Jurnal Penelitian Teknologi Informasi dan Sains
Volume. 3, Nomor. 1, Tahun 2025
e-ISSN : 2985-7635; p-ISSN : 2985-6280; Hal. 92-101
DOI: https://doi.org/10.54066/jptis.v3i1.3136
Available online at: https://jurnal.itbsemarang.ac.id/index.php/JPTIS

TOWR Stock Forecasting From 2021-2025 Using Machine Learning

Andy Hermawan[1*], Angga Sukma Budi Darmawan[2], Muhammad Iqbal[3], Mochammad Rivan Akhsa[4], Nila Rusiardi Jayanti[5], Zidan Amukti Rajendra[6]
[1,5]Universitas Indraprasta PGRI Jakarta, Indonesia
[2,3,4,6]Purwadhika Digital School, Indonesia
Email: andy.hermawan@unindra.ac.id [1], sbdangga16@gmail.com [2], mhdiqbal976@gmail.com [3], rivan.akhsa@gmail.com [4], nilarusiardi.jayanti@unindra.ac.id [5], zidan.amukti@gmail.com [6]

*Author correspondence: andy.hermawan@unindra.ac.id**

Abstract. *Accurate stock price forecasting is a crucial yet challenging task due to the complex and dynamic nature of financial markets. This study employs the Prophet model to predict the stock prices of PT Sarana Menara Nusantara Tbk (TOWR) from 2021 to 2025. The research leverages historical stock data, incorporating dividend distribution dates and Annual General Meeting (AGM) events as external regressors to enhance predictive accuracy. The model was developed using machine learning-based time series forecasting, with hyperparameter tuning applied to optimize performance. The evaluation metrics indicate a Mean Absolute Error (MAE) of Rp49.92 and a Mean Absolute Percentage Error (MAPE) of 6.47%, demonstrating the model's robustness in capturing long-term stock price trends. The findings suggest that stock prices exhibit significant movements around dividend announcement periods and AGM events, highlighting the impact of corporate actions on market behavior. This study reinforces the importance of incorporating fundamental financial indicators into forecasting models to improve decision-making for investors and financial analysts. The results offer practical implications for investment strategy formulation, risk management, and market trend analysis.*

Keywords: *Financial markets, Investment strategies, Machine learning, Prophet model, Stock price forecasting,*

1. RESEARCH BACKGROUND

Accurate forecasting is a challenging yet essential endeavour due to the complexity and dynamic nature of the stock market, which is influenced by a myriad of factors. As a result of the inherent volatility and unpredictability of financial markets, conventional stock market forecasting methods have frequently failed (Kumbure, Lohrmann, Luukka, & Porras, 2022).

Consequently, there has been an increasing interest in utilizing machine learning (ML) techniques to improve the accuracy and reliability of stock market forecasting (Ajiga, et al., 2024). This shift toward machine learning is driven by the potential of integrating these advanced methods to create more precise and robust predictive models, offering a promising alternative to traditional forecasting approaches (Soni, Tewari, & Krishnan, 2022).

A machine learning forecasting algorithm is a method that uses past and present data to estimate future outcomes (Wibowo, Dang, & Wang, 2022). To make these predictions for a specific dataset, historical data points are extracted and processed. The primary focus of this approach is the quantitative aspect (Napitupulu, Sambas, Murniati, & Kusumaningtyas, 2022).

Advanced techniques are employed to analyze historical data, statistical principles, and forecasting methods related to the variable being predicted, such as stock prices. In the context

Received: Januari 13, 2025; Revise:Februari 18, 2025; Accepted: Maret 10, 2025; Published: Maret 13, 2025

of the stock market, the first condition involves a weak market, where forecasting future trends based on past prices is not possible. The second condition, a semi-strong market, indicates that forecasting is also unfeasible due to a lack of sufficient historical or publicly available information (Jaquart, Dann, & Weinhardt, 2021). A strong market, on the other hand, is one where no past, public, or private data can be used to predict future behavior. However, this view was later challenged by research showing that new artificial intelligence models could successfully predict market trends and associated profits (Lin & Marques, 2024).

The goal of forecasting is not necessarily to provide a definitive answer regarding whether certain events will occur, but rather to find predictions that are as accurate as possible. The capital market plays a key role in financing businesses and institutions while providing a platform for investments. It is a market for various long-term financial instruments, and it significantly impacts the economic health of a country (Carta, Consoli, Piras, Podda, & Recupero, 2024).

