STOCK PRICE MONITORING SYSTEM

BY

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I would like to take this opportunity to thank all of those who helped and guided me throughout the whole journey of completing this project.

Firstly, I would like to extend my sincere thanks and appreciation to my supervisor, Dr Abdulkarim Kanaan Jebna, who has given me this bright opportunity to engage in an Artificial Intelligence-based project. It is my first step to embark my journey in data mining and machine learning field.

Finally, I must say express my gratitude to my parents and my family for their unconditional love, tremendous support, and continuous encouragement throughout the project.

ABSTRACT

This project is a development-based project with deep learning approach for academic purpose. This stock price monitoring system is developed to help users keep track of stock price movements and predict the closing price, so that the users can reap benefits from it and make profits. Algorithms trading is commonly practiced in the financial market due to high accuracy and least human error. Nevertheless, there are few issues occur in the Malaysia stock market, which include absence of stock price prediction function for Bursa listed stocks, poor data visualization and lack of investment recommendation. The main objectives of this project are to to develop a stock price forecasting model, to build a dashboard to present data, and to provide investment recommendations. As stock price is time series data, a time series prediction algorithm is being utilized to build a deep learning model, namely Long Short-Term Memory (LSTM). Consequently, Root Mean Squared Error (RMSE) and Mean Absolute Percentage Error (MAPE) are used to evaluate the performance of the prediction algorithms. The methodology used in this project is Cross-Industry Standard Process for Data Mining (CRISP-DM), which is a common standard for data mining projects. Lastly, the expected outcome of this project is to have a web application to be built on Streamlit, that incorporates the deep learning model of stock price prediction and displays a dashboard with stock price insights. The stocks of this project are referring to the stocks in Bursa Malaysia, the one and only stock exchange of Malaysia. With the presence of this proposed system, it can benefit the retail investors to make investment decisions by predicting future stock price.

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LIST OF ABBREVIATIONS

ARIMA	Autoregressive Integrated Moving Average
AI	Artificial Intelligence
CNN	Convolution Neural Network
CRISP-DM	Cross-Industry Standard Process for Data Mining
DNN	Deep Neural Network
HAN	Hierarchical Attention Networks
IT	Information Technology
LSTM	Long Short-Term Memory
RMSE	Root Mean Square Error
RNN	Recurrent Neural Network
MAPE	Mean Absolute Percentage Error
NLP	Natural Language Processing

CHAPTER 1
Introduction

There are many types of investments available in the market, which include bonds, Exchange-Traded Funds (ETFs), mutual funds, retirement plans, fixed deposits, properties, commodities, and the highlight of this project, stocks. Stock investment means buying shares of partial ownership in a public company that is listed in a stock exchange [1]. Stock is one of the most popular and common investment products as it can bring potentially high returns. However, stock investment may bring high risks to the investor's portfolio if they just buy stocks blindly without a strategic plan. Hence, that is why stock trading with algorithms and predictions is becoming prevalent in the market as it provides guidance to the investors in evaluating stocks.

If investors can get access to a system that can provide stock price prediction, they can ideally buy at a low point and sell it at a high point. Thus, investors can make full potential to generate profit by having an estimated entry and exit point for their trading. Besides, investors can cut down the losses to a minimum level. This is because they can predict the stock price with the proper application and analysis of stock price prediction system [2]. In addition, there is a growing trend in financial market adopting Artificial Intelligence to predict the stock price. For instance, [3] uses a comprehensive deep learning system to predict short-term stock market price.

1.1 Problem Statement and Motivation

1. Inadequacy of stock investment tools that utilizes stocks from Bursa Malaysia

Currently, there is only a few online platforms that use stock data from Malaysian equity market - malaysiastock.biz, i3Investor, iSaham, KLSE Screener and Trading View to name a few. Excluding broker and trading platform, these are some of the examples for platforms that provide details of Bursa stocks. Compared to foreign market, especially U.S. stock market, there is a vast number of platforms that can provide stock insights available. No matter local or foreign investors of Bursa Malaysia, they can only use the few alternatives on hand, and some of them even provide very limited and basic functionalities.

2. Poor data visualization and insufficiency of stock insights

The aforementioned platforms for Bursa Malaysia stocks only offer some necessary functions and information of the stocks, such as company name, stock code, stock price, price chart, sector name, change of price in percentage, market type, volume, market capitalization, announcement and news. Other than basic information, the platforms do not provide any other extra or additional details that can give deeper insights to the investors. No summary or analysis of information derived from the existing data is given in the platforms. With this limitation, investors cannot have an overall image of the performance of the index, sector and individual stocks.

3. Lack of investment advice function with machine learning approach

Finally, there is an absence of investment recommendation feature in those existing platforms for Malaysian equity market. Out of all available platforms, only i3investor provides price target with price call [4]. Although this function is similar to investment advice, those data is nevertheless financial research from investment banks and firms. Hence, there is no recommendation provided by performing proven methods that involve cutting-edge technologies. This could be happened due to the fact that artificial intelligence and machine learning projects consume much time and resources.

This report is written with the aim of providing clear indication and background of the proposed project title “Stock Price Monitoring System”. It contains all the key elements of this development-based project, and it can demonstrate the significance and value of the project. This project is inspired by my personal trading experience in Bursa Malaysia. Due to the inadequacy and limitations of the online tools available, investors in Malaysian stock market can only use mobile or web applications that offer basic functions like screening, indexes, news, announcements, and stock details. They can hardly find a platform that can provide comprehensive insights of stocks through data visualization and strategic trading recommendations based on proven technologies. That is why I am eager and motivated to develop a brand-new AI-based stock price monitoring system that can address the common issues in the current market.

1.2 Objectives

1. To develop an AI-based stock price forecasting model

A stock price prediction system can be built by using Artificial Intelligence approach. However, stock price portrays a nonlinear characteristic, and it can fluctuate due to various kinds of factors. This is why few time series algorithm is being tested and evaluated before implementing it into the proposed system. The involved model for this project includes Long Short-Term Memory. After the development of the proposed system, users can check for the predicted price of Bursa Malaysia stocks. It can be a guidance for them to look for entry points and exit points for trading purpose.

2. To explore deep learning model for financial forecasting

This report records the performance of two models, which include Long Short-Term Memory (LSTM) and Naïve Forecasting. Naïve Forecasting model is utilized to act as a benchmark score for comparing with the model performance of the LSTM.

3. To build a dashboard to present data

The proposed system aims to create a dashboard that can show comprehensive summary of Bursa Malaysia stocks, especially the details of the stock price. The dashboard will be customized to accommodate the needs of investors by displaying insightful information as well as creating tables, graphs and charts. For example, it can show the company name, stock code, price prediction for short term and long term, average stock price, chart of existing stock price and predictive stock price and investment recommendations for "BUY" or "SELL".

4. To provide investment recommendations based on machine learning

Some of the aforementioned Bursa stocks platforms give price targets and price calls such as "BUY", "HOLD" and "SELL" for certain stocks based on fundamental research from investment banks. The recommendation provided is based on financial analysis performed on the public companies. In contrast, the stock price forecasting model of this proposed project utilizes machine learning, and it can predict the closing price of stocks. Hence, this system can give accurate estimated price and investment suggestions after learning the data. If the predicted value is above the current price, the system will suggest the users to buy the stock or vice versa.

1.3 Project Scope and Direction

The scope of the project includes developing a web application system that can forecast stock prices by incorporating Artificial Intelligence. Besides, there is a dashboard to display the relevant data of stocks. In addition, different indicators are provided to evaluate each stock. Lastly, investment recommendations are provided to guide investors in making investment decision. This proposed project can benefit many individuals from different background, which include regular investors, novice investors, investment analysts, financial planners, machine learning engineers, and IT researchers. The main direction of the project is incorporating Artificial Intelligence and deep learning algorithms to build this stock price prediction system.

1.4 Contributions

This project works towards developing and designing a stock price monitoring system with machine learning model in a web application. Firstly, this report highlights some of the common issues faced by the investors in Malaysian capital market, and it proposes some viable solutions to tackle the problems. This can benefit to the researchers who are doing similar studies on this stock price monitoring system topic. Secondly, this project involves multiple technologies such as data mining, deep learning, and web application development. Information Technology specialists can take advantage to refer to this project and gain experience if they wish to develop a similar project. Lastly, this proposed system targets to enhance the functionalities of stock price monitoring system and uses stocks from Bursa Malaysia. Thus, this system can become a new tool for investors in Malaysian stock market for stock screening and analysis. In short, this thesis report documents few essential contributions made to the fields of finance and information technology.

1.5 Report Organization

The details of this research are shown in the following chapters. In Chapter 2, literature review is done on the topics of analysis of existing systems, details of stock price, targeted stock, studies on prediction algorithms and evaluation methods. Chapter 3 highlights the system methodology in this project, which is Cross Industry Standard Process for Data Mining (CRISP-DM). Chapter 4 shows the system design while Chapter 5 touches on the system implementation. Chapter 6 evaluates the system performance and discusses on challenges. The last chapter concludes the whole report in a summary and provides some recommendation.

CHAPTER 2

This chapter reviews the existing stock price monitoring systems in web applications for Bursa Malaysia stock market. The functions and features of the existing systems are analyzed and compared. Some of the key functionalities from those systems will be tried out and examined as a reference for the proposed system of this project. Moreover, a few time series algorithms and evaluation methods will be discussed.

Literature Review

2.1 Analysis of Existing Systems

Analysis of three existing similar systems for stock price monitoring systems, which encompass KLSE Screener, i3investor, and MalaysiaStock.Biz, is carried out and recorded as follows. All these 3 platforms come in mobile applications and web applications. Since the objective of this project is to build a web application, existing systems are reviewed according to the web versions.

2.1.1 KLSE Screener [5]

KLSE Screener is a free and user-friendly website and mobile application (see Figure 2.1). KLSE stands for Kuala Lumpur Stock Exchange, currently known as Bursa Malaysia [6]. KLSE Screener is one of the most popular tools for investors to analyze Malaysia stocks. The sync function allows users to trace back historical search and saved records after login. However, data provided in KLSE Screener is not comprehensive according to [7].

First and foremost, there is a search bar in KLSE Screener to look for your desired stocks. This system can also screen for stocks and warrants by applying financial metrics (see Figure 2.1 and Figure 2.2). Besides, this system can check the market performance, such as World Indices, then Top Active, Top Turnover, Top Gainers, Top Losers, Bursa Indices and Sector Performance of Bursa Malaysia (see Figure 2.3). Furthermore, entitlements of stocks such as dividend distributed, and bonus

share issued can be checked (see Figure 2.4). “Finance” tab of the system shows latest quarterly reports of public companies (see Figure 2.5). In addition, “News” tab of the system shows the latest news of Malaysian financial market from online news publisher and the announcements made by the public companies (see Figure 2.6). Lastly, the “Discussions” tab of the system shows the comments made by the users for respective stocks (see Figure 2.7).

Overall, the user interface of KLSE Screener is user-friendly and simple. Only 6 tabs on top of the website, which consist of Screener, Market, Entitlements, Financial, News and Discussions. In the individual stock page (see Figure 2.8), there are some basic information of the stocks, a technical chart, some fundamental metrics, news, announcement and comment sections. The advantage of KLSE Screener is that it embraces both fundamental and technical analysis in the individual stock page, so that it can accommodate the needs from both fundamental and technical investors. Users can also add their favorite stocks to watchlist after login. The disadvantage of KLSE Screener is it does not have investment recommendation and price prediction functions. Also, the layout is plain and simple, no attractive visualization for data presentation.

