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Autoregressive Integrated Moving Average (ARIMA) Algorithm Adaptation for Business Financial Forecasting

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ABSTRACT

Financial management is the key to running a successful business, and financial forecasting is crucial to every business. Companies face difficulties making the right decision regarding their goals as they experience uncertainties in ensuring business growth. This study uses Dutch Lady company as a case study to help identify the company's performance based on eight financial ratios and visualize the results using the visualization technique. Hence, the autoregressive integrated moving average (ARIMA) algorithm and visualization techniques were applied to overcome the problems. The data is obtained from the last quarterly report for the study purpose. There are 14 variables collected and used to calculate the eight financial ratios. The predictive modelling uses the ARIMA algorithm, and the models were evaluated using two types of error metrics: 1) mean absolute error (MAE) and 2) root mean squared error (RMSE). The reliability testing for the system's prediction model shows a result *p-value*<0.05, and functionality testing successfully met the aims. The error metric evaluation result shows no significant differences between the forecast and actual values. The models can appropriately predict and forecast the financial ratio as the rules for both MAE and RMSE are fulfilled. The forecast results of each financial ratio are visualized and presented through the web-based system.

1. Introduction

Any activity that supplies products or services to customers to make a profit is known as business. Profits are generated by selling goods or services, which is a financial reward for taking a challenge and risk to run a business. Profit is the amount of income after paying all the expenses related to the operation of the business. Businesses suffer losses when the expenses exceed the income from the business operation. As asserted by Liu and Giovanni [1], most businesses aim to produce profit by improving revenue while keeping expenses in check. Most companies perform different functions, and various parts of the business handle each function. One reason for diving into the business parts

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is to allow each function to operate within its area of expertise. Hence, establishing effectiveness and efficiency for the business.

Financial forecasting is the process of estimating the company's future financial outcomes as the company's past performance is used to forecast the company's performance in the future [2]. Financial statements are beneficial for evaluating past performance and forecasting the future. The author also claimed that financial statements are business performance and position indices. Analysing the financial statement using Ratio Financial Analysis is intended to establish relationships between two accounting variables with common relationships or characteristics to study a particular case [3]. The financial ratio includes liquidity, efficiency, financial leverage, and profitability.

Amid the competition in the business industry, companies face difficulties in making the right decision regarding their goals, whether they can be achieved positively or not, to ensure business growth. Rombe [4] pointed out that achieving goals without careful planning and forecasting is hard and almost impossible. Companies often suffer significant damage when pursuing unrealistic goals. In order to make the right decision and avoid any damage, an effective forecast is crucial. Financial forecasting should be integral to decision-making activities as it affects business growth. The historical data help capture trends and patterns to produce effective and accurate forecasts for more relevant planning. Therefore, the past financial statement is used to calculate and forecast the financial ratios for this study.

Besides, companies struggle to face uncertainties such as unrealistic goals and decision-making, negatively impacting companies financially. Altig *et al.,* [5] supported that the inability to face uncertainties is one reason financial problems occur and cause the company to face significant financial problems. When the company holds a significant level of uncertainty, it falls into the "unhealthy (crisis) financial position" concept, where the company is technically insolvent in case it is unable to meet its current liabilities [6]. These are required for flexible measures of uncertainty, better outcomes, and performances [7]. Thus, financial forecasting is an effective instrument for this problem [6].

Financial ratios extract information from the company's financial statements and calculate economic indicators. Ratio analysis is a quantitative analysis of the information contained in the company's financial statements. The analysis quotation evaluates various aspects of the company's operations and financial performance, such as liquidity, profitability, leverage, and efficiency [8]. The liquidity ratio measures a firm's ability to meet its obligation in the short run. Whereby the profitability ratio is used to show the output of the operations. The leverage ratio determines the amount of debt incurred by the business, and the efficiency ratio identifies the business's capability to efficiently use its resources.