Shares, the primary form of investment in the capital market, represent ownership stakes in companies or limited liability entities. Investing in shares is expected to yield significant returns in the future, though potential investors must carefully consider the risks and benefits involved, as each investment option carries its own set of challenges (Soni, Tewari, & Krishnan, 2022).

This study analyzes the historical closing price data of PT Sarana Menara Nusantara Tbk (TOWR) to identify patterns, trends, and key factors influencing stock price movements, aiding in better investment decision-making. The primary objective is to understand past trends in the short term and develop a predictive model for future stock prices in the long term. The analysis employs time series forecasting techniques, the Prophet model, incorporating feature engineering with indicators such as mean absolute error (MAE) and mean absolute percentage error (MAPE). Various models are evaluated to determine the most effective approach, ensuring robust predictions that support investors, market analysts, and company management in making strategic financial decisions.

2. LITERATURE REVIEW

Financial forecasting plays a crucial role in stock market investments and corporate finance. It involves predicting future financial trends based on historical data, enabling investors, businesses, and policymakers to make informed decisions (Makridakis et al., 2018). Accurate forecasting is essential for optimizing investment strategies, managing risks, and ensuring financial stability, making it a fundamental tool in economic and financial analysis. In addition, forecasting is also essential to assess the ROI. The ROI, is an economic framework

for measuring the return on investment (ROI) from marketing efforts (Hermawan, Aditama, Ramadhani, Ilham, Saputra, & Jayanti, 2024).

There are many benefits of using forecasting, such as supporting investment decisions, risk management, strategic business planning, and enhancing financial stability. One of the widely adopted models for time series forecasting is Facebook Prophet, a model developed to effectively capture seasonality, trend patterns, and external events such as holidays (Kaninde et al., 2022).

The importance of stock price prediction shows the need for proper techniques for forecast modelling. Prophet, a forecasting model developed by Facebook, is designed to handle time series data that exhibits strong seasonality, trends, and external events such as holidays (Taylor & Letham, 2017). Research has shown that Prophet is highly capable of capturing seasonality, trend components, and external events such as holidays, making it a reliable tool for financial forecasting (Hyndman & Athanasopoulos, 2021). Previous studies have successfully applied Prophet to predict stock price movements, demonstrating its ability to model complex financial time series with minimal parameter tuning, based on the mean absolute error and mean absolute percentage error as their evaluation metrics (Chai & Draxler, 2014). The model's flexibility in handling missing data and outliers further enhances its suitability for stock market forecasting, where fluctuations and external influences frequently occur (Hyndman & Koehler, 2006). Additionally, it allows for easy integration of domain knowledge through custom seasonal effects and external regressors.

Prophet models a time series y(t) as the sum of three main components: trend g(t), seasonality s(t), and holiday effects h(t), along with an error term ε_t:

$$y(t) = g(t) + s(t) + h(t) + \varepsilon_t$$

Prophet decomposes time series data into four main components: trend, seasonality, holiday and event effects, and error terms. The trend component g(t) captures the long-term growth pattern of the data, which can be modeled using either a piecewise linear function or a logistic growth function when there is a natural limit to growth. The seasonality component (t) accounts for recurring patterns over a fixed period, modeled using the Fourier series to capture periodic fluctuations. The holiday and event effects h(t) incorporate external factors such as public holidays or significant economic events that may impact the time series by assigning additional parameters to specific dates. Lastly, the error term ε_t represents unpredictable variations or residual noise in the data that the model does not capture, assuming it follows a normal distribution to account for uncertainty in predictions.

Several studies have explored the application of forecasting techniques, such as Prophet, in stock price prediction. One such study, *"Stock Price Prediction using Facebook Prophet"* (Shinde & Gawali, 2018), examined the effectiveness of Prophet in forecasting stock prices based on historical data obtained from Yahoo Finance. The research highlights that Prophet's capability in handling time series data, particularly in capturing trends and seasonality, makes it a suitable choice for financial forecasting.

