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Indatu Journal of Management and Accounting

Vol. 2, No. 2, 2024

Artificial Intelligence in Islamic Finance: Forecasting Stock Indices with Neural Prophet

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Article History

Received 16 September 2024
Revised 13 November 2024
Accepted 22 November 2024
Available Online 29 November 2024

Keywords:
Stock forecasting
Islamic stock index
Artificial intelligence
Neural Prophet
Financial system stability

Abstract

Ensuring financial system stability is paramount, especially in markets guided by Sharia principles, where investor confidence and adherence to ethical standards play critical roles. The ability to accurately forecast stock movements within this framework not only supports informed investment decisions but also strengthens the overall stability of financial markets. This research employs the innovative Neural Prophet model to predict Islamic stock indices in Indonesia with remarkable accuracy and depth. The model demonstrates its capability not only in accurately forecasting trends but also in detecting subtle fluctuations within three Islamic stock indices: the Jakarta Islamic Index (JII), the Jakarta Islamic Index 70 (JII70), and the Indonesia Sharia Stock Index (ISSI). Visual representations highlight the model's adaptability and advanced foresight, surpassing traditional models. The significance of this research lies in its potential to enhance the precision of stock index predictions, particularly for Islamic stocks, offering stakeholders deeper insights. The model's effectiveness spans both stable and volatile market conditions, making it a valuable tool for informed financial decision-making. Accurate forecasts aid in risk management and support well-informed investment decisions in fluctuating markets, thereby contributing to financial system stability.

1. Introduction

Sharia principles in a company are grounded in Islamic law and emphasize ethical and socially responsible business practices [1, 2]. One of the core principles is the prohibition of riba (interest), meaning companies must avoid interest-based financial transactions and instead utilize Sharia-compliant financing methods, such as profit-sharing (Mudarabah) or joint ventures (Musharakah) [3, 4]. Additionally, companies must avoid engaging in activities deemed haram (forbidden) under Islamic law, such as those related to alcohol, gambling, or pork products [5]. Ethical conduct is paramount, encompassing transparency, honesty, and fairness in all business dealings [6, 7].

Sharia principles also advocate for risk-sharing, structuring financial arrangements to ensure that profits and losses are distributed fairly between parties [8]. This approach promotes equitable financial relationships and

mitigates risk. Companies are encouraged to uphold social responsibility by contributing to community welfare and ensuring fair treatment of employees and customers [9, 10]. The avoidance of gharar (excessive uncertainty) ensures that contracts and agreements are clear and specific, reducing potential disputes [11]. By adhering to these principles, a company not only aligns with Islamic values but also fosters a sustainable and ethical business environment that benefits both the organization and its broader community.

Applying Sharia principles offers several key advantages. Firstly, it fosters ethical business practices by emphasizing transparency, fairness, and social responsibility, which can enhance the company's reputation and build trust with stakeholders [1, 12, 13]. Secondly, adherence to Sharia principles, such as the prohibition of interest and investment in unethical industries, can mitigate financial risks and align the company's operations with moral values, leading to sustainable growth [14–16]. Additionally, it opens access to a niche market of Sharia-compliant investors and customers, potentially expanding the company's market reach and customer base [17, 18]. These advantages contribute to a robust framework for financial management that encourages risk-sharing and equitable distribution of profits, ultimately supporting economic stability and community welfare.

Many Sharia companies in Indonesia operate under Islamic principles, prohibiting activities such as interest-based transactions, gambling, and investing in businesses related to non-halal products [19–21]. These companies are subject to rigorous Sharia compliance standards and are typically monitored by a Sharia supervisory board [22, 23]. Indonesia's Sharia stock market, represented by numerous indices from the Indonesia Stock Exchange (IDX), offers investors opportunities to invest in companies that align with Islamic law [24, 25]. The performance of Sharia-compliant stocks in Indonesia has attracted attention not only from Muslim investors but also from those seeking ethical investment options, contributing to the growth and stability of the country's financial market [26, 27].

The importance of Sharia principles in a company is closely connected to stock forecasting, as these principles can significantly impact financial stability and investor confidence—both of which are crucial for accurate stock predictions. Sharia-compliant practices contribute to financial stability by ensuring that the company's operations align with ethical standards and risk management practices [28]. This stability often leads to more predictable financial performance, which is essential for accurate stock forecasting. Adhering to Sharia principles can also result in fewer financial shocks and less volatility, making the company's stock performance more stable and easier to predict [29, 30].

Furthermore, Sharia principles attract a specific investor base that values ethical and socially responsible investments [31, 32]. This can increase demand for the company's stock among Sharia-compliant investors and potentially enhance stock liquidity and market performance [33, 34]. Forecasting the stock of such a company requires an understanding of the Sharia-compliant market segment and how it influences stock behavior. Additionally, the commitment to transparency, fairness, and social responsibility, as mandated by Sharia principles, can enhance investor trust and confidence [35]. Investors who are confident in a company's ethical practices are more likely to make long-term investments, which can lead to more stable stock prices and predictable trends [36, 37]. Thus, applying Sharia principles not only aligns with ethical standards but also plays a crucial role in shaping the financial metrics and investor perceptions essential for forecasting a company's stock performance.

Predicting stock trends for companies adhering to Sharia principles is a complex endeavor that usually requires a range of analytical and statistical methods [38]. Stock markets are influenced by unpredictable events, such as geopolitical issues, economic changes, and unexpected news [39]. Historically, forecasting in stocks has largely depended on statistical techniques such as Auto-Regressive Integrated Moving Average (ARIMA) [40–43] and Exponential Smoothing [44, 45]. However, these methods have limitations in practical applications due to their reliance on stringent assumptions and specific parameters [46]. Utilizing machine learning algorithms like linear regression, time series models, or more advanced techniques such as neural networks allows for predictions based on historical data and relevant features [47]. Moreover, to enhance forecasting accuracy, it is crucial to involve an expert with deep domain knowledge and expertise in classical time series modeling.

There has been a growing trend toward using deep learning techniques for forecasting recently [48]. Unlike traditional statistical methods, deep learning has the advantage of automatically identifying significant features without requiring extensive domain expertise or manual input [49, 50]. Advances in deep learning tools and prediction models have progressed rapidly, accompanied by a greater reliance on online news and Twitter data for stock market predictions. Additionally, the emergence of graph neural networks that utilize knowledge graph data has introduced new innovations in

this area. Asset management firms are increasingly allocating research funds to artificial intelligence, particularly deep learning models, due to the promising potential for profitability in stock trading [51].

Our primary focus is on applying machine learning and deep learning techniques to the Sharia stock market. In recent years, deep learning has achieved remarkable success, driven by the abundance of big data from the Web, the parallel processing power of graphics processing units (GPUs), and advancements in convolutional neural networks. This success is evident across various applications, including image classification [52], object detection [53], and time series prediction [54, 55]. Deep learning models are particularly adept at managing large datasets and capturing complex, nonlinear relationships between input features and prediction targets, outperforming both linear and traditional machine learning models, especially in stock market prediction tasks.

However, deep learning models have been criticized for their lack of transparency, and understanding their decision-making processes continues to be a major research focus in forecasting [56]. Additionally, using these models typically requires substantial effort in data preprocessing and hyperparameter tuning [57]. A promising solution to this issue is the Neural Prophet method, which combines the strengths of deep learning with the interpretability and user-friendliness of traditional techniques.

Neural Prophet, another forecasting tool developed by Facebook, leverages neural networks to model and predict time series data. Unlike Facebook Prophet, which primarily uses a curve-fitting approach with additive components suited for datasets with strong seasonality and holidays, Neural Prophet aims to capture more intricate patterns and relationships through neural networks, potentially offering enhanced performance for certain types of data [58]. The key distinction between the two lies in their methodologies: Facebook Prophet focuses on additive models, while Neural Prophet utilizes neural networks to address nonlinear patterns and irregular changes in data [59]. Developed using PyTorch [60], Neural Prophet integrates advanced techniques such as automatic model selection, feature engineering, and uncertainty estimation, which enhance its robustness and reliability for accurate predictions [61]. Its ability to handle complex temporal patterns has garnered significant interest, establishing Neural Prophet as a highly promising framework for forecasting time series data [62, 63].