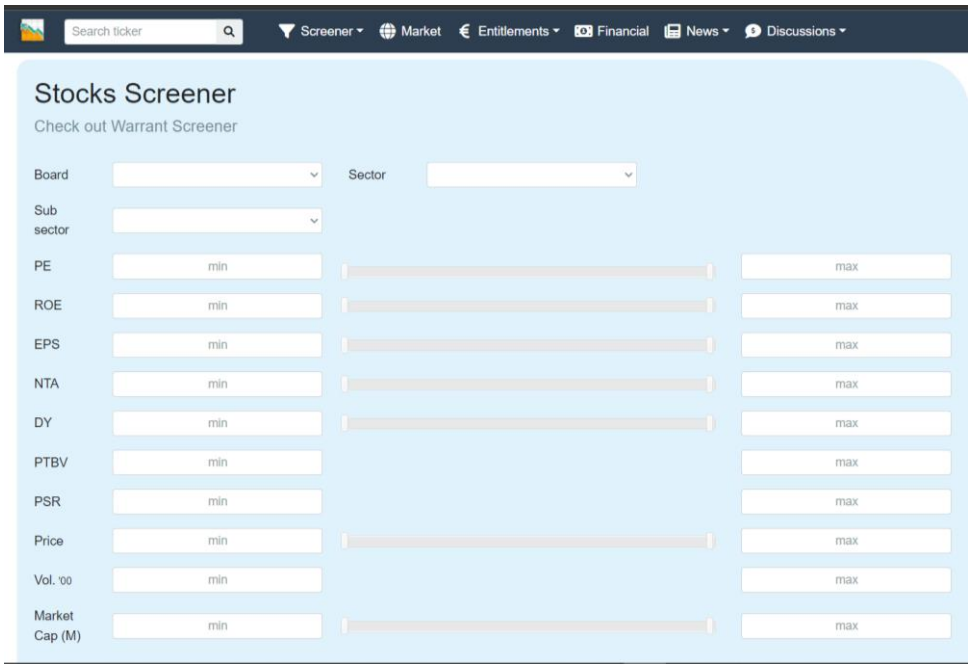

Figure 2.1: Screenshot of KLSE Screener Web Application Interface

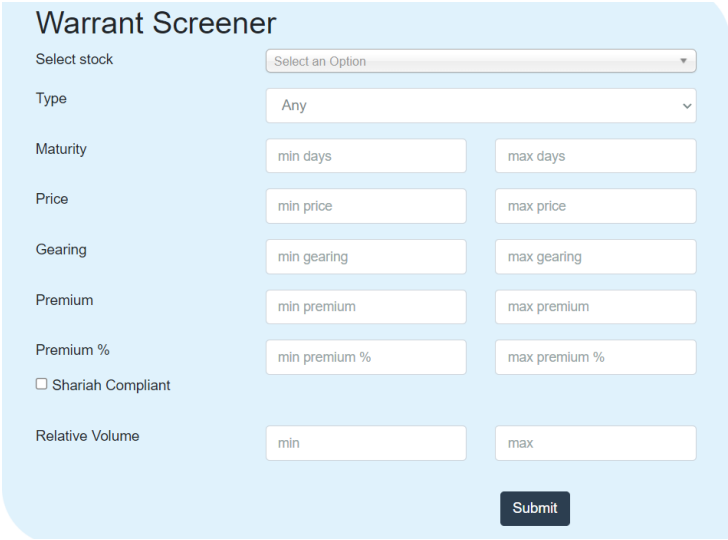

Figure 2.2: Screenshot of KLSE Screener Web Application Interface

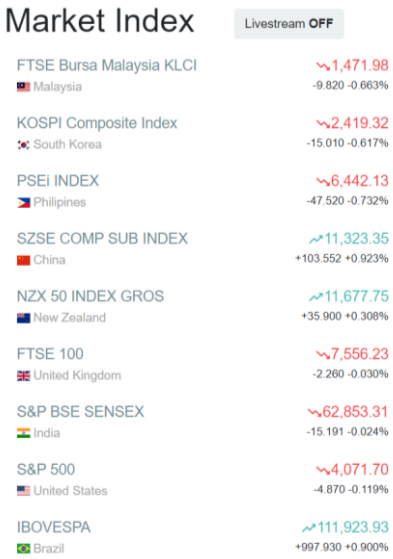

Figure 2.3: Screenshot of Market Tab

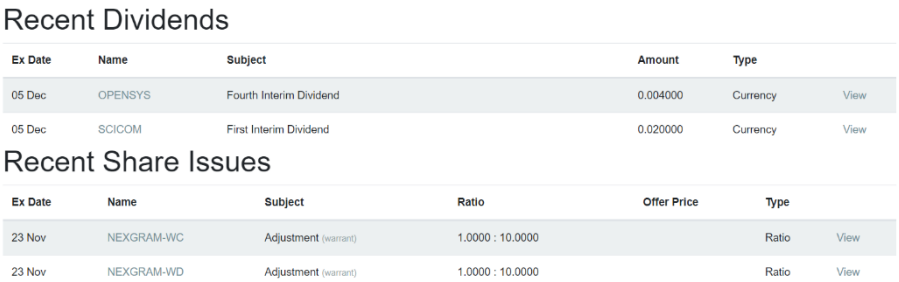

Figure 2.4: Screenshot of Entitlements Tab

Figure 2.5: Screenshot of Financial Tab

Figure 2.6: Screenshot of News Tab

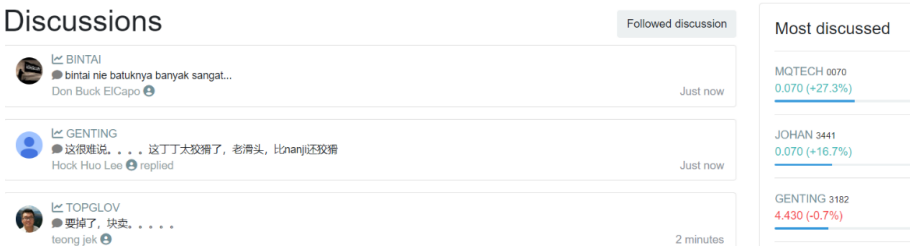

Figure 2.7: Screenshot of Discussions Tab

Figure 2.8: Screenshot of Individual Stock Page (KLSE Screener)

2.1.2 **MalaysiaStock.Biz** [8]

MalaysiaStock.Biz is a free medium for users to acquire up to date information for stocks in Bursa Malaysia (see Figure 2.9). It offers real time stock quote and special bonus like portfolio manager and watchlist manager for users with paid subscription. Users can create accounts to login, so that the system can save the user info and browse history. The free functions of MalaysiaStock.Biz comprise stock details, technical chart, news, market overview, market sentiment, portfolio, member service and forum.

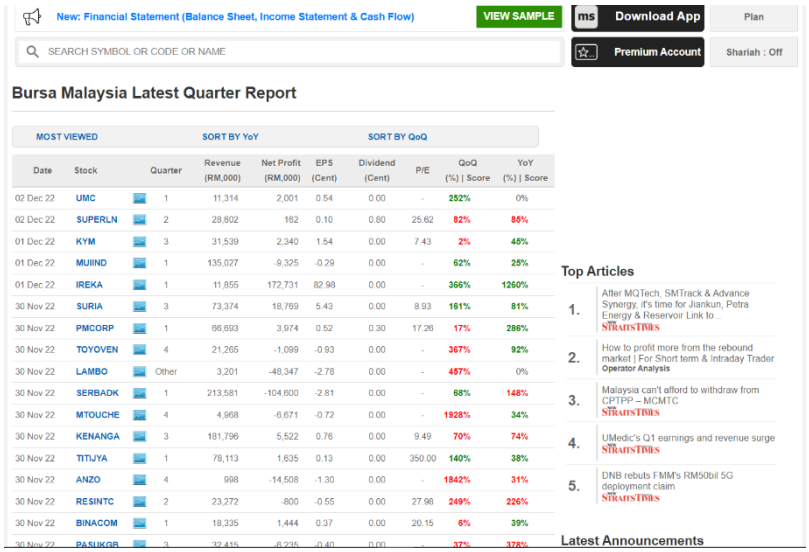

Figure 2.9: Screenshot of MalaysiaStock.Biz Web Application Interface

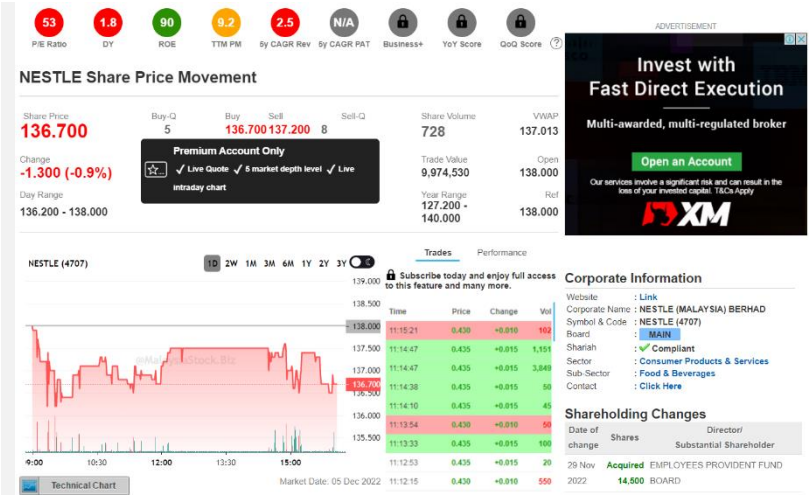

Figure 2.10: Screenshot of Individual Stock Page (MalaysiaStock.Biz)

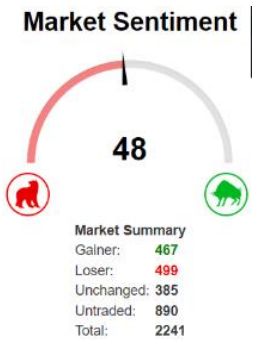

Figure 2.11: Screenshot of Market Sentiment

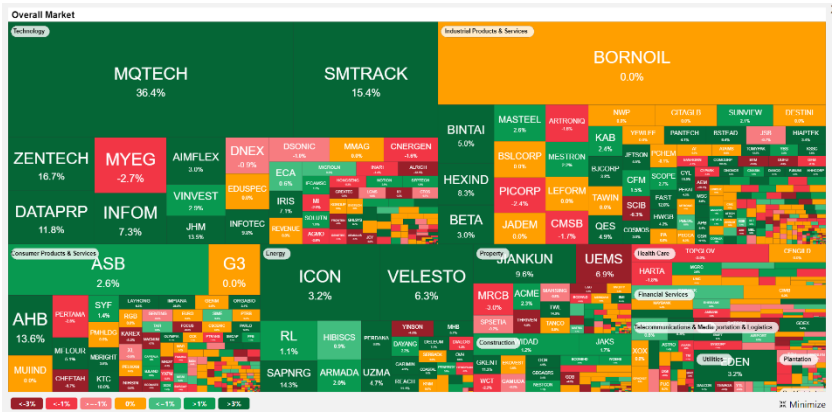

Figure 2.12: Screenshot of Market Overview

Firstly, there is a navigation bar for users to search for symbol, code or stock name. Users can use MalaysiaStock.Biz to watch the newest announcements, news, quarterly report, annual report, dividend and capital change. Besides, MalaysiaStock.Biz also shows news, market overview, market sentiment, trading ideas, and forum. Users can also create a portfolio to manage his holdings of shares. The individual stock page has highlighted some important indicators in different colours, such as PE ratio, Dividend Yield and Return on Equity (see Figure 2.10).

All in all, the user interface of MalaysiaStock.Biz is user-friendly, and the layout has nice data visualization (see Figure 2.11 and Figure 2.12). The pros of MalaysiaStock.Biz is that it incorporates both fundamental analysis and technical chart in the individual stock page. Besides, Muslim investors can switch to Shariah mode. There is also an auto-save function for stock search histories without login. The cons of MalaysiaStock.Biz is that it does not provide investment recommendations and no price prediction function as the website mentioned it does not provide investment advisory service.

2.1.3 **i3investor** [9]

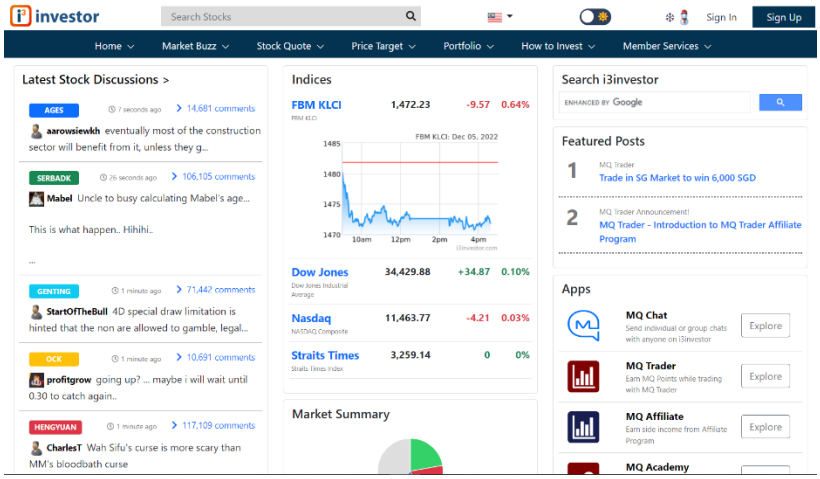

Figure 2.13: Screenshot of i3investor Web Application Interface

i3investor is a one-stop investment portal that provides wide array of functions (see Figure 2.13). For example, there are market summary, headlines, financial results, entitlements, corporate info, stock listing, price target, portfolio, investment advice, and member service. Users can sign up for an account to login, but there is no premium account or extra services to subscribe.