Shinde and Gawali (2018) demonstrated that Prophet's model can provide reliable predictions by decomposing time series data into trend, seasonal, and holiday effects. Additionally, the study emphasizes the advantages of Prophet over traditional statistical models, particularly in terms of its ease of use and ability to automatically handle missing values and outliers. The researchers concluded that Prophet is a practical and efficient tool for forecasting stock prices, especially for long-term trend analysis.

In addition to technical analysis, corporate actions such as dividend distributions and Annual General Meetings (AGMs) play a crucial role in influencing stock price movements. Research indicates that dividend announcements shape investor sentiment, often resulting in price fluctuations (Joshi & Mayur, 2017). Likewise, a study on the U.S. banking sector revealed that dividend declarations can trigger immediate market responses, impacting both short-term volatility and long-term price trends (Korganbekova, 2018). These findings highlight the importance of incorporating fundamental financial events into forecasting models to improve prediction accuracy and support more informed investment decisions.

3. RESEARCH METHODOLOGY

The research methodology adopted in this study is structured into three key phases: Data Preprocessing , Data Modeling , and Model Evaluation . Each phase plays a critical role in ensuring the robustness, accuracy, and generalizability of the predictive model developed for forecasting the closing stock prices of PT Sarana Menara Nusantara Tbk.

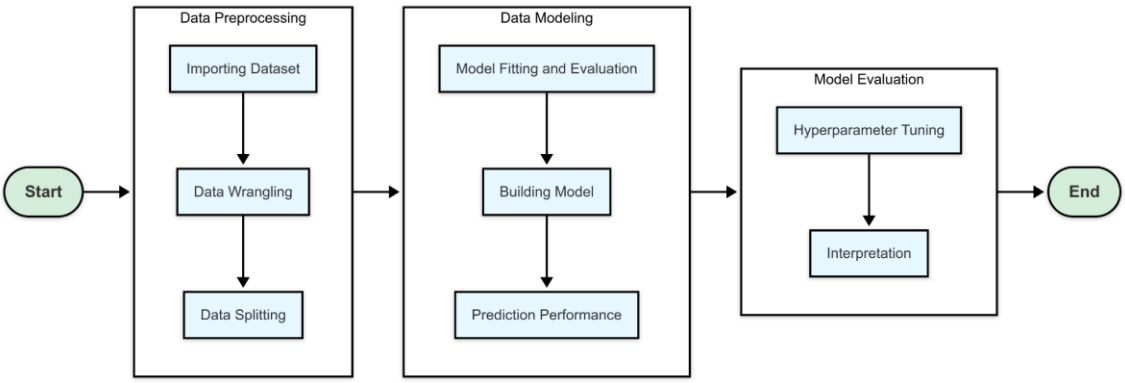

Figure 1. Research Scheme

Data Preprocessing

The performance of the model depends on the size of the data sample and the number of parameters used. A comprehensive dataset comprising 966 data points was sourced from Yahoo Finance, with the training subset encompassing the years 2021 to 2023 and the testing subset extending from 2024 to 2025. This dataset serves as the foundation for forecasting the closing stock price of PT Sarana Menara Nusantara Tbk, leveraging both temporal data (date) and the corresponding daily closing stock prices.

The modeling process involved the systematic partitioning of data points into training, and validation phases to establish a robust numerical framework for forecasting the closing stock prices of PT Sarana Menara Nusantara Tbk. This methodological approach was specifically designed to mitigate the risk of overfitting, a common challenge in machine learning applications. To ensure the model's predictive accuracy and generalizability, the dataset was chronologically segmented, with the training subset encompassing the years 2021 to 2023 and the testing subset extending from 2024 to 2025. This temporal split not only aligns with best practices in time series forecasting but also enhances the reliability of the model's performance evaluation. Additionally, external regressors, such as dividend announcement dates and Annual General Meetings (AGMs), are included to enhance predictive accuracy by capturing the impact of corporate actions on stock price movements (PT Sarana Menara Nusantara Tbk., 2025).

Data Modeling

This study utilizes the Prophet model for stock price forecasting because of its capability to break down time series data into trend, seasonal patterns, and external influencing factors. Prior research has shown its effectiveness in diverse applications, including municipal demand forecasting (VanBerlo, Ross, & Hsia, 2021), which further validates its suitability for financial forecasting. Moreover, Prophet’s ability to incorporate structured event-based variables, such as dividend distribution dates and AGM schedules, enhances its accuracy in predicting stock market movements.

