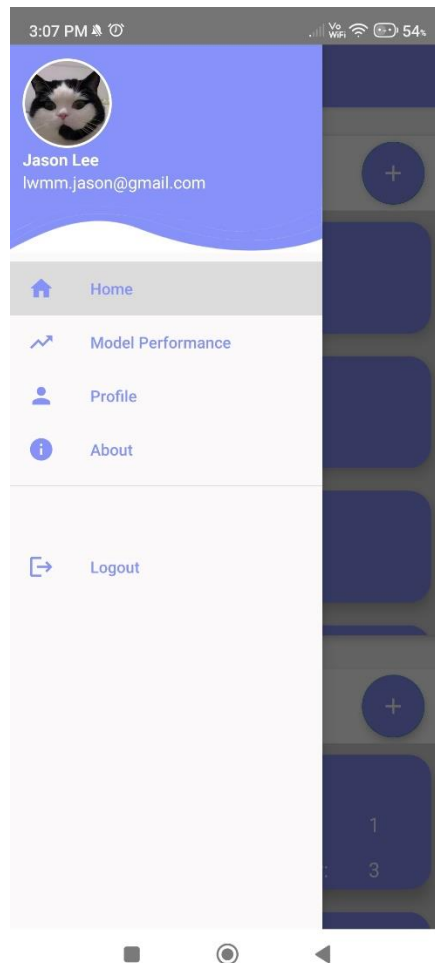
Figure 4.1.4.4 above shows the pop-up window of the watch list update form after the user had pressed one of the watch list items in the watch list section on the home page of the Stock Advisory Tool mobile application. First, this watch list update form will show the current item's watch list's name and currently selected stock checkboxes. The user can modify the watch list's name at the textbox and untick or tick the checkboxes of stocks. Once the user has pressed the 'Update' button, the modified name and selected checkboxes of stocks will be updated inside the Firebase Real-time of this application. The user can press the 'Cancel' button if they wish to close the pop-up window.



**Figure 4.1.4.5** Pop-Up Window of Model Update Form

Figure 4.1.4.5 above shows the pop-up window of the model update form after the user had pressed one of the model items in the model section on the home page of the Stock Advisory Tool mobile application. First, this model update form will show the current item's model's name and currently selected indicator checkboxes. The user can modify the model's name at the textbox and untick or tick the checkboxes of indicators. Once the user has pressed the 'Update' button, the modified name and selected checkboxes of indicators will be updated inside the Firebase Real-time of this application. The user can press the 'Cancel' button if they wish to close the pop-up window.

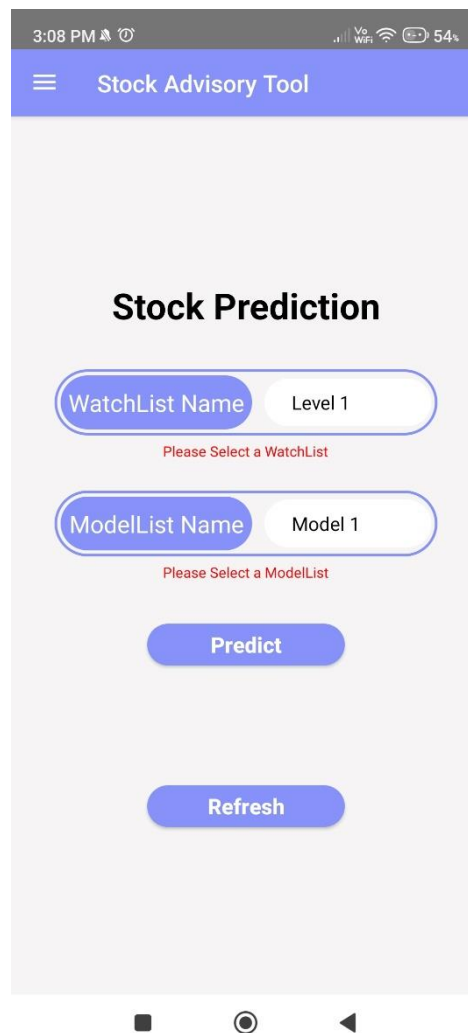




**Figure 4.1.4.6** Navigation Drawer Menu of Stock Advisory Tool

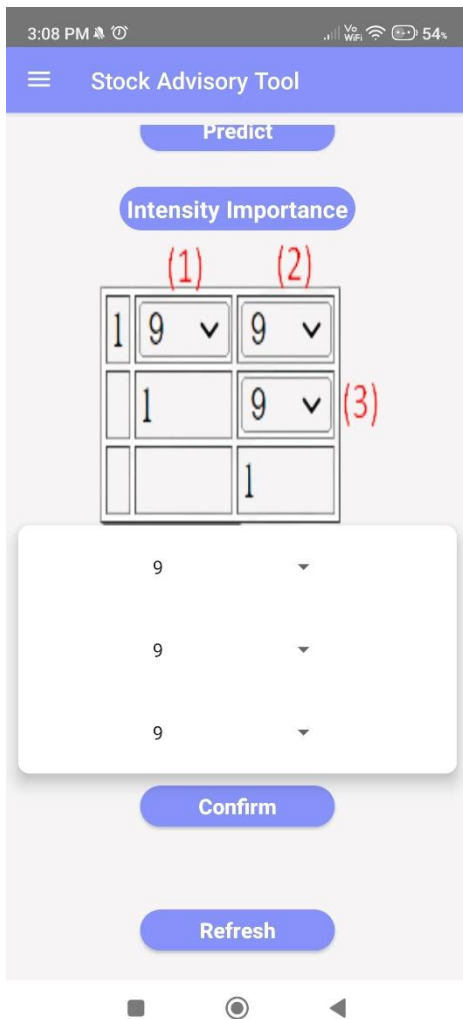
Figure 4.1.4.6 above shows the navigation drawer menu of the Stock Advisory Tool mobile application. The navigation drawer menu page allows users to quickly navigate into other features in Stock Advisory Tool. Users can quickly swipe left to view this navigation drawer, where users can navigate to the Model Performance page, Profile page and About Page. This navigation drawer menu page will also display the current user's username and email address. Users can also press the 'Logout' button to log out of their account from this application whenever they wish to.

### 4.1.5 Model Performance Page

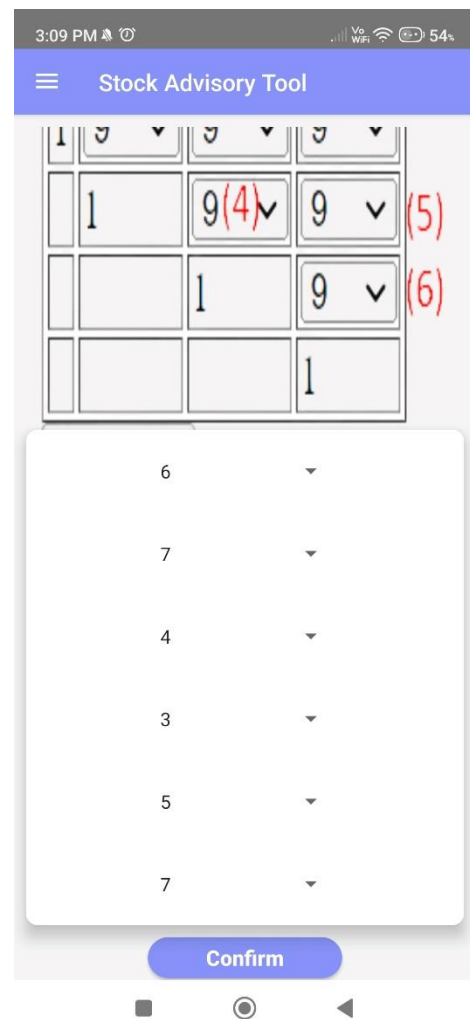


**Figure 4.1.5.1** Model Performance Page of Stock Advisory Tool (Part 1)

Figure 4.1.5.1 above shows the model performance page (part 1) of the Stock Advisory Tool mobile application. This model performance page will allow the user to choose the watch list and model that the user wishes to use to conduct the stock prediction and comparison process. If the user had selected a different number among the number of stocks in the watch list and the number of indicators in the model (For example, selected the watch list consists of 3 stocks and the model consists of 4 indicators), the toast error message “Please select the model and watch list which have the same number of indicator and stock!!!” will be displayed for a while on the screen of user’s mobile device.

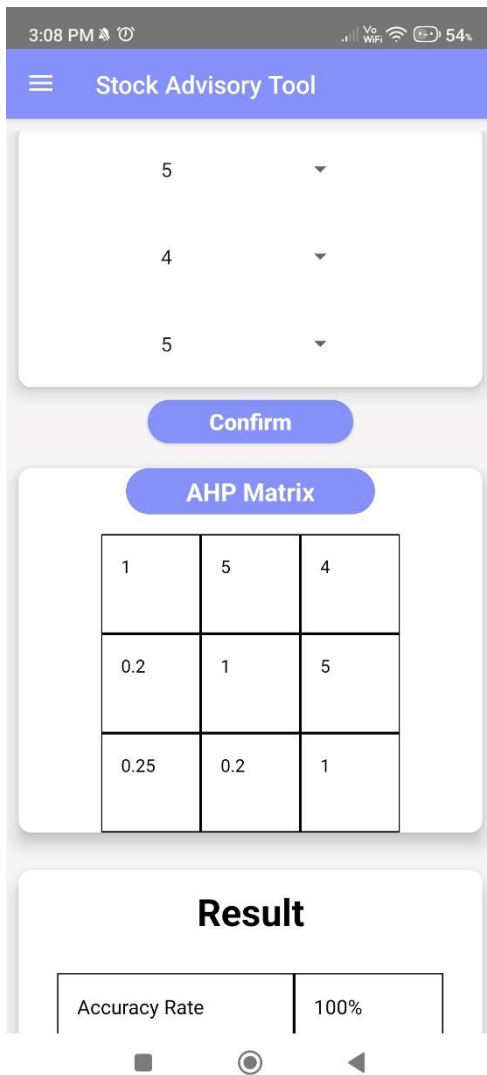


**Figure 4.1.5.2** Model Performance Page of Stock Advisory Tool (Part 2) with 3 dropdown list

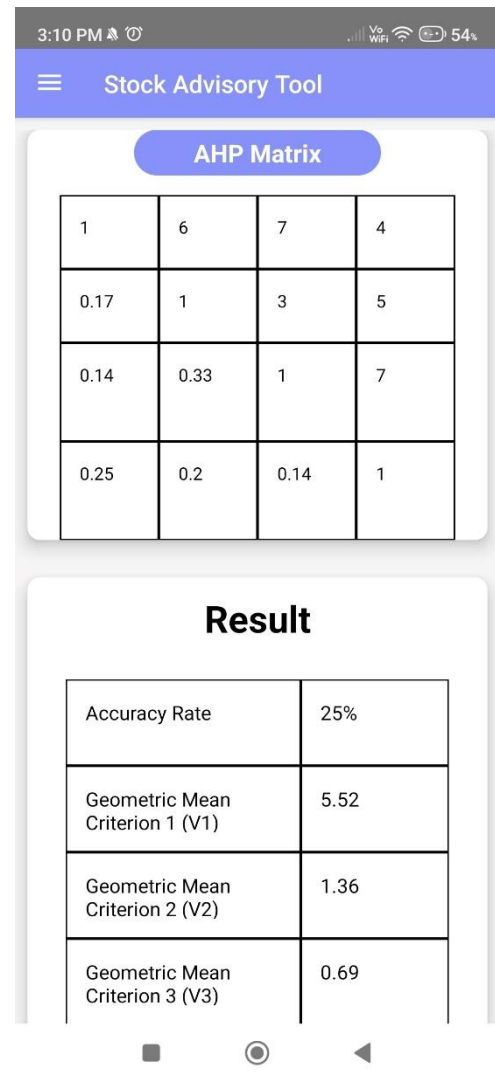


**Figure 4.1.5.3** Model Performance Page of Stock Advisory Tool (Part 2) with 4 dropdown list

Figure 4.1.5.2 and Figure 4.1.5.3 above shows the model performance page (part 2) with 3 x 3 AHP Matrix and 4 x 4 AHP Matrix of the Stock Advisory Tool mobile application. After the user had selected the watch list and model and pressed the ‘Predict’ button, the application will show the dropdown list with the option of 1 to 9 (**Figure 4.1.5.2** => 3 dropdown lists – Selected Model and Watch List have 3 indicators and 3 stocks, **Figure 4.1.5.3** => 4 dropdown lists – Selected Model and Watch List have 4 indicators and 4 stocks) that require the user to select the intensity importance of each indicator based on 1 to 9 scale. After that, the user can press the ‘Confirm’ button to start the stock prediction process.



**Figure 4.1.5.4** Model Performance Page of Stock Advisory Tool (Part 3) with 3x3 AHP Matrix



**Figure 4.1.5.5** Model Performance Page of Stock Advisory Tool (Part 3) with 4x4 AHP Matrix

Figure 4.1.5.4 and Figure 4.1.5.5 above shows the model performance page (part 3) with 3x3 and 4x4 AHP Matrix of the Stock Advisory Tool mobile application. After the user can press the 'Confirm' button, the application will start to conduct the stock prediction process based on the selected watch list and model and the intensity importance of each indicator. After the application had done the stock prediction process, it will show the AHP Matrix (**Figure 4.1.5.4** => 3 x 3 – Selected Model and Watch List have 3 indicators and 3 stocks, **Figure 4.1.5.5** => 4 x 4 – Selected Model and Watch List have 4 indicators and 4 stocks).

3:09 PM VoWiFi 54%

Stock Advisory Tool

### Result

Accuracy Rate	100%
Geometric Mean Criterion 1 (V1)	2.71
Geometric Mean Criterion 2 (V2)	1
Geometric Mean Criterion 3 (V3)	0.37
Importance Weight Indicator 1 (W1)	0.66
Importance Weight Indicator 2 (W2)	0.25
Importance Weight Indicator 3 (W3)	0.09
Sum of Important Weight of Criterion	1

### Final Result

Total utility score for Aeon Co. (M)

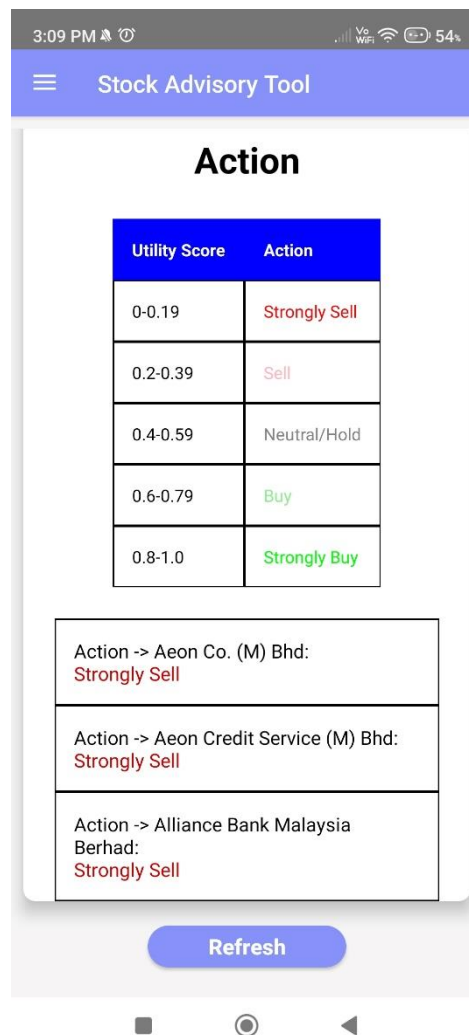
**Figure 4.1.5.6** Model Performance Page of Stock Advisory Tool (Part 4)

Figure 4.1.5.6 above shows the model performance page (part 4) of the Stock Advisory Tool mobile application. After the application had done the stock prediction process, the application also will show result table of the predicted model which consist of accuracy rate of the model, geometric mean of each criterion, importance weight of each indicator and sum of important weight of criterion (To show to the user that the sum important weight is always 1 which means the calculation of important weight is correct).

