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Comparative Analysis of DES-Brown and DES-Holt Methods in Forecasting the Stock Price of PT Telekomunikasi Indonesia Tbk.

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Abstract:

This study aims to dermine the best forecasting method for the stock price of PT Telekomunikasi Indonesia Tbk using the Double Exponential Smoothing (DES) Brown and DES-Holt methods. The data used consist of stock prices from January 2019 to September 2025. The DES-Brown method employs a single parameter, while DES-Holt uses two parameters. Forecasting accuracy is evaluated using Mean Absolute Deviation (MAD), Root Mean Squared Error (RMSE), and Mean Absolute Percentage Error (MAPE). The results indicate that the DES-Brown method with a smoothing parameter $\alpha = 0.5$ produces the smallest forecasting errors compared to the DES-Holt method, with MAD = 194,4472, RMSE = 243,5825, and MAPE = 5.57%. Therefore, it can be concluded that the DES-Brown method is the most suitable approach for forecasting the stock price of PT Telekomunikasi Indonesia Tbk.

1. Introduction

PT Telekomunikasi Indonesia was established in 1884 and operates in the fields of information, communication, and telecommunications infrastructure and services thorughout Indonesia. Its headquarters is located in Bandung. The company's operations are divided into four strategic segments, mobile services, retail consumer services, corporate services, and wholesale and international business. As a stated-owned enterprise, 52.09% of Telkom's shares are owned by the Government of Indonesia, while the remaining 47.91% are publicly held. Telkom also holds a majority stake in nine subsidiaries, including PT Telekomunikasi Selular (Telkomsel). The company's stock price has shown consistent growth, rising from IDR 2,865 per share in 2012 to IDR 3,899 in 2016, and reaching IDR 3,970 in 2019. This steady increase has attracted investors to invest in Telkom shares (Rezaldi & Sugiman, 2021).

Stock represent ownership in a company. Many investors are attracted to stock investments due to the potential for profit from price fluctuations. However, stock prices re difficult to predict and highly volatile, increasing the risk of losses. Therefore, forecasting methods are needed to estimate future stock (Aprilianti dkk., 2022). One commonly used method is Double Exponential Smoothing (DES), which is suitable for data exhibiting trends. Double Exponential Smoothing (DES) consists of two main approaches, DES-Brown and DES-Holt. DES-Brown uses one parameter (α), while DES-Holt uses two parameters (α, β), each ranging between 0 and 1 (Nabilah dkk., 2022).

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Several previous studies have applied Double Exponential Smoothing (DES) methods in various forecasting contexts. Ningsih dkk. (2024), in their study entitled "*Optimization of Total Asset Forecasting of PT BPD Kaltim Kaltara Using Brown's Double Exponential Smoothing*", found that the DES-Brown method with parameters $\alpha = \beta = 0.3$ produced the most accurate forecasts, as indicated by the lowest MAPE value. Similarly, Alfinatuzzahro dkk. (2024), in "*Forecasting Gross Domestic Product (GDP) of the Furniture Industry in Indonesia Using Holt's Double Exponential Smoothing Method"*, reported that the DES-Holt method with $\alpha = 0.658$ and $\beta = 0.008$ yielded a MAPE value of 0.737%, indicating high forecasting accuracy. Several studies have also compared the performance of DES-Brown and DES-Holt, Bidangan, Purnamasari, Hayati. (2016) concluded that the DES-Holt method was the most optimal for forecasting clean water production at PDAM Tirta Kencana Samarinda, with $\alpha = 0.31$ and $\beta = 0.92$, resulting in a MAPE value of 2,9016%. another study by Tajalli dkk. (2024), entitled "*Optimization of Double Exponential Smoothing Parameters Using the Golden Section Method for Forecasting the Closing Stock Price of PT Telkom Indonesia (Persero)*", found that the DES-Holt method with $\alpha = 0.5066578$ and $\beta = 0.458980$ achieved the most optimal forecasting performance, with a MAPE value of 4,7233% for the period January to June 2022. However, this study focused only on parameter optimization of the DES-Holt method within a relatively limited data period and did not compare it with the DES-Brown method.

In addition, several previous studies, such as Parmanto dkk. (2025), Nurlaela dkk. (2025), and Suryana & Silaswara (2024), employed forecasting error measures including MAD, MSE, and MAPE. Therefore, this study adopts MAD, RMSE, and MAPE as evaluation metrics to provide a more comprehensive assessment of forecasting accuracy.