The Autoregressive Integrated Moving Average (ARIMA) model, also known as Box and Jenkins, is one of the statistical techniques used to predict the future. ARIMA is one type of time series forecasting that uses historical data and associated patterns to forecast future outcomes [9]. Since its first implementation, the ARIMA method has been widely used in many fields, such as specification, evaluation, and diagnosis [10]. ARIMA model is in degrees *(p, d, q)* where *p* is the autoregression parameter, *d* is the difference parameter, and *q* is a degree of moving average parameter [11,12]. The Box-Jenkins method was used for future univariate time series forecasting. It shows a systematic approach to creating future discrete and discrete-time series forecasting models. A fixed time series of observations is obtained periodically. The sequence composed of regularly acquired observations is an important assumption of the Box-Jenkins method, discrete and stationary [13]. It is also a very effective timing tool. The ARIMA method combines autoregressive (AR) and moving average (MA) for data analysis. The ARIMA model was used for fixed time series and also used in weather predictions [11].

Data visualization converts abstract data into physical images (such as length, location, shape, and colour). It is a powerful tool for presenting appealing data tales to visually-oriented individuals. It is a great match for providing a decent overview of huge data and making it easier for data scientists to grasp data analytics findings [12]. Data visualization also makes it easier to connect various data points, analyse data relationships, debate problems in real-time, and decide where to focus the investigation [14]. The visualization techniques used in the study were the line graph and bar chart. Thus, visualizing the result on the forecasted financial ratios data is more effective. It is a fast and effective way to use visual information to convey information. For data visualization, Plotly Python Graphing Library is used. Data were imported into Python interactive graph using the panda's data frame, and the visualized graph was presented. Comparison of the company performance based on the financial ratio of past and present were visualized. Based on the problem discussed, a web-based application using Python was implemented using the obtained data from Dutch Lady Milk Industries Berhad, which were downloaded from Bursa Malaysia. It helps users to view the company's performance in terms of financial ratios in visualization form. Therefore, the company and user are able directly compare the company's performance more easily in the past and future. This paper is organized as follows: it begins with a brief introduction in Section 1. Section 2 explains the methodology, followed by the result and discussion in Section 3. Finally, Section 4 concludes the study and briefly mentions potential future improvements.

2. Methodology

The research methodology used to design and develop this project was developed into a few sections. The explanations and justification for the research design and data collection techniques are provided to support the methodology. We divided it into a few phases to achieve the research's aim: developing a web-based application to visualize the forecast trend.

2.1 System Design

The system design of the web-based application that satisfies the project's requirements is described one by one. In the following subsections, use case diagrams, flowcharts and user interfaces are part of the system design. Use case diagram gathers system requirements, including internal and external factors. Interactions between the system and the user are needed to ensure the accomplishment of the system's task [15]. Specific interactions will be used for the flowchart purposes. A flowchart is a tool used to analyse the process involved in a system. Before entering the development phase, the final step for the design phase is the user interface (UI) design. UI design visualizes the proposed system's components layout to interact directly with the system.

2.2 Back-End Development

Back-end development is written in Python. Python is used because it can act as data manipulation and development of web applications. Thus, code written in Python helps transfer information and interact with the front-end site. Python's task is data preparation and building and deploying the model using the ARIMA algorithm. The following subsection describes the data preparation process, predictive modelling and model deployment in detail.

2.2.1 Data preparation

Dutch Lady Malaysia Berhad's quarterly financial statements were downloaded from Bursa Malaysia for the study. The data consists of the company's financial statements obtained from the past quarterly report of Dutch Lady Milk Industries Berhad company from the Bursa Saham website [16]. It starts from the first quarter of 2010 until the second quarter of 2021. Table 1 shows the eleven data types from past quarterly reports to calculate the financial ratio.

Table 1
List of data in financial statement

No	Data
1	Sales
2	Cost of Goods Sales
3	Gross Profit
4	Expenses
5	Earnings Before Interest and Taxes
6	Cash
7	Current Assets
8	Current Liabilities
9	Total Assets
10	Total Liabilities
11	Total Equity

Since the data are in .pdf format, Tableau software is used to pre-process the .pdf format into Microsoft Excel. All the financial statement data are uploaded into Tableau. Tableau has a feature that can recognize and capture tables from .pdf files and transfer them into Microsoft Excel. A total of 14 variables are collected and used to calculate the eight financial ratios. Table 2 shows the four types of financial ratios: liquidity ratio, profitability ratio, leverage ratio and efficiency ratio, and the list of variables used for each financial ratio. All these ratios are used in this study as they can be used to measure company performance [17-19]. After the data is finalized, all the data are stored as .csv files.