First and foremost, there is a navigation bar for users to search for their interested stocks. Other than having own portfolio to see holdings of shares, users can also check for public portfolio by other users. There is a blog that teaches users how to invest and share basic knowledge on investment. The individual stock page has some buttons to reveal more information of the stock (see Figure 2.14). This website is completely free as it does not provide subscription service.

All in all, the user interface of i3investor is consistent and responsive. The benefits of i3investor are it has articles and blogs that share information and knowledge on investment. This website contains data for 6 countries, which include Australia, Canada, Malaysia, Singapore, United Kingdom and United States. Most importantly, it gives price target based on financial research. The drawback of i3investor is that it has a messy main home page as it contains a lot of sections (see Figure 2.13).

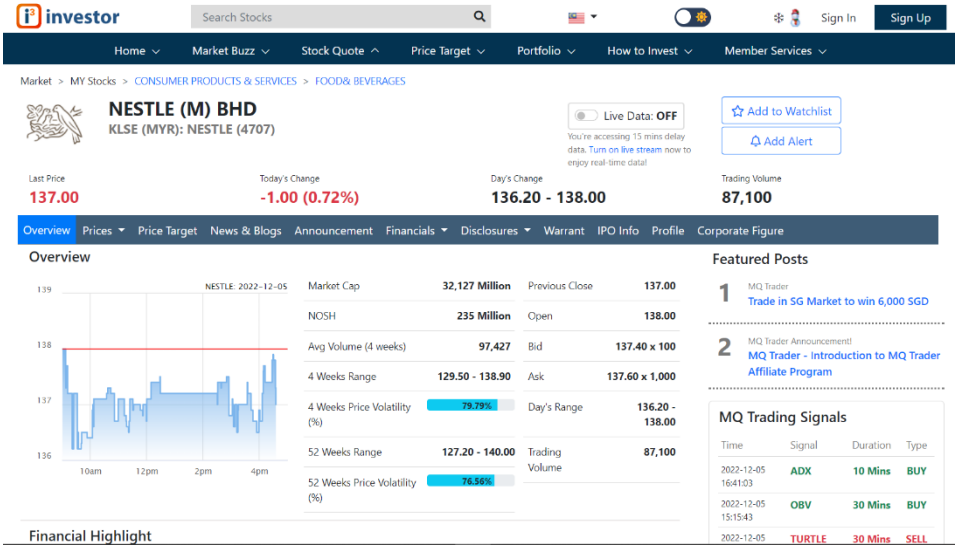

Figure 2.14: Screenshot of Individual Stock Page (i3investor)

2.1.4 Comparison of Reviewed Systems

The three reviewed systems, namely KLSE Screener, i3investor and MalaysiaStock.Biz are available in both web and mobile applications. The platforms are having similar functions such as viewing company info, watchlist, discussion forum, etc. However, KLSE Screener and MalaysiaStock.Biz do not provide investment recommendations to users. Artificial intelligence and stock price prediction function cannot be found in the three platforms.

Table 2.1 Comparison of Reviewed Systems

Functions	KLSE Screener	i3investor	MalaysiaStock.Biz
Web application	Yes	Yes	Yes
Mobile application	Yes	Yes	Yes
Screener	Yes	No	Yes
Watchlist	Yes	Yes	Yes
Portfolio	No	Yes	Yes
Company Profile	No	Yes	No
Price Alert	No	Yes	No
Price Target	No	Yes	No
Market News	Yes	Yes	Yes
Announcements	Yes	Yes	Yes
Technical Chart	Yes	No	Yes
Discussion	Yes	Yes	Yes
Shariah mode	No	No	Yes
Dark mode	No	Yes	No
Backup	Yes	Yes	Yes
Auto sync	Yes	Yes	Yes
Investment Recommendations	No	Yes	No
Artificial Intelligence	No	No	No
Stock Price Prediction	No	No	No

2.2 Details of Stock Price

Stock price can be varied when it is defined at different times. Stock price will fluctuate in Bursa Malaysia starts from pre-opening stage at 8.30am until the last closing stage at 5.00pm. It is only available on weekdays, Monday to Friday, excluding public holidays [10]. Stock price is the most fundamental data of this project, and its attribute is presented in Table 2.2. Ideally, only last price, which is the current day closing price of the stock, will be used in the stock price analysis and prediction process.

Table 2.2: Attribute and Description of Stock Prices [11]

Attribute	Description	Possible Values
Previous	Previous day closing price of the stock	Positive, Negative, Equal
Open	Opening stock price of current day	Positive, Negative, Equal
Min	Lowest stock price of current day	Positive, Negative, Equal
Max	Highest stock price of current day	Positive, Negative, Equal
Last	Closing stock price of current day	Positive, Negative, Equal

2.2.1 Data of of Stock Price in Dataset

Table 2.3 shows the attribute, description and datatype for the columns in the dataset. The stock data is collected by calling yahoo finance API and downloaded using yfinance library. The attribute in the dataset includes “Date”, “Open”, “High”, “Low”, “Close”, “Adj Close”, and “Volume”.

Table 2.3: Attribute and Description of Dataset

Attribute	Description	Data Type
Date	Trading day	datetime64
Open	Current day opening price of the stock	float64
High	Current day highest price of the stock	float64
Low	Current day lowest price of the stock	float64
Close	Current day closing price of the stock	float64
Adj Close	Adjusted closing price of the stock due to corporate actions	float64
Volume	Total number of shares or units traded	int64

2.3 Studies on Prediction Algorithms

2.3.1 Artificial Intelligence

The science and engineering of building intelligent machines, especially intelligent computer programmes, is known as artificial intelligence (AI). It involves simulating human decision-making and problem-solving processes using computers and other technology. Machine learning and deep learning are two areas of artificial intelligence (AI) that employ algorithms to make predictions or categorize data.

A form of machine learning called deep learning uses neural networks with four or more layers to automatically extract features from data. On the other hand, machine learning frequently needs human input to identify data features [14].

2.3.2 Deep Learning

Deep learning is a type of machine learning characterized by the utilization of neural network structures inspired by biological models. These neural networks have multiple concealed layers, enabling the system to delve deeply into data processing. This depth facilitates the establishment of intricate connections and the fine-tuning of input for optimal outcomes [15].

2.3.3 Long Short-Term Memory (LSTM)

Long Short-Term Memory (LSTM) is a type of recurrent neural network (RNN) architecture, which encompasses sequence of neural networks that can process sequential data [16]. It is a form of deep learning algorithm. There are three gates in the LSTM unit, which include forget gate, input gate and output gate (see Figure 2.15). Forget gate discards unnecessary information, input gate adds in new useful information, while output gate filter and extract helpful information [17]. The project of [17] has successfully predict multiple stock prices at a same time using LSTM-based neural network with an average accuracy of above 95%.

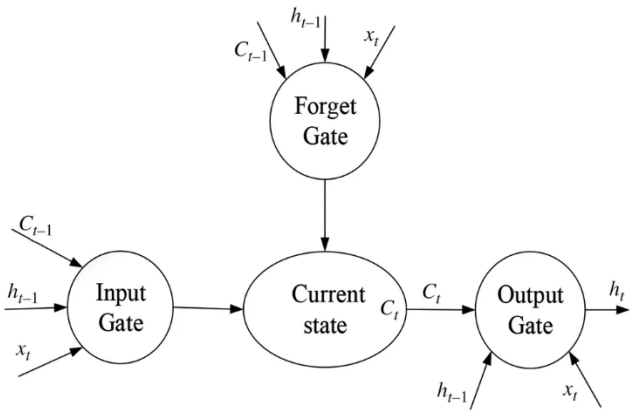

Figure 2.15: Unit Structure of LSTM [13]

2.3.4 Related Research on Stock Price Prediction

Gülmez (2023) attempted to predict stock price with optimized deep LSTM network with Artificial Rabbits Optimization algorithm (ARO). To evaluate the performance of the new model, LSTM-ARO is compared with LSTM1D, LSTM2D, LSTM3D, ANN, and LSTM-GA networks. Result showed that the model of LSTM-ARO has the best performance among all [18].

Liu et al. (2022) utilized Using Convolutional Autoencoders (CAE) to compress and extract features from stock price images and a LSTM model for prediction. The result portrayed that CAE-LSTM model has good performance and generalization ability [19].

Hu et al. (2021) used a broad array of algorithms to predict stock and Forex price movements. The methods include CNN, LSTM, DNN, RNN, reinforcement learning, HAN, NLP, and Wavenet. The paper highlighted that hybrid networks, which integrate different deep learning approaches, exhibit promise for future research endeavours [20].

2.4 Evaluation Methods

1. Root Mean Square Error (RMSE)

Formula:

$$\text{RMSE} = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \hat{x}_i)^2}{n}}$$

where
$\hat{x}$ = predicted values,
x = observed values,
n = number of observations.

As the name suggests, Root Mean Square Error (RMSE) is the square root of Mean Square Error. RMSE makes the value of Mean Square Error smaller, so that it is easier to interpret [21]. RMSE is the most popular method to evaluate regression model, it can be used to measure the quality of the fit of the model [22].

2. Mean Absolute Percentage Error (MAPE)

Formula:

$$\text{MAPE} = \frac{1}{n} \sum_{t=1}^{n} \left| \frac{At - Ft}{At} \right|$$

where
A_t = actual value,
F_t= forecast value

Mean Absolute Percentage Error (MAPE) is a metric used to assess the accuracy of a forecasting model. To determine how closely the predicted values match the actual values, it estimates the average of the absolute percentage errors for each data point in a dataset [23].

CHAPTER 3

System Methodology

3.1 System Design Diagram

3.1.1 Use Case Design

Figure 3.1: Use Case Diagram

Figure 3.1.1 shows the system functionalities of the stock price monitoring system. In the web application, users can navigate through four different pages, namely the "About", "Stock Data", "Stock Price Chart" and "Stock Price Prediction" pages. For instance, by navigating through the "About" page, users may obtain a brief introduction about how this said system works.

Next, by exploring the "Stock Data" page, users will be directed to where they are needed to select a company to obtain the company's information, to view historical stock data and to obtain its fundamental data, such as Balance Sheet and Income Statement.

Thirdly, by selecting into the "Stock Price Chart" page, users will also be directed to a page where they are required to select a company that they desire to view its closing price chart as well as to view the price versus Moving Average (MA). This includes Price vs. MA50 chart, Price vs. MA50 vs. MA100 chart and Price vs. MA100 vs. MA200 chart.

Besides the three pages, users may also navigate through the "Stock Price Prediction" page in this system. Users will again be requested to select a company to view its model information, future stock price, investment recommendations and model performance.

3.1.2 Activity Design

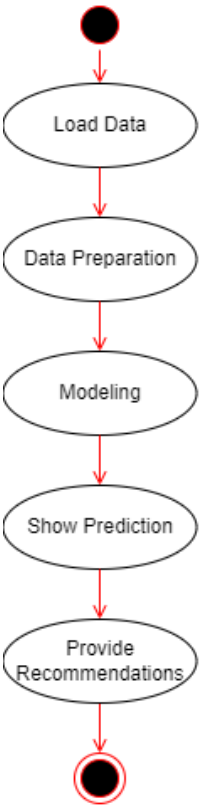

Figure 3.2 Activity Diagram

This activity diagram outlines the whole system process, starting from loading of raw data into the system. After that, they system goes thorough data preparation phase, which includes cleaning, transformation, and integration. This step ensures that the data is of high quality and suitable for analysis.

Moving forward, the next phase involves modeling. In this phase, LSTM model is trained using the prepared data. This includes separating train set and test set, training the model, and evaluating its performance to ensure its effectiveness.

Once the model is successfully trained and evaluated, it is utilized to predict future stock price and provide investment recommendations.

