

Cigarette Sales Forecasting at Bali Jaya Store Using the Single Method Exponential Smoothing

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ABSTRACT

This study aims to forecast cigarette sales at Toko Bali Jaya using the Single Exponential Smoothing method as a quantitative approach to support more effective inventory management. The problems faced are the unstructured sales recording process and the manual determination of stock levels, which leads to inaccuracy in inventory control and potentially leads to overstocking or understocking. The Single Exponential Smoothing method was chosen because it is known to be effective in forecasting time series with fluctuating data patterns and no significant trends. The data used are cigarette sales data for 12 months which are processed to produce forecast values for the following period. The accuracy evaluation process is carried out using the Mean Absolute Percentage Error (MAPE) as an indicator of the level of forecast error. The results show that the best smoothing constant value is obtained at $\alpha = 0.3$ with a MAPE value of 5.93%. This value indicates a low error rate, so the method used is able to produce forecasts that are close to the actual data. Thus, this method can be used as a basis for decision-making related to cigarette inventory management in a more systematic and measurable manner.

Keywords: Forecasting, Cigarette Sales, Single Exponential Smoothing, MAPE

1. INTRODUCTION

Sales is a key business activity closely linked to inventory management. Improper inventory management can lead to an imbalance between inventory availability and market demand, potentially leading to losses due to both overstocking and shortages. In the context of a trading business, inventory plays a crucial role in maintaining smooth operations and optimally meeting consumer needs (Santoso dkk., 2021a). Therefore, an approach is needed to more accurately estimate future sales volumes.

Forecasting is a technique used to *predict* future events using available historical data. In practice, forecasting is a crucial part of the decision-making process, particularly in production planning and inventory management (Utami dkk., 2024). With accurate forecasting, businesses can determine the quantity of goods needed to be stocked, thereby minimizing the risk of losses due to mismatches between stock and demand.

Toko Bali Jaya is a business specializing in selling basic necessities, with cigarettes being a particularly high-selling commodity. However, during its operations, the store continues to face challenges in inventory management, particularly for cigarettes. Unstructured sales recording and decision-making that relies on experience or memory lead to inaccuracies in determining stock levels. This situation results in excess or shortages of inventory, which result in business losses and missed sales opportunities.

One method that can be used to address this problem is the *Single Exponential Smoothing* (SES) method. This

time series forecasting technique places greater weight on recent data, allowing it to adjust for fluctuating data patterns (Azzahra dkk., 2022). Furthermore, the SES method is known for its relatively simple calculation process yet its ability to produce a high level of accuracy on data without significant trends (Santoso dkk., 2021b).

Several previous studies have demonstrated the utility of the SES method in various forecasting applications. Research conducted by Marlim and Hajjah (2022) demonstrated that the SES method can be used to predict sales with a good level of accuracy by testing several α parameters (Marlim & Hajjah, 2022a). Another study conducted by Nuryani et al. (2022) also stated that the SES method is effective in assisting inventory control by determining more accurate stock levels based on historical data (Nuryani dkk., 2022). Furthermore, research by Manalu et al. (2022) demonstrated that implementing the SES method can help companies plan inventory more effectively by utilizing previous sales data (Restyana dkk., 2021).

However, based on a review of previous studies, several limitations were identified. Most studies focused solely on specific research subjects, such as pharmaceutical supplies, MSME products, or industrial goods. Therefore, they did not specifically address forecasting for cigarette products, which have fluctuating demand characteristics. Furthermore, some studies used limited data or focused solely on method implementation without considering the unstructured data recording conditions at the small business level. This situation

indicates a research gap *that* has not been thoroughly explored.

Based on this gap, this study aimed to apply the *Single Exponential Smoothing method* to cigarette sales forecasting at Toko Bali Jaya, utilizing available historical data. This research is expected to contribute to a more systematic forecasting approach for small businesses with rudimentary data recording, thus facilitating more accurate and efficient inventory management decisions.

2. SCOPE AND RESEARCH

In order to ensure that the research remains focused and not overly broad, it is limited to several key aspects. The study was conducted at Bali Jaya Store, which sells various basic food products but primarily focuses on cigarette products offered to consumers. The data used in this research consists of cigarette sales data from previous periods, obtained from store sales records in the form of purchase notes. The results of the study are presented as calculations used to estimate the number of cigarette sales in the next period based on the available historical data. Furthermore, this research is limited to the analysis and calculation process of sales forecasting and does not discuss the store's sales management system in detail.

3. MATERIAL AND METHOD

3.1 Types of research

This study uses a quantitative approach based on time series analysis *to* predict sales based on historical data. Forecasting is a scientific process for estimating future conditions by systematically utilizing past data (Gozali dkk., 2021). This study uses the *Single Exponential Smoothing* (SES) method, which is commonly used on data with fluctuating patterns and no significant trends (Fahrudin dkk., 2021).