Table 2
List of ratios used

Financial Ratio	Type of Ratio
Liquidity Ratio	Current Ratio
	Cash Ratio
Profitability Ratio	Gross Profit Margin Ratio
	Net Profit Margin Ratio
	Return on Assets Ratio
Leverage Ratio	Debt to Equity Ratio
	Interest Coverage Ratio
Efficiency Ratio	Total Assets Turnover Ratio

Before the data goes through the transforming process, the data must not have any missing values. Data has checked whether it has any missing value or not. If there is no missing value, the data is good to go. In order to use the ARIMA algorithm for modelling, this algorithm needs to use only numeric and stationary data or else the data cannot fit [20]. Since the month variable is the main indicator for time series forecasting, months are set as the index. Even though it is in string format, it is not an issue as it is set as an index. The transformation begins with the calculation data value of the p-value using the Augmented Dickey-Fuller (ADF) test [21]. ADF test was performed for the time

series used for the study on the unit roots. This test defines whether the data is stationary based on a calculated p-value. The *p-value<0.05* indicates that the data is stationary.

Not stationary data are identified, and transforming them into stationary begins with the shift function. The shift function is set to shift only once, and then the p-value is tested again. If it is still not stationary, the shift function is used again until the data is completely stationary. After all the data is stationary, the data are ready to be fit into predictive modelling.

2.2.2 Prediction model

The predictive modelling is conducted using the ARIMA algorithm. Before modelling, all data stored in the database are retrieved to be used in modelling. For this project, the auto ARIMA function is used to find the order of ARIMA *(p, d, q)* using the ARIMA model equation. Its suitability is calculated based on Akaike Information Criterion (AIC). AIC calculates how the model fits the data, considering the overall complexity. The lowest AIC value is the best parameter *p, d, q* combination, which can accurately forecast future outcomes. Therefore, this combination of ARIMA *(p, d, q)* is chosen as the best fit ARIMA model to forecast. Parameter *p* represents the AR term, determining how many previous time series values are used to predict the future. Next, parameter *d* represents the data difference, which determines how many different orders are needed. Parameter *q* represents the MA term, determining how many lags are used for the model. The ARIMA model equation combines AR and MA terms, as shown in Eq. (1). Table 3 shows the parameter involved in the ensemble of ARIMA.

$$Y(t) = Constant + LinearCombinationLagsOfY(plags) + LinearCombinationLaggedForecastErrors(qlags) \quad (1)$$

Table 3
Equation parameter

Parameter's Name	Explanation
Constant	Number of differencing (I)
LinearCombinationLagsOfY(plags)	Autoregressive (AR) number of lags
LinearCombinationofLaggedForecastErrors(qlags)	Moving average (MA) number of lags

Next, the ARIMA model is trained and fit to forecast the financial ratio. The dataset is split by 70:30 for training and testing using Python. Then, the ARIMA model predicts future financial ratios until the fourth quarter of 2022. The result of the forecast financial ratio is then used for data visualization.

2.3 Front-End Development

Front-end development refers to the client side, focusing more on users' views in their web browsers. Its development is mainly written in ReactJS. However, languages such as HTML, CSS, JavaScript, and jQuery are also used in front-end development to integrate with Flask's back-end framework. Python's data visualization and the Flask web framework tools are used to build custom plots and charts in a Python web application context, leveraging the power of both front-end and back-end development. The details of each interface available for user interaction are discussed in the following subchapter. It includes the main menu page, financial forecasting page, overall business performance page and financial ratios page.

3. Result and Discussion

This section describes and explains the result of the analysis performed on real-world data. Both error metric evaluation and functionality are performed to test the data. Metric error evaluation is conducted to evaluate the system's reliability and validate the model used in the system. The functionality testing is carried out to ensure the system's functionality works according to its function and appropriately.

3.1 Reliability Testing

The unit-roots test ADF is conducted, and the stationary data is tested to ensure the data is stationary based on a calculated p-value, where a *p-value<0.05*. Table 4 shows the final p-value of each financial ratio that meets the requirement of *p-value<0.05*. It strongly supports that all data series are stationary after the first difference at the 10%, 5%, or 1% significance levels.

