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# Prediction Of Cigarette And Tobacco Price Index In Tangerang City Using Ses And Double Linear Exponential Smoothing

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**Abstract**

The cigarette and tobacco price index is a crucial indicator that reflects changes in prices and demand in the tobacco market. Accurate predictions of this index are essential for the government and industry players in planning policies and business strategies. This study aims to forecast the cigarette and tobacco price index in Banten Province using the Single Exponential Smoothing (SES) and Double Linear Exponential Smoothing (DES) methods. The data used in this research comprises monthly cigarette and tobacco price index data from January 2021 to December 2023. SES and DES models are applied for prediction, and their results are evaluated using performance indicators such as Mean Absolute Percentage Error (MAPE). The research findings indicate that both methods are highly effective in predicting the cigarette and tobacco price index, with the SES method providing slightly more accurate predictions than the DES method. The MAPE error value for the SES method is 0.51%, while the DES method has a MAPE error value of 0.65%. These results are expected to contribute to policymakers and industry players in understanding price trends and making more informative decisions.

*Keywords:* Cigarette price index, Prediction, Single Exponential Smoothing, Double Linear Exponential Smoothing.

## 1. Introduction

### 1.1 Background

Cigarettes and tobacco are commodities of plantation products and businesses that are very lucrative and promising. This can be evidenced by the state revenue that comes in from the sale of cigarettes and tobacco prices whose value touches more than 150 trillion rupiah in one year. In 2019, the smoking prevalence among adults in Indonesia was 32.8%, which is likely associated with a significant economic burden. Therefore, it is crucial to promptly estimate the economic costs of tobacco use to assist policymakers in planning healthcare provisions and other public expenditures (Meilissa et al., 2022). This study aims to gain a more comprehensive understanding of this issue, particularly regarding the impact of price, and to provide relevant and useful recommendations for policymakers (Jovanovic et al., 2023). This is the basis why researchers are interested in conducting research on the price of the index of increasing cigarette and tobacco prices, especially in Banten province. The authors found previous research that used some of the same methods and the same research objectives related to the prediction of the cigarette price index. However, the difference from the previous study is that this study uses cigarette price index data from Riau province written by Septiawati et al. (2022). In addition, researchers first conducted research on the number of smokers in Banten province, especially in the Tangerang area. Banten smokers are estimated at 12.2%. This is certainly inseparable from the marketing and sales targets of cigarettes and tobacco which are intensively and massively carried out on internet pages and websites, as much as 82% of cigarette advertisements are carried out on the internet starting from social media and so on. On the other hand, the increase in the price of cigarette index was influenced by a new regulation from the government that came into effect on January 1, 2024 for machine clove cigarettes (SKM) group I excise increased by 11.8 percent so that the previous price of IDR2,055 to IDR2,260 per stick was followed by white cigarettes (SPM) group I increased by 11.9 percent and followed by other types of cigarettes (SKT) hand clove cigarettes increased by 4.7 percent, filtered hand clove cigarettes (SKTF) increased to 11.8 percent, This has an impact on the smoking community in Indonesia as many as 69.1 million people whose expenditure is interpreted as Rp64 trillion per year (Hidayatullah, 2024).

Based on the reasons mentioned above, therefore the researcher conducted this study to find out the prediction of the cigarette price index in Banten Province, especially in Tangerang City. The method used is to use the SES (single exponential smoothing) and double exponential smoothing methods. Referring to previous studies and studies that use the same research method, one of the studies that the author uses as a reference in using this method is a study Wiyanti (2023) that uses the SES method and Holt's linear for time series to predict health data; Fourth, vaccinations that produce significant small MAPE values using the SES method with a result of 0% to 0.73% and Holt's linear which produces a value of 0% to 0.29%. Research conducted by Perdana (2016) about the comparison of the DES method (double exponential smoothing) with the Test (triple exponential smoothing) in the forecasting of cigarette sales (case study of the main store of Lumajang). This study produced the best MAPE value from the DES method with a value of 15.262%. By using the SES and Holt's linear methods, it is hoped that later the research on the cigarette and tobacco price index in Banten Province will produce a significant value with a small error.