The main objective of this research is to apply the Neural Prophet model to accurately predict the stock performance of Sharia-compliant companies, represented as indices. We analyzed historical data from various Islamic stock indices in Indonesia to understand complex correlations and patterns. Forecasting the stock of Sharia-compliant companies using the Neural Prophet model can significantly contribute to financial system stability in Indonesia by enhancing financial planning and strengthening investor confidence. This novel method promotes ethical investments by adhering to Sharia principles, reducing speculation, and encouraging more stable financial practices. By increasing the predictability and attractiveness of Sharia-compliant stocks, it supports financial inclusion and broadens market participation, fostering a more robust and equitable financial environment. Additionally, by identifying trends and risks specific to Sharia-compliant companies, the method can minimize market volatility, further contributing to financial system stability.

2. Literature Review

The incorporation of Sharia principles into financial and business practices has garnered significant scholarly interest, particularly in Islamic finance and ethical investing. Grounded in Islamic law, these principles promote ethical and socially responsible business practices, influencing corporate governance, financial performance, and market behavior. Farooq & Ahmed [64] found that Sharia-compliant firms exhibit significantly higher levels of synchronicity compared to their non-compliant counterparts, highlighting the distinct market behavior of firms adhering to Islamic principles.

This section presents relevant studies related to our topic, beginning with traditional forecasting approaches. Ghaemi Asl et al. [65] was the first to forecast the time-varying return and volatility connectedness between oil prices and Islamic stock indices in seven oil-exporting countries (Iran, Oman, Saudi Arabia, Qatar, Kuwait, Bahrain, UAE). Using a Bayesian time-varying parameter VAR (BTVP-VAR) model for connectedness analysis and a cascade-forward backpropagation network for forecasting, the study found that Iran's Islamic stock index is disconnected from both the oil market and other countries' indices, while the UAE and Saudi Arabia lead the network. Connectedness increased during crises, underscoring the importance of spillovers in predicting total network connectedness.

Similarly, Wijayanti et al. [66] examined the impact of macroeconomic shocks on Sharia and sustainable indices—ISSI, JII, and SKEHATI—on the Indonesia Stock Exchange using VAR/VECM analysis. Analyzing 10 years of

data, the study found that JII responds more quickly to macroeconomic changes compared to ISSI and SKEHATI, with SKEHATI playing a dominant role in influencing the Sharia indices. These insights are crucial for guiding investors and stakeholders during market fluctuations.

Khairunnisa et al. [67] aimed to forecast Islamic stock market indices in six countries—Indonesia, Thailand, Malaysia, Pakistan, the UAE, and Qatar—using the ARIMA model. By analyzing monthly data from 2013 to 2023, the study provided 25-month predictions and insights into potential price trends. The research demonstrated the predictability of index prices through historical data, supporting the Efficient Market Hypothesis (EMH) in these Islamic markets.

In another study, Mu'arrif [68] analyzed and forecasted the market capitalization of the Jakarta Islamic Index through 2028 using the ARIMA method. By examining historical data from 2011 to 2024, the study identified key drivers of Islamic capital market growth, including rising investor interest, innovation in Islamic financial products, and stable macroeconomic conditions. The findings reveal a strong positive growth trend, offering valuable insights for investors, analysts, and policymakers.

In addition to traditional methods, several researchers have explored Sharia stock forecasting using machine learning approaches. For instance, Ghaemi Asl et al. [65] highlighted the importance of forecasting stock prices for informed investment decisions, particularly given financial market unpredictability. This study used a model based on Long Short-Term Memory (LSTM) networks combined with maximum overlap discrete wavelet transformation (MODWT) to predict oil and gas stocks in Islamic and conventional markets before and during COVID-19. The model was found to be more accurate during the crisis and generally more precise for conventional stocks.

Similarly, Budiprasetyo et al. [69] explored the prediction of Sharia stock prices using LSTM models, finding that the number of layers significantly impacts the Mean Absolute Percentage Error (MAPE). The study identified an 8-layer LSTM model as the most effective, achieving the lowest MAPE for stocks such as PT Aneka Tambang Tbk, Erajaya Swasembada Tbk, Kalbe Farma, Semen Indonesia, and Wijaya Karya.

Several studies have explored the use of Neural Prophet for forecasting, showcasing its effectiveness across various contexts. For example, Ghosh & Jana [70] used Neural Prophet to predict clean energy stock prices, while Noviandy et al. [71] applied it to forecast Bitcoin prices. Both studies demonstrated that Neural Prophet offers highly accurate predictions, highlighting its robustness and precision in financial forecasting. However, this approach has yet to be applied to Sharia-compliant stocks.

Despite significant advancements in machine learning and deep learning techniques, particularly with the Neural Prophet model, their application in forecasting Sharia-compliant stock performance remains largely unexplored. Most existing studies have focused on traditional statistical methods or basic machine learning models, leaving a gap in understanding how sophisticated models like Neural Prophet can predict the unique behaviors of Sharia-compliant stocks. This is particularly relevant in the context of Indonesia's Sharia stock market, where region-specific studies are critically needed. Furthermore, the influence of Sharia principles on the accuracy and effectiveness of these advanced predictive models has not been thoroughly examined.

This research aims to fill these gaps by being the first to apply the Neural Prophet model to forecast the stock performance of Sharia-compliant companies in Indonesia, represented as indices. By doing so, it seeks to enhance the understanding of how machine learning models can be tailored to align with ethical investment practices central to Sharia principles. This study not only contributes to the academic literature on financial forecasting but also offers practical insights that can support the sustainable growth of ethical investments, thereby fostering a more robust and equitable financial environment in Sharia-compliant markets.

3. Materials and Methods

3.1. Dataset

This study selected the Islamic stock index from the Indonesia Stock Exchange (IDX) to test the chosen Neural Prophet model for forecasting. Since the objective of this study is to apply a novel method to accurately predict Islamic stock trends, Indonesia's Islamic stock index is a suitable choice as it aligns with the study's purpose. This index is a statistical measure reflecting the price movements of a group of Islamic stocks in Indonesia. The selection of sharia stocks is conducted by the Financial Services Authority (OJK) through the issuance of the List of Sharia Securities (DES). Currently, there are five sharia stock indices in the Indonesian capital market: the Jakarta Islamic Index, Jakarta Islamic Index 70, Indonesia Sharia Stock Index, IDX-MES BUMN 17, and IDX Sharia Growth. However, this study excludes IDX-MES BUMN 17 and IDX Sharia Growth because these indices were introduced later than the other three and have a shorter time range, which is less suitable for forecasting with Neural Prophet, as this method requires a larger dataset to be effective. The study utilizes daily data, covering the period from

January 2019 to May 2024, based on the latest available data from IDX at the time this article was written [72].

The Jakarta Islamic Index (JII), launched on July 3, 2000, is Indonesia's first Islamic stock index. It comprises the 30 most liquid Islamic shares listed on the IDX. Similar to the ISSI, the JII's constituents are reviewed twice a year, in May and November, according to the DES review schedule set by the OJK. The IDX determines and selects the Islamic shares included in the JII using specific liquidity criteria. First, the sharia stocks must be part of the Indonesia Sharia Stock Index (ISSI) and have been listed for at least six months. From these, the 60 stocks with the highest average market capitalization over the past year are identified, and then 30 of these are selected based on their highest average daily transaction value in the regular market. These 30 stocks constitute the JII [24].

The Jakarta Islamic Index 70 (JII70) is a sharia stock index launched by the IDX on May 17, 2018. It features the 70 most liquid sharia stocks listed on the IDX. The JII70 constituents are reviewed twice a year, in May and November, following the DES review schedule set by the OJK. The IDX determines and selects the sharia stocks that make up the JII70 using specific liquidity criteria. To be eligible, sharia stocks must be part of the ISSI and have been listed for at least six months. From these, the 150 stocks with the highest average market capitalization over the past year are identified, and then 70 of these are selected based on their highest average daily transaction value in the regular market. These 70 stocks form the JII70 index [24].

The Indonesia Sharia Stock Index (ISSI), launched on May 12, 2011, is a composite index representing Islamic stocks listed on the IDX. ISSI serves as a benchmark for the performance of the Islamic stock market on the IDX. The index comprises all sharia-compliant shares that are part of the DES issued by the OJK and listed on the IDX's main and development boards. Similar to the JII70, ISSI's constituents are re-evaluated twice annually, in May and November, in line with the DES review schedule. Consequently, Islamic stocks may be added to or removed from ISSI during each selection period. The ISSI is calculated using the same method as other IDX indices, applying a market capitalization-weighted average with December 2007 as the base year [24].