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3.1.3 Sequence Design

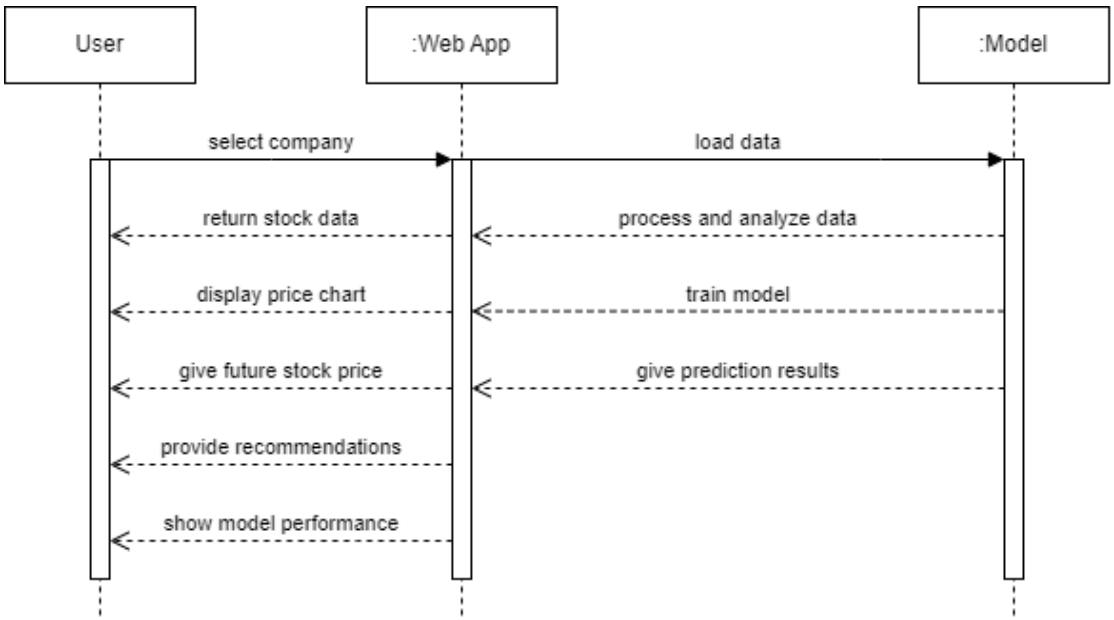


Figure 3.3 Sequence Diagram

Users will be required to select a desired company through the web application. Subsequently, the model will proceed to load the data by processing and analyzing the stock data according to the selected stock ticker. Next, the LSTM model will be trained to supply prediction results of future stock prices. All information will be displayed through the web application for the usage of users.

The web application will then show information to users which include returning the stock data of the selected company, displaying its price chart, presenting future stock prices, providing investment recommendations and showing the model performance.

3.1.4 Wireframe for Web Application

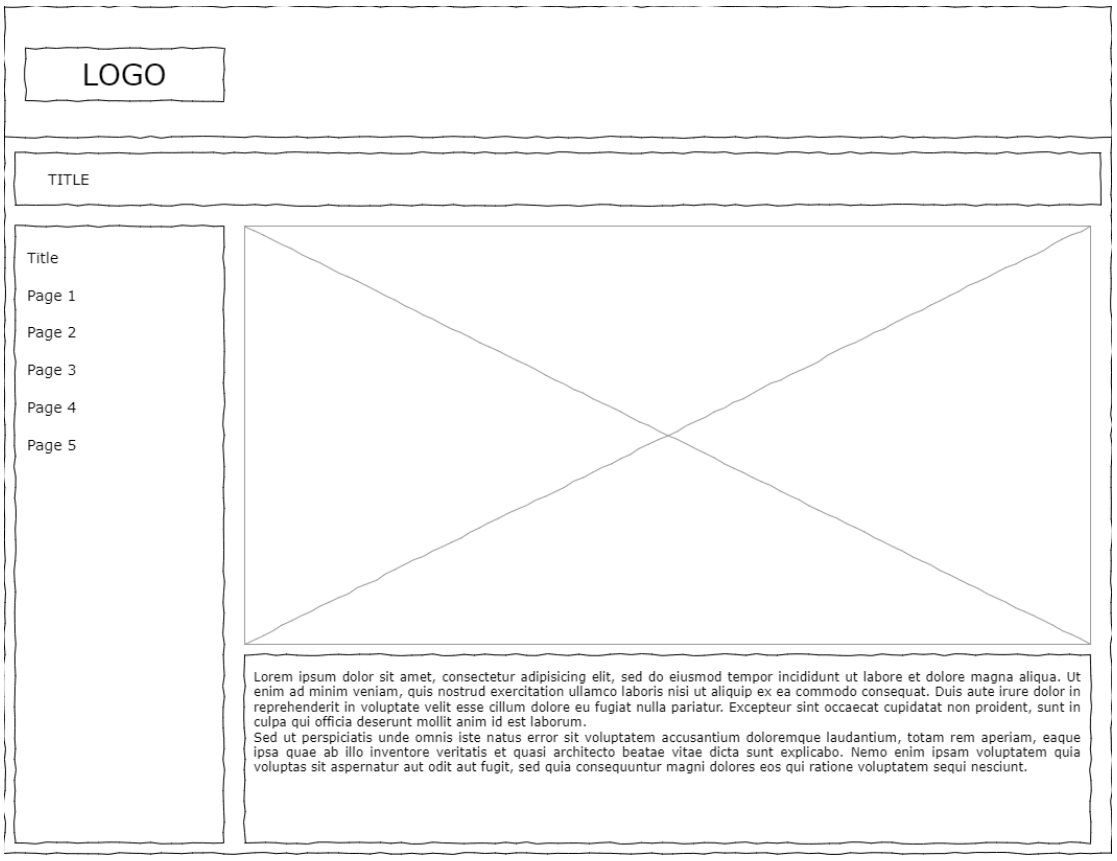


Figure 3.4 Wireframe for Web Application

Figure 3.1.4 shows the wireframe of the web application. Basically, the interface is only having one main page, which is the landing page, whereby it comes with 4 radio buttons which will lead to other pages. The design of the web page is relatively simple to showcase a user-friendly interface.

On top of the web page, there is the main title of the web application, which is Stock Price Monitoring System. On the left-hand side, there is a navigation bar which shows the buttons for the four different pages. The right-hand side will be the content of the system.

3.2 Proposed Methodology

CRISP-DM represents Cross-Industry Standard Process for Data Mining, and it is known as the most popular methodology that is commonly practiced for analytics, data mining and data science projects [24]. The life cycle of a data mining project comprises 6 phases. Figure 4.1 illustrates the 6 phases of a data mining process. The arrows in Figure 4.1 signifies the most vital and frequent relationships between phases. The order of the phases is not immutable because they are iterative and flexible. Users can customize the CRISP-DM model, when necessary, by moving to the previous or successive phases depend on the project's needs [25].

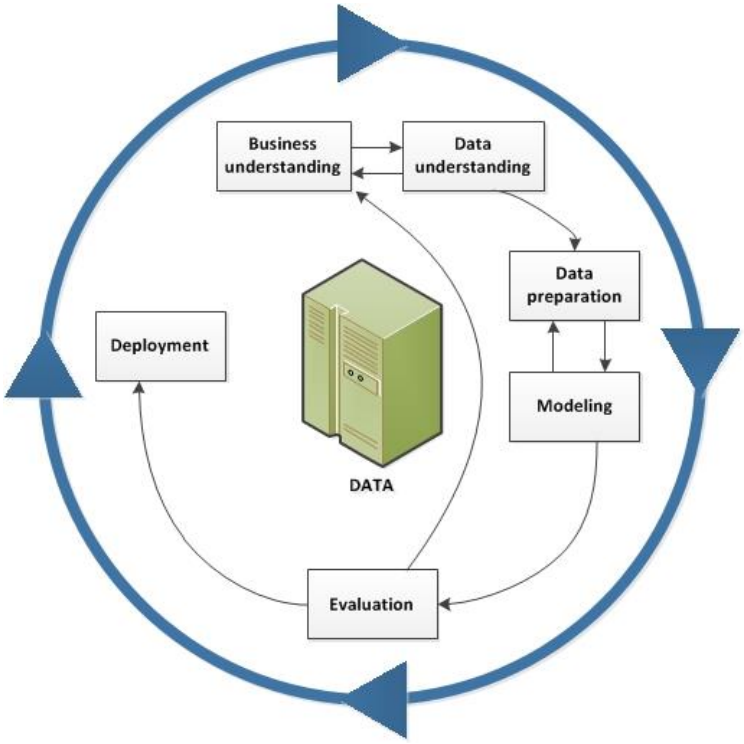


Figure 3.5: Data Mining Life Cycle

Figure 3.2 below outlines the generic tasks and outputs of each phase in the CRISP-DM according to the user guide of CRISP-DM [26].

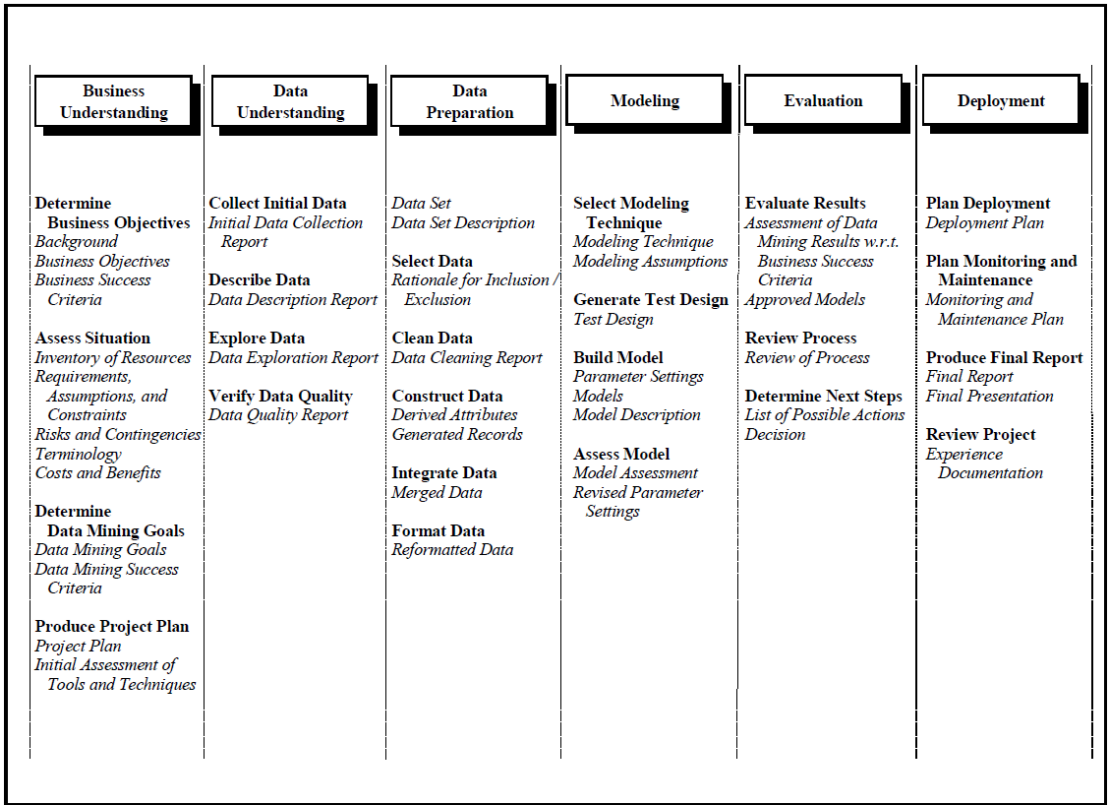


Figure 3.6: Generic tasks and outputs of the CRISP-DM process model [26]

3.2.1 Business Understanding

The project's requirements and objectives are established during this preliminary stage. This includes identifying data mining goals, calculating costs and benefits, estimating risks and contingencies as well as producing a project plan. This first step can help to align the data mining efforts with the business objectives [26].

The primary objective of this project is to develop a robust and accurate stock price prediction model using data mining and machine learning techniques. The project is motivated by the critical need for precise and timely stock price forecasts, as they are essential to investment decision-making for both individual and institutional investors. Retail investors can make us of this model to predict stock price movements in order to optimize portfolios, mitigate risks, and maximize returns.

3.2.2 Data Understanding

This stage will obtain, gather and explore the data that will be utilized for analysis purpose. Initial insights are gained, and the caliber of the data is evaluated. Data is prepared for modelling and data sources are identified [26].

The data for this project was obtained from Yahoo Finance using the yfinance library. The first date is set on 1st January 2015 and the last date is set on "today", which means latest current date. It covers a duration of approximately 10 years.

The dataset includes various features such as Open, High, Low, Close, Volume, and Adjusted Close prices. "Close" attribute will be the main focus of this project, as it is the closing price for a particular stock, and it is also the final value that the retail investors are looking for. The basic information and statistical description of the stock data are as shown in Table 4.1 and Table 4.2.