### 1.2 Problem Formulation

Based on the background of the above problem, the problem formulation in this study is:

a) How to apply the SES and DLES methods to predict the cigarette price index in Tangerang City?
b) What is the significance of the SES and DLES methods in predicting the Cigarette Price Index in Tangerang City?

### 1.3 Research Objectives

Based on the formulation of the problem, the purpose of this study is to find out

a) Knowing the application of the SES and DLES methods to predict the cigarette price index in Tangerang City.
b) Knowing what is the level of significance of the SES and DLES methods in predicting the Cigarette Price Index in Tangerang City.

### 1.4 Research Benefits

a) To contribute to scientific knowledge related to time sequence analysis
b) To provide education to the public about the estimated price of cigarettes in the future.

### 1.5 Problem Limitations

The limitation of the problem in this study is to implement the SES and HOLTS methods to predict secondary data on the value of cigarette and tobacco price indices in the Tangerang area.

## 2. Theoretical Foundation

### 2.1 Simple Exponential Smoothing

Mathematical model for single exponential smoothing (SES) according to Makridakis (2008).

$$y_t = \alpha \cdot y_{t-1} + (1 - \alpha) \cdot \hat{y}_{t-1}$$

For the equation, y is the value of the previous period while is the value of the previous Forecast, and α is the alignment parameter.$\hat{y}$

### 2.2 Holt's Linear Exponential Smoothing

Holt's Linear exponential smoothing is a forecasting method that adds a level component. Holt's linear exponential smoothing has the basis of two equation smoothing, one for evaluating levels and the other for trends (Makridakis, 2008). The forecast formula is

$$\hat{y}_{t+h} = L_t + h \cdot b_t$$
$$b_t = \beta \cdot (L_t - L_{t-1}) + (1 - \beta) \cdot b_{t-1}$$
$$L_t = \alpha \cdot y_t + (1 - \alpha) \cdot (L_{t-1} + b_{t-1})$$

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Where:

$t$ : Time to $t = 0,1,2, \dots, n$
$\hat{y}_{t+h}$ : Previous forecast value plus h which is the corresponding period
$y_t$ : The actual value of the series at time t
$L_t$ : Level components in the period t
$\beta$ : Trend Parameters

$\alpha$ : Alignment parameters with values between 0 to 1
$b_t$ : Trend components where t was previously

### 2.3 MAPE

MAPE (Mean Absolute Percentage Error) is an additional metric that is useful in model evaluation, although it provides more relative information than the absolute information provided by MAE or MSE. MAPE calculates the error as a percentage of the actual value, thus providing a relative idea of how accurate the model's predictions. The lower the MAPE value, the more accurate and specific the forecasting model will be. MAPE values range from 0% - 100%. The MAPE formula is appropriate (Melantika et al., 2024).

$$MAPE = \frac{1}{n}\sum_{t=1}^{n}\left|\frac{A_t - F_t}{A_t}\right| \times 100\%$$

Which:
$A_t$ : Actual value at t
$F_t$ : The value predicted by the model at t
n : Number of observations in the data

## 3. Research Methodology

### 3.1. Data Sources

The data used is secondary data on the cigarette and tobacco price index in Banten Province. The data is accessed and taken from the official website of Badan Pusat Statistik (BPS) in Indonesia. The data taken is data for the last 3 years, namely from 2021 to 2023 per month.

### 3.2. Research Methods

This research method uses a quantitative method. The methods used are Simple Exponential Smoothing (SES) and Holt's Linear Exponential Smoothing. The flow of data analysis of this research can be seen in Figure 1.