Table 4
Stationary testing result

Financial Ratio	*p-value*
Current Ratio	1.05×10^{-14}
Cash Ratio	6.11×10^{-4}
Gross Profit Margin Ratio	5.44×10^{-4}
Net Profit Margin Ratio	4.81×10^{-4}
Return on Assets Ratio	3.04×10^{-4}
Debt to Equity Ratio	2.70×10^{-7}
Interest Coverage Ratio	6.90×10^{-4}
Total Assets Turnover Ratio	9.49×10^{-30}

Reliability testing is performed to evaluate and validate the model used in the system. This is important as the model metric determines how accurate the financial ratio is, as the value of forecast financial ratios is based on the model itself. Error metrics are used to evaluate instead of accuracy scores because this project uses the ARIMA algorithm, a regression model and not a classification model.

Therefore, accuracy cannot be used for a regression model. For this project, root mean squared error (RMSE) and mean absolute error (MAE) are the metrics used to evaluate and validate the models. RMSE is one of the most useful metrics and standard ways to measure the model's error in predicting quantitative data [22]. MAE is the simplest measure of forecast accuracy. RMSE calculates the standard deviation of the mean residual and takes the root of that mean; meanwhile, MAE is also the same, but it uses the absolute residual value [23]. Eq. (2) and Eq. (3) show the formula used to calculate RMSE and MAE, respectively.

$$MAE = \frac{1}{n}\sum|y - \hat{y}| \tag{2}$$

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N}\|y(i) - \hat{y}(i)\|^2}{N}} \tag{3}$$

RMSE and MAE are suitable to be used together for evaluating the model because both are compared to determine whether the forecast contains large but infrequent errors and diagnose the

variation in the errors in a set of forecasts [24]. The model's performance improves as the RMSE and MAE decrease [25]. Table 5 shows the result of RMSE and MAE after applying the formula for each value. All financial ratios fulfil the rule mentioned earlier; therefore, all models are considered good.

We provide evidence on the actual and prediction trends for the first financial ratio, the liquidity ratio. Figure 3 shows the graph with actual and prediction values for two liquidity ratio models: current and cash ratio. The financial ratio prediction (with legend testing prediction) matches the actual trends though a certain acceptance lag exists.

During the research's initial development, financial statements for Dutch Lady Milk Industries Berhad were only available from the first quarter of 2010 until the second quarter of 2021. The latest updated financial statements for the third quarter of 2021 are uploaded on the Bursa Malaysia Official Website. Therefore, extended validation of the system's accuracy has been done by comparing all financial ratios forecast for the third quarter of 2021 with actual data, as shown in Table 5. There are no significant differences between the forecast value and the actual value. Therefore, it concludes that all the models can forecast appropriately.

Table 5
Mean, RMSE and MAE value of each financial ratio

Financial Ratio	Mean	RMSE	MAE
Current Ratio	1.5330741210	0.0949099898	0.0736430214
Cash Ratio	0.6162696488	0.0528966645	0.0384561221
Gross Profit Margin Ratio	1.6256680347	0.0316024183	0.0260413377
Net Profit Margin Ratio	0.1473845281	0.0339585437	0.0276216755
Return on Assets Ratio	0.0875602232	0.0208402795	0.0157780176
Debt to Equity Ratio	0.2536017972	0.1722546546	0.1367956197
Interest Coverage Ratio	105.4626213234	102.4794040453	62.1828489335
Total Assets Turnover Ratio	0.5928138728	0.0632503712	0.0469087287