Table 3.1 Information of the Stock Data

Column	Count	Null	Data Type
Date	2466	Non-null	datetime64
Open	2466	Non-null	float64
High	2466	Non-null	float64
Low	2466	Non-null	float64
Close	2466	Non-null	float64
Adj Close	2466	Non-null	float64
Volume	2466	Non-null	float64

Table 3.2 Statistical Description of the Stock Data

	Open	High	Low	Close	Adj Close	Volume
count	2466.0000	2466.0000	2466.0000	2466.0000	2466.0000	2.47E+03
mean	3.478987	3.508742	3.448561	3.48097	3.341864	1.42E+06
std	1.696751	1.71353	1.679274	1.695683	1.690262	2.19E+06
min	1.063116	1.070275	1.030900	1.03090	0.928680	0.00E+00
25%	2.051282	2.061538	2.035897	2.051282	1.892434	4.86E+05
50%	2.880000	2.893333	2.856666	2.880000	2.754117	9.58E+05
75%	5.000000	5.060000	4.960000	5.000000	4.903574	1.77E+06
max	6.850000	7.200000	6.746666	6.746666	6.543118	8.38E+07

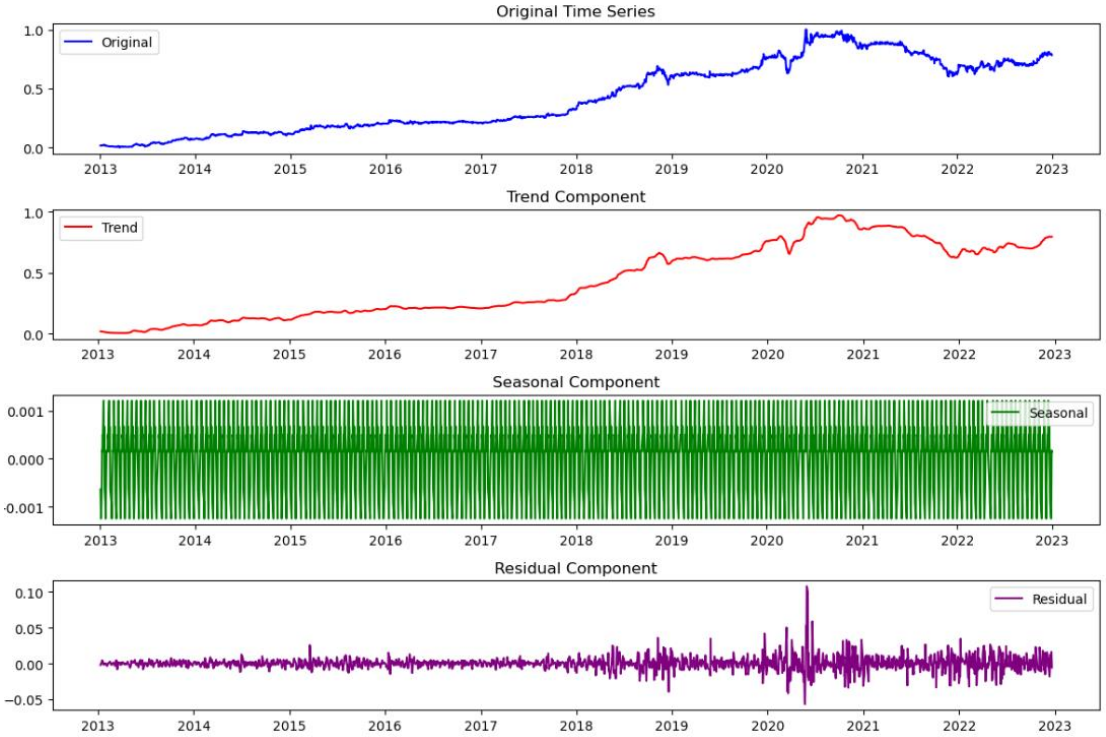
3.2.3 Data Preparation

This phase will involve data preprocessing, whereby the data is cleaned, transformed, and constructed to be suitable for modeling. The steps encompass handling missing values, treating outliers and creating new features when necessary [26].

The dataset was cleaned by handling missing values and removing unnecessary columns, namely High, Low, Adj Close. The "Date" column was set as the index for time-series analysis. Feature Scaling is done by applying Min-Max scaling to normalize the data for model training. Figure 4.1 shows the graph of stock price after normalization for 10 years. As stock data is time series data, seasonal decomposition is generated in the graphs as shown in Figure 4.2. The data is then split into 80% for training set and 20% for test set.

Figure 3.7 Graph of Normalized Closing Stock Price

Figure 3.8 Seasonal Decomposition of Stock Data



3.2.4 Modeling

Multiple modelling methods will be chosen and used on the ready data. Depending on the objectives of the project, these strategies could include statistical models, machine learning algorithms, or other approaches. Several models are frequently developed and assessed [26].

In this current project, Long Short-Term Memory (LSTM) neural network was chosen for time-series prediction model due to its ability to capture sequential dependencies. The model architecture consists of an LSTM layer followed by a Dense output layer. More algorithms will be explored and utilized in the further development of this project.

A Sequential model in Keras, a deep learning library, is built with two layers of LSTM. First layer consists of 50 units, which signifies it will have 50 memory cells to remember pattern in the input data over time, and it returns sequences instead of just the last output. On the other hand, the second layer also has 50 units, whereas no activation function is applied by default. Both layers of LSTM also have a dropout rate of 20%, which is a regularization technique to help prevent overfitting. The model is then fed with prepared training sequences and optimized it using the Adam optimizer while minimizing the mean squared error (MSE) loss. The training process ran for 20 epochs with a batch size of 1. Early stopping technique is utilized to prevent overfitting.

3.2.5 Evaluation

Evaluation metrics such as metrics such as accuracy, recall, precision, F1-score, etc. will be used to measure the performance of the models. The best model with highest accuracy and lowest errors will be selected for deployment [26].

The performance of the model is evaluated with two metrics, which include Mean Absolute Error (MAE) and Root Mean Squared Error (RMSE).

3.2.6 Deployment

This final stage will put the selected model into the production environment, integrated with the current system to generate predictions or offer solutions. Regular monitoring and maintenance are required to carry out to make sure the continuous effectiveness of the model [26].

Naïve Forecasting model and LSTM model are integrated into the web application to perform AI-based prediction feature and dashboard function. Web application is then deployed to Streamlit Cloud.

CHAPTER 4
System Design

This section talks about system design of Stock Price Monitoring System, which includes system architecture design, system block diagram and system component specifications.

4.1 System Architecture Design

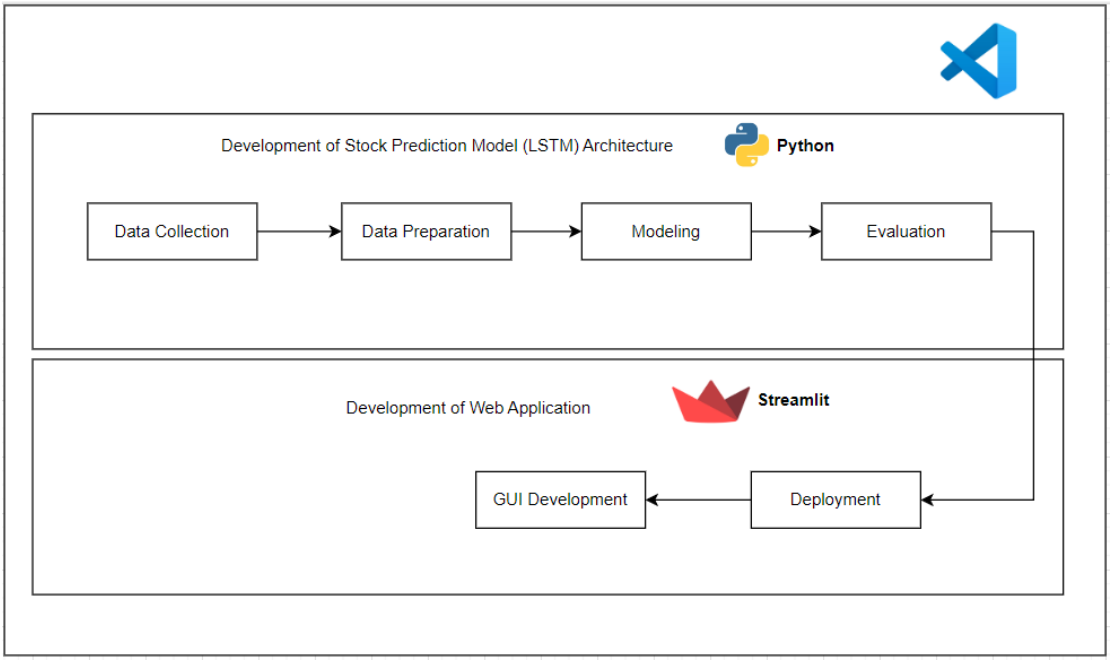


Figure 4.1: System Architecture Design

Figure 4.1 shows the system architecture design for the stock price monitoring system as a whole. The whole system is written with Python language in Visual Studio Code. The development of stock prediction model is using LSTM, which starts from data collection, data preparation, modeling to evaluation.

Moving on, returned data from the model such as stock prediction, investment recommendations and stock ticker information are presented in web application. It is built on Streamlit, which is using Python as main language as well, then it is deployed to Streamlit Cloud. GUI development of the web pages is enhanced in Streamlit.

4.2 Block Diagram of LSTM Model

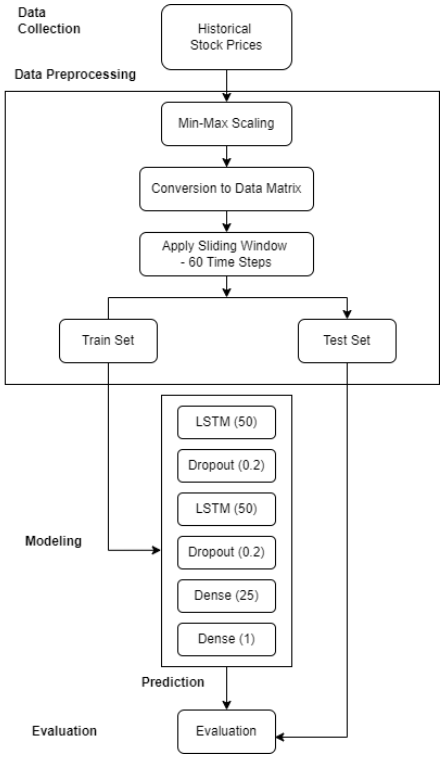


Figure 4.2: Block Diagram of LSTM Model

Figure 4.2 shows the flow of LSTM from data collection to evaluation.

To start off, it begins with collecting historical stock prices. Next, data preprocessing phase includes scaling, data conversion, sliding window application and splitting of train set and test set.

Followed by model building and training, few layers are constructed in the LSTM model. They are two layers of LSTM with dropout and two layers of Dense. The prediction results are then evaluated to determine the model performance.

4.3 Block Diagram of Web Application

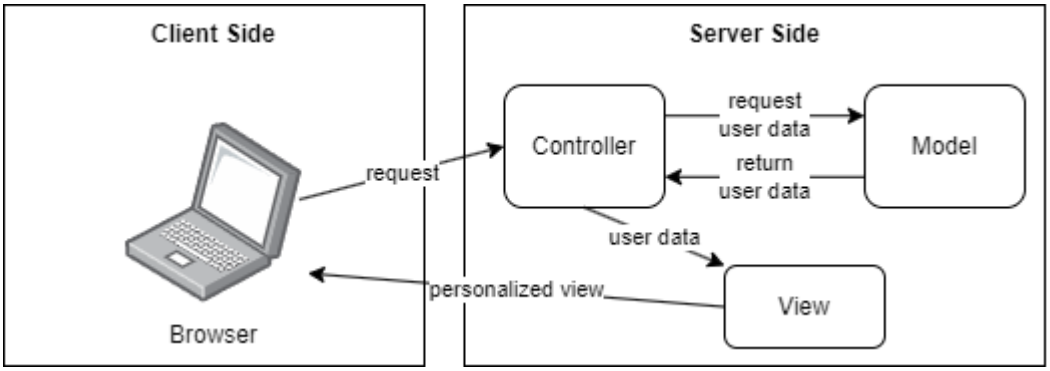


Figure 4.3: Block Diagram of Web Application

The design of this web application is Client-Server architecture. Client refers to the users of this system such as investor, while server refers to the web app with a deep learning model working inside. The web app design pattern is Model-View-Controller pattern. The Controller module will handle user request created from the client-side. The View module will generate the customized content based on the data that passed by the Controller, and Model module will be training data and provide stock predictions.