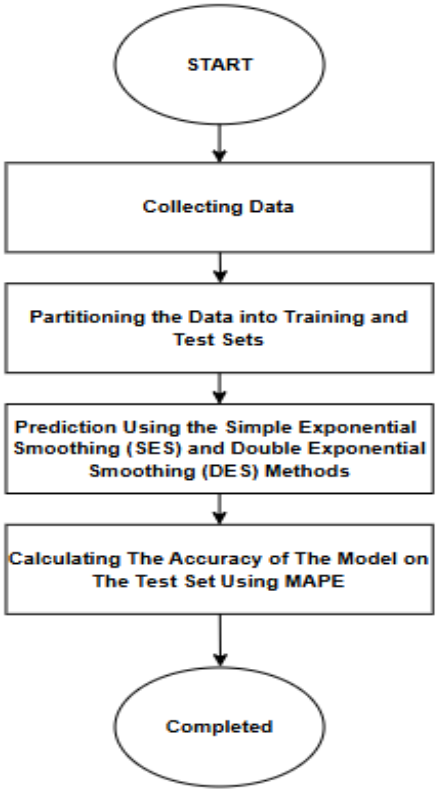


**Figure 1:** Research Flow Chart

This flowchart shows the steps to make predictions using the Simple Exponential Smoothing (SES) and Double Exponential Smoothing (DES) methods, and measures the accuracy of the predictions using the Mean Absolute Percentage Error (MAPE). The process begins with the necessary data collection stage. After the data is collected, the data is divided into two parts, namely data for training (initial) and data for testing (testing). Then, predictions are made using two forecasting methods, namely Simple Exponential Smoothing (SES) and Double Exponential Smoothing (DES). After that, the error rate or accuracy of the prediction is measured using the Mean Absolute Percentage Error (MAPE). The process is completed after measuring the accuracy of the prediction.

## 4. Results and Discussion

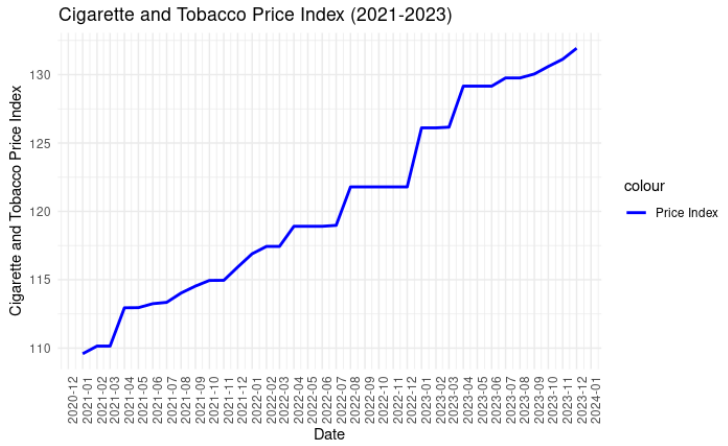


**Figure 2:** Cigarette and Tobacco Price Index

### 4.1. Simple Exponential Smoothing

The results of the analysis of cigarette and tobacco price index data are summarized from the plot results in Figure 3. This analysis uses the SES method as described in Equation 1. In *r software*, to use the SES method, use the ses() library. And a prediction is generated as shown in Figure 3.

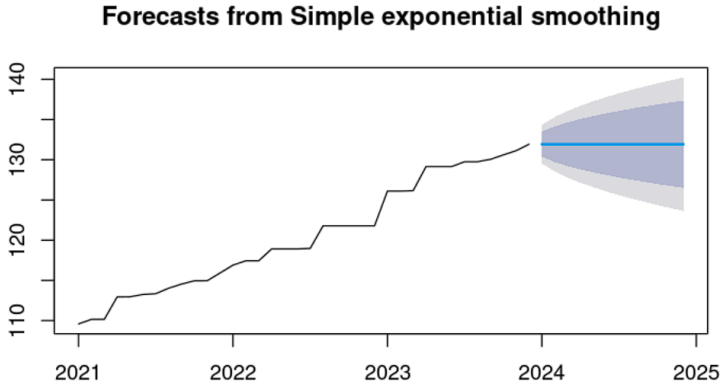


**Figure 3:** SES Method Prediction Plot

```
                    ME      RMSE       MAE        MPE      MAPE      MASE
Training set 0.6206198 1.186813 0.6206198 0.5106388 0.5106388 0.0774645
                   ACF1
Training set -0.2813443
```

The results *of* the MAPE error value are measured using library accuracy (). The SES method produces a MAPE value of 0.51% where this *error* value can be said to be very small. So that it is possible to become the best model.