Based on the background and previous studies described above, this research aims tp compare the performance of the DES-Brown and DES-Holt methods in forecasting the stock price of PT Telekomunikasi Indonesia Tbk using data from January 2019 to September 2025. Furthermore, this study evaluates several smoothing parameter values ($\alpha = 0.3, 0.5, and\ 0.7$), representing low, medium, and high smoothing levels, to examine the sensitivity of the models to parameter changes. Finally, the study seeks to determine the most accurate forecasting method based on the selected error measures.

2. Literature Review

2.1. Forecasting

Forecasting is a technique used to estimate future values based on historical data for decision-making purposes. Forecasting methods are generally classified into qualitative and quantitative approaches. Quantitative methods include causal models (e.g.,regression) and time series models such as Moving Average, ARIMA, adn Exponential Smoothing. Model selection depends on identifying patterns such as trend, seasonality, or cyclic behavior (Bidangan dkk., 2016b; Nurrohmah & Kurniati, 2022).

2.2. Exponential Smoothing

Exponential Smoothing is a forecasting method that assigns greater weight to recent observations, with weights decreasing exponentially for older data. The smoothing parameter determines the magnitude of these weights (Nabilah dkk., 2022).

2.3. DES-Brown

The DES-Brown method is a forecasting approach that applies double exponential smoothing using a single parameter (α) to estimate the level and trend components of the data (Pujiati dkk., 2016). The equatins used in the DES-Brown method can be described as follows:

Calculating the first smoothing value $(S_t^{'})$

$$S_t^{'} = \alpha X_t + (1-\alpha) S_{t-1}^{'} \quad (1)$$

Calculating the second smoothing value $(S_t^{''})$

$$S_t^{''} = \alpha X_t + (1-\alpha) S_{t-1}^{''} \quad (2)$$

Calculating the constant value (a_t)

$$a_t = 2S_t^{'} - S_t^{''} \quad (3)$$

Calculating the *trend* and *level* coefficients (b_t)

$$b_t = \frac{\alpha}{1-\alpha}(S_t^{'} - S_t^{''}) \quad (4)$$

Calculating the forecast value (F_{t+m})

$$F_{t+m} = a_t + b_t m \quad (5)$$

Where:

$S_t^{'}$	: First smoothing value at period *t*
$S_{t-1}^{'}$	: First smoothing value at period *t-1*
$S_t^{''}$	: Second smoothing value at period *t*
$S_{t-1}^{''}$	: Second smoothing value at period *t-1*
α	: Smoothing parameter, $0 \le \alpha \le 1$;
X_t	: Time series data at period *t*
a_t	: Smoothing constant at period *t*
b_t	: Smoothing constant at period *t*
F_{t+m}	: Forecast value for period (*t*+*m*)
m	: Number of future periods to be forecasted

2.4. Double Exponential Smoothing Holt

The *DES-Holt* method applies double exponential smoothing using two parameters(α for level and β for trend), each ranging from 0 to 1, to model the level and trend components. This method is suitable for time series data that exhibit a gradual increasing or decreasing trend (Andini dkk., 2024). The equations used in the DES-Holt method can be described as follows:

Calculating the level (first smoothing value)

$$S_t = \alpha X_t + (1-\alpha)(S_{t-1} + B_{t-1}) \quad (6)$$

Calculating the trend value

$$B_t = \beta(S_t - S_{t-1}) + (1-\beta) B_{t-1} \quad (7)$$

The initialization process of the DES-Holt method to obtain the initial level S_1 and trend B_1 values can be carried out based on Equations (6) and (7)

$$S_1 = X_1 \tag{8}$$

$$B_1 = X_2 - X_1 \tag{9}$$

Calculating the forecast values for m periods ahead as follows

$$F_{t+m} = S_t + B_t m \tag{10}$$

where:

S_t	: Trend smoothing value at period t
α	: Level smoothing parameter, $0 \le \alpha \le 1$;
β	: Trend smoothing parameter, $0 \le \beta \le 1$;
X_t	: Time series data at period t
B_t	: Trend value at period t
F_{t+m}	: Forecast value at period ($t+m$)

2.5. Mean Absolute Deviation (MAD)

Mean Absolute Deviation (MAD) is a measure of forecasting accuracy obtained by calculating the average of the absolute differences between the forecasted values and the actual data over a certain number of periods. This measure does not distinguish the direction of the error, whether the forecasted values are higher or lower than the actual values (Rasyid dkk., 2023). The formula for MAD can be expressed as shown in Equation (11).