The modeling process began with defining the Prophet model using its Python implementation. The model was fitted to a training dataset spanning from 2021 to 2023. To generate predictions, a future dataframe was created using the make_future_dataframe method, extending the forecast horizon to 730 days. This covers the period from January 1, 2024, to February 5, 2025. This temporal range aligns with the testing subset of the dataset, enabling rigorous evaluation of the model's performance against actual stock prices during this timeframe.

Model Evaluation

To enhance the model's performance, several critical hyperparameters were systematically tuned, and additional features were incorporated into the Prophet model. Notably, the General Meeting of Shareholders (GMS) was included as a feature to account for potential impacts on stock prices during these significant events. The following hyperparameters were adjusted to optimize the model's performance. The Changepoint Prior Scale controls the flexibility of the trend component, where smaller values produce smoother trends, while larger values allow for greater adaptability to significant changes in the data (Taylor & Letham, 2018). The Seasonality Prior Scale governs the strength of seasonal components, enabling the model to account for recurring patterns in stock prices (Hamdani et al., 2023). Lastly, the Yearly Fourier Order determines the complexity of yearly seasonality patterns, with higher values allowing the model to capture intricate cyclical variations, which are often observed in financial data.

In addition to these hyperparameters, two binary indicators were created to represent periods surrounding the General Meeting of Shareholders. Specifically, these indicators; before_indicator and after_indicator, were set to 1 during the months leading up to and following the GMS, respectively. This inclusion aims to capture any potential effects that shareholder meetings may have on stock price movements.

The model’s accuracy is evaluated using Mean Absolute Error (MAE) and Mean Absolute Percentage Error (MAPE), ensuring a robust and reliable forecasting framework (Hyndman & Koehler, 2006). To identify the optimal combination of these hyperparameters and features, a grid search approach was implemented. This method systematically tested various configurations, retraining the model for each iteration. The performance of each configuration was evaluated using MAE on a validation dataset corresponding to the years 2024-2025. The optimal set of hyperparameters was selected based on the configuration that minimized MAE, ensuring maximum accuracy.

4. RESULT AND ANALYSIS

Data Collection Process and Research Characteristics

The data used in this study consists of secondary closing price data obtained from a reputable online financial data source. Data collection was conducted by downloading historical datasets from platforms such as Yahoo Finance and subsequently validating the data to ensure its quality and integrity.

This study covers a period from February 2021 to February 2025, representing market dynamics over a four-year span. Although the research is global in nature, most of the data reflects market conditions in the Indonesian market. Thus, the findings of this study can be applied in contexts such as investment planning and market trend analysis.

Data Analysis Results

After data preprocessing, the analysis was carried out using univariate time series forecasting approaches: **Facebook Prophet**.

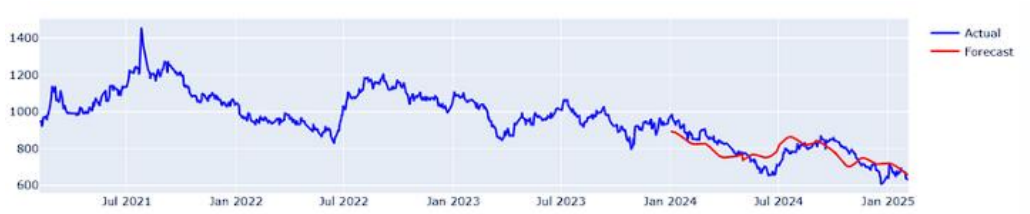

Figure 2. Actual vs Predicted Results

Figure 2 displays a comparison between the actual data and the predicted results from the Prophet model. This figure illustrates that the Prophet model effectively captures long-term trends, including seasonal variations and holiday effects.

Discussion on the Relationship between the Results and Fundamental Concepts

The analysis results support the fundamental concept that historical time series data can be decomposed into trend, seasonal, and residual components. The Prophet model explicitly incorporates this decomposition, as evidenced by the close alignment between the predicted values (y_{hat}) and the historical trends (Figure 2). This finding is consistent with the theory of time series decomposition and the effectiveness of additive models in capturing underlying patterns in stock prices.