3.2. Neural Prophet

Neural Prophet is a state-of-the-art forecasting model that combines the strengths of neural networks and Prophet, a widely-used time series forecasting tool developed by Facebook. Neural Prophet extends the capabilities of Prophet by incorporating deep learning techniques, allowing it to capture complex patterns and interactions in time series data that traditional methods might miss. This model is particularly adept at handling non-linear relationships and seasonal variations, which are common in financial data such as stock prices and economic indicators [61].

The architecture of Neural Prophet consists of a combination of a feedforward neural network and a Prophet-like decomposable model. The feedforward neural network component enhances the model's ability to learn intricate patterns and interactions, while the Prophet component ensures robustness in handling seasonality and holiday effects. This hybrid approach makes Neural Prophet a powerful tool for forecasting in dynamic environments [59].

3.3. Performance Evaluation

To evaluate the performance of the Neural Prophet models, several metrics are utilized, including Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), and Mean Absolute Percentage Error (MAPE). Each of these metrics provides unique insights into the accuracy and reliability of predictions. RMSE measures the average magnitude of forecasting errors by taking the square root of the average of the squared differences between observed and predicted values [73]. This metric is particularly useful for assessing overall accuracy and is sensitive to larger errors, thus highlighting models that may struggle with extreme values. In contrast, MAE calculates the average of the absolute differences between predicted and actual values, offering a clear indication of average prediction error and being less influenced by outliers. MAPE expresses prediction accuracy as a percentage of the actual values, facilitating comparison across different datasets and scales. By analyzing these metrics, we can gain a comprehensive understanding of how well Neural Prophet performs in capturing trends and making accurate predictions. The equations for RMSE, MAE, and MAPE are provided in Equations 1-3 [71].

$$RMSE(y,\hat{y}) = \sqrt{\frac{1}{n_{samples}} \sum_{i=0}^{n_{samples}-1} (y_i - \hat{y}_i)^2} \quad (1)$$

$$MAE(y,\hat{y}) = \frac{1}{n_{samples}} \sum_{i=0}^{n_{samples}-1} |y_i - \hat{y}_i| \quad (2)$$

$$MAPE(y,\hat{y}) = \frac{1}{n_{samples}} \sum_{i=0}^{n_{samples}-1} \frac{|y_i - \hat{y}_i|}{\max(\epsilon, |y_i|)} \quad (3)$$

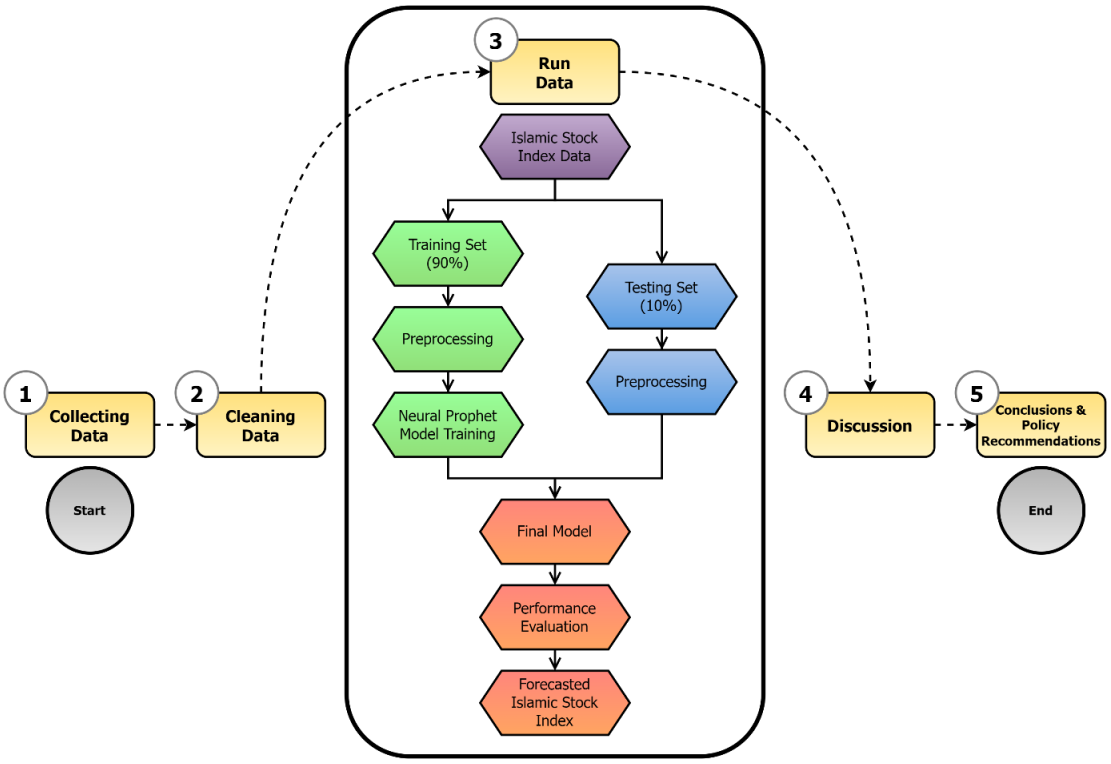

Figure 1. Workflow of the research.

Table 1. Forecasting performance of Neural Prophet model.

Index Symbol	RMSE		MAE		MAPE	
	Training Set	Testing Set	Training Set	Testing Set	Training Set	Testing Set
JII	23.214	25.585	16.301	22.616	0.028	0.043
JII70	7.957	9.260	5.642	8.261	0.029	0.046
ISSI	5.857	5.774	4.252	5.185	0.024	0.025

3.4. Stages of the Research Process

Figure 1 illustrates the workflow for forecasting the Islamic Stock Index using a Neural Prophet model. The process begins with data collection and cleaning, followed by splitting the data into training (90%) and testing (10%) sets. Both sets undergo preprocessing to ensure suitability for modeling. The training set is used to train the model, while the testing set evaluates its performance. Once trained, the model generates forecasts, which are analyzed and discussed. The process concludes with drawing insights and making policy recommendations, highlighting a systematic approach to data handling, model training, and stock trend prediction.

4. Results and Discussion

4.1. Training the Neural Prophet Model

In this study, the Neural Prophet model was successfully trained through an iterative process involving 100 epochs. This extensive training ensured that the model could learn the complex relationships within the data, allowing for better generalization and minimizing prediction errors. Prior to the training process, the data was scaled using the min-max method, which transformed the stock price variables to a range between 0 and 1. This scaling was implemented to enhance model convergence time and stability. After the training was completed, the data was automatically restored to its original scale.

The performance of the Neural Prophet model across different stock indices is summarized in Table 1, focusing on key metrics such as Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), and Mean Absolute Percentage Error (MAPE) for both the training and testing sets. For the JII, the model achieved an RMSE of 23.214 on the training set and 25.585 on the testing set. The MAE values were 16.301 and 22.616, respectively. These results indicate that while the model performed reasonably well on the training data, there was a noticeable increase in error when applied to the testing set. The MAPE values of 0.028 for the training set and 0.043 for the testing set suggest that the model's predictions were generally accurate, with a slightly higher

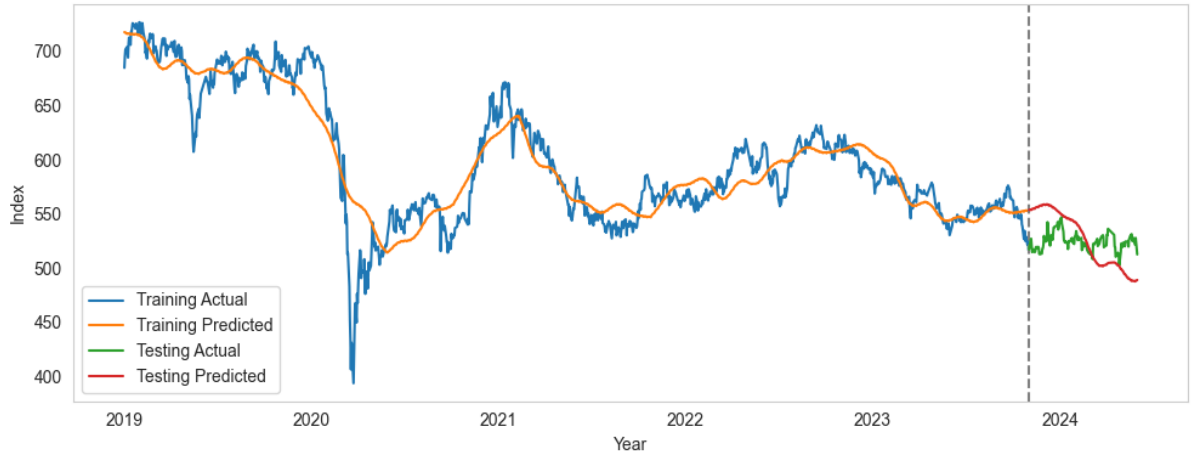

Figure 2. Forecasting results of JII with Neural Prophet.