Stock Advisory Tool	
Geometric Mean Criterion 2 (V2)	1
Geometric Mean Criterion 3 (V3)	0.37
Importance Weight Indicator 1 (W1)	0.66
Importance Weight Indicator 2 (W2)	0.25
Importance Weight Indicator 3 (W3)	0.09
Sum of Important Weight of Criterion	1
<b>Final Result</b>	
Total utility score for Aeon Co. (M) Bhd: 0.02267156862745098	
Total utility score for Aeon Credit Service (M) Bhd: 0.0014074370305738008	
Total utility score for Alliance Bank Malaysia Berhad: 0.00528676116911411	

**Figure 4.1.5.7** Model Performance Page of Stock Advisory Tool (Part 5)

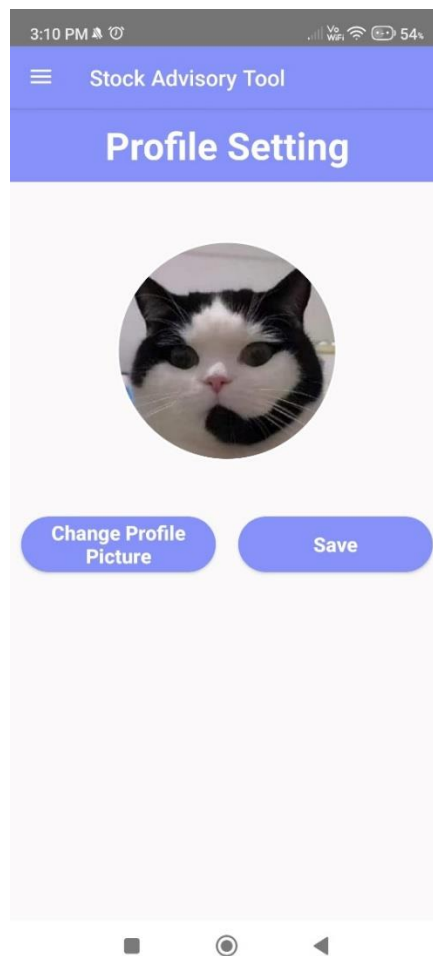
Figure 4.1.5.7 above shows the model performance page (part 5) of the Stock Advisory Tool mobile application. Continuing with the screenshot of Figure 4.1.5.6, the application also will show Final Result table of the predicted model which consist of total utility score of each stock (the total utility score will be in the range of 0 to 1).



**Figure 4.1.5.8** Model Performance Page of Stock Advisory Tool (Part 6)

Figure 4.1.5.8 above shows the model performance page (part 6) of the Stock Advisory Tool mobile application. Continuing with the screenshot of Figure 4.1.5.7, the application also will show Action table of the predicted model which consist of the action measuring table, recommended action of each stock by the application. If the user which to start another stock prediction process, the user can press the ‘Refresh’ button to refresh the prediction process and clear the result.

### 4.1.6 Profile Page



**Figure 4.1.6.1** Profile Page of Stock Advisory Tool

Figure 4.1.6.1 above shows the profile page of the Stock Advisory Tool mobile application. The profile page will show the current profile picture of user's account. If the user wishes to change the profile picture of their account, they can press the 'Change Profile Picture' button. After selected and cropped their preferred picture from their gallery, the user needs to press the 'Save' button to save and store the picture in the Firebase Storage.



### 4.1.7 About Page



**Figure 4.1.7.1** About Page of Stock Advisory Tool

Figure 4.1.7.1 above shows the about page of the Stock Advisory Tool mobile application. The about page shows an introduction to the Stock Advisory Tool and information about the developers of this application.

4.2 Data Storage Design of Stock Market Equity Advisory Tool

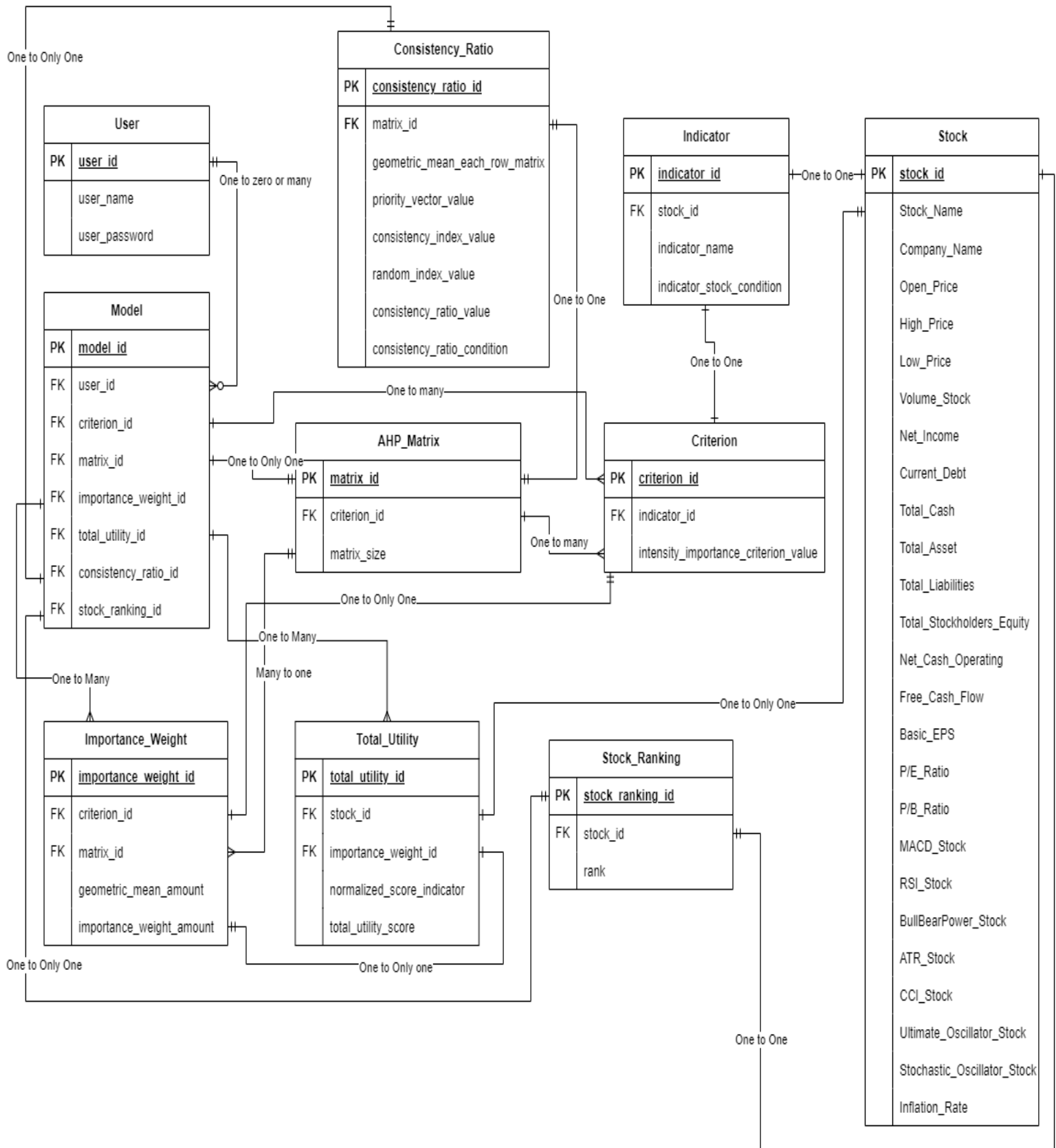


Figure 4.2.1 Data Storage Design of Stock Market Equity Advisory Tool

Figure 4.2.1 shows the data storage design of Stock Market Equity Advisory Tool. In this Stock Market Equity Advisory Tool, the information that will be store in the Firebase is the user’s chat history of this tool, which including the user, indicator, importance weight of each criterion, total utility score of each stock, consistency ratio of AHP result, and stock ranking list.

In the database, Table “**User**” will be stored user\_name and user\_password which will be authenticate the access of the users to the system. The user\_id and user\_name will be unique and will serve as the identifier for each user in the system. The primary key of table “User” is user\_id, which will be auto generated by the Firebase. (Relationship: One user has zero or many chat history)

In table “**Model**”, the primary key is model\_id and it contains 7 foreign keys, which are user\_id, criterion\_id, matrix\_id, importance\_weight\_id, total\_utility\_id, consistency\_ratio\_id, and stock\_ranking\_id. These foreign keys are used to establish a relationship between the "Model" table and other tables in the database. For example, the user\_id foreign key is used to link the “Model” table with the Users table, which contains information about the users involved in the chat. Similarly, other foreign keys are linked to their respective tables to provide a comprehensive view of the chat history. (Relationships: One model has many criterions, One model has only one AHP matrix, One model has many important weight, One model has many total utility, One model has only one consistency ratio, One model has only one stock ranking.)

In table “**Consistency\_Ratio**”, there will be stored 1 primary key (consistency\_ratio\_id), 1 foreign key (matrix\_id) and 6 attributes (geometric\_mean\_each\_row\_matrix, priority\_vector\_value, consistency\_index\_value, random\_index\_value, consistency\_ratio\_value, consistency\_ratio\_condition). The foreign key (matrix\_id) will be used to get the information from the table “AHP\_Matrix”. (Relationship: Only one consistency ratio will used only one AHP matrix in the calculation of consistency ratio.)

In table “**Importance\_Weight**”, there will be stored 1 primary key (importance\_weight\_id), 2 foreign keys (criterion\_id, matrix\_id) and 2 attributes (geometric\_mean\_amount, importance\_weight\_amount). The foreign key (criterion\_id) will be used to get the information from the table “Criterion” and the foreign key (matrix\_id) will be used to get the information from the table

“AHP\_Matrix”. (Relationship: Each one of important weight has only one criterion, Many important weights will used only one AHP matrix.)

In table “**Total Utility**”, there will be stored 1 primary key (total\_utility\_id), 2 foreign keys (stock\_id, importance\_weight\_id) and 2 attributes (normalized\_score\_indicator, total\_utility\_score). The foreign key (stock\_id) will be used to get the information from the table “Stock” and the foreign key (importance\_weight\_id) will be used to get the information from the table “Important\_Weight”. (Relationship: Each one of total utility has only one stock details, Each one of total utility has only one importance weight amount.)

In table “**AHP\_Matrix**”, there will be stored 1 primary key (matrix\_id), 1 foreign key (criterion\_id) and 1 attribute (matrix\_size). The foreign key (criterion\_id) will be used to get the information from the table “Criterion”. (Relationship: One AHP matrix will use many criterions.)

In table “**Criterion**”, there will be stored 1 primary key (criterion\_id), 1 foreign key (indicator\_id) and 1 attribute (intensity\_importance, criterion\_value). The foreign key (indicator\_id) will be used to get the information from the table “Indicator”. (Relationship: One criterion has one indicator.)

In table “**Indicator**”, there will be stored 1 primary key (indicator\_id), 1 foreign key (stock\_id) and 2 attributes (indicator\_name, indicator\_stock\_condition). The foreign key (stock\_id) will be used to get the information from the table “Stock”. (Relationship: Each one of indicator has one stock.)

In table “**Stock\_Ranking**”, there will be stored 1 primary key (stock\_ranking\_id), 1 foreign key (stock\_id) and 1 attribute (rank). The foreign key (stock\_id) will be used to get the information from the table “Stock”.

In table “**Stock**”, there will be stored 1 primary key (stock\_id), 25 attributes (**Refer Table 4.2.1**). The data of these 25 attributes will get from the “assets” directory under the “main” directory of my Android Studio project. An “AssetManager” java class will be responsible for opening, reading, and looping through the CSV file (“dataset.csv”). (Relationship: Each one of stock has only one stock ranking.)

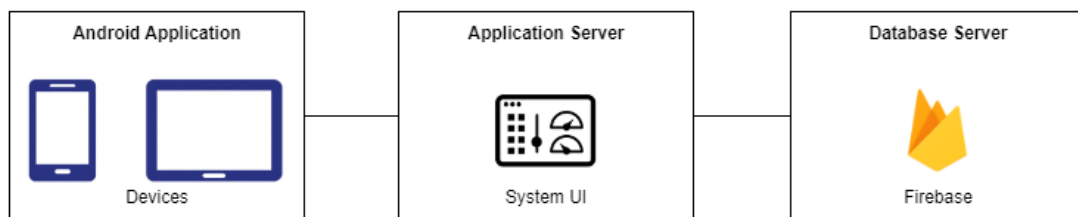
<b>Stock</b>		
<b>Attribute Name</b>	<b>Data Type</b>	<b>Description</b>
Stock_id	int	The unique ID of each stock. It is the primary key of the “Stock” table and it can automatically be generated by the system.
Stock_Name	String	The name of the Stock
Company_Name	String	The name of the Stock’s company
Open_Price	Float	The first price traded of the Stock
High_Price	Float	The highest closing price of the Stock
Low_Price	Float	The highest closing price of the Stock
Volume_Stock	Float	The volume of the Stock
Net_Income	Float	The net income of the Stock’s company
Current_Debt	Float	The current debt of the Stock’s company
Total_Cash	Float	The total cash of the Stock’s company
Total_Asset	Float	The total asset of the Stock’s company
Total_Liabilities	Float	The total liabilities of the Stock’s company
Total_Stockholders_Equity	Float	The total stockholders' equity of the Stock’s company
Net_Cash_Operating	Float	The net cash provided by operating activities of the Stock’s company
Free_Cash_Flow	Float	The free cash flow of the Stock’s company
Basic_EPS	Float	The basic earnings per share of the Stock’s company
P/E_Ratio	Float	The price-to-earnings ratio of the Stock’s company
P/B_Ratio	Float	The price-to-book ratio of the Stock’s company
MACD_Stock	Float	The moving average convergence divergence of the Stock

RSI_Stock	Float	The relative strength index of the Stock
BullBearPower_Stock	Float	The bull/bear power of the Stock
ATR_Stock	Float	The average true range of the Stock
CCI_Stock	Float	The commodity channel index of the Stock
Ultimate_Oscillator_Stock	Float	The ultimate oscillator of the Stock
Stochastic_Oscillator_Stock	Float	The stochastic oscillator of the Stock
Inflation_Rate	Float	The inflation rate of Malaysia

**Table 4.2.1** – Attributes Detail of “Stock” Table

**Table 4.2.1** shows the attributes detail of “Stock” table from the data storage of Stock Market Equity Advisory Tool.

### 4.3 System Architecture Design of Stock Market Equity Advisory Tool



**Figure 4.3.1** System Architecture Design of Stock Market Equity Advisory Tool

Figure 4.3.1 shows the system architecture design of this project. Stock Market Equity Advisory Tool will be developed as an Android application because nowadays mobile device is very convenient and commonly used by people. First, the user is required to have an Android Mobile device and their devices must be ready to install the Stock Market Equity Advisory Tool Application to access the application server.