Additionally, incorporating new features such as dividend payments and annual general meeting (AGM) dates into the Prophet model further refines its predictive capabilities. The enhanced model demonstrates how external regressors can improve forecasting accuracy by accounting for fundamental financial events that impact stock prices.

Model Performance and Comparison Before and After Tuning

This study examines the performance of the Prophet model in its default configuration and after hyperparameter tuning, as well as with the inclusion of additional financial features. The baseline Prophet model provides a strong fit with historical data, reinforcing the fundamental principles of time series decomposition. However, after hyperparameter tuning, the model shows improved accuracy, suggesting that optimizing parameters such as changepoints, seasonality, and holidays can enhance predictive performance.

Furthermore, integrating dividends and AGM events as external regressors significantly impacts the model's performance. The results indicate that stock price movements are influenced not only by historical trends and seasonality but also by key financial events. This aligns with existing research emphasizing the importance of incorporating domain-specific knowledge into forecasting models for improved predictive power.

Implications of the Research Findings

The findings of this study emphasize the significance of data decomposition in time series forecasting, particularly in understanding stock price movements. By demonstrating the impact of financial events such as dividend distributions and Annual General Meetings (AGMs), the study highlights the necessity of incorporating external factors into forecasting models. Additionally, the research validates that optimizing Prophet's hyperparameters and integrating external regressors can significantly enhance prediction accuracy, reinforcing the theoretical foundation of structured event-based forecasting.

For the financial and investment sectors, the tuned Prophet model offers a more reliable framework for long-term investment planning and portfolio management by improving trend detection and seasonality modeling. Furthermore, incorporating dividends and AGM events into the model provides deeper insights into the influence of corporate actions on stock prices, allowing investors and financial analysts to make more informed, data-driven decisions in navigating market fluctuations.

5. CONCLUSION AND RECOMMENDATION

Conclusion

The stock price prediction model for TOWR using Prophet demonstrates strong performance, with a Mean Absolute Error (MAE) of Rp49.92 and a Mean Absolute Percentage Error (MAPE) of 6.47%, indicating a relatively high level of accuracy. Further analysis reveals that dividend distribution dates and the Annual General Meeting (AGM) significantly influence TOWR stock price fluctuations, triggering market volatility that investors can leverage for more optimal trading strategies.

Recommendations

Monitoring press releases after the Annual General Meeting (AGM) is crucial, as these announcements often contain key information about company strategies, dividend policies, and management changes that can impact stock prices. Investors are advised to follow these updates as part of their fundamental analysis. Additionally, anticipating sell-off trends and post-dividend price declines is essential. After the expired dividend date, stock prices typically decline as dividend-seeking investors sell off their shares, presenting an opportunity to buy at

lower prices or adjust investment strategies to manage market volatility. Understanding the dividend distribution timeline is equally important; the cum date is the last day to purchase shares to be eligible for dividends, while the ex-date marks the first day shares trade without dividend rights. Proper knowledge of these dates allows investors to plan optimal buy/sell strategies. Lastly, leveraging positive market sentiment during the January Effect can be beneficial. Stock prices often rise at the beginning of the year due to renewed investor activity, and entering the market early can help investors capitalize on potential bullish trends.

REFERENCE

Ajiga, D. I., Adeleye, R. A., Tubokirifuruar, T. S., Bello, B. G., Ndubuisi, N. L., & Asuzu, O. F. (2024). Machine learning for stock market forecasting: A review of models and accuracy. *Finance & Accounting Research Journal*, *6*(2). Retrieved February 20, 2025, from https://www.fepbl.com/index.php/farj/article/view/783

Carta, S. M., Consoli, S., Piras, L., Podda, A. S., & Recupero, D. R. (2024). Explainable machine learning exploiting news and domain-specific lexicon for stock market forecasting. *IEEE Access, 9*(1). Retrieved February 20, 2025, from https://ieeexplore.ieee.org/abstract/document/9355141/

Chai, T., & Draxler, R. R. (2014). Root mean square error (RMSE) or mean absolute error (MAE)? – Arguments against avoiding RMSE in the literature. *Geoscientific Model Development*, *7*(3), 1247-1250. https://doi.org/10.5194/gmd-7-1247-2014

Chandra, C., & Budi, S. (2020). Analisis komparatif ARIMA dan Prophet dengan studi kasus dataset pendaftaran mahasiswa baru. *Jurnal Teknik Informatika dan Sistem Informasi*, *6*(2).