$$MAD = \frac{1}{n}\sum_{t=1}^{n} X_t - \hat{X}_t \tag{11}$$

2.6. Root Mean Squared Error (RMSE)

Root Mean Squared Error (RMSE) is a measure of forecasting error obtained by taking the square root of the average of the squared differences between the actual values and the forecasted values (Rasyid dkk., 2023). The formula for RMSE can be expressed as shown in Equation (12).

$$RMSE = \sqrt{\frac{1}{n}\sum_{t=1}^{n}(X_t - \hat{X}_t)^2} \tag{12}$$

2.7. Mean Absolute Percentage Error (MAPE)

Mean Absolute Percentage Error (MAPE) is a measure of forecasting accuracy that expresses the average percentage of the absolute errors between the forecasted values and the actual values over a given period (Rasyid dkk., 2023). The formula for MAPE can be expressed as shown in Equation (13).

$$MAPE = \frac{1}{n}\sum_{i=1}^{n}\left|\frac{X_t - \hat{X}_t}{X_t}\right| \times 100 \tag{13}$$

3. Research Methodology

The data used in this study consist of monthly stock prices of PT Telekomunikasi Indonesia Tbk from January 2019 to September 2025. The research steps include:

1. Descriptive statistical analysis and time series visualization
2. Implementation of the DES-*Brown* method:
   a. Determining the smoothing parameter α
   b. Calculating the *Single Exponential Smoothing* values using Equation (1)
   c. Calculating the *Double Exponential Smoothing* values using Equation (2)
   d. Calculating the constant values using Equation (3)
   e. Calculating the level and trend values using Equation (4)
   f. Calculating the forecast values using Equation (5)
   g. Evaluating the forecasting accuracy using Equations (11), (12), and (13)
3. Implementation of the DES-Holt method:
   a. Determining the smoothing parameters α and β
   b. Calculating the level *Single Exponential Smoothing* dan *trend* values using Equations (6) and (7)
   c. Calculating the forecasting values using Equation (10)
   d. Evaluating the forecasting accuracy using Equatins (11), (12), and (13)
4. Selecting the best method based on MAD, RMSE, and MAPE using Equations (11), (12), and (13)
5. Determining the final forecasting results.

4. Results and Discussion

4.1. Time Series Identification

The graphical identification aims to determine whether the data used exhibit a seasonal pattern

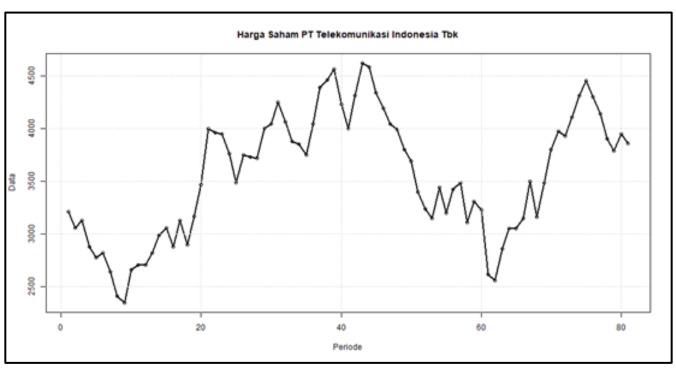

Figure 1 Time Series Plot

Based on Figure 1, it can be observed that the stock price data of PT Telekomunikasi Indonesia show an upward trend druing the period from November 2020 to August 2022, followed by a downward trend from September 2022 to October 2025. In addition, the plot indicates relatively sharp fluctuations, characterized by rapid upward and downward movements, suggesting that the data exhibit high volatility. This high level of volatility may affect the performance of the forecasting methods applied. In datasets with sharp fluctuations and unstable trend changes, more complex models do not necessarily yield better forecasting accuracy.

4.2. Forecasting using DES-Brown

The results of the MAD, RMSE, and MAPE calculations for the DES-Brown method are presented in Table 1
.

Table 1. Results of MAD, RMSE, and MAPE Calculations Using *DES-Brown*

Parameter α	MAD	RMSE	MAPE (%)
0.3	225,9193	263,5546	6.49%
0.5	**194,4472**	**243,5825**	**5.57%**
0.7	200,583	248,5744	5.79%

Based on Table 1, the smallest values of MAD, RMSE, and MAPE are obtained using the DES-Brown method with a smoothing parameter of $\boldsymbol{\alpha = 0.5}$, resulting in values of 194.4472, 243.5825, and 5.57%, respectively. After determining the optimal paarameter, forecasting of the stock price of PT Telekomunikasi Indonesia Tbk can be performed for the next three periods. The forecasted stock prices are IDR 3,837.991 for October 2025, IDR 3,810.010 for November 2025, and IDR 3,782.029 for December 2025.