In the application server, there will consist of the UI for the Stock Market Equity Advisory System. The UI will provide users with various features, such as personalised stock investment recommendations, and stock prediction tools. Besides, the storage service provided by Google Firebase will be the real-time database storage of the Stock Market Equity Advisory Application to store the user information such as username, password, email address, and profile picture, and store watchlist and model created by the user.

## CHAPTER 5

### System Testing

#### 5.1 Verification Plans

The first test is conducting a test on **the stock comparisons using the AHP method**. The purpose of this testing is to ensure that the stock advisory tool can compare stocks based on financial data and market trends of the Malaysia Stock Market from the CSV file of the dataset by using the AHP + ANN model, showing the AHP matrix, showing each step of calculation for AHP + ANN process, show the ranking list of each stock, and identify the most suitable or recommended action of stock for the user. The expected inputs for this stock comparing function will be create and select one of the models which consists of selected indicators and one of the watch lists which consists of selected company's stocks which are from the datasets consists of financial data and historical stock data of 100 Malaysian companies, then the user will be able to select preferred fundamental and technical indicators from a list of 19 indicators and select the intensity of importance for each selected indicators on the 1 to 9 fundamental scale. For example, the user will create the model and watch list and select one of the models and one of the watch lists, then the user will be able to select the intensity of importance for each selected indicator on the 1 to 9 fundamental scale on this stock market equity advisory tool. After that, it is important to verify whether the stock advisory tool can accurately compare the stocks based on financial data and market trends of the Malaysia Stock Market from the CSV file of the dataset by using the AHP + ANN model, show the correct result of the AHP matrix, each step of calculation for AHP + ANN process and the ranking list of each stock, and able to identify the most suitable or recommended action of stock for me or not. The expected output of this stock comparing function will be that the stock advisory tool can show the accurate result of the AHP matrix, each step of calculation for the AHP process and the ranking list of each stock with the most suitable or recommended action of stock to the user. To achieve the first objective of this project, it is important to observe and record the accuracy of the tool's AHP + ANN model and ensure that the AHP + ANN model of the tool can meet the expected accuracy result of the AHP matrix, each step of

calculation for the AHP + ANN process and the ranking list of each stock, and the users' expectations based on the selected model and watch list.

The second test is conducting a test on **the analysing stock information and providing investment advice based on the dataset of the Malaysia Stock Market**. The purpose of this testing is to ensure that the stock advisory tool can read, provide valuable insights, and stock investment advice from the dataset of the Malaysia Stock Market. The expected inputs for this analysing of stock information of the Malaysia Stock Market dataset function will be select the model and watch list in the Model Performance Page of stock advisory tool. For example, the user will select the model and watch list in the Model Performance Page for helping the user to find what is the score of Aeon Malaysia Bhd when it had compared with others two companies. After that, it is important to verify whether the stock advisory tool can read through the data from the csv file for the dataset of the Malaysia Stock Market and provide the correct reply of the recommend action whether the stock advisory tool can be able to provide the correct analysis result of the stock for the AHP + ANN process based on the selected model and watch list or not. The expected output of this analysing stock information function will be that the stock advisory tool can analyse and show correct and accurate advice of each stock information to the user. To achieve the second objective of this project, it is important to observe and record that the stock advisory tool is not missing showing information on other stocks from the Malaysia Stock Market dataset based on the selected watch list and model.

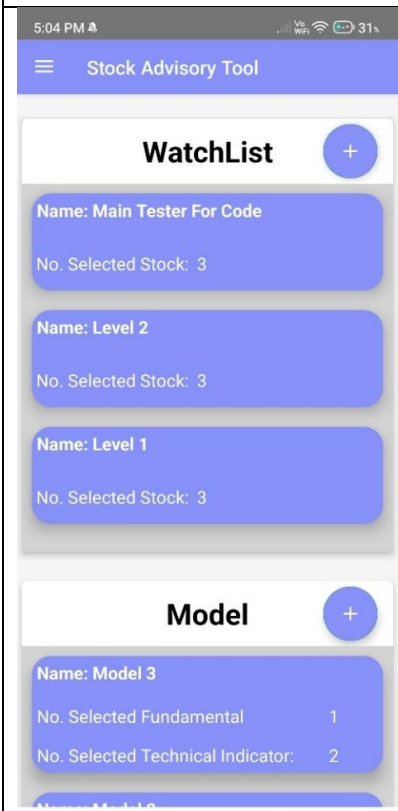

The third test is conducting a test on **each indicator options for the Stock Market Equity Advisory Tool application**. The purpose of this testing is to ensure that the stock market advisory tool can allow users to choose their preferences for fundamental indicators or technical indicators of Malaysian companies and provide accurate stock recommendations based on user preferences of indicators. The expected input for this indicator's options function is the user selects his preferences for fundamental indicators or technical indicators of Malaysian companies at the first step of the AHP process (stock decision-making process). For example, the user will be able to select 2 fundamental indicators and 1 technical indicator from the list of 23 indicators and select the intensity of importance for each selected indicator on the 1 to 9 fundamental scale on this stock market equity advisory tool. After that, it is important

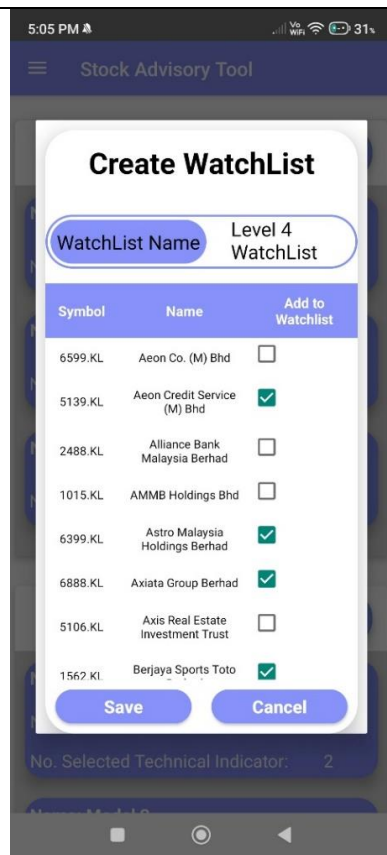


to verify the expected output whether the stock market advisory tool can accurately compare the stocks, show the correct result for the dynamic model of the AHP matrix, each step of calculation for the AHP process and the ranking list of each stock, and able to identify the most suitable stock for the user based on their preferences for fundamental indicators or technical indicators of Malaysia companies or not. To achieve the third objective of this project, it is important to observe and record the accuracy of the tool's stock recommendations based on the user preferences indicator and ensure that it meets the expected accuracy result of the stock recommendation of the Malaysia Stock Market based on the user chosen indicators.

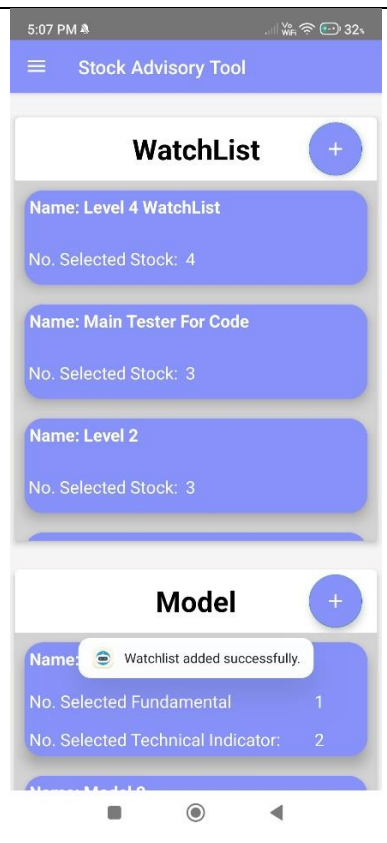
## 5.2 System Testing Result

The screenshots below are the steps of testing for the stock prediction of the model with 3 and 4 indicators and the watch list with 3 and 4 stocks based on the test plan listed in the **5.1 section of the Verification Plan**.

Step 1: Create Watch List	
	<p>The first step of test plan will be started to create the watch list by clicking the  button.</p>

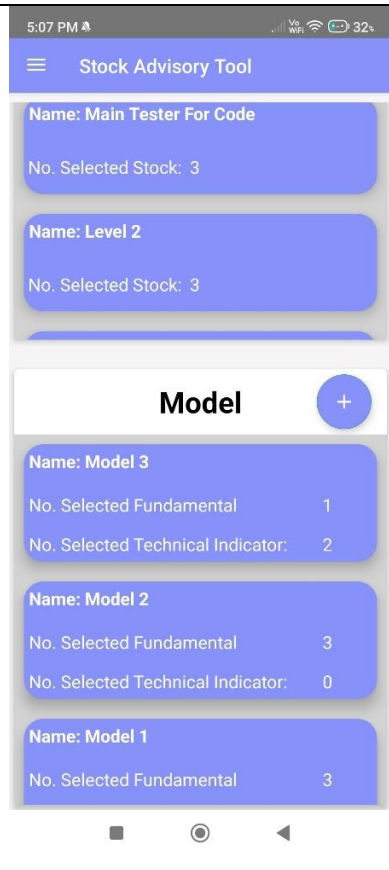
**Step 2: Input Watch List's Name and Select Stock**


Inputting the watch list name and selecting 4 of the preferred stocks (**Expected Input**) by clicking the checkbox which is on the right side of each stock. Then, click 'Save' button to save the watch list.

**Step 3: Save Watch List**

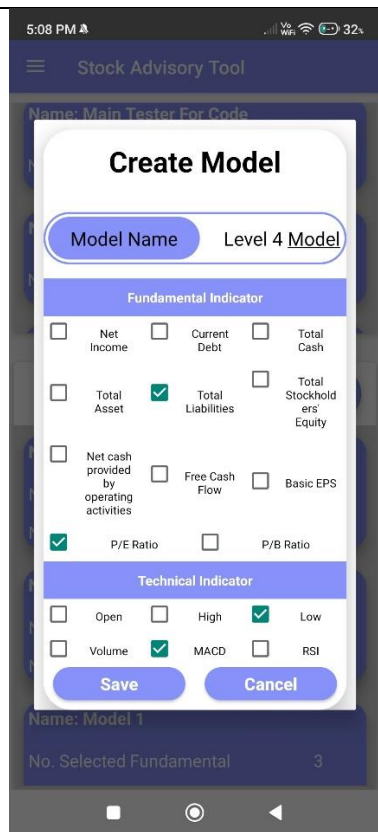
Once the watch list has been saved successfully to the Firebase, then it will show the message "WatchList added successfully" to the screen or else it will show the error message to the screen if the watch list is not able to be saved to the Firebase.

**Step 4: Create Model**



The fourth step of test plan will be started to create the model by clicking the  button.

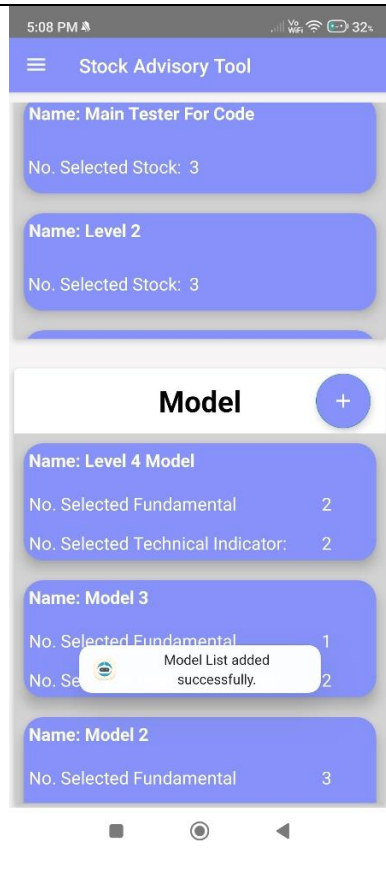
**Step 5: Input Model's Name and Select Indicators**



Inputting the model name and selecting 4 of the preferred indicators (**Expected Input**) by clicking the checkbox which is on the right side of each indicator. Then, click 'Save' button to save the model.

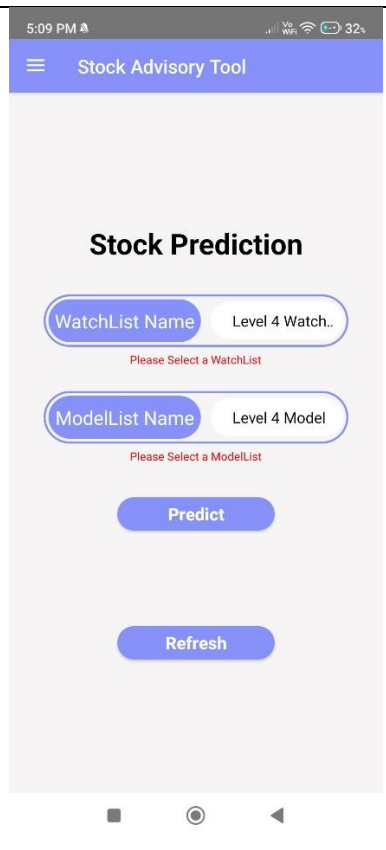
**(Achieved the third objective of this final year project)**

**Step 6: Save Model**



Once the model has been saved successfully to the Firebase, then it will show the message “Model List added successfully” to the screen or else it will show the error message to the screen if the model is not able to be saved to the Firebase.

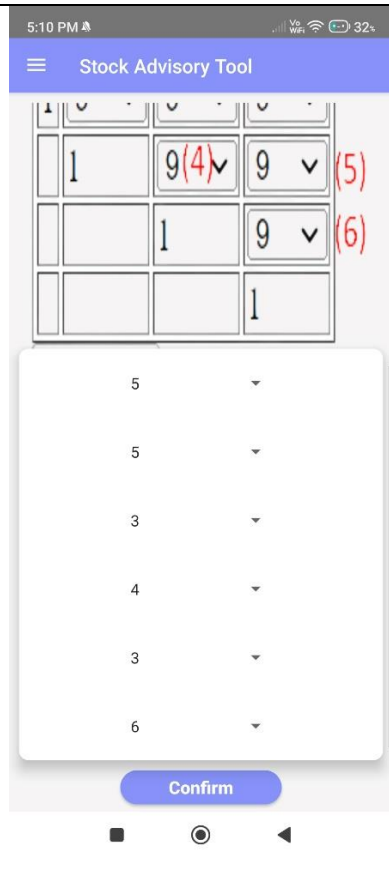
**Step 7: Select the Model and Watch List to conduct the Stock Prediction**



Select one of the watch list and model which have the **4 stocks and 4 indicators (Expected Input)** created on just now and then click ‘Predict’ button to proceed to the next step.