Hamdani, A. F., Swanjaya, D., & Helilintar, R. (2023). Facebook Prophet model with Bayesian optimization for USD Index prediction. *Jurnal Nasional UMP*, 293–300.

Hermawan, A., Aditama, F., Ramadhani, L. R., Ilham, N. M., Saputra, A., & Jayanti, N. R. (2024). Analisis segmentasi pelanggan berbasis RFM dan evaluasi efektivitas kampanye pemasaran untuk meningkatkan retensi. *Neptunus, 2*(4). https://doi.org/10.61132/neptunus.v2i4.400

Hyndman, R. J., & Athanasopoulos, G. (2018). *Forecasting: Principles and practice* (2nd ed.). OTexts. https://otexts.com/fpp2/

Jaquart, P., Dann, D., & Weinhardt, C. (2021). Short-term Bitcoin market prediction via machine learning. *The Journal of Finance and Data Science*, *7*(1). Retrieved February 20, 2025, from https://www.sciencedirect.com/science/article/pii/S2405918821000027

Joshi, A., & Mayur, M. (2017). Impact of dividend announcements on stock prices: An analysis of some select sectors. *International Journal of Advanced Research in Management and Social Sciences, 6*(10), 72-83.

Kaninde, S., Mahajan, M., Janghale, A., & Joshi, B. (2022). Stock price prediction using Facebook Prophet. *ITM Web of Conferences, 44*, 03060.

Korganbekova, A. (2018). The impact of dividend announcements on stock prices: Evidence from the U.S. banking sector. *Central European University, Master's Thesis.*

Kumbure, M. M., Lohrmann, C., Luukka, P., & Porras, J. (2022). Machine learning techniques and data for stock market forecasting: A literature review. *Expert Systems with Applications, 197*(1). Retrieved February 2025, from https://www.sciencedirect.com/science/article/pii/S0957417422001452

Lin, C. Y., & Marques, J. A. (2024). Stock market prediction using artificial intelligence: A systematic review of systematic reviews. *Social Sciences & Humanities Open, 9*(1). Retrieved February 20, 2025, from https://www.sciencedirect.com/science/article/pii/S2590291124000615

Makridakis, S., Wheelwright, S. C., & Hyndman, R. J. (2018). *Forecasting: Methods and applications* (5th ed.). Wiley.

Napitupulu, H., Sambas, A., Murniati, A., & Kusumaningtyas, V. A. (2022). Artificial neural network-based machine learning approach to stock market prediction model on the Indonesia Stock Exchange during the COVID-19. *Engineering Letters, 30*(3). Retrieved February 20, 2025, from https://www.researchgate.net/profile/Aceng-Sambas/publication/362983602_Artificial_Neural_Network-Based_Machine_Learning_Approach_to_Stock_Market_Prediction_Model_on_the_Indonesia_Stock_Exchange_During_the_COVID-19

PT Sarana Menara Nusantara Tbk. (2024). Company financial reports and stock performance data. *Yahoo Finance.* Retrieved from https://finance.yahoo.com/quote/TOWR.JK/

Shinde, S. K., & Gawali, D. H. (2018). Stock price prediction using Facebook Prophet. *International Journal of Computer Applications, 182*(21), 32-37. https://doi.org/10.5120/ijca2018917985

Soni, P., Tewari, Y., & Krishnan, D. (2022). Machine learning approaches in stock price prediction: A systematic review. *Journal of Physics: Conference Series, 2161*(1). Retrieved February 20, 2022, from https://iopscience.iop.org/article/10.1088/1742-6596/2161/1/012065/meta

Taylor, S. J., & Letham, B. (2017). Forecasting at scale. *PeerJ Preprints.* https://doi.org/10.7287/peerj.preprints.3190v2

VanBerlo, B., Ross, M. A. S., & Hsia, D. (2021). Univariate long-term municipal water demand forecasting. *arXiv preprint arXiv:2105.08486.* https://arxiv.org/abs/2105.08486

Wibowo, F. D., Dang, T. T., & Wang, C. N. (2022). Forecasting Indonesia stock price using time series analysis and machine learning in R. *Indonesian Scholars Scientific Summit Taiwan Proceeding, 4*(1).