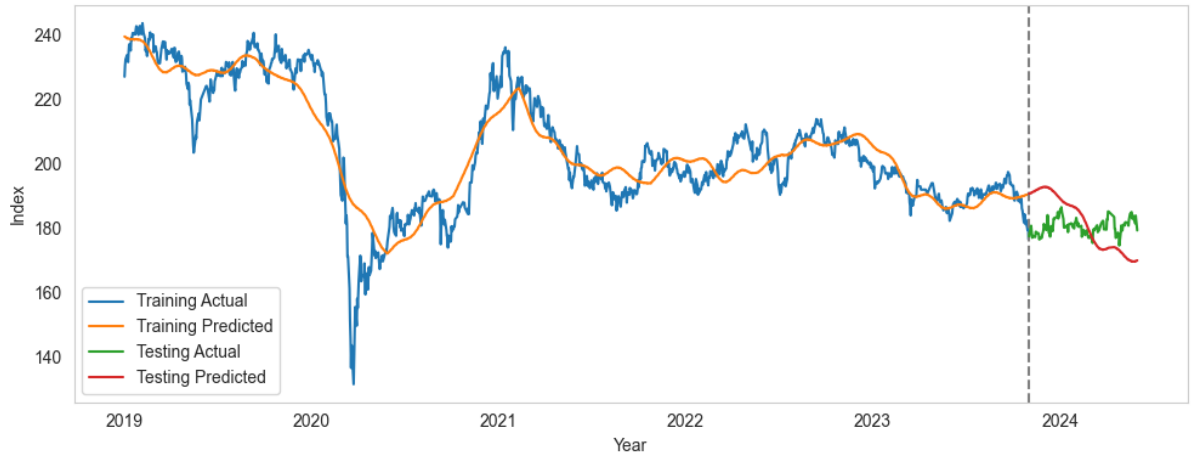

Figure 3. Forecasting results of JII70 with Neural Prophet.

Figure 4. Forecasting results of ISSI with Neural Prophet.

error in the testing phase, likely due to the complex nature of the index's movements.

In the case of the JII70, the RMSE values were 7.957 for the training set and 9.260 for the testing set, with corresponding MAE values of 5.642 and 8.261. The model exhibited a slight increase in error from training to testing, but the MAPE remained low at 0.029 for the training set and 0.046 for the testing set. This indicates that the model maintained a consistent performance across both datasets, with only a minor degradation in accuracy when predicting unseen data.

Lastly, the ISSI, the RMSE was 5.857 for the training set and 5.774 for the testing set, reflecting minimal change in error between the two datasets. The MAE values were

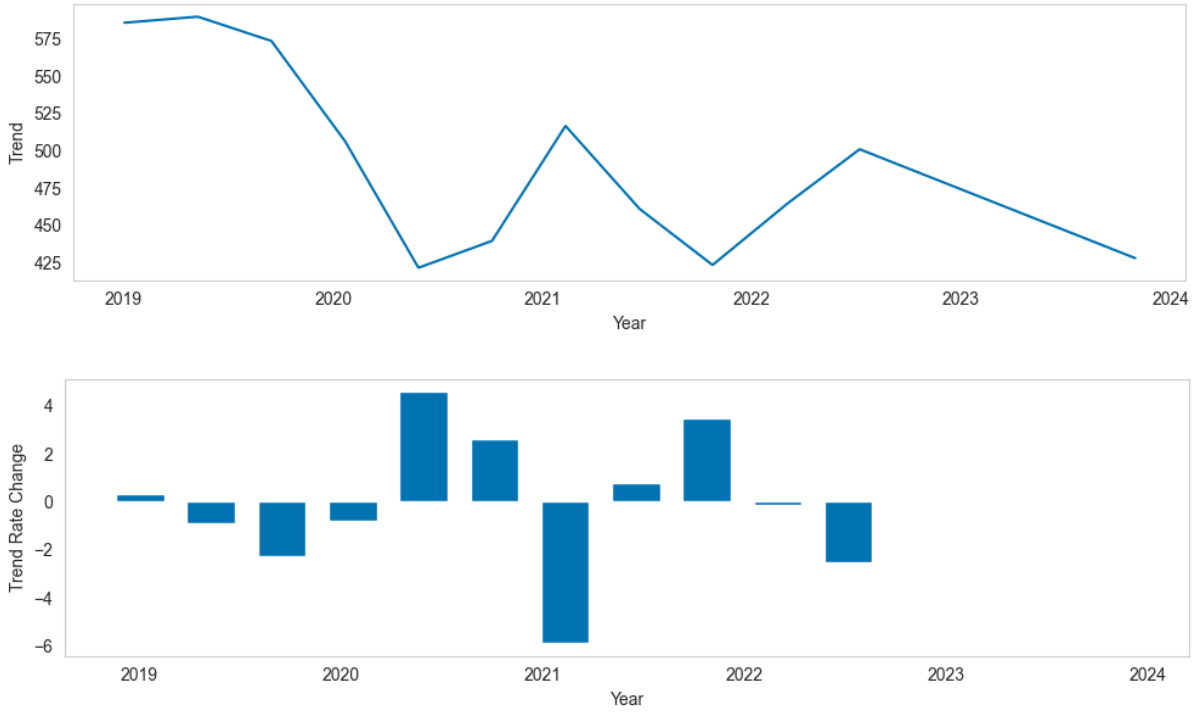

Figure 5. Trend and rate of change for JII.

similarly close, at 4.252 for the training set and 5.185 for the testing set. The low MAPE values of 0.024 and 0.025 further demonstrate the model's strong performance in predicting this index, with almost negligible difference between training and testing phases, indicating that the model generalizes well.

4.2. Results of Neural Prophet Forecasting

The actual versus forecasted values for the JII, JII70, and ISSI are visually presented in Figures 2 to 4. These figures show the model's performance in predicting both the training and testing datasets.

For the JII (Figure 2), the Neural Prophet model demonstrated a strong ability to track the actual values during both the training and testing periods. The model was able to capture the overall trends and smaller fluctuations within the index data, with only minor deviations observed in the testing phase. This indicates that the model successfully identified and learned the key patterns in the data, allowing it to make accurate forecasts even when applied to unseen data.

In the case of the JII70 (Figure 3), the model similarly performed well, closely following the actual values during the training period. While there was a slight divergence in the testing period, the forecasted values remained within a reasonable range of the actual data. This suggests that the Neural Prophet model was effective in modeling the dynamics of this index, although some challenges may exist in predicting the more complex movements observed in the testing phase.

The performance of the Neural Prophet model on the ISSI index (Figure 4) was particularly strong, with the model effectively capturing both the upward and downward trends within the data. The alignment between the actual and predicted values was consistent across both the training and testing sets, demonstrating the model's capability to generalize well across different time periods and market conditions. This consistency highlights the model's robustness in handling various market dynamics.

4.3. Index Trend Fluctuation

In addition to the forecasting results, we also present the trends and rates of change for the JII, JII70, and ISSI, as illustrated in Figures 5 through 7. These figures are intended to enhance the comprehensiveness of our analysis by providing a deeper understanding of the underlying dynamics and temporal shifts within each index over the study period.

Figure 5 presents the trend and rate of change for the JII. The overall trend indicates a declining pattern from 2019 to 2024, with notable fluctuations in 2021 and 2023, where the index experienced brief recoveries. The rate of change plot highlights the most significant shifts occurring in 2021, where the index saw a substantial positive rate of change, followed by a sharp decline in 2022 and 2023. This suggests that the index was highly volatile during this period, reflecting broader economic uncertainties and market conditions.