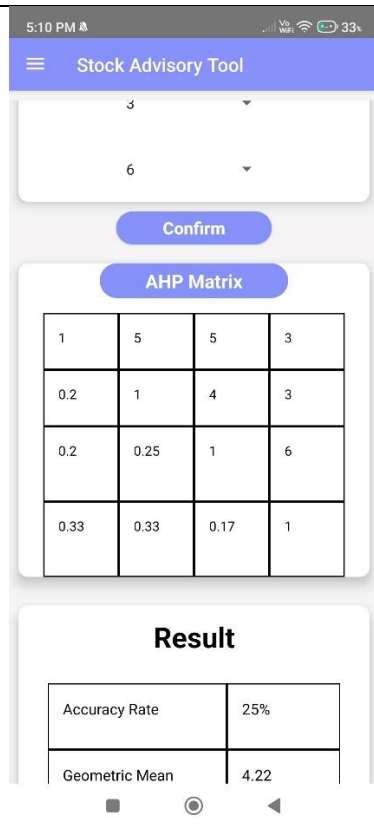
**(Achieved the first objective of this final year project)**

**Step 8: Select the Intensity Importance**



After clicking, it should be allow the user to select the Intensity Importance at the **6 Dowpdown List** based on 1 to 9 scale (**Expected Input**) and then click ‘Confirm’ button to start the stock prediction process.

**Step 10.1: Result - AHP Matrix**



After the stock prediction process had finished, the application should be able to show the first section of the result which will be showing on the screen is the **4 x 4 AHP matrix** of the model (**Expected Output**).

**Step 10.2: Result – Accuracy, Geometric Mean, Important Weight**

Accuracy Rate	25%
Geometric Mean Criterion 1 (V1)	4.22
Geometric Mean Criterion 2 (V2)	1.34
Geometric Mean Criterion 3 (V3)	0.67
Geometric Mean Criterion 4 (V4)	0.26
Importance Weight Indicator 1 (W1)	0.65
Importance Weight Indicator 2 (W2)	0.21
Importance Weight Indicator 3 (W3)	0.1
Importance Weight Indicator 4 (W4)	0.04

The second section of result which will be showing on the screen is the table of result which shows accuracy rate of the model, geometric mean of each criterion, important weight of each indicator **(Expected Output)**.

**Step 10.3: Result - Sum of Important weight, Total Utility Score of each stock**

Importance Weight Indicator 1 (W1)	0.65
Importance Weight Indicator 2 (W2)	0.21
Importance Weight Indicator 3 (W3)	0.1
Importance Weight Indicator 4 (W4)	0.04
Sum of Important Weight of Criterion	1

**Final Result**

Total utility score for Aeon Credit Service (M) Bhd: 0.2064714944583259

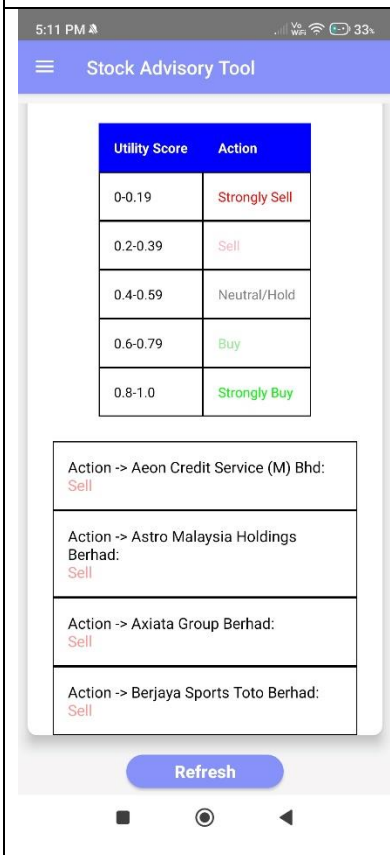
Total utility score for Astro Malaysia Holdings Berhad: 0.20647149402244575

Total utility score for Axiata Group Berhad: 0.20647149462315154

Total utility score for Berjaya Sports Toto Berhad: 0.20647149388273195

Besides, the table of result also will be showing the result for the sum of important weight and the total utility score of each stock **(Expected Output)**.

**Step 10.4: Action Result of each stock**



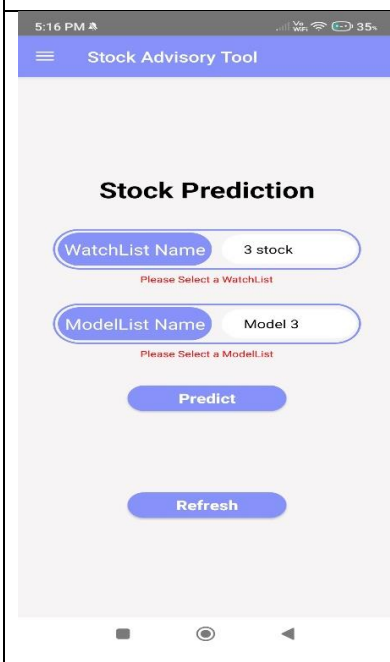
At last, there will be an action result table which shows each recommended action or advice given by the application in the last section of the result of stock prediction (**Expected Output**).

**(Achieved the second objective of this final year project)**

**Table 5.2.1 Testing Plan of Stock Prediction for 4 indicators and 4 stocks**

Table 5.2.1 shows all the step of testing stock prediction function by using 4 indicators of model and 4 stocks of watch list.

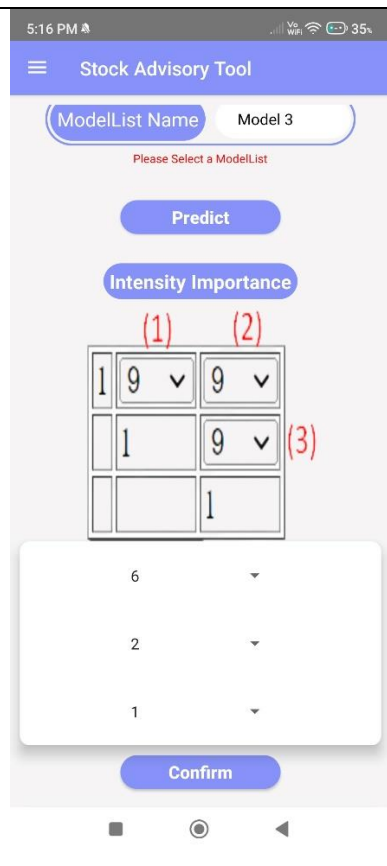
**Step 1: Select the Model and Watch List to conduct the Stock Prediction**



Select one of the watch list and model which have the **3 stocks and 3 indicators (Expected Input)** created on just now and then click 'Predict' button to proceed to the next step.

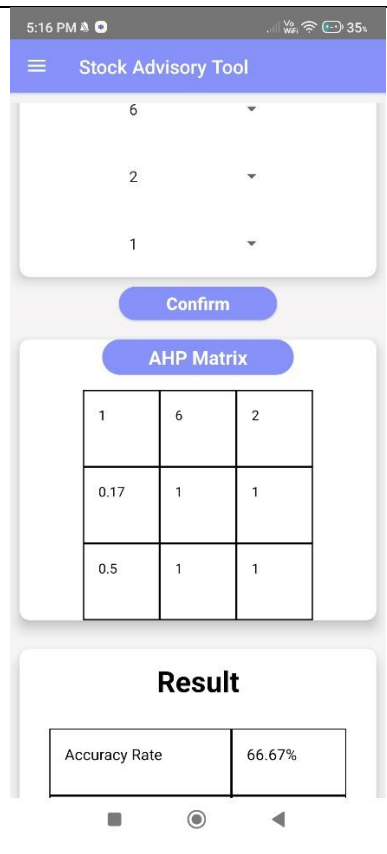
**(Achieved the first objective of this final year project)**

**Step 2: Select the Intensity Importance**



After clicking, it should allow the user to select the Intensity Importance at the **3 Downdown List** based on 1 to 9 scale (**Expected Input**) and then click 'Confirm' button to start the stock prediction process.

**Step 3.1: Result - AHP Matrix**



After the stock prediction process had finished, the application should be able to show the first section of the result which will be showing on the screen is the **3 x 3 AHP matrix** of the model (**Expected Output**).



**Step 3.2: Result – Accuracy, Geometric Mean, Important Weight**

The screenshot shows a mobile application interface titled 'Stock Advisory Tool'. It displays a table with the following data:

Accuracy Rate	66.67%
Geometric Mean Criterion 1 (V1)	2.29
Geometric Mean Criterion 2 (V2)	0.55
Geometric Mean Criterion 3 (V3)	0.79
Importance Weight Indicator 1 (W1)	0.63
Importance Weight Indicator 2 (W2)	0.15
Importance Weight Indicator 3 (W3)	0.22
Sum of Important Weight of Criterion	1

Below the table, there is a section titled 'Final Result'.

The second section of result which will be showing on the screen is the table of result which shows accuracy rate of the model, geometric mean of each criterion, important weight of each indicator (**Expected Output**).

**Step 3.3: Result - Sum of Important weight, Total Utility Score of each stock**

The screenshot shows a mobile application interface titled 'Stock Advisory Tool'. It displays a table with the following data:

Criterion 2 (V2)	
Geometric Mean Criterion 3 (V3)	0.79
Importance Weight Indicator 1 (W1)	0.63
Importance Weight Indicator 2 (W2)	0.15
Importance Weight Indicator 3 (W3)	0.22
Sum of Important Weight of Criterion	1

Below the table, there is a section titled 'Final Result' containing the following text:

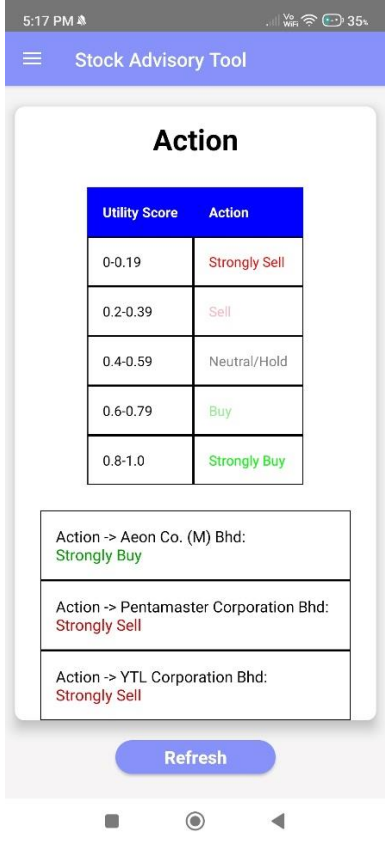
Total utility score for Aeon Co. (M) Bhd: 0.9999955001721785

Total utility score for Pentamaster Corporation Bhd: 0.151515138448288

Total utility score for YTL Corporation Bhd: 0.0

Besides, the table of result also will be showing the result for the sum of important weight and the total utility score of each stock (**Expected Output**).

**Step 3.4: Action Result of each stock**



Utility Score	Action
0-0.19	Strongly Sell
0.2-0.39	Sell
0.4-0.59	Neutral/Hold
0.6-0.79	Buy
0.8-1.0	Strongly Buy

Action -> Aeon Co. (M) Bhd:  
Strongly Buy

---

Action -> Pentamaster Corporation Bhd:  
Strongly Sell

---

Action -> YTL Corporation Bhd:  
Strongly Sell

Refresh

At last, there will be an action result table which shows each recommended action or advice given by the application in the last section of the result of stock prediction (**Expected Output**).

**(Achieved the second objective of this final year project)**

**Table 5.2.2 Testing Plan of Stock Prediction for 3 indicators and 3 stocks**

Table 5.2.2 shows all the step of testing stock prediction function by using 3 indicators of model and 3 stocks of watch list.

### 5.3 Performance Measurement of Stock Prediction Models

Stock Name	Net Income	Current Debt	Total Cash
Padini Holdings Berhad	154000000	74000000	809000000
Chin Hin Group Berhad	97000000	150000000	518000000
PPB Group Berhad	2197000000	1279000000	1587000000

**Table 5.3.1 Sample Data of Performance Measurement**

**Goal of stock prediction:** Select the most suitable stock among Padini Holdings Berhad, Chin Hin Group Berhad and PPB Group Berhad.

**Criteria:** Net Income, Total Cash, Current Debt

**Alternatives:** Padini Holdings Berhad, Chin Hin Group Berhad, PPB Group Berhad

#### (A) Performance Measurement of AHP Model in conducting stock prediction

Using **Table 5.3.1 Sample Data of Performance Measurement** as the sample data of this stock prediction process for the AHP Model.

	Current Debt	Net Income	Total Cash
Current Debt	1	5	4
Net Income	1/5	1	1/2
Total Cash	1/4	2	1

**Table 5.3.2 AHP Matrix of Criterions**

#### 1. First Step: Calculation of Geometric Mean for criterion from each row of AHP matrix (Table 5.3.2)

(1a) Find Geometric Mean of Current Debt (V<sub>1</sub>):

$$V_1 = \sqrt[3]{X_{11} * X_{12} * X_{13}}$$

$$V_1 = \sqrt[3]{1 * 5 * 4}$$

$$V_1 = \sqrt[3]{20}$$

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$$V_1 (\text{Current Debt}) = 2.71 \text{ (rounded off to 2 decimal places)}$$

(1b) Find Geometric Mean of Net Income (V2):

$$V_2 = \sqrt[3]{X_{21} * X_{22} * X_{23}}$$

$$V_2 = \sqrt[3]{\frac{1}{5} * 1 * \frac{1}{2}}$$

$$V_2 = \sqrt[3]{\frac{1}{10}}$$

$$V_2 (\text{Net Income}) = 0.46 \text{ (rounded off to 2 decimal places)}$$

(1c) Find Geometric Mean of Total Cash (V3):

$$V_3 = \sqrt[3]{X_{31} * X_{32} * X_{33}}$$

$$V_3 = \sqrt[3]{\frac{1}{4} * 2 * 1}$$

$$V_3 = \sqrt[3]{\frac{1}{2}}$$

$$V_3 (\text{Total Cash}) = 0.79 \text{ (rounded off to 2 decimal places)}$$

### **2. Second Step: Calculation of Importance Weight**

(2a) Find Importance Weight of Current Debt (W1):

$$W_1 (\text{Current Debt}) = \frac{V_1}{V_1 + V_2 + V_3}$$

$$W_1 (\text{Current Debt}) = \frac{2.71}{2.71 + 0.46 + 0.79}$$

$$W_1 (\text{Current Debt}) = \frac{2.71}{3.96}$$

$$W_1 (\text{Current Debt}) = 0.68 \text{ (rounded off to 2 decimal places)}$$

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(2b) Find Importance Weight of Net Income (W<sub>2</sub>):

$$W_2 (\text{Net Income}) = \frac{V_2}{V_1 + V_2 + V_3}$$

$$W_2 (\text{Net Income}) = \frac{0.46}{2.71 + 0.46 + 0.79}$$

$$W_2 (\text{Net Income}) = \frac{0.46}{3.96}$$

$$W_2 (\text{Net Income}) = 0.12 \text{ (rounded off to 2 decimal places)}$$

(2c) Find Importance Weight of Total Cash (W<sub>3</sub>):

$$W_3 (\text{Total Cash}) = \frac{V_3}{V_1 + V_2 + V_3}$$

$$W_3 (\text{Total Cash}) = \frac{0.79}{2.71 + 0.46 + 0.79}$$

$$W_3 (\text{Total Cash}) = \frac{0.79}{3.96}$$

$$W_3 (\text{Total Cash}) = 0.20 \text{ (rounded off to 2 decimal places)}$$

### **3. Third Step: Checking the correctness of Importance Weight Calculation**

*The sum of importance weight of three criterion*

$$= 0.68 + 0.12 + 0.20 = 1$$

### **Conclusion of Importance Weight Calculation**

After finished calculating all the Importance Weight of three criterion (Current Debt, Net Income, Total Cash), the result tells us that:

- Current Debt accounts for 68% of the overall decision of which Malaysian Company's stock to buy. (**The most important criteria**)
- Net Income accounts for 12% of the overall decision of which Malaysian Company's stock to buy. (**The second most important criteria**)
- Total Cash accounts for 20% of the overall decision of which Malaysian Company's stock to buy. (**The least important criterion**)

**4. Fourth Step: Determine preference of each alternative in term of each criterion****Current Debt**

	Padini Holdings Berhad	Chin Hin Group Berhad	PPB Group Berhad
Padini Holdings Berhad	1	1/4	4
Chin Hin Group Berhad	4	1	4
PPB Group Berhad	1/4	1/4	1

**Table 5.3.3 AHP Matrix of Alternative in term of Current Debt****Calculation of Geometric Mean for alternatives from each row of AHP matrix in term of Current Debt**

(1a) Find Geometric Mean of Padini Holdings Berhad (V1):

$$V_1 = \sqrt[3]{X_{11} * X_{12} * X_{13}}$$

$$V_1 = \sqrt[3]{1 * \frac{1}{4} * 4}$$

$$V_1 = \sqrt[3]{1}$$

$$V_1 (\text{Padini Holdings Berhad}) = 1 \text{ (rounded off to 2 decimal places)}$$

(1b) Find Geometric Mean of Chin Hin Group Berhad (V2):

$$V_2 = \sqrt[3]{X_{21} * X_{22} * X_{23}}$$

$$V_2 = \sqrt[3]{4 * 1 * 4}$$

$$V_2 = \sqrt[3]{16}$$

$$V_2 (\text{Chin Hin Group Berhad}) = 2.52 \text{ (rounded off to 2 decimal places)}$$

(1c) Find Geometric Mean of PPB Group Berhad (V3):

$$V_3 = \sqrt[3]{X_{31} * X_{32} * X_{33}}$$

$$V_3 = \sqrt[3]{\frac{1}{4} * \frac{1}{4} * 1}$$

$$V_3 = \sqrt[3]{\frac{1}{16}}$$

$$V_3 (\text{PPB Group Berhad}) = 0.40 \text{ (rounded off to 2 decimal places)}$$

### **Calculation of Importance Weight in term of Current Debt**

(2a) Find Importance Weight of Padini Holdings Berhad in term of Current Debt (W1):

$$W_1 (\text{Padini Holdings Berhad}) = \frac{V_1}{V_1 + V_2 + V_3}$$

$$W_1 (\text{Padini Holdings Berhad}) = \frac{1}{1 + 2.52 + 0.40}$$

$$W_1 (\text{Padini Holdings Berhad}) = 0.26 \text{ (rounded off to 2 decimal places)}$$

(2b) Find Importance Weight of Chin Hin Group Berhad in term of Current Debt (W2):

$$W_2 (\text{Chin Hin Group Berhad}) = \frac{V_2}{V_1 + V_2 + V_3}$$

$$W_2 (\text{Chin Hin Group Berhad}) = \frac{2.52}{1 + 2.52 + 0.40}$$

$$W_2 (\text{Chin Hin Group Berhad}) = 0.64 \text{ (rounded off to 2 decimal places)}$$

(2c) Find Importance Weight of PPB Group Berhad in term of Current Debt (W3):

$$W_3 (\text{PPB Group Berhad}) = \frac{V_3}{V_1 + V_2 + V_3}$$

$$W_3 (\text{PPB Group Berhad}) = \frac{0.40}{1 + 2.52 + 0.40}$$

$$W_3 (\text{PPB Group Berhad}) = 0.10 \text{ (rounded off to 2 decimal places)}$$

### **Checking the correctness of Importance Weight Calculation**

*The sum of importance weight of three alternatives*

$$= 0.26 + 0.64 + 0.10 = 1$$

### **Conclusion of Importance Weight Calculation in term of Current Debt**

After finished calculating all the Importance Weight of three alternatives (Padini Holdings Berhad, Chin Hin Group Berhad, PPB Group Berhad), the result tells us that:

- Chin Hin Group Berhad accounts for 64% and it is **the most important alternative in term of Current Debt**.
- Padini Holdings Berhad accounts for 26% and it is **the second most important alternative in term of Current Debt**.
- PPB Group Berhad accounts for 10% and it is **the least important alternative in term of Current Debt**.

#### **Net Income**

	Padini Holdings Berhad	Chin Hin Group Berhad	PPB Group Berhad
Padini Holdings Berhad	1	2	5
Chin Hin Group Berhad	1/2	1	3
PPB Group Berhad	1/5	1/3	1

**Table 5.3.4 AHP Matrix of Alternative in term of Net Income**

### **Calculation of Geometric Mean for alternatives from each row of AHP matrix in term of Net Income**

(1a) Find Geometric Mean of Padini Holdings Berhad (V1):

$$V_1 = \sqrt[3]{X_{11} * X_{12} * X_{13}}$$

$$V_1 = \sqrt[3]{1 * 2 * 5}$$

$$V_1 = \sqrt[3]{10}$$

$$V_1 (\text{Padini Holdings Berhad}) = 2.15 \text{ (rounded off to 2 decimal places)}$$

(1b) Find Geometric Mean of Chin Hin Group Berhad (V2):



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$$V_2 = \sqrt[3]{X_{21} * X_{22} * X_{23}}$$

$$V_2 = \sqrt[3]{\frac{1}{2} * 1 * 3}$$

$$V_2 = \sqrt[3]{1.5}$$

$$V_2 (\text{Chin Hin Group Berhad}) = 1.14 \text{ (rounded off to 2 decimal places)}$$

(1c) Find Geometric Mean of PPB Group Berhad (V3):

$$V_3 = \sqrt[3]{X_{31} * X_{32} * X_{33}}$$

$$V_3 = \sqrt[3]{\frac{1}{5} * \frac{1}{3} * 1}$$

$$V_3 = \sqrt[3]{0.07}$$

$$V_3 (\text{PPB Group Berhad}) = 0.41 \text{ (rounded off to 2 decimal places)}$$

### **Calculation of Importance Weight in term of Net Income**

(2a) Find Importance Weight of Padini Holdings Berhad in term of Net Income (W1):

$$W_1 (\text{Padini Holdings Berhad}) = \frac{V_1}{V_1 + V_2 + V_3}$$

$$W_1 (\text{Padini Holdings Berhad}) = \frac{2.15}{2.15 + 1.14 + 0.41}$$

$$W_1 (\text{Padini Holdings Berhad}) = 0.58 \text{ (rounded off to 2 decimal places)}$$

(2b) Find Importance Weight of Chin Hin Group Berhad in term of Net Income (W2):

$$W_2 (\text{Chin Hin Group Berhad}) = \frac{V_2}{V_1 + V_2 + V_3}$$

$$W_2 (\text{Chin Hin Group Berhad}) = \frac{1.14}{2.15 + 1.14 + 0.41}$$

$$W_2 (\text{Chin Hin Group Berhad}) = 0.31 \text{ (rounded off to 2 decimal places)}$$

(2c) Find Importance Weight of PPB Group Berhad in term of Net Income (W3):

$$W_3 (PPB Group Berhad) = \frac{V_3}{V_1 + V_2 + V_3}$$

$$W_3 (PPB Group Berhad) = \frac{0.41}{2.15 + 1.14 + 0.41}$$

$$W_3 (PPB Group Berhad) = 0.11 \text{ (rounded off to 2 decimal places)}$$

### **Checking the correctness of Importance Weight Calculation**

*The sum of importance weight of three alternatives*

$$= 0.58 + 0.31 + 0.11 = 1$$

### **Conclusion of Importance Weight Calculation in term of Net Income**

After finished calculating all the Importance Weight of three alternatives (Padini Holdings Berhad, Chin Hin Group Berhad, PPB Group Berhad), the result tells us that:

- Padini Holdings Berhad accounts for 58% and it is **the most important alternative in term of Net Income**.
- Chin Hin Group Berhad accounts for 31% and it is **the second most important alternative in term of Net Income**.
- PPB Group Berhad accounts for 11% and it is **the least important alternative in term of Net Income**.

#### **Total Cash**

	Padini Holdings Berhad	Chin Hin Group Berhad	PPB Group Berhad
Padini Holdings Berhad	1	3	6
Chin Hin Group Berhad	1/3	1	2
PPB Group Berhad	1/6	1/2	1

**Table 5.3.5 AHP Matrix of Alternative in term of Total Cash**

### **Calculation of Geometric Mean for alternatives from each row of AHP matrix in term of Total Cash**

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(1a) Find Geometric Mean of Padini Holdings Berhad (V1):

$$V_1 = \sqrt[3]{X_{11} * X_{12} * X_{13}}$$

$$V_1 = \sqrt[3]{1 * 3 * 6}$$

$$V_1 = \sqrt[3]{18}$$

$$V_1 (\text{Padini Holdings Berhad}) = 2.62 \text{ (rounded off to 2 decimal places)}$$

(1b) Find Geometric Mean of Chin Hin Group Berhad (V2):

$$V_2 = \sqrt[3]{X_{21} * X_{22} * X_{23}}$$

$$V_2 = \sqrt[3]{\frac{1}{3} * 1 * 2}$$

$$V_2 = \sqrt[3]{\frac{2}{3}}$$

$$V_2 (\text{Chin Hin Group Berhad}) = 0.87 \text{ (rounded off to 2 decimal places)}$$

(1c) Find Geometric Mean of PPB Group Berhad (V3):

$$V_3 = \sqrt[3]{X_{31} * X_{32} * X_{33}}$$

$$V_3 = \sqrt[3]{\frac{1}{6} * \frac{1}{2} * 1}$$

$$V_3 = \sqrt[3]{\frac{1}{12}}$$

$$V_3 (\text{PPB Group Berhad}) = 0.44 \text{ (rounded off to 2 decimal places)}$$

### **Calculation of Importance Weight in term of Total Cash**

(2a) Find Importance Weight of Padini Holdings Berhad in term of Total Cash (W1):

$$W_1 (\text{Padini Holdings Berhad}) = \frac{V_1}{V_1 + V_2 + V_3}$$

## CHAPTER 5

$$W_1 (\text{Padini Holdings Berhad}) = \frac{2.62}{2.62 + 0.87 + 0.44}$$

$$W_1 (\text{Padini Holdings Berhad}) = 0.67 \text{ (rounded off to 2 decimal places)}$$

(2b) Find Importance Weight of Chin Hin Group Berhad in term of Net Income (W2):

$$W_2 (\text{Chin Hin Group Berhad}) = \frac{V_2}{V_1 + V_2 + V_3}$$

$$W_2 (\text{Chin Hin Group Berhad}) = \frac{0.87}{2.62 + 0.87 + 0.44}$$

$$W_2 (\text{Chin Hin Group Berhad}) = 0.22 \text{ (rounded off to 2 decimal places)}$$

(2c) Find Importance Weight of PPB Group Berhad in term of Net Income (W3):

$$W_3 (\text{PPB Group Berhad}) = \frac{V_3}{V_1 + V_2 + V_3}$$

$$W_3 (\text{PPB Group Berhad}) = \frac{0.44}{2.62 + 0.87 + 0.44}$$

$$W_3 (\text{PPB Group Berhad}) = 0.11 \text{ (rounded off to 2 decimal places)}$$

### **Checking the correctness of Importance Weight Calculation**

*The sum of importance weight of three alternatives*

$$= 0.67 + 0.22 + 0.11 = 1$$

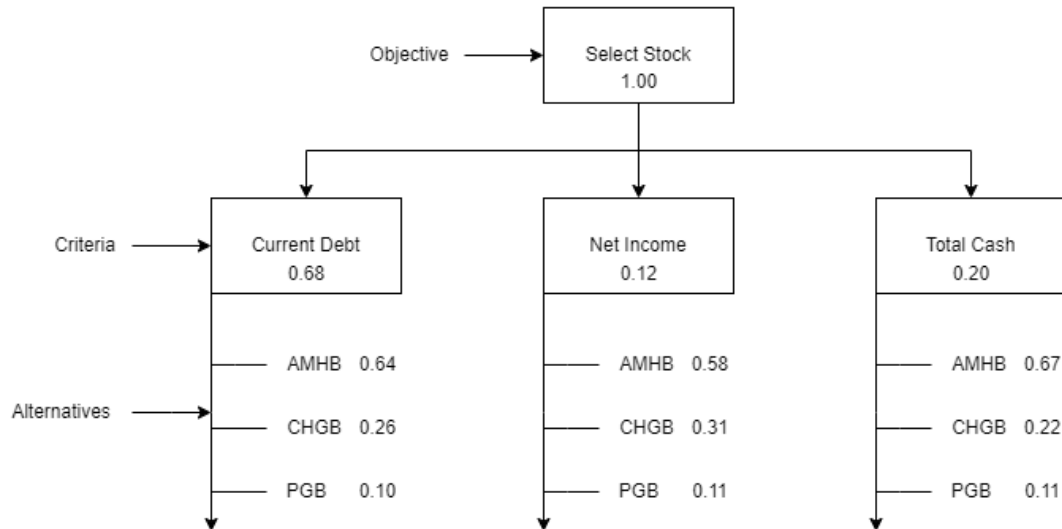
### **Conclusion of Importance Weight Calculation in term of Total Cash**

After finished calculating all the Importance Weight of three alternatives (Padini Holdings Berhad, Chin Hin Group Berhad, PPB Group Berhad), the result tells us that:

- Padini Holdings Berhad accounts for 67% and it is **the most important alternative in term of Total Cash.**
- Chin Hin Group Berhad accounts for 22% and it is **the second most important alternative in term of Total Cash.**
- PPB Group Berhad accounts for 11% and it is **the least important alternative in term of Total Cash.**

### **5. Fifth Step: Draw a hierarchical tree with all weights of criteria and alternatives**

The hierarchical tree of AHP Model with all weights of criteria and alternatives are shown as below:



**Figure 5.3.1 Hierarchical Tree of AHP Model**

*PHB = Padini Holdings Berhad*

*CHGB = Chin Hin Group Berhad*

*PGB = PPB Group Berhad*

### **6. Sixth Step: Multiply the alternatives with ranking criteria**

	Current Debt	Net Income	Total Cash	Criteria Ranking		
PHB	0.64	0.58	0.67	0.68	Current Debt	
CHGB	0.26	0.31	0.22	X	0.12	Net Income
PGB	0.10	0.11	0.11	0.20	0.20	Total Cash

$$PHB \Rightarrow (0.64 \times 0.68) + (0.58 \times 0.68) + (0.67 \times 0.68) = 1.29$$

$$CHGB \Rightarrow (0.26 \times 0.12) + (0.31 \times 0.12) + (0.22 \times 0.12) = 0.09$$

$$PGB \Rightarrow (0.10 \times 0.20) + (0.11 \times 0.20) + (0.11 \times 0.20) = 0.06$$

### Conclusion of AHP Model

After finished multiplying the alternatives (Padini Holdings Berhad, Chin Hin Group Berhad, PPB Group Berhad) with ranking criteria, the predicted result of AHP model tells us that:

- Padini Holdings Berhad is the **highest ranked stock / Uptrend (1.29)**.
- Chin Hin Group Berhad is the **second highest ranked stock / Downtrend (0.09)**.
- PPB Group Berhad is the **third highest ranked stock / Downtrend (0.06)**.

