CHAPTER 1
INTRODUCTION

1.1. Background

Forecasting can be described as the process of estimating a future value of a variable by relying on patterns observed in historical data [1]. Within the domain of capital markets, this process is most commonly applied to stock prices, a figure that shifts on a daily basis. Such shifts are driven by a wide range of underlying forces, including macroeconomic conditions, government policy, global news, and overall market sentiment [2]. Because stock price movement is inherently dynamic and difficult to model precisely, conventional statistical approaches and traditional quantitative analysis frequently fall short in terms of predictive accuracy [3]. It is precisely this unpredictable and ever-shifting nature of stock prices that makes the subject worth investigating further.

The stock of PT Telkom Indonesia Tbk (ticker: TLKM) was selected as the object of this study because it represents one of the larger and comparatively stable equities traded on the Indonesian market. According to official data published by the Indonesia Stock Exchange (IDX), TLKM is listed among the fifty issuers with the largest market capitalization, placing it firmly within the blue-chip category of Indonesian equities [4]. Kontan (2024) further notes that TLKM is regarded as one of the leading non-banking blue-chip stocks and is frequently favored by foreign investors due to its comparatively steady price behavior [5]. Additional figures from Google Finance (2024) indicate that TLKM's market capitalization has surpassed Rp317 trillion, underscoring the stock's substantial weight within Indonesia's capital market [6]. Given the availability of extensive historical records and a high level of trading activity, TLKM serves as an appropriate case study for testing stock price prediction models.

This research applies a hybrid modeling approach, combining Linear Regression with a Deep Neural Network (DNN) ensemble. Linear Regression is well suited to capturing linear relationships between variables and offers a straightforward interpretation of how past prices relate to future movement. Its main shortcoming, however, lies in its inability to capture non-linear patterns within the data. DNN, on the other hand, is capable of learning complex, non-linear structures through its hidden layers. By combining the two techniques, the resulting model is expected to deliver predictions that are both more accurate and more consistent, since each method compensates for the limitations of the other Linear Regression handles the underlying linear relationship,

while the DNN component focuses on capturing the more erratic dynamics of the market [7], [8].

Several earlier studies lend support to combined modeling strategies, or at minimum highlight the constraints of relying on a single method. Li (2024), for instance, introduced a hybrid preprocessing technique applied prior to feeding data into a neural network, finding that this combination handled noise and non-linear patterns more effectively than a single-method approach [8]. He and Wang (2024) similarly observed that forecasting stock indices remains a persistently difficult undertaking given their volatility and complexity, a point they raised while discussing hybrid feature and optimization systems [9]. Other research has likewise concluded that the highly dynamic and complex nature of financial markets keeps stock forecasting a challenging task [10]. Taken together, these findings suggest that combined modeling strategies are worth pursuing as a means of improving prediction accuracy in markets characterized by constant change.

Even so, a broad consensus exists among researchers and institutions that accurately forecasting stock prices remains inherently difficult, owing to the intricate, ever-changing nature of price behavior, which often departs from standard statistical patterns. Gülmez (2023) points out that stock price movement tends to be highly non-linear and chaotic, meaning conventional techniques such as standard ARIMA models frequently fail to capture the market's true underlying dynamics [11]. Durgapal and Vimal (2021) emphasize that stock price trends are strongly shaped by global-level factors, ranging from macroeconomic conditions and monetary policy to shifting investor sentiment, all of which contribute to volatility that is difficult to manage or predict [12]. IDX (2024) and LPS (2024) likewise indicate that Indonesia's capital market can experience marked fluctuations as a result of changes in global interest rates, inflation, and foreign capital flows [4], [13].

Stock price movement can be understood as a time series shaped by intertwined linear trends and non-linear volatility [2], [3]. Relying on a single prediction method tends to introduce limitations of its own. A Deep Neural Network, for example, performs well at mapping non-linear structures [10], yet is prone to overfitting when applied directly to data containing a strong underlying trend. To address this weakness, the present study adopts a hybrid approach built around residual learning: Linear Regression is used to extract the dominant linear component of the data, while the residual errors representing

the non-linear anomalies are subsequently processed through the DNN [7]. Empirical evidence suggests that this kind of combination compensates for the shortcomings of each individual algorithm, yielding predictions that are more stable and precise [8].