4.3. Forecasting using DES-Holt

The results of the MAPE, RMSE, and MAD calculations are presented in Table 2.

Table 2. Results of MAPE, RMSE, and MAD Calculations using the *DES-Holt*

Parameter		MAD	RMSE	MAPE (%)
α	β			
0.3	0.05	317,8907	382,2023	9.13%
	0.1	299,5688	351,1651	8.62%
	0.15	289,8054	333,9037	8,29%
0.5	0.05	245,7818	288,8586	7.05%
	0.1	235,8799	275,2397	6.75%
	0.15	230,1474	269,1984	6.59%
0.7	0.05	215,1579	251,6245	6,17%
	0.1	208,7235	244,9778	5.99%
	0.15	**204,3134**	**243,9301**	**5.86%**

Based on Table 2, the smallest values of MAD, RMSE, and MAPE are obtained using the DES-Holt methid with smoothing parameters $\boldsymbol{\alpha = 0.7}$ and $\boldsymbol{\beta = 0.15}$, resulting in values of 204.3134, 243.9301, and 5.86% respectively. After determining the optimal parameters, forecasting of the stock price of PT Telekomunikasi Indonesia Tbk can be conducted for the next three periods. The forecasted stock prices are IDR 4,008.679 for October 2025, IDR 4,023.840 for November 2025, and IDR 4,039.000 for December 2025.

4.4. Comparison of DES-Brown and DES-Holt

The comparison of the best method for forecasting the stock price of PT Telekomunikasi Indonesia Tbk can be evaluated based on the smallest values of MAD, RMSE, and MAPE, as presented in Table 3.

Table 3. Comparison of DES-Brown and DES-Holt

Method	MAD	RMSE	MAPE (%)
DES-*Brown*	**194,4472**	**243,5825**	**5.57%**
DES-*Holt*	204,3134	243,9301	5.86%

The MAD, RMSE, and MAPE values obtained using the DES-Brown method with $\alpha = 0.5$ are 194.4472, 243.5825, and 5.57%, respectively. In contrast, the DES-Holt method with $\alpha = 0.7$ and $\beta = 0.15$ yields MAD, RMSE, and MAPE values of 204.3134, 243.9301, and 5.86%, respectively. The DES-Brown method with $\alpha = 0.5$ produces lower MAD, RMSE, and MAPE values compared to the DES-Holt method. Therefore, the best model for forecasting in this study is the DES-Brown method with $\alpha = 0.5$.

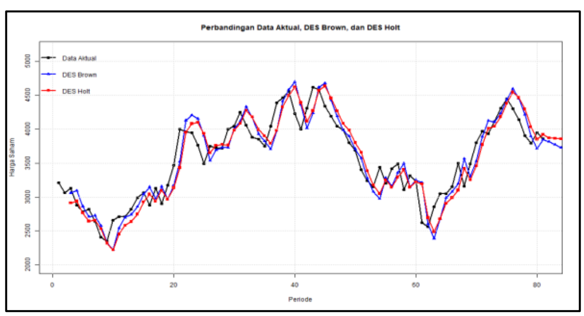

Figure 2. Comparison of Actual and Predicted Values

Figure 2 shiws that the predicted values tend to follow the pattern of the actual data. Based on the figure, it can be concluded that the smoothing results of the DES-Brown method produce a smoother pattern compared to the actual data. Visually, there is no significant difference between the patterns generated by the DES-Brown and DES-Holt methods.

5. Conclusion

Based on the results and discussion presented in this study, the conclusions are as follows:

1. The forecasting results of the stock price of PT Telekomunikasi Indonesia Tbk for the next three periods using the DES-Brown method with $\boldsymbol{\alpha = 0.5}$ are IDR 3,837.991 for October 2025, IDR 3,810.010 for November 2025, and IDR 3,782.029 for December 2025.
2. The forecasting results using the DES-Holt method with $\boldsymbol{\alpha = 0.7}$ and $\boldsymbol{\beta = 0.15}$ yield predicted values of IDR 4,008.679 for October 2025, IDR 4,023.840 for November 2025, and IDR 4,039.000 for December 2025.
3. Furthermore, the DES-Brown method with $\alpha = 0.5$ produces MAD, RMSE, and MAPE values of 194.4472, 243.5825, and 5.57%, respectively. Therefore, it can be concluded that the DES_brown method with $\alpha = 0{,}5$ is the most optimal model for forecasting the stock price of PT Telekomunikasi Indonesia Tbk.

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