In Figure 6, the JII70 also exhibits a downward trend over the same period, similar to the JII. The trend line shows a

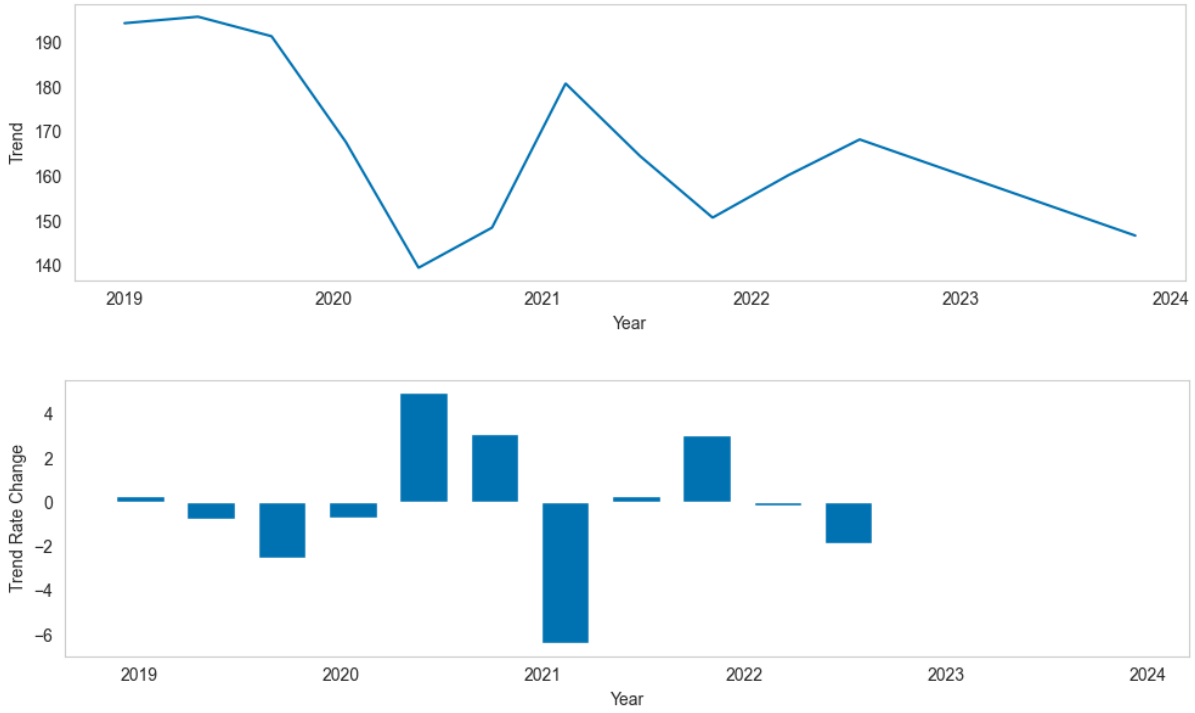

Figure 6. Trend and rate of change for JII70.

general decrease in the index's value, with a temporary recovery observed in 2021 and 2023. The rate of change for this index mirrors the pattern seen in the JII, with significant positive changes in 2021 followed by a downturn in subsequent years. This indicates that both indices reacted similarly to market conditions during this period, possibly due to their overlapping constituents and the broader economic context.

The ISSI, as shown in Figure 7, presents a more mixed trend compared to the previous indices. While the overall trend line suggests a gradual recovery from 2020 onwards, the rate of change plot reveals significant fluctuations, particularly in 2021, where there was a marked positive shift followed by relative stability in the following years. This suggests that the index was more resilient to market shocks, managing to maintain a steady growth trajectory despite the volatility observed in 2021.

4.4. Discussion

The results of this study demonstrate the effectiveness of the Neural Prophet model in forecasting Sharia-compliant stock indices, specifically the JII, JII70, and ISSI. The model's ability to accurately predict both the training and testing datasets across all indices highlights its potential as a powerful tool for financial forecasting, particularly in the context of Islamic finance.

One of the key findings is the consistency in performance across different indices, as evidenced by the low MAPE values, which remained below 0.050 in all cases. This indicates that the Neural Prophet model was able to maintain a high level of accuracy even when applied to unseen data, suggesting strong generalization capabilities. The minimal discrepancy between training and testing errors further supports the model's robustness, particularly in the ISSI index, where the RMSE and MAE values showed negligible variation between the two datasets.

The slightly higher error rates observed in the JII and JII70 indices during the testing phase may be attributed to the inherent volatility and complexity of these indices, which contain a larger number of stocks and are more sensitive to market fluctuations. Despite this, the Neural Prophet model still demonstrated a commendable ability to track and predict the overall trends and minor fluctuations in these indices, highlighting its adaptability to different market conditions.

In comparison to traditional forecasting methods like ARIMA and Exponential Smoothing, the Neural Prophet model offers several advantages, particularly in dealing with complex, non-linear time series data. Its ability to automatically handle seasonality, trend changes, and external factors such as holidays, combined with the flexibility of neural networks, makes it a versatile tool for financial forecasting. However, the slight increase in error observed in the testing phase for some indices suggests that further refinement of the model could potentially improve its accuracy.

The findings of this research hold significant implications for investors, particularly those involved in

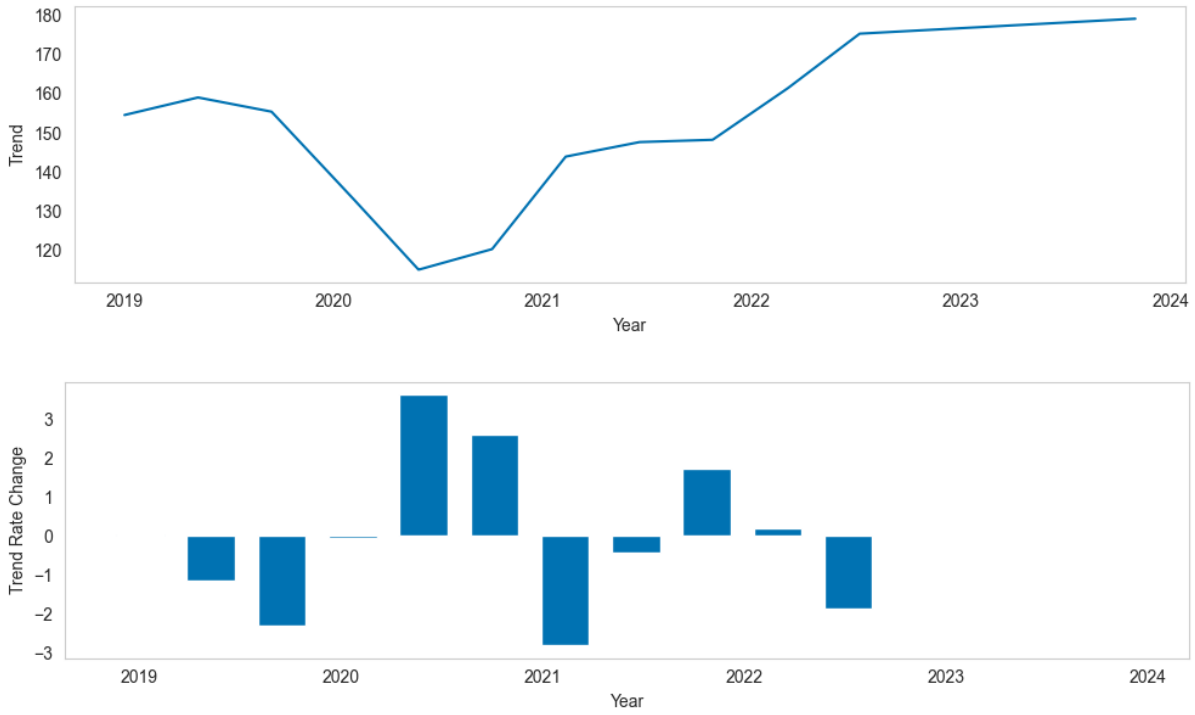

Figure 7. Trend and rate of change for ISSI.

Sharia-compliant markets. The demonstrated effectiveness of the Neural Prophet model in forecasting key indices such as the JII, JII70, and ISSI suggests that this model can serve as a powerful tool for predicting market movements in Islamic finance. The model's consistent performance across all indices indicates its reliability and potential for application in real-world scenarios. This level of accuracy, even with unseen data, provides investors with a robust forecasting method that could enhance decision-making processes [71].

Particularly in the context of Islamic finance, the findings of this research have important implications for financial system stability. The Neural Prophet model's ability to accurately forecast the selected Sharia-compliant stock indices provides a reliable tool for anticipating market trends and potential fluctuations. This predictive accuracy is crucial for maintaining stability within the financial system, as it allows regulators, policymakers, and financial institutions to better anticipate and mitigate risks associated with market volatility. The model's robustness, demonstrated by its low error rates and consistent performance across different indices, supports its use in monitoring and managing financial markets, thereby reducing the likelihood of unforeseen shocks that could disrupt financial stability. By offering a more sophisticated method for forecasting, this study contributes to enhancing the resilience of financial systems, ensuring they can better withstand periods of stress and uncertainty, ultimately safeguarding the overall economic environment [70, 71].

