

CHAPTER V

CONCLUSION

This chapter is a summary of the results of the research that has been carried out and provides recommendations for the development of further research. Conclusions are based on the results of testing and evaluation of the model that has been obtained, while suggestions are intended for researchers who want to continue or develop this research further.

5.1 Conclusion

This subchapter contains conclusions obtained from the results of the research based on the analysis and discussion that has been carried out to answer the research objectives.

1. The BiLSTM model has been successfully implemented to predict the closing price of PT Bukit Asam Tbk (PTBA) shares based on historical data for 10 years (February 12, 2016 – February 12, 2026). The best configuration of the model was obtained by using 3 input features (Price, High, and Low), a data partition ratio of 80:10:10, a window size of 15, and a 2 hidden layer BiLSTM architecture. This configuration has been proven to be able to effectively capture the temporal patterns of PTBA's volatile share price data, with the ability to follow the trend of actual price movements for most of the test period.
2. The WOA algorithm is successfully used to determine the optimal hyperparameter configuration on the BiLSTM model automatically, replacing the manual determination process that risks resulting in a less than optimal configuration. The best WOA configuration uses 20 individual populations and 40 iterations, which results in an optimal combination of hyperparameters in the form of a learning rate of 0.00322, 123 units of the first layer of hidden units, 53 units of the second layer of hidden units, and a dropout rate by 0.20225. The WOA convergence curve across all test scenarios shows that the algorithm is able to find the optimal solution before the maximum iteration is reached, which indicates good optimization

process efficiency. The implementation of WOA has been proven to be able to improve the prediction accuracy of the BiLSTM model, as shown by comparing the performance of the LSTM and BiLSTM models without optimization. The LSTM model produced an MAE value of 39.3057, an RMSE of 56.9615, and a MAPE of 1.5819%, while the non-optimization BiLSTM model produced an MAE of 33.5175, an RMSE of 52.4820, and a MAPE of 1.3107%. The WOA-BiLSTM model with optimal configuration resulted in an MAE value of 29.5851, an RMSE of 49.7249, and a MAPE of 1.1700%, which is the lowest value among the three models, thus proving that the WOA algorithm has succeeded in significantly improving the prediction accuracy of the BiLSTM model compared to without optimization.

3. From the conclusion applied in point 2, the WOA-BiLSTM Model that has been implemented has succeeded in predicting PTBA's share price for the next one-day period (D+1), by utilizing the latest historical data as input to produce an estimated closing price on the next trading day. This ability shows that the model is not only statistically accurate, but also applicative to be used as a short-term investment decision-making tool.

5.2 Suggestions

The suggestion subchapter contains inputs that can be considered for development in future research in an effort to obtain better results.

1. This study only uses historical stock price data from one platform (Investing.com). The next research can enrich input variables by adding macroeconomic data such as interest rates, exchange rates, and global coal prices, or adding market sentiment features based on news text and social media analysis, in order to improve the model's ability to capture external factors that affect PTBA's stock price movements.
2. This study only optimizes 3 hyperparameters, namely learning rate, hidden units, and dropout rate. Further research can expand the optimization search space by adding other hyperparameters such as batch size, number of epochs, and optimizers used, so that the configuration combinations

explored by WOA become more comprehensive and potentially result in models with more optimal prediction accuracy.

3. This study uses WOA as the only hyperparameter optimization algorithm. The next study can compare the performance of WOA with other metaheuristic algorithms such as PSO, GA, or GWO, to find out the most effective optimization algorithm in the context of BiLSTM-based stock price prediction.