4.4 Graphical User Interface of Web Application

This section shows the Graphical User Interface (GUI) of the web application, which consists of 4 different web pages. Detailed functions will be further explained in Chapter 5.

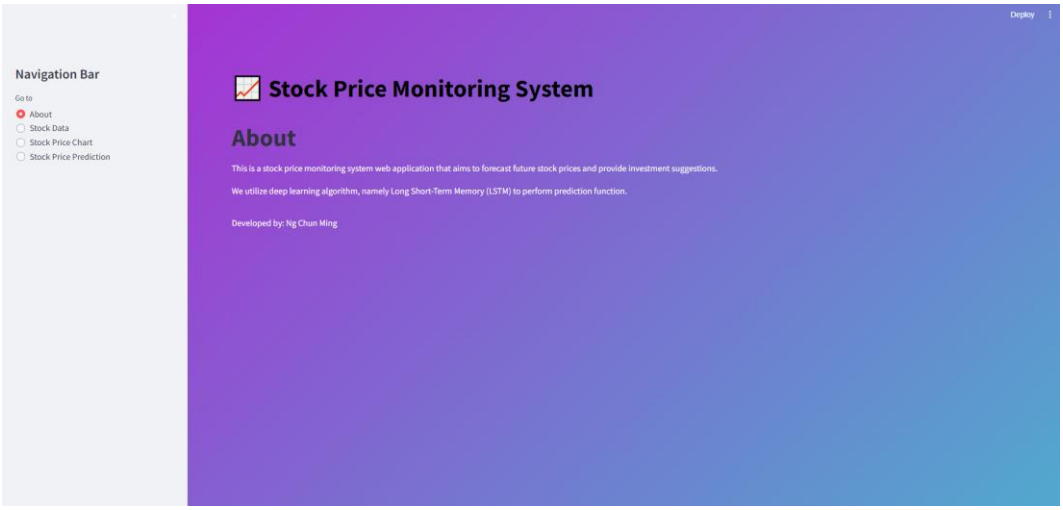


Figure 4.4: About (Page 1)

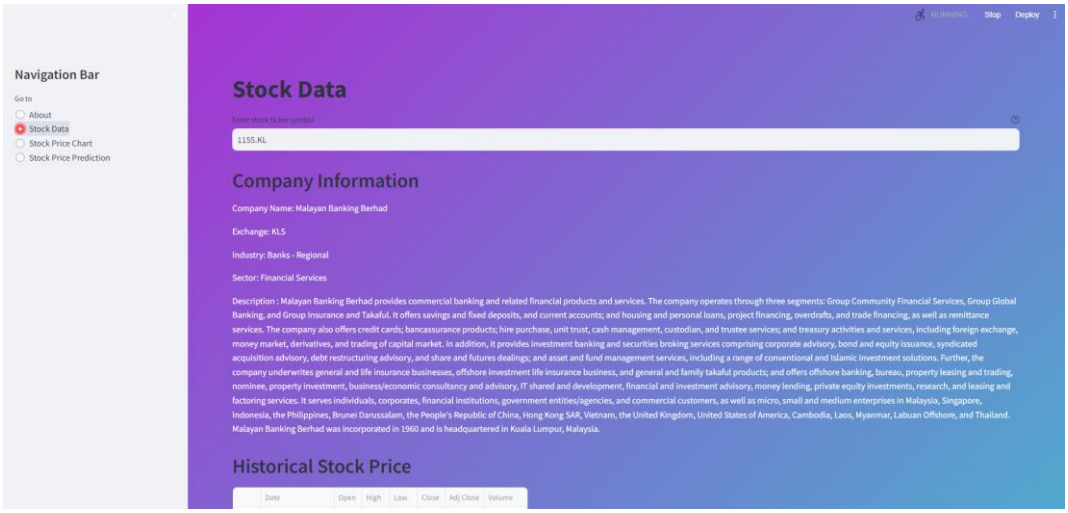


Figure 4.5: Stock Data (Page 2)

Figure 4.6: Stock Price Chart (Page 3)

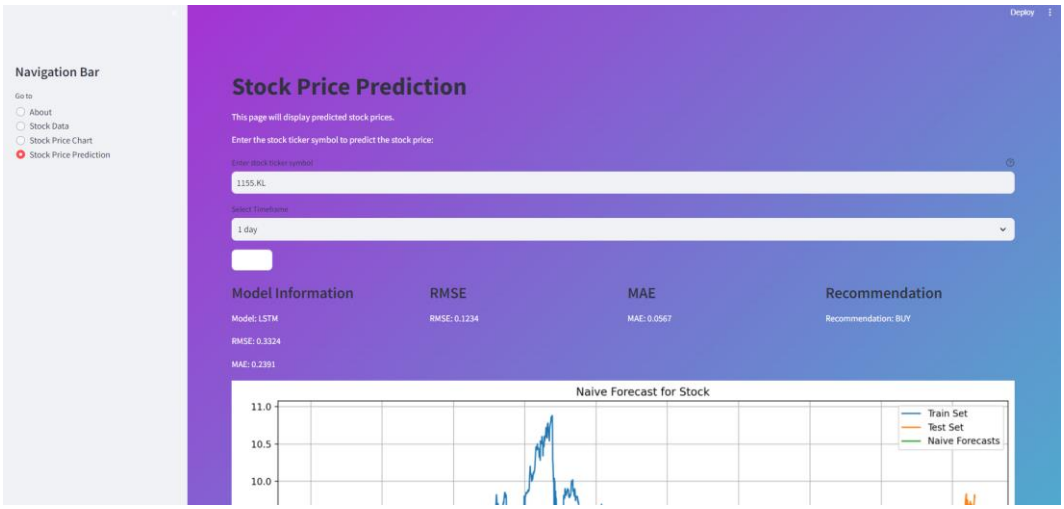


Figure 4.7: Stock Price Prediction (Page 4)

CHAPTER 5
SYSTEM IMPLEMENTATION

5.1 Hardware Setup

The hardware required in this project is a laptop and a mobile device. A laptop is needed to develop a web application with machine learning model and data visualization model. A mobile device is used to review existing stock price tracking mobile applications.

Table 5.1 Specifications of Laptop

Aspect	Details
Model	HONOR Magicbook 14
Processor	AMD Ryzen 5 3500U
Operating System	Windows 10
Graphic	AMD Radeon Vega 8 Graphic
Memory	16GB DDR4 RAM
Storage	512GB SSD

Table 5.2 Specifications of Mobile Device

Description	Specifications
Model	POCO F3
Processor	Qualcomm Snapdragon 870 5G
Operating System	Android 12
Memory	8GB RAM
Storage	256GB

5.2 Software Setup

The development of this project is divided into two phases, which include building a deep learning model and a web application. There is a few software needed to be downloaded and installed to kick start this project:

1. Python
2. Anaconda Navigator
3. Visual Studio Code

This project will be mainly using Python as programming language to build the stock price prediction model with Artificial Intelligence approaches as there a lot of available libraries in Python. Anaconda Navigator is downloaded to launch integrated development environment (IDE), Jupyter Notebook. The model is being trained in Jupyter Notebook before it is incorporated into the web application. Then, the web application is built on Streamlit, using Visual Studio Code as platform. No additional software is needed for web development as Streamlit is a Python built-in library for web framework.

5.3 Setting and Configuration

To begin with, stock data is collected from Yahoo Finance API. The stock data covers the date range from 1 January 2015 to current date, which means “today”, which is approximately 10 years. Other non-relevant columns are filtered out, left only the key component, “Closing Price”.

Next, the model architecture of LSTM model comprises of two layers with 50 units each and a dropout rate of 20%. Data set is split into train set and test set with 80% and 20% respectively. Optimize is Adam and loss function is Mean Squared Error (MSE). Evaluation metrics used to evaluate model performance includes RMSE and MAE.

5.4 System Operation

The whole system is constructed from two key components, namely web application and model development. The prediction models include a deep learning model, LSTM and a simple forecasting method, Naïve Forecasting. Models are trained to predict future stock price. The web application acts as a platform to display all the information generated by the model such as ticker information and prediction results.

The development of both models starts with data collection, whereby stock price data is collected from yfinance library. The data is then preprocessed and scaled using MinMaxScaler to normalize the values. Both models are trained on the training set using the configured parameters and the performances are being evaluated using two metrics on the test set. The difference in performance of Naïve Forecasting and LSTM will distinguish how good is the LSTM model. Once done, LSTM model is utilized to make future stock price predictions. Investment recommendations will be given according to the predicted price and latest closing price.

Web application consists of a few pages to cater to the need of having a dashboard to display the data and navigation to required web pages. Data is presented in the form of text, paragraphs, tables and graphs. The user-interface is designed to be user-friendly, making it accessible to everyone even for novice investors.

5.4.1 About Page

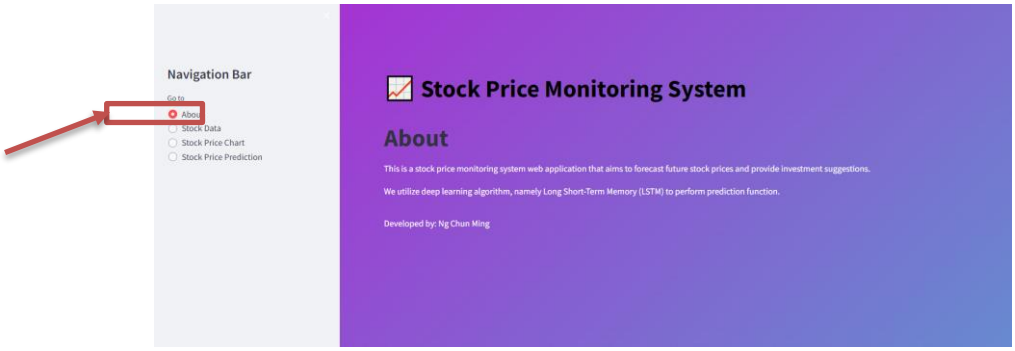


Figure 5.1: About Page

First, go to the Navigation Bar and click “About” button. This page is also the landing page of this web application by default. This page will show the main title and a brief description of what this web application is about.

5.4.2 Stock Data Page

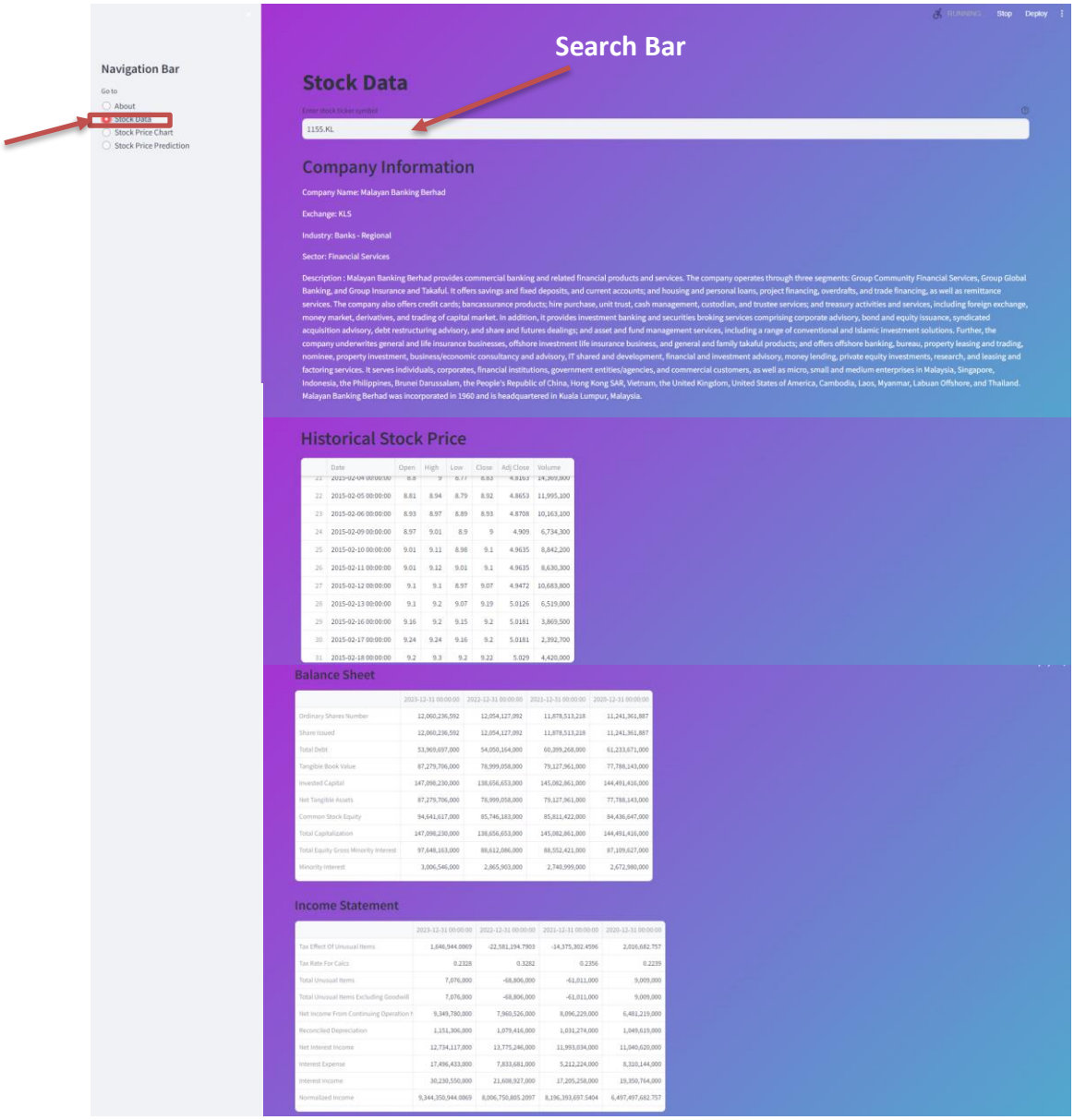


Figure 5.2: Stock Data Page

To begin with, go to the Navigation Bar and click “Stock Data” button. This page will allow user to browse through basic information of selected stock.