3.2 Functionality Testing

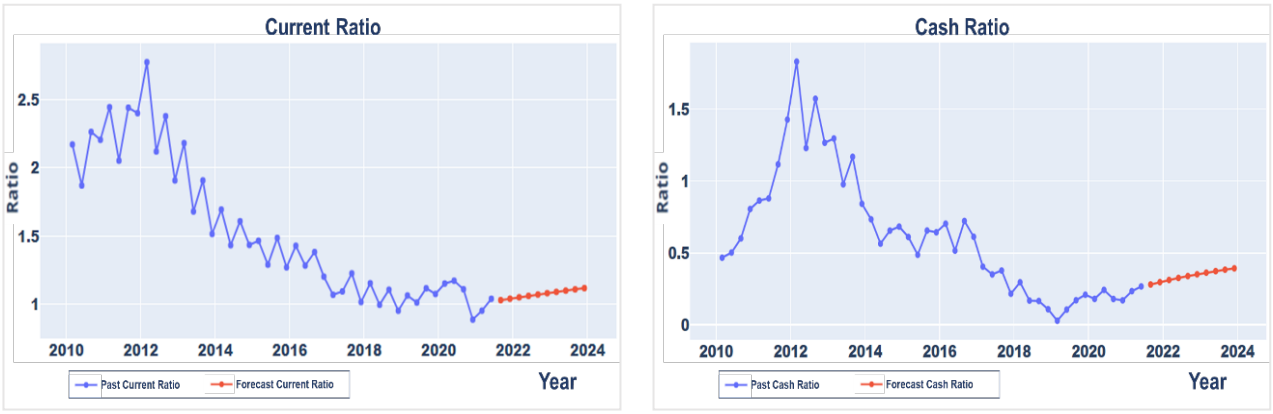
In order to ensure the application's features, work correctly, it is essential to test all the features and correct all detected errors. Functional testing aims to ensure that each function of the visualization application, through its step, sees the specifications as equal by giving appropriate input and comparing the output to the functional requirements as outlined in the previous chapters. The test uses test case scenarios acquired with the list of functionalities tested. The results show that the system can redirect to the right page and display the correct information.

The web-based application on business financial forecasting starts with the "Main Menu" page as in Figure 1 (a) and details for "About" page in Figure 1 (b), where the user can view information on the function, the financial statement and the study's aims. The visualization of the line graph was also tested to ensure the user could view the selected visualization from the eight financial ratios.

(a) (b)

Fig. 1. Web-based application on business financial forecasting (a) the "Main Menu" page and (b) details for "About" page

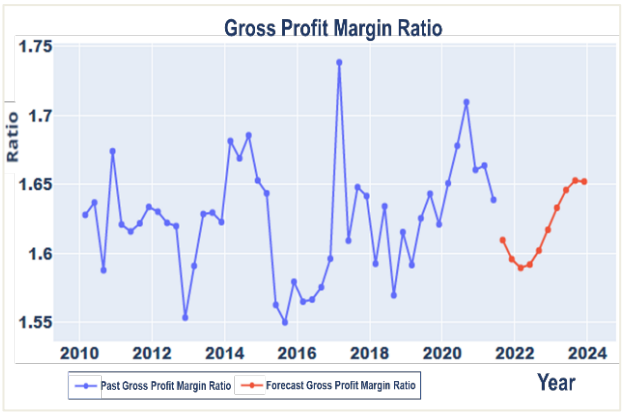
It starts with the forecast liquidity ratio for the current ratio in Figure 2 (a) and cash ratio in Figure 2 (b). It is predicted that both have an incremental forecast trend.



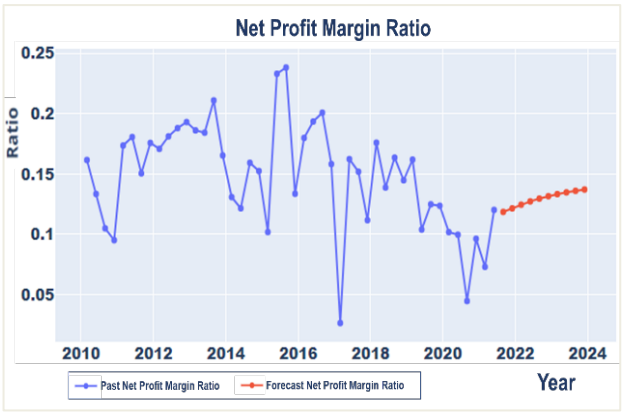
(a) (b)