### 7. Seventh Step: Conducting the Performance Measurement Metrics for this AHP Model



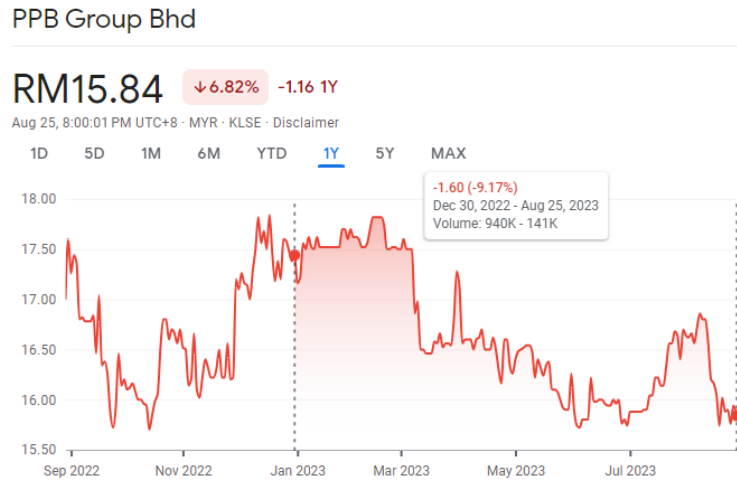
**Figure 5.3.2 Stock Trend of Padini Holdings Berhad after Year 2022**

Figure 5.3.2 shows the actual stock trend of Padini Holdings Berhad after year 2022 is **uptrend**.



**Figure 5.3.3 Stock Trend of Chin Hin Group Berhad after Year 2022**

Figure 5.3.3 shows the actual stock trend of Chin Hin Group Berhad after year 2022 is **uptrend**.



**Figure 5.3.4 Stock Trend of PPB Group Berhad after Year 2022**

Figure 5.3.4 shows the actual stock trend of PPB Group Berhad after year 2022 is **downtrend**.

**Confusion Matrix of AHP Model**

	-----Actual-----	
	<b>Uptrend</b>	<b>Downtrend</b>
<b>Uptrend</b>	1 (TP)	0 (FP)
<b>Downtrend</b>	1 (FN)	1 (TN)
Predicted		

**Table 5.3.6 Confusion matrix of AHP Model**

TP = True Positives, TN = True Negatives, FP = False Positives, FN = False Negatives

**Accuracy of AHP Model**

$$= \frac{TP + TN}{TP + TN + FP + FN}$$

$$= \frac{1 + 1}{1 + 1 + 0 + 1}$$

$$= 0.67 (67 \%), (rounded\ off\ to\ 2\ decimal\ places)$$

**Recall of AHP Model**

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$$= \frac{TP}{TP + FN}$$

$$= \frac{1}{1 + 1}$$

$$= 0.5 (50 \%)$$

### Precision of AHP Model

$$= \frac{TP}{TP + FP}$$

$$= \frac{1}{1 + 0}$$

$$= 1.0 (100 \%)$$

### F1 Score of AHP Model

$$= \frac{2}{\frac{1}{Recall} + \frac{1}{Precision}}$$

$$= \frac{2}{\frac{1}{0.5} + \frac{1}{1.0}}$$

$$= 0.67, (67 \%) \text{ (rounded off to 2 decimal places)}$$

### **(B) Performance Measurement of AHP + ANN Model in conducting stock prediction**

Using **Table 5.3.1 Sample Data of Performance Measurement** as the sample data of this stock prediction process for the AHP + ANN Model.

	Current Debt	Net Income	Total Cash
Current Debt	1	5	4
Net Income	1/5	1	1/2
Total Cash	1/4	2	1



**Table 5.3.2 AHP Matrix of Criteria****1. First Step: Calculation of Geometric Mean for criterion from each row of AHP matrix (Table 5.3.2)**

(1a) Find Geometric Mean of Current Debt (V1):

$$V_1 = \sqrt[3]{X_{11} * X_{12} * X_{13}}$$

$$V_1 = \sqrt[3]{1 * 5 * 4}$$

$$V_1 = \sqrt[3]{20}$$

$$V_1 (\text{Current Debt}) = 2.71 \text{ (rounded off to 2 decimal places)}$$

(1b) Find Geometric Mean of Net Income (V2):

$$V_2 = \sqrt[3]{X_{21} * X_{22} * X_{23}}$$

$$V_2 = \sqrt[3]{\frac{1}{5} * 1 * \frac{1}{2}}$$

$$V_2 = \sqrt[3]{\frac{1}{10}}$$

$$V_2 (\text{Net Income}) = 0.46 \text{ (rounded off to 2 decimal places)}$$

(1c) Find Geometric Mean of Total Cash (V3):

$$V_3 = \sqrt[3]{X_{31} * X_{32} * X_{33}}$$

$$V_3 = \sqrt[3]{\frac{1}{4} * 2 * 1}$$

$$V_3 = \sqrt[3]{\frac{1}{2}}$$

$$V_3 (\text{Total Cash}) = 0.79 \text{ (rounded off to 2 decimal places)}$$

**2. Second Step: Calculation of Importance Weight**

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(2a) Find Importance Weight of Current Debt (W1):

$$W_1 (\text{Current Debt}) = \frac{V_1}{V_1 + V_2 + V_3}$$

$$W_1 (\text{Current Debt}) = \frac{2.71}{2.71 + 0.46 + 0.79}$$

$$W_1 (\text{Current Debt}) = \frac{2.71}{3.96}$$

$$W_1 (\text{Current Debt}) = 0.68 \text{ (rounded off to 2 decimal places)}$$

(2b) Find Importance Weight of Net Income (W2):

$$W_2 (\text{Net Income}) = \frac{V_2}{V_1 + V_2 + V_3}$$

$$W_2 (\text{Net Income}) = \frac{0.46}{2.71 + 0.46 + 0.79}$$

$$W_2 (\text{Net Income}) = \frac{0.46}{3.96}$$

$$W_2 (\text{Net Income}) = 0.12 \text{ (rounded off to 2 decimal places)}$$

(2c) Find Importance Weight of Total Cash (W3):

$$W_3 (\text{Total Cash}) = \frac{V_3}{V_1 + V_2 + V_3}$$

$$W_3 (\text{Total Cash}) = \frac{0.79}{2.71 + 0.46 + 0.79}$$

$$W_3 (\text{Total Cash}) = \frac{0.79}{3.96}$$

$$W_3 (\text{Total Cash}) = 0.20 \text{ (rounded off to 2 decimal places)}$$

### **3. Third Step: Checking the correctness of Importance Weight Calculation**

*The sum of importance weight of three criterion*

$$= 0.68 + 0.12 + 0.20 = 1$$

### **Conclusion of Importance Weight Calculation**

After finished calculating all the Importance Weight of three criterion (Current Debt, Net Income, Total Cash), the result tells us that:

- Current Debt accounts for 68% of the overall decision of which Malaysian Company's stock to buy. (**The most important criteria**)
- Net Income accounts for 12% of the overall decision of which Malaysian Company's stock to buy. (**The second most important criteria**)
- Total Cash accounts for 20% of the overall decision of which Malaysian Company's stock to buy. (**The least important criterion**)

### **4. Fourth Step: Calculate the utility of ANN Model**

In Step 4 of the AHP + ANN Model, we need to **calculate and determine the utility based on the completed matrix based on the previous steps** and we will the numerical value of utility to get the useful information which can help us to select the best option/choice of stock. The higher the value of that criterion's utility, the more beneficial that criterion.

### **Example of calculating Total Utility:**

We use **Table 5.3.2** as the example for Calculation of Importance Weights:

	Current Debt	Net Income	Total Cash
Current Debt	1	5	4
Net Income	1/5	1	1/2
Total Cash	1/4	2	1

**Table 5.3.2 AHP Matrix of Criteria**

### **Calculation of Total Utility for each alternative (Padini Holdings Berhad, Chin Hin Group Berhad, PPB Group Berhad):**

### **5. Fifth Step: Identifying the Importance Weight of each criterion**

From previous calculation (Second Step of AHP + ANN Model), we have the Importance Weight of each criterion (Current Debt, Net Income, Total Cash)

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Importance Weight of Current Debt = 0.68

Importance Weight of Net Income = 0.12

Importance Weight of Total Cash = 0.20

### **6. Sixth Step: Calculation of Score for each criterion**

In this step, we need to calculate the score for each criterion (Net Income, Current Debt, Total Cash) for each stock (Padini Holdings Berhad, Chin Hin Group Berhad, PPB Group Berhad).

#### **Example:**

Suppose we list down each indicator of the companies which are found from the financial statement of each company and got from **Table 5.3.1 Sample Data of Performance Measurement:**

(a) Padini Holdings Berhad

Net Income: RM 154,000,000, Current debt: RM 74,000,000, Total Cash: 809,000,000

(b) Chin Hin Group Berhad

Net Income: RM 97,000,000, Current debt: RM 150,000,000, Total Cash: 518,000,000

(c) PPB Group Berhad

Net Income: RM 2,197,000,000, Current debt: RM 1,279,000,000, Total Cash: 1,587,000,000

### **7. Seventh Step: Normalization of score for each criterion:**

Based on the fundamental indicator of those companies above, to calculate the total utility of each stock, we need to first normalize the values of each criterion for each stock using the formula based on different condition or situation of indicators (**Table 2.5.1 Input Parameter (Technical Indicator/Fundamental Indicator)**):

**(a) Condition 1:** The higher the value of that fundamental indicator, the best the score of that company's stock. Then, we will use this formula:

$$\text{Normalized value} = \frac{\text{Actual value} - \text{Minimum value}}{\text{Maximum value} - \text{Minimum value}}$$

**(b) Condition 2:** The higher the value of that fundamental indicator, the bad the score of that company's stock, then we need to invert the normalized value by subtracting it from 1. Then, we will use this formula:

$$\text{Normalized value} = 1 - \frac{\text{Actual value} - \text{Minimum value}}{\text{Maximum value} - \text{Minimum value}}$$

We will find out the maximum value and minimum value of each criterion.

Net Income (max) = RM 2,197,000,000, Net Income (min) = RM 97,000,000

Current Debt (max) = RM 1,279,000,000, Current Debt (min) = RM 74,000,000

Total Cash (max) = RM 1,587,000,000, Total Cash (min) = RM 518,000,000

Once we had found out the maximum value and minimum value of each criterion, then we can start to normalize the values of each criterion for each stock and calculate the total utility of each stock:

(a) For Net Income and Total Cash, since the higher the value of the criterion, the better the score of that company's stock, we can use the normal formula to calculate the normalized values.

(b) For Current Debt, since the higher the value of current debt, the bad the score of that company's stock, we need to invert the normalized value by subtracting it from 1.

Padini Holdings Berhad:

$$X_{(\text{Normalized Net Income}-\text{Padini Holdings Berhad})} = \frac{154,000,000-97,000,000}{2,197,000,000-97,000,000}$$

$$X_{(\text{Normalized Net Income}-\text{Padini Holdings Berhad})} = \frac{57,000,000}{2,100,000,000}$$

$$X_{(\text{Normalized Net Income}-\text{Padini Holdings Berhad})} = 0.03 \text{ (rounded off to 2 decimal places)}$$

$$X_{(\text{Normalized Current Debt}-\text{Padini Holdings Berhad})} = 1 - \frac{74,000,000-74,000,000}{1,279,000,000-74,000,000}$$

$$X_{(\text{Normalized Current Debt}-\text{Padini Holdings Berhad})} = 1 - \frac{0}{1,205,000,000}$$

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$$X_{(\text{Normalized Current Debt-Padini Holdings Berhad})} = 1 - 0$$

$$X_{(\text{Normalized Current Debt-Padini Holdings Berhad})} = 1$$

$$X_{(\text{Normalized Total Cash-Padini Holdings Berhad})} = \frac{809,000,000 - 518,000,000}{1,587,000,000 - 518,000,000}$$

$$X_{(\text{Normalized Total Cash-Padini Holdings Berhad})} = \frac{291,000,000}{1,069,000,000}$$

$$X_{(\text{Normalized Total Cash-Padini Holdings Berhad})} = 0.27 \text{ (rounded off to 2 decimal places)}$$

### Chin Hin Group Berhad:

$$X_{(\text{Normalized Net Income-Chin Hin Group Berhad})} = \frac{97,000,000 - 97,000,000}{2,197,000,000 - 97,000,000}$$

$$X_{(\text{Normalized Net Income-Chin Hin Group Berhad})} = \frac{0}{2,100,000,000}$$

$$X_{(\text{Normalized Net Income-Chin Hin Group Berhad})} = 0$$

$$X_{(\text{Normalized Current Debt-Chin Hin Group Berhad})} = 1 - \frac{150,000,000 - 74,000,000}{1,279,000,000 - 74,000,000}$$

$$X_{(\text{Normalized Current Debt-Chin Hin Group Berhad})} = 1 - 0.06$$

$$X_{(\text{Normalized Current Debt-Chin Hin Group Berhad})} = 0.94 \text{ (rounded off to 2 decimal places)}$$

$$X_{(\text{Normalized Total Cash-Chin Hin Group Berhad})} = \frac{518,000,000 - 518,000,000}{1,587,000,000 - 518,000,000}$$

$$X_{(\text{Normalized Total Cash-Chin Hin Group Berhad})} = \frac{0}{1,069,000,000}$$

$$X_{(\text{Normalized Total Cash-Chin Hin Group Berhad})} = 0$$

### PPB Group Berhad:

$$X_{(\text{Normalized Net Income-PPB Group Berhad})} = \frac{2,197,000,000 - 97,000,000}{2,197,000,000 - 97,000,000}$$

$$X_{(\text{Normalized Net Income-PPB Group Berhad})} = \frac{2,100,000,000}{2,100,000,000}$$

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$$X_{(\text{Normalized Net Income-PPB Group Berhad})} = 1$$

$$X_{(\text{Normalized Current Debt-PPB Group Berhad})} = 1 - \frac{1,279,000,000 - 74,000,000}{1,279,000,000 - 74,000,000}$$

$$X_{(\text{Normalized Current Debt-PPB Group Berhad})} = 1 - \frac{1,205,000,000}{1,205,000,000}$$

$$X_{(\text{Normalized Current Debt-PPB Group Berhad})} = 0$$

$$X_{(\text{Normalized Basic EPS-PPB Group Berhad})} = \frac{1,587,000,000 - 518,000,000}{1,587,000,000 - 518,000,000}$$

$$X_{(\text{Normalized Basic EPS-PPB Group Berhad})} = \frac{1,069,000,000}{1,069,000,000}$$

$$X_{(\text{Normalized Basic EPS-PPB Group Berhad})} = 1$$

### **8. Eighth Step: Calculation of Total Utility for each stocks**

After we have the importance weight and normalized score of each criterion (Net Income, Current Debt, Total Cash) for each stock (Padini Holdings Berhad, Chin Hin Group Berhad, PPB Group Berhad), we can calculate the total utility for each stock by multiplying the importance weight for each criterion by the normalized data for that criterion, and then sum up these values across all criteria.