5. Conclusions, Implications and Limitations

The findings of this study underscore the proven effectiveness of the Neural Prophet model in forecasting Indonesia's Sharia-compliant stock indices, specifically the Jakarta Islamic Index (JII), Jakarta Islamic Index 70 (JII70), and the Indonesia Sharia Stock Index (ISSI). The model's accuracy in predicting both training and testing datasets across all indices confirms its robustness as a financial forecasting tool within Islamic finance. Notably, the low Mean Absolute Percentage Error (MAPE) values, consistently below 0.050, indicate the model's strong performance in minimizing forecasting errors relative to actual values, demonstrating its reliability in handling unseen data. The negligible variation between training and testing errors, particularly for the ISSI index, further attests to the model's precision. Although higher error rates were observed in the JII and JII70 indices, likely due to their inherent volatility and complexity, the Neural Prophet model effectively tracked and predicted trends and minor fluctuations. This adaptability highlights the model's potential to provide valuable insights across diverse market conditions, reinforcing its utility in Islamic financial forecasting and contributing to overall financial system stability.

Based on the powerful capabilities of the Neural Prophet model in forecasting selected Sharia-compliant stock indices, financial experts should consider integrating this advanced forecasting tool into their investment strategies. The model's high accuracy and adaptability across different market conditions can enhance portfolio

management by providing more reliable predictions of stock performance. Investment managers should leverage the model's capabilities to refine their asset allocation, optimize investment timing, and manage risks more effectively. Regularly incorporating the Neural Prophet model into financial analysis can improve the accuracy of forecasts and enable analysts to make more informed decisions, particularly in volatile and complex market environments. Additionally, professionals should stay updated on advancements and refinements in forecasting methodologies to continuously enhance their investment strategies.

Policy decision-makers should advocate for the adoption of innovative forecasting tools like the Neural Prophet model within regulatory frameworks to enhance market stability and investor confidence. Supporting initiatives that promote the integration of such advanced models into financial institutions' risk management and regulatory practices is essential. Decision-makers should also consider establishing guidelines for the application of predictive analytics in monitoring Sharia-compliant financial products, ensuring these tools are used to mitigate market volatility and enhance transparency. Furthermore, encouraging collaboration between academic researchers and financial institutions can facilitate the development and implementation of cutting-edge forecasting methods, thereby strengthening the resilience of the financial system. Regularly updating regulatory frameworks to accommodate technological advancements in financial forecasting can contribute to a more stable and robust financial environment.

Despite the promising results, this study has several limitations that warrant consideration. It primarily focused on Indonesia's Sharia-compliant stock indices, which limits the generalizability of the findings to other markets or financial systems. Furthermore, the study did not examine external factors, such as macroeconomic conditions or market sentiment, that could influence the indices' movements and potentially affect the model's forecasting performance. Addressing these limitations in future research could enhance the model's applicability and provide a more comprehensive understanding of its capabilities in diverse financial contexts.

Author Contributions: Conceptualization, M.M.; methodology, A.M.; software, M.M. and A.M.; validation, M.M. and G.M.I.; formal analysis, G.M.I. and A.M.; investigation, A.M.; resources, M.M.; data curation, G.M.I.; writing—original draft preparation, M.M. and G.M.I.; writing—review and editing, M.M. and G.M.I.; visualization, G.M.I.; supervision, A.M.; project administration, A.M. All authors have read and agreed to the published version of the manuscript.

Funding: This study does not receive external funding.

Data Availability Statement: The data is available for free download on the official Indonesia Stock Exchange (IDX) website.

Acknowledgments: The authors would like to express their gratitude to their respective institutions.

Conflicts of Interest: All the authors declare that there are no conflicts of interest.

References

1. Mohd Zain, F. A., Muhamad, S. F., Abdullah, H., Sheikh Ahmad Tajuddin, S. A. F., and Wan Abdullah, W. A. (2024). Integrating Environmental, Social and Governance (ESG) Principles with Maqasid Al-Shariah: A Blueprint for Sustainable Takaful Operations, *International Journal of Islamic and Middle Eastern Finance and Management*, Vol. 17, No. 3, 461–484. doi:10.1108/IMEFM-11-2023-0422.
2. Jaballah, J., Peillex, J., and Weill, L. (2018). Is Being Sharia Compliant Worth It?, *Economic Modelling*, Vol. 72, 353–362. doi:10.1016/j.econmod.2018.02.011.
3. Rahman, M. H. (2018). Mudarabah and its Applications in Islamic Finance: An Analysis, *Asian Journal of Research in Banking and Finance*, Vol. 8, No. 6, 33. doi:10.5958/2249-7323.2018.00042.1.
4. Yustiardhi, A. F., Diniyya, A. A., Faiz, F. A. A., Subri, N. S., and Kurnia, Z. N. (2020). Issues and Challenges of the Application of Mudarabah and Musharakah in Islamic Bank Financing Products, *Journal of Islamic Finance*, Vol. 9, No. 2, 26–41. doi:10.31436/jif.v9i2.482.
5. Che Azmi, A., Ab Aziz, N., Non, N., and Muhamad, R. (2016). Sharia Disclosures: An Exploratory Study from the Perspective of Sharia-Compliant Companies and Professional Users, *Journal of Islamic Accounting and Business Research*, Vol. 7, No. 3, 237–252. doi:10.1108/JIABR-03-2016-0029.
6. Ibrahim, M., and Idris, S. (2023). Islamic Work Ethics in Modern Organizations: The Mediating Role of Organizational Culture, *Indatu Journal of Management and Accounting*, Vol. 1, No. 2, 43–50. doi:10.60084/ijma.v1i2.93.
7. Sikdar, A., Bani, N. Y. binti M., Salimullah, A. H. M., Majumder, S. C., Idroes, G. M., and Hardi, I. (2024). Energy Poverty and Environmental Quality Nexus: Empirical Evidence from Selected South Asian Countries, *Ekonomikalia Journal of Economics*, Vol. 2, No. 2, 119–135. doi:10.60084/eje.v2i2.221.
8. Khalifah, M. H., Aslan, H., and Abdullah, A. (2024). Challenges in the Implementation of Mudharabah Financing in the Islamic Banking Industry, *Equinox Journal of Economics Business and Political Studies*. doi:10.48064/equinox.1341793.
9. Ray, S., and Hardi, I. (2024). Refining ESG Disclosure's Role in Corporate Economic, Environmental, and Social Sustainability Performance, *Indatu Journal of Management and Accounting*, Vol. 2, No. 1, 1–8. doi:10.60084/ijma.v2i1.144.
10. Noviandy, T. R., Idroes, G. M., and Hardi, I. (2024). Enhancing Loan Approval Decision-Making: An Interpretable Machine Learning Approach Using LightGBM for Digital Economy Development, *Malaysian Journal of Computing (MJOC)*, Vol. 9, No. 1, 1734–1745. doi:10.24191/mjoc.v9i1.25691.
11. Elhessi, A. R., Youssef, A. A., and Ragheb, M. A. (2018). Gharar in Futures Contracts from Islamic Perspective: A Case Study of USA & Malaysia, *Journal of Governance and Regulation*, Vol. 7, No. 3, 18–30. doi:10.22495/jgr_v7_i3_p3.
12. Rohali, Y., Basri, Y. Z., Ismail, R., and Dwi Septian, R. A. (2022). Factors Affecting the Decision-Making of Indonesian Sharia Banking Companies, *ADI Journal on Recent Innovation (AJRI)*, Vol. 4, No. 1, 13–25. doi:10.34306/ajri.v4i1.725.
13. Judijanto, L., Ansori, T., and Rusdi, R. (2024). Analysis of the Effects of Sharia Governance and Corporate Social Responsibility on Corporate Reputation and Financial Performance in Indonesian Sharia Multinational Companies,

West Science Interdisciplinary Studies, Vol. 2, No. 05, 1128–1140. doi:10.58812/wsis.v2i05.932.

14. Rizki, M. K., Agriyanto, R., and Farida, D. N. (2019). The Effect of Sustainability Report and Profitability on Company Value: Evidence from Indonesian Sharia Shares, *Economica: Jurnal Ekonomi Islam*, Vol. 10, No. 1, 117–140. doi:10.21580/economica.2019.10.1.3747.

15. Noviandy, T. R., Idroes, G. M., Hardi, I., Afjal, M., and Ray, S. (2024). A Model-Agnostic Interpretability Approach to Predicting Customer Churn in the Telecommunications Industry, *Infolitika Journal of Data Science*, Vol. 2, No. 1, 34–44. doi:10.60084/ijds.v2i1.199.