Fig. 2. Forecast liquidity ratio for (a) current ratio and (b) cash ratio

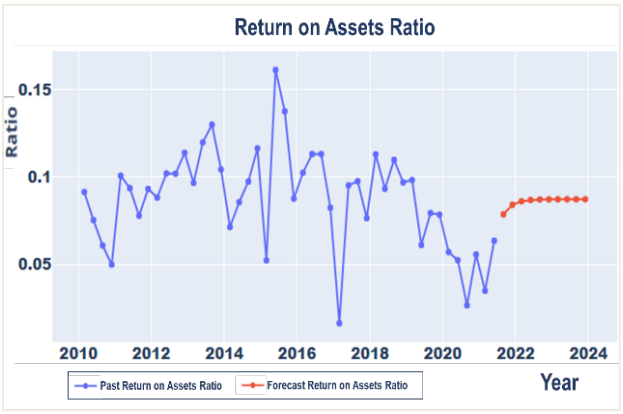
Figure 3 indicates the three-forecast probability gross profit margin ratio in Figure 3 (a), net profit margin ratio in Figure 3 (b) and return on assets ratio in Figure 3 (c). All ratios show a positive trend in the forecast, despite the gross profit margin ratio showing a slight decrease in 2022.



(a)



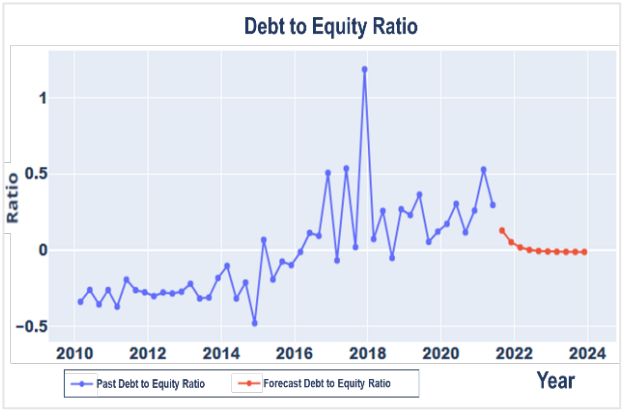
(b)



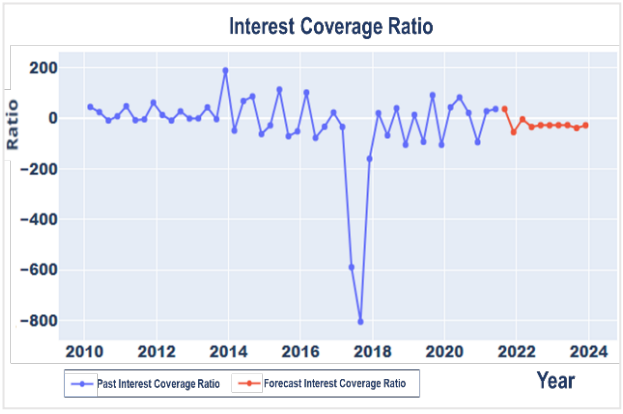
(c)

Fig. 3. Forecast profitability ratio for (a) gross profit margin ratio, (b) net profit margin ratio and (c) return on assets ratio

Figure 4 shows decreased and stagnant trends for the forecast liquidity ratio for debt-to-equity ratio in Figure 4 (a) and interest coverage ratio in Figure 4 (b).



(a)



(b)

Fig. 4. Forecast liquidity ratio for (a) debt to equity ratio and (b) interest coverage ratio

However, the forecast efficiency ratio for the total asset turnover ratio in Figure 5 shows a promising trend starting from the beginning of 2022. All the line graphs are interactive visualization. Hence, the user can see the graph information when hovering over the graph. Besides, the user also can use the function provided by Ploty to download the desired graph and change the graph size.