### 4.2. Double Exponential Smoothing (Linear Holt's)

In using Holt's Linear method, we need to know that the trend of a data must be linear. So, we need to check whether the trend is linear or not. The author uses the durbin Watson Test () library in the software r. A summary of the outputs of this analysis can be seen in Figure 4.

```
        Durbin-Watson test

data:  Model.SJ
DW = 0.98145, p-value = 0.0002212
alternative hypothesis: true autocorrelation is greater than 0
```

**Figure 4:** Durbin-Watson analysis output with *r software*

Based on figure 4.2, it can be seen that the P-Value < 0.05. This indicates that the data has a linear trend. Thus, the data is feasible to be analyzed using Holt's Linear Exponential Smoothing method.

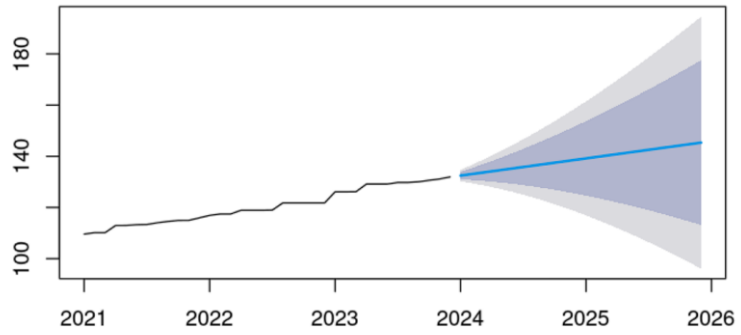


**Figure 5:** Holt's Linear Exponential Smoothing Method Prediction Graph

| | Point Forecast <dbl> |
|---|---|
| Jan 2024 | 132.4556 |
| Feb 2024 | 133.0155 |
| Mar 2024 | 133.5754 |
| Apr 2024 | 134.1353 |
| May 2024 | 134.6951 |
| Jun 2024 | 135.2550 |
| Jul 2024 | 135.8149 |
| Aug 2024 | 136.3748 |
| Sep 2024 | 136.9347 |
| Oct 2024 | 137.4946 |

**Figure 6:** HLT Method Prediction Results

The prediction results using the HLT method can be seen in figure 4.3. and 4.4. This prediction uses the values $\alpha = 0.9$ and $\beta = 0.3$.

```
                      ME      RMSE       MAE           MPE      MAPE
Training set -1.240053e-05 1.141998 0.8035513 -0.001800542 0.6598739
                   MASE       ACF1
Training set 0.1002976 -0.2585546
```

The results of the MAPE *error value* prediction are 0.65% using the HLT method. This model has *a* small error as well.

## 5. Conclusion

Based on the research that has been conducted, it can be summarized that the Simple Exponential Smoothing (SES) and Holt's Linear Exponential Smoothing methods are good methods in researching data on cigarette and tobacco price indices in Banten. Both of these methods are suitable for use in data with trending and non-seasonal characters. We can see this from the results of the MAPE error value owned by each method. The Simple Exponential Smoothing (SES) method has a MAPE value of 0.51%, while the Holt's linear method has a MAPE value of 0.65%. The errors of these two methods are very small and have a high level of accuracy. The next suggestion for researchers is to use the Simple Exponential Smoothing (SES) and Holt's Linear Exponential Smoothing methods in the case of cigarette and tobacco price index data that have trend and non-seasonal data characters.

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