#### **Formula of Total Utility:**

*Total Utility*

= (*Weight of Criterion 1 \* Normalized Score of Criterion 1*)

+ (*Weight of Criterion 2*

\* *Normalized Score of Criterion 2*) + ... + (*Weight of Criterion n*

\* *Normalized Score of Criterion n*)

(3a) Find **Total Utility for Padini Holdings Berhad:**

*Total utility (Padini Holdings Berhad)*

$$(0.12 \times 0.03) + (0.68 \times 1) + (0.20 \times 0.27) = 0.7376$$

(3b) Find **Total Utility for Chin Hin Group Berhad:**

*Total utility (Chin Hin Group Berhad)*

$$= (0.12 \times 0) + (0.68 \times 0.94) + (0.20 \times 0) = 0.6392$$

(3c) Find **Total Utility for PPB Group Berhad:**

*Total utility (PPB Group Berhad)*

$$= (0.12 \times 1) + (0.68 \times 0) + (0.20 \times 1) = 0.32$$

### **9. Ninth Step: Identify and rank best option of stocks for the AHP + ANN Model**

#### **Conclusion of Total Utility Calculation for each alternative of stock (Padini Holdings Berhad, Chin Hin Group Berhad, PPB Group Berhad) of the AHP + ANN Model**

After finished calculating all the Total Utility Calculation for each alternative (Padini Holdings Berhad, Chin Hin Group Berhad, PPB Group Berhad), the result tells us that:

- Total utility score for Padini Holdings Berhad is 0.7376
- Total utility score for Chin Hin Group Berhad is 0.6392
- Total utility score for PPB Group Berhad is 0.32

From the above result, we see that Padini Holdings Berhad has the highest total utility of 0.7376, followed by Chin Hin Group Berhad with the total utility of 0.6392, and PPB Group Berhad with the total utility of 0.32. So, we can say that the best choice for us to buy the stock in Malaysian Stock Market is Padini Holdings Berhad which is ranked the First Place of stock ranking list, followed Chin Hin Group Berhad which is ranked at the Second Place of stock ranking list and at last is PPB Group Berhad which is ranked the Third Place of stock ranking list.

#### **Stock Trend**

$$(0.0000 - 0.4999 = \text{Downtrend of Stock}, 0.5000 - 1.0000 = \text{Uptrend of Stock})$$



Rank	Stock Name	Total utility score	Stock Trend
1st	Padini Holdings Berhad	0.7376	Uptrend
2nd	Chin Hin Group Berhad	0.6392	Uptrend
3rd	PPB Group Berhad	0.32	Downtrend

**Table 5.3.7** Stock Ranking Table of AHP + ANN Model

Table 5.3.7 above shows the Stock Ranking Table of AHP + ANN Model. The higher the total utility score of stock, the higher the ranking of the stock will be in the stock ranking table of AHP + ANN model.

### **10. Tenth Step: Conducting the Performance Measurement Metrics for this AHP + ANN Model**

#### Padini Holdings Berhad



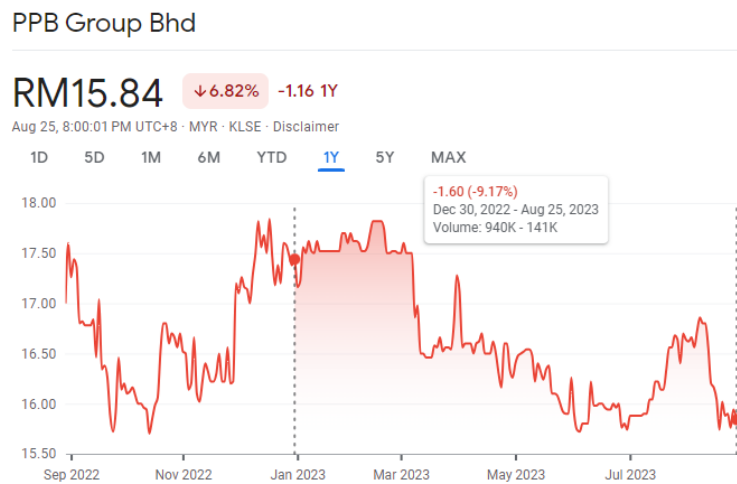
**Figure 5.3.5** Stock Trend of Padini Holdings Berhad after Year 2022

Figure 5.3.5 shows the actual stock trend of Padini Holdings Berhad after year 2022 is **uptrend**.



**Figure 5.3.6 Stock Trend of Chin Hin Group Berhad after Year 2022**

Figure 5.3.6 shows the actual stock trend of Chin Hin Group Berhad after year 2022 is **uptrend**.



**Figure 5.3.7 Stock Trend of PPB Group Berhad after Year 2022**

Figure 5.3.7 shows the actual stock trend of PPB Group Berhad after year 2022 is **downtrend**.

**Confusion Matrix of AHP + ANN Model**

		-----Actual-----	
		Uptrend	Downtrend
Predicted	Uptrend	2 (TP)	0 (FP)
	Downtrend	0 (FN)	1 (TN)

**Table 5.3.8 Confusion matrix of AHP + ANN Model**

TP = True Positives, TN = True Negatives, FP = False Positives, FN = False Negatives

Accuracy of AHP + ANN Model

$$\begin{aligned}
 &= \frac{TP + TN}{TP + TN + FP + FN} \\
 &= \frac{2 + 1}{2 + 1 + 0 + 0} \\
 &= 1.0 \text{ (100 \%)}
 \end{aligned}$$

Recall of AHP + ANN Model

$$\begin{aligned}
 &= \frac{TP}{TP + FN} \\
 &= \frac{2}{2 + 0} \\
 &= 1.0 \text{ (100 \%)}
 \end{aligned}$$

Precision of AHP + ANN Model

$$\begin{aligned}
 &= \frac{TP}{TP + FP} \\
 &= \frac{2}{2 + 0} \\
 &= 1.0 \text{ (100 \%)}
 \end{aligned}$$

F1 Score of AHP + ANN Model

$$\begin{aligned}
 &= \frac{2}{\frac{1}{Recall} + \frac{1}{Precision}} \\
 &= \frac{2}{\frac{1}{1.0} + \frac{1}{1.0}} \\
 &= 1.0, \text{ (100 \%)}
 \end{aligned}$$

<b>Classification Evaluation Metrics</b>	<b>Value</b>
Accuracy	0.67
Recall	0.5
Precision	1.0
F1 Score	0.67

**Table 5.3.9 Classification Evaluation Metrics of AHP Model**

<b>Classification Evaluation Metrics</b>	<b>Value</b>
Accuracy	1.0
Recall	1.0
Precision	1.0
F1 Score	1.0

**Table 5.3.10 Classification Evaluation Metrics of AHP + ANN Model**

<b>No. Ranking</b>	<b>Stock Name</b>
1	PHB
2	CHGB
3	PGB

**Table 5.3.11 Stock Ranking of AHP Model**

<b>No. Ranking</b>	<b>Stock Name</b>
1	PHB
2	CHGB
3	PGB

**Table 5.3.12 Stock Ranking of AHP + ANN Model**

*PHB = Padini Holdings Berhad*

*CHGB = Chin Hin Group Berhad*

*PGB = PPB Group Berhad*

Table 5.3.9 and Table 5.3.10 shows the classification evaluation metrics of AHP Model and AHP + ANN Model after finishing the stock prediction process based on the Sample Data of Performance Measurement (Table 5.3.1).

Table 5.3.11 and Table 5.3.12 shows the stock ranking of AHP Model and AHP + ANN Model after finishing the stock prediction process based on the Sample Data of Performance Measurement (Table 5.3.1).

Based on the comparison of **Table 5.3.9** and **Table 5.3.10**, the tables show that

**Accuracy:**

- The Accuracy of the AHP + ANN Model (1.0) is better than the AHP Model (0.67)
- This accuracy score of both models can be said that the integration of the Artificial Neural Network (ANN) with the Analytic Hierarchy Process (AHP) (AHP + ANN model) improves the accuracy of the model and enhances the overall performance and reliability of AHP-based models.
- **AHP + ANN Model BETTER.**

**Recall:**

- The Recall of the AHP + ANN Model (1.0) is better than the AHP Model (0.5).
- The recall score of both models can be said the AHP + ANN model is good at identifying the positive examples.
- **AHP + ANN Model perform BETTER.**

**Precision:**

- The Precision of the AHP Model (1.0) and AHP + ANN Model (1.0) have the same score of Precision.
- The precision score of both models can be said that both the models (AHP Model & AHP + ANN Model) makes fewer false positive predictions.
- Both Model perform the **SAME**.

**F1 Score:**

- The F1 Score of the AHP + ANN Model (1.0) is better than the AHP Model (0.67)
- The range of F1-score is between 0 and 1 and if the F1 score of a model is closer to 1, then the model is better. AHP + ANN model is closer to 1 compared to the original model, so it can be said that the AHP + ANN model is a better model than the original AHP model.
- **AHP + ANN Model perform BETTER.**

Based on the result of Accuracy, Recall, Precision, F1 Score for the AHP Model and AHP + ANN Models, it can indicate that the integration of ANN with AHP not only improves its accuracy, recall score and F1 score, but also enhances the overall

performance and reliability of AHP-based models. This indicates that the AHP + ANN Model is more effective in accurately classifying and predicting outcomes compared to the original AHP Model alone.

Furthermore, the comparisons of **Table 5.3.11** and **Table 5.3.12** also show that the predicted stock ranking for each stock is the same for both models, so it can be said that the two models are consistent in their predictions of stock rankings.

### **Conclusion of the overall Performance Measurement of Stock Prediction Models (AHP Model & AHP + ANN Models)**

In conclusion, the use of a combination of the AHP and ANN techniques in the stock prediction process of the Stock Market Equity Advisory Tool for this final year project is essential to achieve more accurate and reliable predictions. Besides, the combination use of the AHP + ANN techniques in a model of this Stock Market Equity Advisory Tool for this final year project is better than the use of only the AHP techniques for the tool, as the **Table 5.3.9** and **Table 5.3.10** had shown that the combination use of the AHP + ANN techniques in a model for the stock prediction have a better score of accuracy, recall, and F1 score compare to the use of only the AHP techniques for the stock prediction,

Therefore, by integrating the strengths of combination of both techniques (AHP and ANN techniques), the model of the Stock Market Equity Advisory Tool for this final year project can **accurately compare the stock performance** whether a stock is going to be uptrend or downtrend which has been **achieved the first objective** of this final year projects and **accurately give advices to the fresh investor** whether the stock is recommended to buy or sell which has been **achieved the second objective** of this final year project based on the prove of **5.3 Performance Measurement of Stock Prediction Models, Table 5.3.9 and table 5.3.10.**

## CHAPTER 6

### Discussion

#### 6.1 System Limitation

The first limitation of this Stock Market Equity Advisory Tool can be predicted by the model and watch list, which have 3 or 4 stocks and an indicator. If the user wishes to predict or compare the stock or watchlist with more than 4 stocks and 4 indicators, then this tool is not suitable. Besides, the second limitation of this tool is that it only covers the top 100 stocks in Malaysia. If the user wishes to predict stocks other than these 100, then it is not possible with this tool. Moreover, the third limitation of this tool is that it only covers 23 indicators of fundamental and technical analysis. If the user requires access to a wider range of indicators for their analysis, this tool is not able to provide that. Other than that, the fourth limitation of this tool is that it cannot provide real-time stock market data for making predictions and relies on historical data in the CSV files for analysis.

#### 6.2 Future Enhancement

The Stock Market Equity Advisory Tool of this project had achieved all the objectives such as it can be known that the tool has the ability of AHP + ANN Techniques to accurately compare and identify the best stocks for the user based on the total utility score of each stock based on the result of the 5.3 Performance Measurement of Stock Prediction Models by testing and comparing the accuracy and performance between the combined techniques (AHP + ANN) and the original technique (AHP). The tool also can analyse the stock information of Malaysia Stock Market such as the technical indicators, fundamental indicators and stock prices and giving advice of recommended action either it is the opportunity to buy or sell the stocks to the fresh investor who has the limited investment knowledge but they wish to invest in Malaysia Stock Market based on the result of system testing process (5.2) in the Chapter 5, and the last objective which had been achieved by this tool is it can allow the user to choose their own preferences of indicators based on the result of system testing process (5.2)

in the Chapter 5. For example, the user can create a model that contains their preferences for indicators and use this model to conduct stock predictions in this tool.

However, because of the time limitation of this project, there is a lot of future enhancement that can be done to address these limitations and improve the tool's functionality. To overcome the first limitation, which is related to the number of stocks and indicators, the tool can be upgraded to allow the users to customise more fundamental and technical indicators and stocks. This can be achieved by making the model of this tool more dynamic rather than just allowing the user to compare 3 stocks with 3 indicators or 4 stocks with 4 indicators. Besides, to address the second and third limitations, the tool can be expanded to cover some popular foreign stocks and indicators for users who are interested in global market analysis and other indicators other than the current indicators of this tool. This can be achieved by conducting a survey for the users to gather feedback on what additional indicators and stocks they would like to see included in the tool and then incorporating some of the suggestions into future updates. Furthermore, to solve the fourth limitation of replying to historical data from the CSV file, the stock market equity advisory tool can be enhanced to retrieve real-time stock market data from trusted financial data sources such as the Yahoo Finance API. This can be achieved by implementing an API integration with the Yahoo Finance API to fetch livestock market data. By using real-time data in the stock comparison process of this tool, users can make more informed decisions and react quickly to market changes based on the latest market trends.

### **6.3 Performance Comparison between the proposed techniques and exiting technique**

The proposed system for this project is the Stock Market Equity Advisory Tool, which has been using the combination techniques of AHP and ANN to conduct the stock prediction process. The Stock Market Equity Advisory Tool is designed to provide accurate and reliable predictions for stock market trends. The reason for using the combined techniques of AHP and ANN instead of the AHP techniques alone to conduct the sock prediction and stock comparison process for this proposed system is that the accuracy, recall score, and F1 score of the combined techniques of AHP and ANN are much better than the AHP techniques alone after conducting the performance



## CHAPTER 6

measurement of stock prediction models at the 5.3 section of Chapter 5 by testing and comparing the accuracy and performance between the combined techniques (AHP + ANN) and the original technique (AHP). As the result, the integration of AHP and ANN shows that it can allow for a more comprehensive analysis of stock prediction models by leveraging the strengths of both techniques. Besides, this combination techniques also can enhance the accuracy and performance of the proposed system, ultimately leading to more reliable stock predictions and comparisons. Therefore, with its advanced combined techniques of AHP and ANN developed in this stock market equity advisory tool of this final year project, it can assist users and fresh investors in making more informed and accurate decisions and maximising their returns in the stock market.

## CHAPTER 7

### Conclusion

This final year project is aimed at solving the problems that have been found in the existing system, which are the lack of the ability to compare and identify the best stock for the investor, the lack of focus on analysing the stock information from the Malaysia Stock Market, and the lack of allowing the user to choose their own preferences of indicator for stock predicting or decision-making.