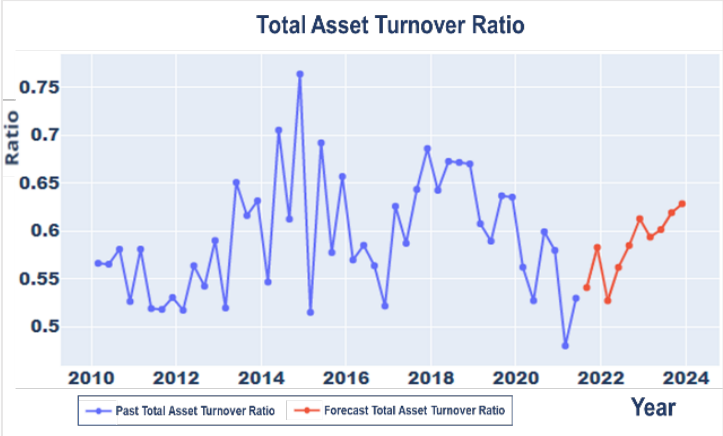


Fig. 5. Forecast efficiency ratio for total asset turnover ratio

4. Conclusions

This study uses the past financial statement from Dutch Lady Milk Industries Berhad from the first quarter of 2010 until the second quarter of 2021. This web application is developed to calculate and forecast the future financial ratio based on past financial statements to establish business goals that are both realistic and feasible. Besides, it gives valuable insights into how the business performed in the past and future visualization for a better view. ARIMA algorithm is used to calculate and forecast the financial ratio based on past financial statements that have been included in the application, enabling the user to view the results displayed on the web application.

Based on the result, this study has achieved its aims by correctly calculating and forecasting all financial ratios and displaying the correct information. The limited information on the Bursa Malaysia website for Dutch Lady Milk Industries Berhad financial statement data is a drawback. For a future project, the monthly data of financial statements can better predict the future financial ratio using a more advanced machine learning algorithm that enables users to update the data, giving the user a better experience.

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References

[1] Liu, Baolong, and Pietro De Giovanni. "Green process innovation through Industry 4.0 technologies and supply chain coordination." *Annals of Operations Research* (2019): 1-36. https://doi.org/10.1007/s10479-019-03498-3

[2] L. Learning, "Introduction to business," 2019. https://courses.lumenlearning.com/wm-introductiontobusiness/

[3] G. Kurthy *et al.*, "*Basic of finance*" 1st ed. Budapest: Corvinus University of Budapest, 2018.

[4] Rombe, Michael Lawrence Mogga. "The impact of effective forecasting on business growth, a case of business in juba market." *International Journal of Economics, Business and Management Research* 2, no. 1 (2018): 196-212.

[5] Altig, David, Jose Maria Barrero, Nicholas Bloom, Steven J. Davis, Brent Meyer, and Nicholas Parker. "Surveying business uncertainty." *Journal of Econometrics* 231, no. 1 (2022): 282-303. https://doi.org/10.1016/j.jeconom.2020.03.021

[6] Krylov, Sergey. "Target Financial Forecasting as an Instrument to Overcome Financial Difficulties." *Available at SSRN 3206470* (2018). https://doi.org/10.2139/ssrn.3206470

[7] Jasni, Nur Hazwani, Aida Mustapha, Siti Solehah Tenah, Salama A. Mostafa, and Nazim Razali. "Prediction of player position for talent identification in association netball: a regression-based approach." *International Journal of Advances in Intelligent Informatics* 8, no. 1 (2022). https://doi.org/10.26555/ijain.v8i1.707