This part will be taking stock ticker symbol: 1155.KL as example. This company is Malayan Banking Berhad, also known as Maybank. User is requested to key in their desired listed company in the search bar. Then, company information such as company name, stock exchange, industry, sector and description will be shown.

Followed by three tables, namely Historical Stock Price, that shows all the previous price data in the range of nearly 10 years; Balance Sheet, is a statement that shows the assets, liabilities and equity of a company [12]; as well as Income Statement, a table that displays the profit and loss of the company [13].

5.4.3 Stock Price Chart

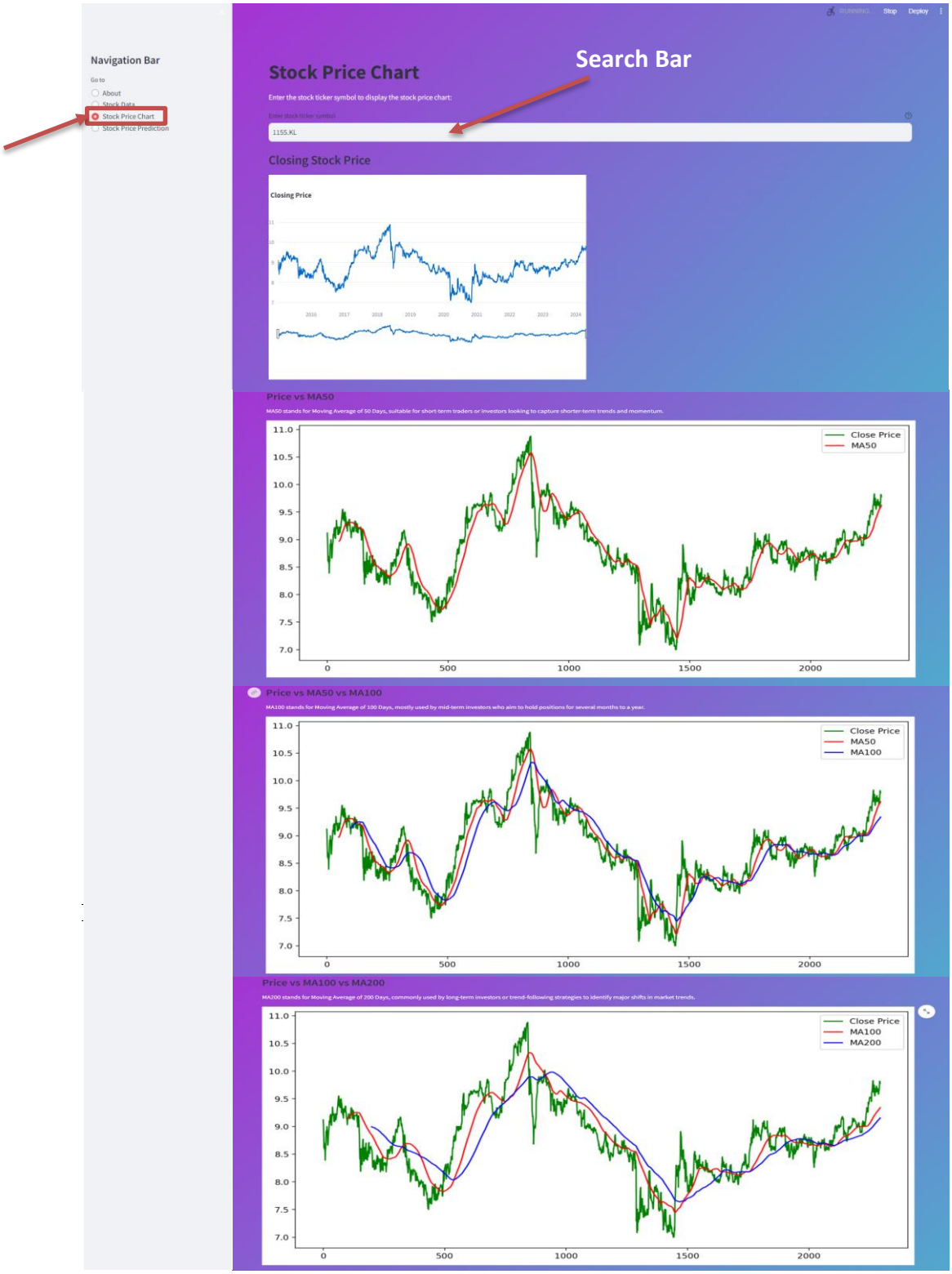


Figure 5.3: Stock Price Chart

As usual, go to the Navigation Bar and click “Stock Price Chart” button. This page will display multiple price charts.

Same as previous, user is requested to key in their desired listed company in the search bar. Then, closing price chart will be shown. There are also 3 more charts, which are Price vs MA50, Price vs MA50 vs MA100 and Price vs MA100 vs MA200.

5.4.4 Stock Price Prediction

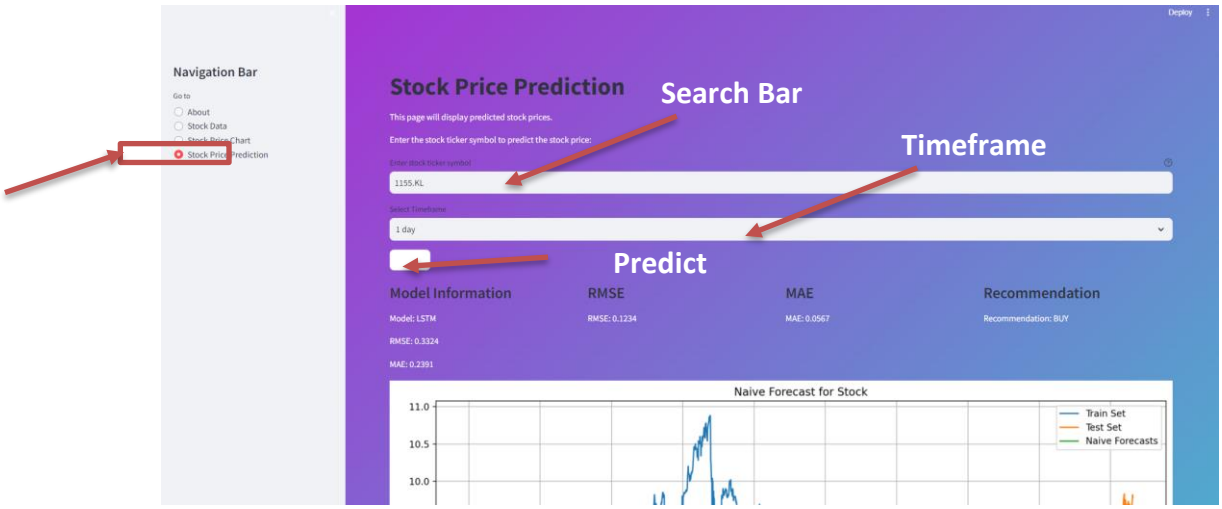


Figure 5.4: Stock Price Prediction

Lastly, go to the Navigation Bar and click “Stock Price Prediction” button. This page is the highlight of this whole system.

After user keys in the stock ticker symbol in the search bar, user can choose a specific duration. The particular stock will be predicted with the stipulated timeframe after clicking the “Predict” button.

Prediction results will be shown at the bottom, such as model performance, predicted stock price, investment recommendations and graph of stock price prediction.

5.5 Implementation Issues and Challenges

Throughout the development of the web application and machine learning model, there are multiple hurdles being faced. At first, I had a hard time looking for a suitable platform to integrate machine learning models into web application. However, this is solved by using a Python web framework library called Streamlit.

Next, there is a hindrance in the process of data collection. Although there is a myriad of options available to download stock data, most of them require exorbitant cost to proceed. Fortunately, Yahoo Finance has API that provides free access to stock data, such as stock prices, company information, etc.

Furthermore, the system initially took a lot of computational resources and long time to load the model due to its complexity. This is then tackled by reducing epochs number and implementing early stopping to decrease time taken to load the model.

In addition, machine learning model often leads to overfitting if not handled well. To address this issue, dropout layers are added to the LSTM model as a regularization technique.

5.6 Concluding Remark

To sum up this section, the development of this project requires setting up the necessary hardware and software, collecting stock data, building machine learning models, and creating a user-friendly web application. Despite encountering challenges in terms of platforms, data collection, computational resource, and model overfitting, these issues were effectively addressed through innovative solutions and optimization techniques. The final system comprises a robust deep learning model, LSTM, along with a simple forecasting method, Naïve Forecasting, integrated into a streamlined web application that offers insightful stock price predictions and investment recommendations.

CHAPTER 6
SYSTEM EVALUATION AND DISCUSSION

6.1 System Testing and Performance Metrics

In this chapter, the performance of our LSTM (Long Short-Term Memory) model is evaluated for stock price prediction. The evaluation is based on various performance metrics to assess the model's accuracy and effectiveness in forecasting stock prices.

Performance Metrics Used:

- Root Mean Squared Error (RMSE)
- Mean Absolute Error (MAE)

6.2 Testing Setup and Result

A Naïve Forecasting model is created to serve as a baseline for comparison. This is because Naïve model is a simple forecasting model without incorporating complex algorithms. The performance metrics of both LSTM and Naïve Forecasting model will be compared side-by-side to highlight the competitiveness of LSTM model.

Table 6.1: Evaluation Result

Model	RMSE	MAE
Naïve Forecasting	0.3324	0.2391
LSTM	0.0657	0.048323

RMSE and MAE of LSTM model are having smaller values than RMSE and MAE of Naïve Forecasting. This shows that LSTM is performing well in terms of prediction power, and the difference is quite significant. Lower RMSE and lower MAE values indicate the model makes accurate predictions.

6.3 Objectives Evaluation

Objective 1: To develop an AI-based stock price forecasting model.
This objective is met because LSTM neural network is implemented to perform prediction function in the system.

Objective 2: To explore deep learning model for financial forecasting.
This objective is achieved because a deep learning model, LSTM, is successfully built to predict stock prices with better accuracy based on evaluation metrics compared to Naïve Forecasting model.

Objective 3: To build a dashboard to present data.
This objective is met because a dashboard is built in the web application using Streamlit web framework.

Objective 4: To provide investment recommendations based on machine learning.
This objective is achieved because the system in web application provides suggestions like "HOLD", "BUY" or "SELL" based on the predicted stock price.

6.4 Concluding Remark

In brief, the objectives of this project have been achieved accordingly by implementing technologies such as model training and web application development. The LSTM model is performing well as it scores better than the Naïve Forecasting method. Metrics such as RMSE and MAE is used to evaluate the performance of both models.

CHAPTER 7
CONCLUSION AND RECOMMENDATION

7.1 Conclusion

In essence, this project aims to develop an AI-based stock price forecasting system with a focus on the Bursa Malaysia stock market. The objectives of the project encompass the development of a stock price prediction model, exploration of the best forecasting algorithms, building a user-friendly dashboard to present data, and providing investment recommendations based on machine learning.