This project is aimed at developing a stock advisory tool that can help investors, especially fresh investors who don't know how to use the complex stock predicting system and wish to have an advisor who is willing to help them select the most suitable stock for them. Therefore, the tool will be using the AHP model plus AHP result to evaluate the selected model and watch list, which will enable the stock advisory tool to choose the most suitable stock decision for the investor. Besides, the innovation of this stock advisory tool is that it can provide a customizable stock decision-making model to the investor by allowing the investor to select their own preferred indicator, and the selected indicators will produce a dynamic stock decision-making AHP + ANN model for the tool to use in the stock decision-making process. This dynamic AHP + ANN model will ensure that the investor receives personalised advice that aligns with their stock investment goals.

In conclusion, the dynamic AHP + ANN model and the AHP + ANN's result evaluating model developed inside this stock market equity advisory tool are the proposed solutions to the problem found in the existing systems. These models will be able to provide the most accurate and suitable stock decisions for the investor. However, this "Stock Advisory Tool" application also has some limitations due to time constraints. Therefore, there will be some future improvements of this tool to address these limitations and improve the tool's functionality in the future for this Stock Market Equity Advisory Tool mobile application.

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## APPENDIX A

### A.1 The List of FTSE Bursa Malaysia 100 Index Constituents [53] & [54]

No.	Stock Code	Company Name / Constituents Name
1	6599	AEON CO. (M) BHD
2	5139	AEON CREDIT SERVICE (M) BHD
3	2488	ALLIANCE BANK MALAYSIA BERHAD
4	1015	AMMB HOLDINGS BHD
5	6399	ASTRO MALAYSIA HOLDINGS BERHAD
6	5106	AXIS REITS
7	5248	BERMAZ AUTO BERHAD
8	5254	BOUSTEAD PLANTATIONS BHD
9	4162	BRITISH AMERICAN TOBACCO (M)
10	5210	BUMI ARMADA BERHAD
11	1818	BURSA MALAYSIA BHD
12	2836	CARLSBERG BREWERY MALAYSIA BHD
13	5273	CHIN HIN GROUP BERHAD
14	5301	CTOS DIGITAL BERHAD
15	7204	D & O GREEN TECHNOLOGIES BERHAD
16	4456	DAGANG NEXCHANGE BERHAD
17	1619	DRB-HICOM BHD
18	7233	DUFU TECHNOLOGY CORP. BHD
19	7148	DUOPHARMA BIOTECH BERHAD
20	8206	ECO WORLD DEVELOPMENT GROUP BERHAD
21	5306	FARM FRESH BERHAD
22	5222	FGV HOLDINGS BERHAD
23	3689	FRASER & NEAVE HOLDINGS BHD
24	128	FRONTKEN CORPORATION BHD
25	5398	GAMUDA BHD
26	2291	GENTING PLANTATIONS BERHAD

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27	21	<b>GHL SYSTEMS BHD</b>
28	208	<b>GREATECH TECHNOLOGY BERHAD</b>
29	5102	<b>GUAN CHONG BHD</b>
30	4324	<b>HENGYUAN REFINING COMPANY BERHAD</b>
31	5151	<b>HEXTAR GLOBAL BERHAD</b>
32	5199	<b>HIBISCUS PETROLEUM BHD</b>
33	41	<b>HONG SENG CONSOLIDATED BERHAD</b>
34	3336	<b>IJM CORPORATION BHD</b>
35	7153	<b>KOSSAN RUBBER INDUSTRIES BHD</b>
36	5878	<b>KPJ HEALTHCARE BHD</b>
37	6633	<b>LEONG HUP INTERNATIONAL BERHAD</b>
38	5284	<b>LOTTE CHEMICAL TITAN HOLDING BERHAD</b>
39	5014	<b>MALAYSIA AIRPORTS HOLDINGS BHD</b>
40	1171	<b>MALAYSIA BUILDING SOCIETY BHD</b>
41	3867	<b>MALAYSIAN PACIFIC INDUSTRIES</b>
42	1651	<b>MALAYSIAN RESOURCES CORPORATION BERHAD</b>
43	5236	<b>MATRIX CONCEPTS HOLDINGS BHD</b>
44	3069	<b>MEGA FIRST CORPORATION BHD</b>
45	5286	<b>MI TECHNOVATION BERHAD</b>
46	138	<b>MY E.G. SERVICES BHD</b>
47	7052	<b>PADINI HOLDINGS BHD</b>
48	7160	<b>PENTAMASTER CORPORATION BHD</b>
49	7084	<b>QL RESOURCES BHD</b>
50	9822	<b>SAM ENGINEERING &amp; EQUIPMENT</b>
51	5126	<b>SARAWAK OIL PALMS BHD</b>

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52	4731	SCIENTEX BERHAD
53	7155	SKP RESOURCES BHD
54	8664	SP SETIA BHD
55	1562	SPORTS TOTO BERHAD
56	5211	SUNWAY BERHAD
57	5176	SUNWAY REAL ESTATE INVT TRUST
58	7106	SUPERMAX CORPORATION BHD
59	6139	SYARIKAT TAKAFUL MALAYSIA KELUARGA BERHAD
60	5012	TA ANN HOLDINGS BHD
61	5031	TIME DOTCOM BHD
62	5148	UEM SUNRISE BERHAD
63	4588	UMW HOLDINGS BHD
64	5005	UNISEM (M) BHD
65	5292	UWC BERHAD
66	6963	V.S INDUSTRY BHD
67	97	VITROX CORPORATION BHD
68	5246	WESTPORTS HOLDINGS BERHAD
69	7293	YINSON HOLDINGS BHD
70	4677	YTL CORPORATION BHD
71	6888	AXIATA GROUP BERHAD
72	1023	CIMB GROUP HOLDINGS BERHAD

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73	7277	<b>DIALOG GROUP BHD</b>
74	6947	<b>DIGI.COM BHD</b>
75	3182	<b>GENTING BHD</b>
76	4715	<b>GENTING MALAYSIA BERHAD</b>
77	5168	<b>HARTALEGA HOLDINGS BHD</b>
78	5819	<b>HONG LEONG BANK BHD</b>
79	1082	<b>HONG LEONG FINANCIAL GROUP BHD</b>
80	5225	<b>IHH HEALTHCARE BERHAD</b>
81	166	<b>INARI AMERTRON BERHAD</b>
82	1961	<b>IOI CORPORATION BHD</b>
83	2445	<b>KUALA LUMPUR KEPONG BHD</b>
84	1155	<b>MALAYAN BANKING BHD</b>
85	6012	<b>MAXIS BERHAD</b>
86	3816	<b>MISC BHD</b>
87	5296	<b>MR D.I.Y. GROUP (M) BERHAD</b>
88	4707	<b>NESTLE (M) BHD</b>
89	5183	<b>PETRONAS CHEMICALS GROUP BHD</b>
90	5681	<b>PETRONAS DAGANGAN BHD</b>
91	6033	<b>PETRONAS GAS BHD</b>
92	4065	<b>PPB GROUP BHD</b>
93	8869	<b>PRESS METAL ALUMINIUM HOLDINGS BERHAD</b>
94	1295	<b>PUBLIC BANK BHD</b>

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<b>95</b>	<b>1066</b>	<b>RHB BANK BERHAD</b>
<b>96</b>	<b>4197</b>	<b>SIME DARBY BHD</b>
<b>97</b>	<b>5285</b>	<b>SIME DARBY PLANTATION BERHAD</b>
<b>98</b>	<b>4863</b>	<b>TELEKOM MALAYSIA BHD</b>
<b>99</b>	<b>5347</b>	<b>TENAGA NASIONAL BHD</b>
<b>100</b>	<b>7113</b>	<b>TOP GLOVE CORPORATION BHD</b>

## FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

<b>Trimester, Year: Y3T2</b>	<b>Study week no.: 2</b>
<b>Student Name &amp; ID: Lee Woon Ming, 19ACB01575</b>	
<b>Supervisor: Ts Dr Ku Chin Soon</b>	
<b>Project Title: Stock Market Equity Advisory Tool using Analytic Hierarchy Process and Single-Layer Perceptron Neural Network</b>	

### 1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Some of the user interface for the application.

### 2. WORK TO BE DONE

Continue designing the user interface of application and connecting the firebase database with the application.

### 3. PROBLEMS ENCOUNTERED

Spend more time in designing the interface.

### 4. SELF EVALUATION OF THE PROGRESS

Discover a strategy for handling interface components.



Supervisor's signature



Student's signature



## FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

<b>Trimester, Year: Y3T2</b>	<b>Study week no.: 4</b>
<b>Student Name &amp; ID: Lee Woon Ming, 19ACB01575</b>	
<b>Supervisor: Ts Dr Ku Chin Soon</b>	
<b>Project Title: Stock Market Equity Advisory Tool using Analytic Hierarchy Process and Single-Layer Perceptron Neural Network</b>	

### 1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Completed the user interface design of application and connected the firebase database with the application.

### 2. WORK TO BE DONE


Continue developing the function for the AHP + ANN model of Stock Market Equity Advisory Tool mobile application.

### 3. PROBLEMS ENCOUNTERED

There are some bugs in the code.

### 4. SELF EVALUATION OF THE PROGRESS

Try to search for the solution and recheck the code to handle the bugs.

  
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Supervisor's signature



\_\_\_\_\_  
Student's signature

## FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

<b>Trimester, Year: Y3T2</b>	<b>Study week no.: 7</b>
<b>Student Name &amp; ID: Lee Woon Ming, 19ACB01575</b>	
<b>Supervisor: Ts Dr Ku Chin Soon</b>	
<b>Project Title: Stock Market Equity Advisory Tool using Analytic Hierarchy Process and Single-Layer Perceptron Neural Network</b>	

### 1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Complete the development of AHP Model.

### 2. WORK TO BE DONE


Continue developing the function for the ANN model and combining the ANN model with AHP model.

### 3. PROBLEMS ENCOUNTERED

There are some bugs in the code.

### 4. SELF EVALUATION OF THE PROGRESS

Try to search for the solution and recheck the code to handle the bugs.

  
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Supervisor's signature

  
\_\_\_\_\_  
Student's signature

## FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

<b>Trimester, Year: Y3T2</b>	<b>Study week no.: 8</b>
<b>Student Name &amp; ID: Lee Woon Ming, 19ACB01575</b>	
<b>Supervisor: Ts Dr Ku Chin Soon</b>	
<b>Project Title: Stock Market Equity Advisory Tool using Analytic Hierarchy Process and Single-Layer Perceptron Neural Network</b>	

### 1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Complete the development of the overall application.

### 2. WORK TO BE DONE


Final testing for the function of application.

### 3. PROBLEMS ENCOUNTERED

Found some bugs when conducting the system testing for the application.

### 4. SELF EVALUATION OF THE PROGRESS

Solve the bugs and conduct a system testing again for the application.

  
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Supervisor's signature

  
\_\_\_\_\_  
Student's signature

## FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

<b>Trimester, Year: Y3T2</b>	<b>Study week no.: 9</b>
<b>Student Name &amp; ID: Lee Woon Ming, 19ACB01575</b>	
<b>Supervisor: Ts Dr Ku Chin Soon</b>	
<b>Project Title: Stock Market Equity Advisory Tool using Analytic Hierarchy Process and Single-Layer Perceptron Neural Network</b>	

### 1. WORK DONE

[Please write the details of the work done in the last fortnight.]

System testing of the application is successfully and the application is working perfectly now.

### 2. WORK TO BE DONE


Design the benchmark prototypes for the model and start the report writing for chapter 4, 5, 6 and 7.

### 3. PROBLEMS ENCOUNTERED

Spend more time in designing the benchmark prototypes for the model.

### 4. SELF EVALUATION OF THE PROGRESS

Need to plan and reorganize the time for this report and other subjects' assignment.

  
\_\_\_\_\_  
Supervisor's signature

  
\_\_\_\_\_  
Student's signature

## FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

<b>Trimester, Year: Y3T2</b>	<b>Study week no.: 10</b>
<b>Student Name &amp; ID: Lee Woon Ming, 19ACB01575</b>	
<b>Supervisor: Ts Dr Ku Chin Soon</b>	
<b>Project Title: Stock Market Equity Advisory Tool using Analytic Hierarchy Process and Single-Layer Perceptron Neural Network</b>	

### 1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Complete the design of the benchmark prototypes for the model and report writing for chapter 4.

### 2. WORK TO BE DONE


report writing for chapter 5, 6 and 7.

### 3. PROBLEMS ENCOUNTERED

Spend more time in writing the chapter 5, 6, and 7.

### 4. SELF EVALUATION OF THE PROGRESS

Need to plan and reorganize the time for this report and other subjects' assignment.

  
\_\_\_\_\_  
Supervisor's signature

  
\_\_\_\_\_  
Student's signature

## FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

<b>Trimester, Year: Y3T2</b>	<b>Study week no.: 12</b>
<b>Student Name &amp; ID: Lee Woon Ming, 19ACB01575</b>	
<b>Supervisor: Ts Dr Ku Chin Soon</b>	
<b>Project Title: Stock Market Equity Advisory Tool using Analytic Hierarchy Process and Single-Layer Perceptron Neural Network</b>	

### 1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Report writing for chapter 5, 6 and 7.

### 2. WORK TO BE DONE


Finalize the documentation and format of the report and submit the report before the deadlines.


### 3. PROBLEMS ENCOUNTERED

The issues of report formatting.


### 4. SELF EVALUATION OF THE PROGRESS

Learn and check how to format the report based on the FYP 2 guidelines given by the faculty.

  
Supervisor's signature

  
Student's signature

## POSTER



**FACULTY OF INFORMATION AND  
COMMUNICATION TECHNOLOGY**

**BACHELOR OF INFORMATION SYSTEMS  
(HONOURS) INFORMATION SYSTEMS  
ENGINEERING**

**Title:** Stock Market Equity Advisory Tool using Analytic Hierarchy Process and Single-Layer Perceptron Neural Network

### Introduction

Stock Market Equity Advisory Tool is an investment analysis and decision-marking tool that can provide advice to an investor in selecting a stock to purchase. The target audience of this tool is fresh Malaysian investors. This tool will be very beneficial for those investors who are having difficulty selecting a suitable stock.

### Methods

- Analytic Hierarchy Process (AHP)
- Single-Layer Perceptron Neural Network - (Artificial Neural Networks (ANN))

### Discussion

This stock market equity advisory tool has achieved all the objectives. However, this tool still has some limitations due to the time limitation of this final-year project. Therefore, this tool can make some improvements in the future to address these limitations to make this tool more perfect.

### Conclusion

The dynamic AHP + ANN model and the result evaluating model developed inside the tool is the proposed solution to the problem found in the existing systems. It believes that those models will be able to provide the most accurate and suitable stock decisions for the investors.

StudentName & ID: Lee Woon Ming, 19ACB01575 | SupervisorName: Ts. Dr Ku Chin Soon

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<b>ID Number(s)</b>	19ACB01575
<b>Programme / Course</b>	IA
<b>Title of Final Year Project</b>	Stock Market Equity Advisory Tool using Analytic Hierarchy Process and Single-Layer Perceptron Neural Network

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