

CHAPTER I

INTRODUCTION

The Introductory Chapter is prepared to describe the basics of research implementation which includes the background of the problem, problem formulation, research objectives, research benefits, and problem limitations set as a frame of reference in the implementation of research.

1.1 Background

Stock investment is increasingly in demand by the public as technological developments that make it easier to access the capital market through online stock trading platforms [1]. By the beginning of 2026, the total capital market investors had reached around 21 million Single Investor Identification (SID) with stock investors almost reaching 9 million SID, an increase of around 367 thousand SID compared to the end of 2025 [2]. Surging investor participation reflects heightened societal interest in capital market instruments, notably corporate shares. One of the factors that attracts investors' interest in stocks is the potential for relatively higher returns compared to some other investment instruments [3]. However, behind this potential, stock investment also contains high risk because stock prices are volatile, influenced by demand and supply dynamics, macroeconomic conditions such as interest rates and exchange rates, and the company's internal performance [4][5]. These volatile fluctuations cause investors to face uncertainty in their investment decision-making, so the need for analysis that can support the process is even more important.

One of the issuers that attracted investors' attention was PT Bukit Asam Tbk, a state-owned company in the coal mining sector that plays a strategic role in maintaining national energy security [6]. PTBA is a large-cap issuer with a capitalization of around IDR 29.36 trillion with an average daily trading volume of 22 million shares in February 2026 [7]. In terms of performance, PTBA recorded solid operational growth with sales volume increasing 8% on an annual basis to 33.70 million tons in September 2025, driven by domestic demand which grew 11% [8][9]. PTBA is also consistent in distributing dividends with a total of almost

touching IDR 3.9 trillion in 2025. The dividend distribution also makes PTBA one of the highest with a value of IDR 332 per share and a yield of 12.09%, making it an attractive issuer for long-term return-oriented investors [10][11]. However, in the 52-week period until February 2026, PTBA's share price moved in the range of IDR 2,170 to IDR 3,070, reflecting volatility influenced by fluctuations in global coal prices, macroeconomic conditions, and market sentiment [7]. PTBA's promising and volatile characteristics make it relevant as an object of data-driven stock price research time series.

Volatile stock price movements make it difficult for investors to make sure about right time to buy, hold, even sell the shares. One commonly used approach to support investment decision-making is historical stock price predictions, specifically closing price data compiled in the form of time series data. Historical stock price data represents changes in value over time and can be used to study price movement patterns in subsequent periods [12]. However, because the price of stock movements are very dynamic and influenced by other factors, the process of predicting stock prices is a challenging problem and requires an analytical approach that is able to make effective use of historical data information.

Dynamic stock price movement patterns cause conventional statistical methods such as ARIMA and ARCH/GARCH to often encounter limitations in producing consistent accuracy, especially on high-volatility data [13][14]. As a more effective alternative, the deep learning is starting to be widely used, because deep learning have ability to extract complex features from data time series without the need for rigid statistical assumptions [13]. Architecture Long Short-Term Memory (LSTM) proven to be superior in processing data time series due to its ability to store long-term information [15]. However, LSTMs process data in one direction and that's because does not fully have to capture temporal the dependencies in two directions. Further development resulted in the architecture Bidirectional Long Short-Term Memory (BiLSTM) which processes data in a Forward and backward simultaneously. Yafik and Azhari (2025) show that BiLSTM produces lower RMSE than LSTM in the prediction of BBKA and TLKM stocks [16], while Puteri (2023) confirmed that BiLSTM obtained a smaller MAPE on the prediction of sharia stocks and was categorized as very accurate [12].

Although BiLSTM offers superior temporal representation, its performance depends heavily on hyperparameters like learning rate, neuron count, and dropout rate. Determination hyperparameter manually or trial and error Potentially resulting in suboptimal and inefficient configurations [17]. Mitigating this requires a systematic optimization approach. The Whale Optimization Algorithm (WOA) fulfills this need as a metaheuristic framework that balances exploration and exploitation by mimicking humpback whale foraging behaviors [18][19]. An R^2 score of 0.99 in near-term projections validates the performance advantage and rapid convergence capabilities of this hybrid WOA-BiLSTM approach against alternative models like LSTM, BiLSTM, GRU, CNN, ARIMA, and SVM, with sustained efficacy exceeding 0.9 across multi-day horizons [20].

Based on the review, there are several research gaps that are the basis for the urgency of this research. Conventional models are still limited in capturing dynamic stock price patterns, while LSTM and BiLSTM still rely on manually determining hyperparameters. Meanwhile, the implementation of WOA-BiLSTM is only limited to non-financial domains such as epidemic data and has never been applied to the prediction of stock prices in the energy sector such as PTBA. Therefore, this study implements a BiLSTM model optimized using WOA for PTBA stock price prediction, with the hope of producing a more automated, systematic, and accurate prediction system compared to previous methods.

1.2 Problem Formulation

Drawing from the outlined context, this research centers on multiple issues that warrant attention. The problem is formulated as follows.

1. How to implement the Bidirectional Long Short-Term Memory (BiLSTM) architecture to predict the share price of PTBA which has the characteristics of volatile time series data?
2. How can the Whale Optimization Algorithm be used to determine the optimal hyperparameters in the BiLSTM model to improve prediction accuracy?

1.3 Research Objectives

In light of the defined problem structure, this study has multiple objective to accomplish., which are as follows.

1. Applying the BiLSTM model to predict the closing price of PT Bukit Asam Tbk shares based on historical data.
2. Optimizing BiLSTM hyperparameters which include learning rate, hidden units, and dropout rate using WOA to get the best model performance.

1.4 Research Benefits

The dual theoretical and practical values for relevant stakeholders are elaborated in the following section.

1.4.1 Theoretical Benefits

From a theoretical perspective, the outcomes of this study are anticipated to offer the following scholarly contributions:

1. Contributing to the development of science in the field of Artificial Intelligence and Data Science, especially regarding the implementation of BiLSTM architecture combined with WOA's metaheuristic algorithm.
2. It is a reference for other studies that want to conduct comparative studies for the development of predictive models of volatile time series data.
3. Provides scientific insights on the effectiveness of the use of WOA algorithms in finding optimal hyperparameter configurations in complex artificial neural networks compared to conventional methods.

1.4.2 Practical Benefits

This study offers distinct practical values for designated entities:

1. The prediction results are expected to be a tool or decision support system for investors in determining the right time to buy, maintain, or sell PTBA shares, so as to minimize the risk of losses due to price fluctuations.
2. Provides an overview of the trend of the company's stock price movements in the capital market which is influenced by various historical factors, which can be used as additional information in looking at market sentiment.

3. Increase understanding and practical experience in implementing Deep Learning algorithms and metaheuristic optimization techniques to solve problems in the capital market financial sector.

1.5 Problem Limitations

Specific scope boundaries are defined below to preserve the research focus.

1. The object of the research only focuses on the share price of PT Bukit Asam Tbk (PTBA).
2. The data used is daily historical data on PTBA's share price in a span of 10 years starting from February 12, 2016 to February 12, 2026.
3. The optimization algorithm uses the Whale Optimization Algorithm.