The project follows a structured approach, adhering to the CRISP-DM methodology, which involves stages from business understanding, data understanding, data preparation, modeling, evaluation to deployment. The primary goal is to create a reliable and precise stock price prediction model that can aid investors in making investment decisions.

The stock data is sourced from Yahoo Finance and covers a duration of a decade, providing valuable historical information for analysis. The dataset is prepared through data preprocessing techniques, including handling missing values, column selection, and normalization.

For modeling purposes, Long Short-Term Memory (LSTM) neural network is employed, showcasing its ability to capture sequential dependencies in time-series data. The model architecture is developed using Keras, and key parameters are optimized to enhance performance. The model's performance is evaluated using Mean Absolute Error (MAE) and Root Mean Squared Error (RMSE) metrics.

In summary, this project contributes to the fields of finance and IT by addressing common issues faced by investors, providing insights into stock price monitoring systems, and offering a valuable tool for investors in the Malaysian stock market. It showcases the potential of artificial intelligence and machine learning in enhancing investment decision-making and serves as a foundation for future developments in this domain.

7.2 Recommendation

Before concluding this report, multiple suggestions and recommendations can be made to further develop and refine this project.

First and foremast, this web application is using a simple Python web framework, called Streamlit. It can create simple dashboard with limited functions; hence, this project can be improved by using other complex frameworks like Django or Flask to enhance user browsing experience.

Other than that, this system can incorporate more AI-powered prediction models such as ARIMA and Holt Winters method, which proved to be powerful time series forecasting models. In this way, users can try out different models to predict for future stock prices.

Moving on, the model's scope can be expanded by integrating external factors such as economic indicators and corporate news using sentiment analysis. These additional variables can enhance the predictive power of the model and provide more comprehensive insights.

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FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: 3, 3	**Study week no.: 4**
Student Name & ID: Ng Chun Ming (2003408)	
Supervisor: Dr. Abdulkarim Kanaan Jebna	
Project Title: Stock Price Monitoring System	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Trained a LSTM model since FYP1

2. WORK TO BE DONE

Development of web application

3. PROBLEMS ENCOUNTERED

Incompatible platform for model and web app.
Model can only predict for one particular stock ticker.

4. SELF EVALUATION OF THE PROGRESS

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: 3, 3	**Study week no.: 6**
Student Name & ID: Ng Chun Ming (2003408)	
Supervisor: Dr. Abdulkarim Kanaan Jebna	
Project Title: Stock Price Monitoring System	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Model can now predict for different stock tickers across different exchanges using yfinance library.

2. WORK TO BE DONE

Development of web application

3. PROBLEMS ENCOUNTERED

Searching for suitable platform to integrate model into web app.

4. SELF EVALUATION OF THE PROGRESS

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: 3, 3	**Study week no.: 8**
Student Name & ID: Ng Chun Ming (2003408)	
Supervisor: Dr. Abdulkarim Kanaan Jebna	
Project Title: Stock Price Monitoring System	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Design wireframe of web page

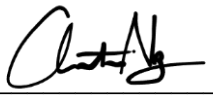
2. WORK TO BE DONE

FYP Report
Development of web application

3. PROBLEMS ENCOUNTERED

4. SELF EVALUATION OF THE PROGRESS

Supervisor's signature



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FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: 3, 3	**Study week no.: 10**
Student Name & ID: Ng Chun Ming (2003408)	
Supervisor: Dr. Abdulkarim Kanaan Jebna	
Project Title: Stock Price Monitoring System	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Draw system functionalities diagrams for report.
Built a web structure for dashboard.

2. WORK TO BE DONE

Development of web application

3. PROBLEMS ENCOUNTERED

Model and web app are in different python file.

4. SELF EVALUATION OF THE PROGRESS

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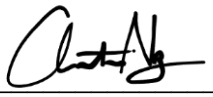

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FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: 3, 3	**Study week no.: 12**
Student Name & ID: Ng Chun Ming (2003408)	
Supervisor: Dr. Abdulkarim Kanaan Jebna	
Project Title: Stock Price Monitoring System	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Development of Web Application

2. WORK TO BE DONE

Compilation of FYP Report.

3. PROBLEMS ENCOUNTERED

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4. SELF EVALUATION OF THE PROGRESS

Supervisor's signature

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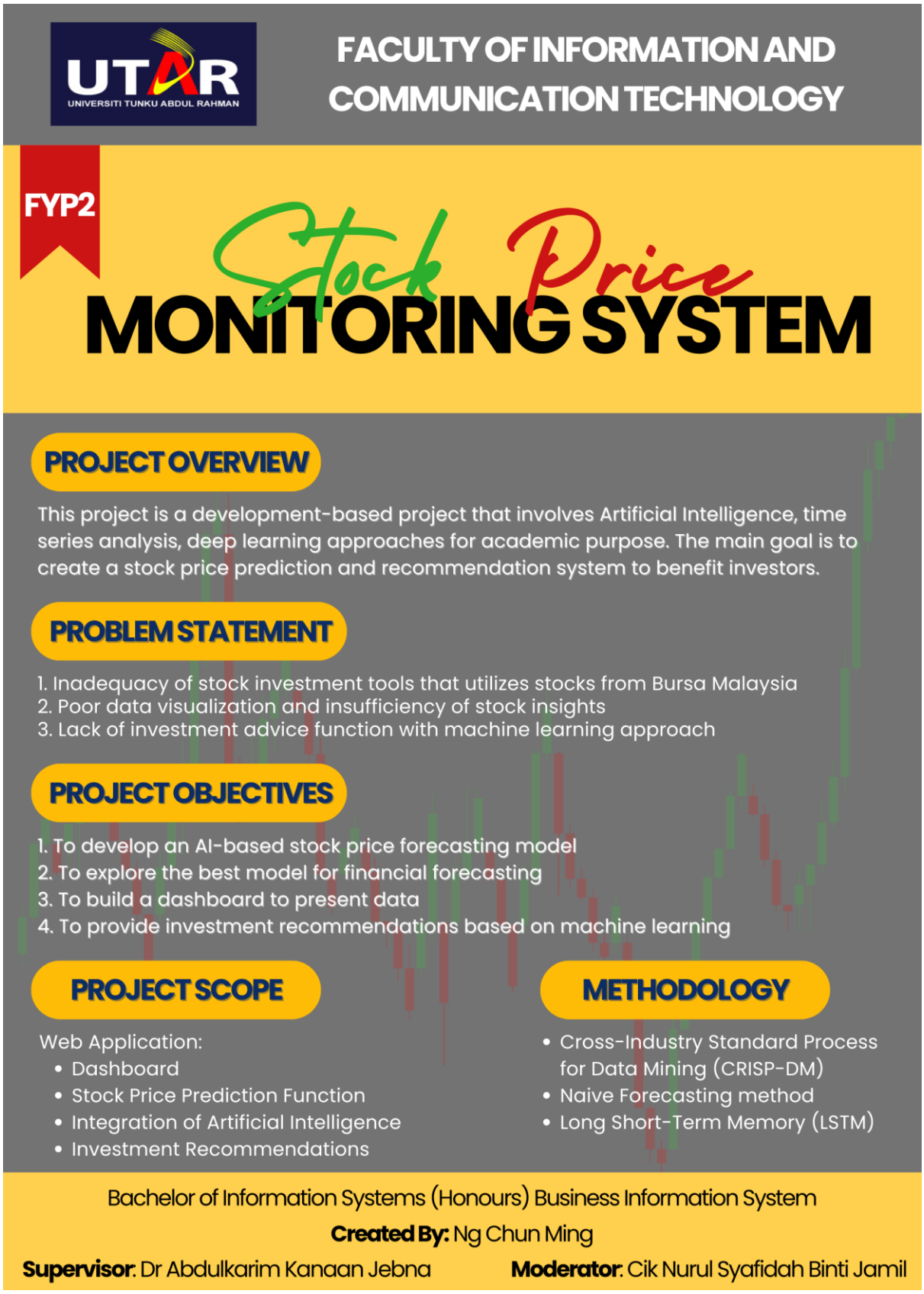
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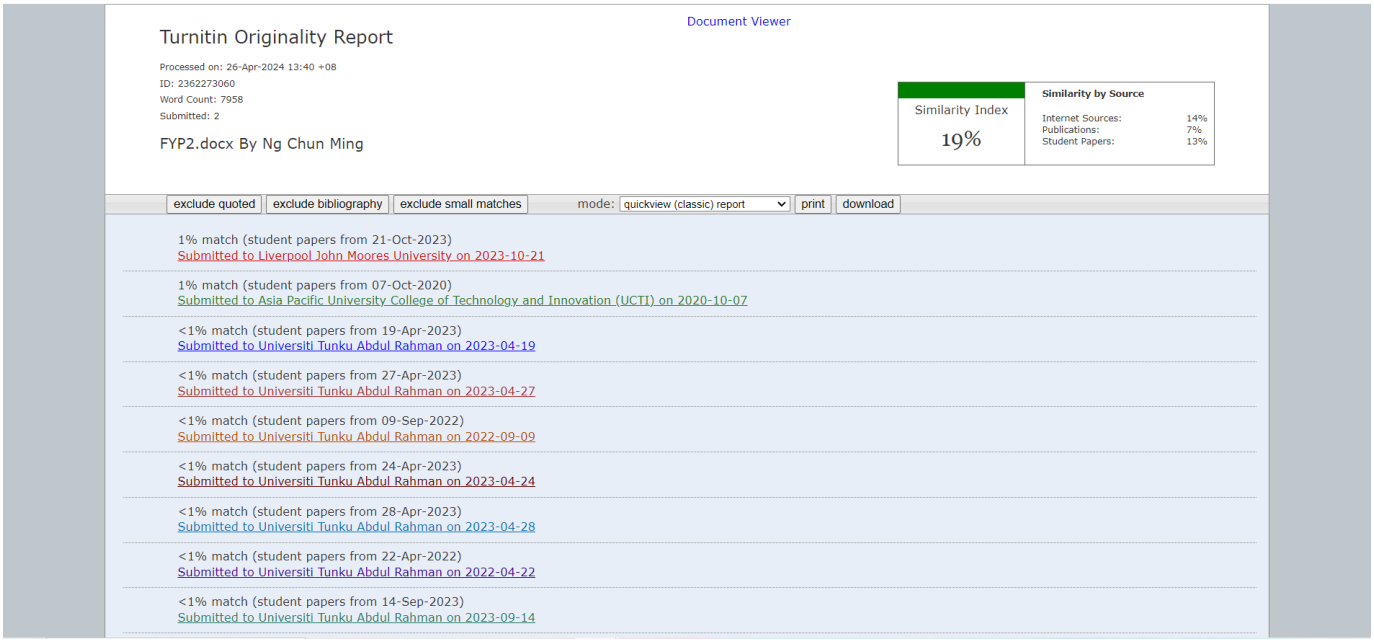
FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
FYP2
Stock Price
MONITORING SYSTEM
PROJECT OVERVIEW
This project is a development-based project that involves Artificial Intelligence, time series analysis, deep learning approaches for academic purpose. The main goal is to create a stock price prediction and recommendation system to benefit investors.
PROBLEM STATEMENT
1. Inadequacy of stock investment tools that utilizes stocks from Bursa Malaysia
2. Poor data visualization and insufficiency of stock insights
3. Lack of investment advice function with machine learning approach
PROJECT OBJECTIVES
1. To develop an AI-based stock price forecasting model
2. To explore the best model for financial forecasting
3. To build a dashboard to present data
4. To provide investment recommendations based on machine learning
PROJECT SCOPE
Web Application:
• Dashboard
• Stock Price Prediction Function
• Integration of Artificial Intelligence
• Investment Recommendations
METHODOLOGY
• Cross-Industry Standard Process for Data Mining (CRISP-DM)
• Naive Forecasting method
• Long Short-Term Memory (LSTM)
Bachelor of Information Systems (Honours) Business Information System
Created By: Ng Chun Ming
Supervisor: Dr Abdulkarim Kanaan Jebna
Moderator: Cik Nurul Syafidah Binti Jamil

PLAGIARISM CHECK RESULT



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Signature of Supervisor

Name: Dr Abdulkarim M. Jamal Kanaan

Date: 26 April 2024

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(KAMPAR CAMPUS)

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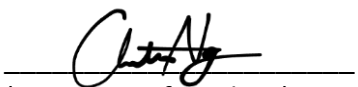

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