16. Bunnag, T. (2024). The Importance of Gold's Effect on Investment and Predicting the World Gold Price Using the ARIMA and ARIMA-GARCH Model, *Ekonomikalia Journal of Economics*, Vol. 2, No. 1, 38–52. doi:10.60084/eje.v2i1.155.

17. Said, R., Abd Samad, K., Mohd Sidek, N. Z., Ilias, N. F., and Omar, N. (2018). Corporate Social Responsibility Disclosure Index of Malaysian Shariah – Compliant Companies, *International Journal of Ethics and Systems*, Vol. 34, No. 1, 55–69. doi:10.1108/IJOES-09-2016-0068.

18. Faizi, F. (2024). How Are Islamic Banking Products Developed? Evidence from Emerging Country, *Cogent Economics & Finance*, Vol. 12, No. 1. doi:10.1080/23322039.2024.2378961.

19. Hati, S. R. H., Prasetyo, M. B., and Hendranastiti, N. D. (2023). Sharia vs Non-Sharia Compliant: Which Gives Much Higher Financial-Based Brand Equity to the Companies Listed in the Indonesian Stock Market?, *Journal of Islamic Marketing*, Vol. 14, No. 9, 2167–2187. doi:10.1108/JIMA-08-2021-0251.

20. Hardi, I., Ali, N., Duwal, N., Devi, N. C., Mardayanti, U., and Idroes, G. M. (2024). Business Confidence in Indonesia: Which Macroeconomic Factors Have Long-Term Impact?, *Indatu Journal of Management and Accounting*, Vol. 2, No. 1, 40–54. doi:10.60084/ijma.v2i1.203.

21. Hardi, I., Afjal, M., Can, M., Idroes, G. M., Noviandy, T. R., and Idroes, R. (2024). Shadow Economy, Energy Consumption, and Ecological Footprint in Indonesia, *Sustainable Futures*, Vol. 8, 100343. doi:10.1016/j.sftr.2024.100343.

22. Financial Services Authority. (2024). Sharia IKNB.

23. Hardi, I., Idroes, G. M., Hardia, N. A. K., Fajri, I., Furqan, N., Noviandy, T. R., and Utami, R. T. (2023). Assessing the Linkage Between Sustainability Reporting and Indonesia's Firm Value: The Role of Firm Size and Leverage, *Indatu Journal of Management and Accounting*, Vol. 1, No. 1, 21–28. doi:10.60084/ijma.v1i1.79.

24. Indonesia Stock Exchange. (2024). Islamic Stock Index.

25. Hardi, I., Idroes, G. M., Utami, R. T., Dahlia, P., Mirza, M. A. F., Humam, R. A., Chairunnisa, R., Hardia, N. A. K., and Mahdani, R. (2023). Dynamic Impact of Inflation and Exchange Rate in Indonesia's Top 10 Market Capitalization Companies: Implications for Stock Prices, *Indatu Journal of Management and Accounting*, Vol. 1, No. 2, 51–59. doi:10.60084/ijma.v1i2.110.

26. Nindiasari, A. D. (2021). Good Corporate Governance Practices and Voluntary Disclosure in Companies Listed in the Indonesia Sharia Stock Index (ISSI), *Asian Journal of Islamic Management (AJIM)*, Vol. 3, No. 1, 45–55. doi:10.20885/ajim.vol3.iss1.art5.

27. Noviandy, T. R., Hardi, I., Zahriah, Z., Sofyan, R., Sasmita, N. R., Hilal, I. S., and Idroes, G. M. (2024). Environmental and Economic Clustering of Indonesian Provinces: Insights from K-Means Analysis, *Leuser Journal of Environmental Studies*, Vol. 2, No. 1, 41–51. doi:10.60084/ljes.v2i1.181.

28. Alsharari, N. M., and Alhmoud, T. R. (2019). The Determinants of Profitability in Sharia -Compliant Corporations: Evidence from Jordan, *Journal of Islamic Accounting and Business Research*, Vol. 10, No. 4, 546–564. doi:10.1108/JIABR-05-2016-0055.

29. Lusyana, D., and Sherif, M. (2017). Shariah -Compliant Investments and Stock Returns: Evidence from the Indonesian Stock Market, *Journal of Islamic Accounting and Business Research*, Vol. 8, No. 2, 143–160. doi:10.1108/JIABR-10-2015-0052.

30. Hardia, N. A. K., and Rezeki, G. (2024). Examining the Static and Dynamic Relationship Between Policy Rates and Stock Prices: A Panel Data Analysis, *Grimsa Journal of Business and Economics Studies*, Vol. 1, No. 1, 25–32. doi:10.61975/gjbes.v1i1.16.

31. Akguc, S., and Al Rahahleh, N. (2021). Shariah Compliance and Investment Behavior: Evidence from GCC Countries, *Emerging Markets Finance and Trade*, Vol. 57, No. 13, 3766–3791. doi:10.1080/1540496X.2019.1706164.

32. Ray, S., Kumar, D., Roy, S., and Verma, A. (2024). ESG and Firm Value Linkage: A Case Study in the Automotive Industry, *Indatu Journal of Management and Accounting*, Vol. 2, No. 1, 19–28. doi:10.60084/ijma.v2i1.154.

33. Alam, M. M., Akbar, C. S., Shahriar, S. M., and Elahi, M. M. (2017). The Islamic Shariah Principles for Investment in Stock Market, *Qualitative Research in Financial Markets*, Vol. 9, No. 2, 132–146. doi:10.1108/QRFM-09-2016-0029.

34. Proud, L. M., and Suhendra, E. S. (2023). Financial Performance and Company Values: A Study in the Banking Sector, *Indatu Journal of Management and Accounting*, Vol. 1, No. 2, 60–68. doi:10.60084/ijma.v1i2.96.

35. Erragragui, E., and Revelli, C. (2016). Is It Costly to Be Both Shariah Compliant and Socially Responsible?, *Review of Financial Economics*, Vol. 31, No. 1, 64–74. doi:10.1016/j.rfe.2016.08.003.

36. Pepis, S., and de Jong, P. (2019). Effects of Shariah-Compliant Business Practices on Long-Term Financial Performance, *Pacific-Basin Finance Journal*, Vol. 53, 254–267. doi:10.1016/j.pacfin.2018.11.002.

37. Hardi, I., Idroes, G. M., Hamaguchi, Y., Can, M., Noviandy, T. R., and Idroes, R. (2024). Business Confidence in the Shift to Renewable Energy: A Country-Specific Assessment in Major Asian Economies, *Journal of Economy and Technology*. doi:10.1016/j.ject.2024.08.002.

38. Zhao, C., Wu, M., Liu, J., Duan, Z., Li, J., Shen, L., Shangguan, X., Liu, D., and Wang, Y. (2023). Progress and Prospects of Data-Driven Stock Price Forecasting Research, *International Journal of Cognitive Computing in Engineering*, Vol. 4, 100–108. doi:10.1016/j.ijcce.2023.03.001.

39. Huy, D. T. N., Nhan, V. K., Bich, N. T. N., Hong, N. T. P., Chung, N. T., and Huy, P. Q. (2021). Impacts of Internal and External Macroeconomic Factors on Firm Stock Price in an Expansion Econometric model—A Case in Vietnam Real Estate Industry, 189–205. doi:10.1007/978-3-030-48853-6_14.

40. Almasarweh, M., and Alwadi, S. (2018). ARIMA Model in Predicting Banking Stock Market Data, *Modern Applied Science*, Vol. 12, No. 11, 309.

41. Mondal, P., Shit, L., and Goswami, S. (2014). Study of Effectiveness of Time Series Modeling (ARIMA) in Forecasting Stock Prices, *International Journal of Computer Science, Engineering and Applications*, Vol. 4, No. 2, 13.

42. Syarif, A. (2020). Forecasting the Development of Islamic Bank in Indonesia: Adopting ARIMA Model, *JTAM (Jurnal Teori Dan Aplikasi Matematika)*, Vol. 4, No. 2, 190–203.

43. Ahmed, R., Vveinhardt, J., Ahmad, N., and Streimikiene, D. (2017). Karachi Inter-bank Offered Rate (KIBOR) Forecasting: Box-Jenkins (ARIMA) Testing Approach, *E&M Economics and Management*, Vol. 20, No. 2, 188–198.