Beyond price data alone, this study also incorporates external variables — specifically the USD/IDR exchange rate, Indonesia's inflation rate, and the Bank Indonesia benchmark interest rate — given that all three factors carry a meaningful influence on movements within the national stock market [14], [15]. By combining macroeconomic indicators with historical stock market data, the hybrid model developed here is expected to produce TLKM price estimates that are more precise, consistent, and responsive to shifting economic and market conditions [7], [15]. To sustain this responsiveness over time, the system incorporates a self-updating mechanism through automated retraining. Whenever the system is triggered by specific events such as a user login or the arrival of new data the application architecture automatically ingests the latest daily data and retrains the model in the background. This adaptive design is intended to keep the model's parameters aligned with current market volatility and to prevent performance degradation caused by data drift as market trends shift over time. Specifically, this research aims to build a combined model capable of predicting TLKM stock prices while keeping the resulting error rate as low as possible. It is hoped that the findings will prove useful to researchers, academic institutions, and capital market readers or practitioners alike, serving as a reference point for understanding how hybrid models can be applied to stock price forecasting in Indonesia.

Building on the discussion above, this research centers on developing and evaluating a hybrid model for predicting TLKM stock prices, one that merges historical price data with macroeconomic variables — namely inflation, the USD/IDR exchange rate, and the Bank Indonesia interest rate. This combined approach is expected to strengthen both the model's accuracy and its capacity to adjust to changing market conditions. In addition, the findings of this study are intended to serve as a reference point for future development of stock prediction methods and to support the broader process of investment analysis and decision-making.

1.2. Problem Formulation

Drawing on the background outlined above, the problems addressed in this research are as follows:

1. How can a hybrid model combining Linear Regression and a Deep Neural Network (DNN) be constructed to predict TLKM stock prices using stock data, the USD/IDR exchange rate, and Indonesia's inflation rate?
2. How low can the error rate of the hybrid Linear Regression–DNN model be kept when predicting TLKM stock prices?
3. How effective is the combined Linear Regression–DNN model at forecasting TLKM's closing price based on historical data and the applied economic indicators?

1.3. Research Objectives

Based on the problem statement above, the objectives of this research are as follows:

1. To develop a hybrid Linear Regression and Deep Neural Network (DNN) model capable of predicting TLKM stock prices more accurately and efficiently by drawing on stock data, the USD/IDR exchange rate, and Indonesia's inflation rate.
2. To analyze the error rate of the hybrid Linear Regression and DNN model in predicting TLKM stock prices using the MAE, RMSE, and MAPE evaluation metrics.
3. To assess how well the hybrid model's predicted TLKM stock prices align with actual data, drawing on historical information and available economic indicators.

1.4. Research Benefits

The findings of this research are expected to benefit several parties, including:

1. For Researchers

   This study contributes to a deeper understanding of how a hybrid model combining Linear Regression and a Deep Neural Network (DNN) can be built to predict stock prices, evaluated for performance, and assessed for error rate accuracy. It also aims to provide a comprehensive performance evaluation using a range of relevant assessment metrics.
2. For the University

   This research contributes academically to the fields of machine learning and financial analysis, particularly in relation to stock markets, and may serve as a reference for future studies.

3. For Readers

   This study serves as an academic reference on the development of a hybrid Linear Regression–Deep Neural Network (DNN) model for predicting TLKM stock prices.

1.5. Scope and Limitations

Berdasarkan rumusan masalah yang sudah ditentukan maka, Batasan masalah dari penelitian ini adalah:

1. Penelitian ini terpusat pada Upaya untuk memprediksi harga saham TLKM, dan tidak mencakup analisis harga pembukaan, tertinggi, terendah, maupun volume saham.
2. Data awal yang digunakan dalam penelitian ini untuk pembentukan model dasar (*base-training*) mencakup data historis saham TLKM, kurs USD/IDR, tingkat inflasi di Indonesia, dan Bank Indonesia *rate* dari bulan Januari 2025 sampai bulan Desember 2025 yang diperoleh dari Yahoo Finance sebagai sumber sekunder. Namun, rentang waktu data ini akan terus bertambah secara dinamis karena sistem dilengkapi dengan *pipeline* otomatis yang menyerap data harian pasar untuk memperbarui basis data. Model yang dibuat hanya meliputi gabungan antara metode Regresi Linear dan *Deep Neural Network* (DNN) sebagai pendekatan campuran, tanpa membandingkannya dengan metode lain.
3. Model yang dikembangkan dalam penelitian ini hanya digunakan untuk memprediksi harga saham Telkom Indonesia (TLKM) pada periode tahun 2026. Hasil prediksi yang dihasilkan terbatas pada rentang waktu tersebut dan tidak ditujukan untuk peramalan jangka panjang di luar periode penelitian, karena model dibangun berdasarkan pola data historis yang digunakan serta asumsi kondisi ekonomi yang berlaku pada periode penelitian.
4. Proses *retraining* model dilakukan melalui sinkronisasi saat pengguna login dan *scheduler* otomatis yang berjalan setiap pukul 18:00 WIB setelah jam bursa berakhir. Mekanisme ini memastikan model selalu diperbarui dengan data terbaru tanpa proses manual.