[8] Lagat, Nicole Jerop. "Validity of the multiple discriminate analysis failure prediction model on corporate financial distress: An analysis of the Kenyan market." (2021).
[9] Al Hadar, Habib Abubakar. "The Effect Of Sustainability Report Disclosure On Company Financial Performance (Empirical Study Of State-Owned Mining Companies Listed In Indonesia Stock Exchange)." (2022).
[10] Toğa, Gülhan, Berrin Atalay, and M. Duran Toksari. "COVID-19 prevalence forecasting using autoregressive integrated moving average (ARIMA) and artificial neural networks (ANN): case of Turkey." *Journal of infection and public health* 14, no. 7 (2021): 811-816. https://doi.org/10.1016/j.jiph.2021.04.015
[11] Sofian, Ian Mochamad, Azhar Kholiq Affandi, Iskhaq Iskandar, and Yosi Apriani. "Monthly rainfall prediction based on artificial neural networks with backpropagation and radial basis function." *International Journal of Advances in Intelligent Informatics* 4, no. 2 (2018): 154-166. https://doi.org/10.26555/ijain.v4i2.208
[12] Qin, Xuedi, Yuyu Luo, Nan Tang, and Guoliang Li. "Making data visualization more efficient and effective: a survey." *The VLDB Journal* 29 (2020): 93-117. https://doi.org/10.1007/s00778-019-00588-3
[13] Shadab, Ahzam, Shamshad Ahmad, and Saif Said. "Spatial forecasting of solar radiation using ARIMA model." *Remote Sensing Applications: Society and Environment* 20 (2020): 100427. https://doi.org/10.1016/j.rsase.2020.100427
[14] Khalid, Zhwan M., and Subhi RM Zeebaree. "Big data analysis for data visualization: A review." *International Journal of Science and Business* 5, no. 2 (2021): 64-75.
[15] Khan, Naimul Mefraz, Nabila Abraham, and Marcia Hon. "Transfer learning with intelligent training data selection for prediction of Alzheimer's disease." *IEEE Access* 7 (2019): 72726-72735. https://doi.org/10.1109/ACCESS.2019.2920448
[16] B. M. Berhad, "No Title," *Dutch Lady Milk Industries Berhad*, 2021. https://www.bursamalaysia.com/trade/trading_resources/listing_directory/company-profile?stock_code=3026
[17] Indrajaya, Danang, Dadan Ramdhan, and Lukmanul Hakim. "The Influence of Profitability and Solvency Ratios on Stock Prices with Inflation as Moderating Variable (Case Study on BUMN)." *International Journal of Technology And Business* 3, no. 2 (2019): 1-10.
[18] Suprihati, Suprihati, Abdul Haris Romdhoni, and Gita Wahyu AM. "Increasing Company Performance with Liquidity, Solvency in Cigarette Industry Listed in IDX." *International Journal of Economics, Business and Accounting Research (IJEBAR)* 2, no. 02 (2018). https://doi.org/10.29040/ijebar.v2i02.281
[19] Mahdi, Mahruzal, and Muammar Khaddafi. "The influence of gross profit margin, operating profit margin and net profit margin on the stock price of consumer good industry in the Indonesia stock exchange on 2012-2014." *International Journal of Business, Economics, and Social Development* 1, no. 3 (2020): 153-163. https://doi.org/10.46336/ijbesd.v1i3.53
[20] Lynch, Christopher J., and Ross Gore. "Application of one-, three-, and seven-day forecasts during early onset on the COVID-19 epidemic dataset using moving average, autoregressive, autoregressive moving average, autoregressive integrated moving average, and naïve forecasting methods." *Data in Brief* 35 (2021): 106759. https://doi.org/10.1016/j.dib.2021.106759
[21] Hariadi, Wigid, and Sulantari Sulantari. "Aplication of ARIMA Model for Forecasting Additional Positive Cases of Covid-19 in Jember Regency." *Enthusiastic: International Journal of Applied Statistics and Data Science* (2021): 20-27. https://doi.org/10.20885/enthusiastic.vol1.iss1.art4
[22] Yang, Wendong, Shaolong Sun, Yan Hao, and Shouyang Wang. "A novel machine learning-based electricity price forecasting model based on optimal model selection strategy." *Energy* 238 (2022): 121989. https://doi.org/10.1016/j.energy.2021.121989
[23] Nguyen, Thuy-Anh, Hai-Bang Ly, Hai-Van Thi Mai, and Van Quan Tran. "On the training algorithms for artificial neural network in predicting the shear strength of deep beams." *Complexity* 2021 (2021): 1-18. https://doi.org/10.1155/2021/5548988
[24] Samah, Khyrina Airin Fariza Abu, Nurqueen Sayang Dinnie Wirakarnain, Raseeda Hamzah, Nor Aiza Moketar, Lala Septem Riza, and Zainab Othman. "A linear regression approach to predicting salaries with visualizations of job vacancies: a case study of Jobstreet Malaysia." *IAES International Journal of Artificial Intelligence* 11, no. 3 (2022): 1130. https://doi.org/10.11591/ijai.v11.i3.pp1130-1142
[25] Pham, Binh Thai, Manh Duc Nguyen, Kien-Trinh Thi Bui, Indra Prakash, Kamran Chapi, and Dieu Tien Bui. "A novel artificial intelligence approach based on Multi-layer Perceptron Neural Network and Biogeography-based Optimization for predicting coefficient of consolidation of soil." *Catena* 173 (2019): 302-311. https://doi.org/10.1016/j.catena.2018.10.004