44. Zaini, B. J., Mansor, R., Yusof, Z. M., Gabda, D., and Seng, W. K. (2020). Comparison of Double Exponential Smoothing for Holt's Method and Artificial Neural Network in Forecasting the Malaysian Banking Stock Markets, *J. Appl. Stat.*, Vol. 48, 2231–2238.

45. Arisoma, D. S., Supangat, S., and Narulita, L. F. (2019). System Design and Development of Financial Product Sales Forecasting

with exponentially weighted moving average and exponential smoothing method, *Proceeding UII-ICABE*, 1–6.

46. Maria, F. C., and Eva, D. (2011). Exchange-Rates Forecasting: Exponential Smoothing Techniques and ARIMA Models, *Annals of Faculty of Economics*, Vol. 1, No. 1, 499–508.
47. Tsai, C. F., and Wang, S. P. (2009). Stock Price Forecasting by Hybrid Machine Learning Techniques, *Proceedings of the International Multiconference of Engineers and Computer Scientists* (Vol. 1), 60.
48. Sarveswararao, V., Ravi, V., and Vivek, Y. (2023). ATM Cash Demand Forecasting in an Indian Bank with Chaos and Deep Learning, *Expert Systems with Applications*, Vol. 211, 118645.
49. Pouyanfar, S., Sadiq, S., Yan, Y., Tian, H., Tao, Y., Reyes, M. P., Shyu, M.-L., Chen, S.-C., and Iyengar, S. S. (2019). A Survey on Deep Learning, *ACM Computing Surveys*, Vol. 51, No. 5, 1–36. doi:10.1145/3234150.
50. Idroes, G. M., Maulana, A., Suhendra, R., Lala, A., Karma, T., Kusumo, F., Hewindati, Y. T., and Noviandy, T. R. (2023). TeutongNet: A Fine-Tuned Deep Learning Model for Improved Forest Fire Detection, *Leuser Journal of Environmental Studies*, Vol. 1, No. 1, 1–8. doi:10.60084/ljes.v1i1.42.
51. Jiang, W. (2021). Applications of Deep Learning in Stock Market Prediction: Recent Progress, *Expert Systems with Applications*, Vol. 184, 115537. doi:10.1016/j.eswa.2021.115537.
52. Jiang, W., and Zhang, L. (2020). Edge-Siamnet and Edge-Triplenet: New Deep Learning Models for Handwritten Numeral Recognition, *IEICE Transactions on Information and Systems*, Vol. 103, No. 3, 720–723. doi:10.1587/transinf.2019EDL8199.
53. Zhao, Z.-Q., Zheng, P., Xu, S., and Wu, X. (2019). Object Detection with Deep Learning: A Review, *IEEE Transactions on Neural Networks and Learning Systems*, Vol. 30, No. 11, 3212–3232. doi:10.1109/TNNLS.2018.2876865.
54. Brownlee, J. (2018). *Deep Learning for Time Series Forecasting: Predict the Future with MLPs, CNNs and LSTMs in Python*, Machine Learning Mastery.
55. Jiang, W., and Zhang, L. (2018). Geospatial data to images: A deep-learning framework for traffic forecasting, *Tsinghua Science and Technology*, Vol. 24, No. 1, 52–64. doi: 10.26599/TST.2018.9010033.
56. Sezer, O. B., Gudelek, M. U., and Ozbayoglu, A. M. (2020). Financial Time Series Forecasting with Deep Learning: A Systematic Literature Review: 2005–2019, *Applied Soft Computing*, Vol. 90, 106181. doi:10.1016/j.asoc.2020.106181.
57. Almalaq, A., and Edwards, G. (2017). A Review of Deep Learning Methods Applied on Load Forecasting, *2017 16th IEEE International Conference on Machine Learning and Applications (ICMLA)*, IEEE, 511–516. doi:10.1109/ICMLA.2017.0-110.
58. Shehzad, M. K., Rose, L., Azam, M. F., and Assaad, M. (2022). Real-Time Massive MIMO Channel Prediction: A Combination of Deep Learning and NeuralProphet, *GLOBECOM 2022-2022 IEEE Global Communications Conference*, IEEE, 1423–1428. doi:10.1109/GLOBECOM48099.2022.10001362.
59. ChikkaKrishna, N. K., Rachakonda, P., and Tallam, T. (2022). Short-Term Traffic Prediction Using Fb-PROPHET and Neural-PROPHET, *2022 IEEE Delhi Section Conference (DELCON)*, IEEE, 1–4. doi:10.1109/DELCON54057.2022.9753459.
60. Imambi, S., Prakash, K. B., and Kanagachidambaresan, G. R. (2021). PyTorch, *Programming with TensorFlow: Solution for Edge Computing Applications*, 87–104.
61. Triebe, O., Hewamalage, H., Pilyugina, P., Laptev, N., Bergmeir, C., and Rajagopal, R. (2021). Neuralprophet: Explainable Forecasting at Scale, *ArXiv Preprint ArXiv:2111.15397*. doi: 10.48550/arXiv.2111.15397.
62. Yu, Z., Niu, K., Chen, X., Guo, Z., and Li, D. (2022). A Hybrid Model Based on NeuralProphet and Long Short-Term Memory for Time Series Forecasting, *2022 IEEE International Conference on Big Data (Big Data)*, IEEE, 1182–1191. doi:10.1109/BigData55660.2022.10020471.
63. Velásquez, R. M. A. (2022). A Case Study of NeuralProphet and Nonlinear Evaluation for High Accuracy Prediction in Short-Term Forecasting in PV Solar Plant, *Heliyon*, Vol. 8, No. 9. doi:10.1016/j.heliyon.2022.e10639.
64. Farooq, O., and Ahmed, N. (2024). Shariah Compliance and Stock Price Synchronicity: Evidence from India, *International Journal of Emerging Markets*, Vol. 19, No. 3, 752–774. doi:10.1108/IJOEM-07-2021-1149.
65. Ghaemi Asl, M., Adekoya, O. B., Rashidi, M. M., Oliyide, J. A., and Rajab, S. (2024). A New Approach to Forecasting Islamic and Conventional Oil and Gas Stock Prices, *International Review of Economics & Finance*, 103513. doi:10.1016/j.iref.2024.103513.
66. Wijayanti, F., Pramono, S. E., and Indra, I. (2024). The Impact of Macroeconomic Variables Shocks on Sustainable and Islamic Indices in Indonesia (2016-2023), *Review of Islamic Economics and Finance*, Vol. 7, No. 1, 182–197.
67. Khairunnisa, D. A., Rodoni, A., and Rama, A. (2024). Predicting Shariah Stock Market Indices with Machine Learning: A Cross-Country Case Study, *Jurnal Ekonomi Syariah Teori Dan Terapan*, Vol. 11, No. 1, 86–104. doi:10.20473/vol11iss20241pp86-104.
68. Zul Ihsan Mu'arrif. (2024). Forecasting Market Capitalization on The Jakarta Islamic Index using The Arima Method, *Reslaj: Religion Education Social Laa Roiba Journal*, Vol. 6, No. 6. doi:10.47467/reslaj.v6i6.2423.
69. Budiprasetyo, G., Hani'ah, M., and Aflah, D. Z. (2023). Prediksi Harga Saham Syariah Menggunakan Algoritma Long Short-Term Memory (LSTM), *Jurnal Nasional Teknologi Dan Sistem Informasi*, Vol. 8, No. 3, 164–172. doi:10.25077/TEKNOSI.v8i3.2022.164-172.
70. Ghosh, I., and Jana, R. K. (2024). Clean Energy Stock Price Forecasting and Response to Macroeconomic Variables: A Novel Framework Using Facebook's Prophet, NeuralProphet and Explainable AI, *Technological Forecasting and Social Change*, Vol. 200, 123148. doi:10.1016/j.techfore.2023.123148.
71. Noviandy, T. R., Maulana, A., Idroes, G. M., Suhendra, R., Adam, M., Rusyana, A., and Sofyan, H. (2023). Deep Learning-Based Bitcoin Price Forecasting Using Neural Prophet, *Ekonomikalia Journal of Economics*, Vol. 1, No. 1, 19–25. doi:10.60084/eje.v1i1.51.
72. Indonesia Stock Exchange. (2024). Daily IDX Indices. https://idx.co.id
73. Kumar Jha, B., and Pande, S. (2021). Time Series Forecasting Model for Supermarket Sales using FB-Prophet, *2021 5th International Conference on Computing Methodologies and Communication (ICCMC)*, IEEE, 547–554. doi:10.1109/ICCMC51019.2021.9418033.