3.2 Data collection

The data used is secondary data, including cigarette sales over 12 monthly periods. Time series data is used because it can depict sequential changes in value over a specific interval, allowing it to be used to predict future values (Fahrudin dkk., 2021). The use of historical data as a basis for forecasting has also been widely used in previous research in various sectors such as industry, health, and education (Restyana dkk., 2021).

The data used falls into the time series category, which is data collected periodically over a specific time interval. The use of historical data in forecasting aims to identify patterns and trends that occurred in previous periods so that they can be used as a basis for predicting values in future periods (Saragih dkk., 2024).

Data collection techniques used include:

1. Observation, namely conducting direct observation of sales activities and the sales data recording process carried out at the Bali Jaya Store.
2. Documentation, namely collecting cigarette sales data from archives or sales records held by the shop.

3.3 Data Pattern Analysis

Data pattern analysis is performed to determine the characteristics of the sales data used in the research. This stage is crucial for determining the appropriate forecasting method. Time series data generally exhibits several patterns, such as horizontal (stationary), trend, seasonal, and cyclical (Restyana dkk., 2021).

Based on the analysis of cigarette sales data, the resulting data pattern tends to fluctuate and shows no significant trend. This condition indicates that the data is stationary, or fluctuates around the average value. Therefore, the *Single Exponential Smoothing method* is considered appropriate for use in this study because it is effective for data with horizontal patterns or no clear trend (Azzahra dkk., 2022; Reba dkk., 2021).

3.4 Single Exponential Smoothing Method

Single Exponential Smoothing method is a forecasting method used to estimate values for the next period using available historical data. This method works by giving more weight to the most recent data compared to previous data so that the forecast results can adjust to changes in data patterns.

The Exponential Smoothing method is a time series forecasting technique that uses a smoothing process on historical data by assigning a certain weight to each period to produce an estimated value in the next period (Wheelwright, 1998). Meanwhile, Heizer and Render stated that the *Single Exponential Smoothing method* is widely used in demand forecasting because it has a simple calculation process and is quite effective for fluctuating data (Heizer and Render, 2015). The formula used in the *Single Exponential Smoothing method* can be seen below (1):

$$F_{t+1} = \alpha X_t + (1 - \alpha)F_t \quad (1)$$

Information:

- F_{t+1} : forecast value in the next period
- X_t : actual data in period t
- F_t : forecast value in period t
- α : smoothing constant with a value between 0 and 1

In the calculation process, the smoothing constant (α) is used to determine the level of influence of the most recent data on the forecast results. The greater the α value, the greater the influence of the most recent data on the forecast results.

Through this method, cigarette sales data from the previous period can be processed to obtain an estimate of the number of sales in the following period, thereby assisting in the decision-making process related to inventory management.

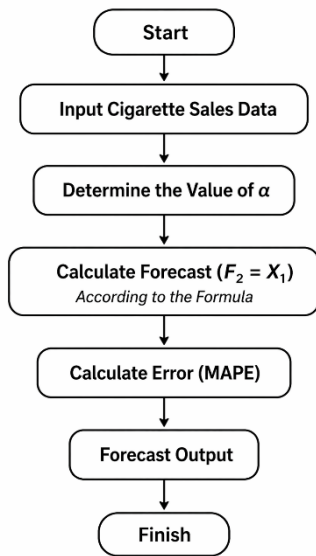


Figure 1. System Overview

The F -lowchart in the figure illustrates the stages of the cigarette sales forecasting process using the *Single Exponential Smoothing* (SES) method , starting from data processing to generating the forecast output. Further explanation of Figure 1 is as follows:

1. Start

The initial stage of the forecasting process. At this stage, the analysis system or process begins to run.

2. Input Cigarette Sales Data

At this stage, historical cigarette sales data (time series) is collected and input, usually in the form of monthly data. This data serves as the primary basis for the forecasting process.

3. Determine the value of α (Alpha)

α value is a smoothing constant used in the SES method with a range of $0 < \alpha < 1$. This value determines how much influence the latest data has on the forecast results. The larger the α value , the more responsive the forecast results will be to changes in the data.

4. Calculate Forecast

At this stage, the forecast value is calculated using SES. For the initial calculation, initialization is used with the following stages (2):

$$F_2 = X_1 \quad (2)$$

Information:

F_2 = Forecast value in the 2nd period

X_1 = Actual data in the first period

This process is repeated for each data period.

5. Calculate Error (MAPE)

After the forecast value is obtained, the error level is measured using the *Mean Absolute Percentage Error*.(MAPE).

MAPE is used to determine the level of accuracy of a method by comparing actual values and forecast results.

6. Forecasting Output

This stage produces a sales forecast for the following period. These results can be used as a reference for decision-making, particularly in determining stock levels.

7. Done

The final stage of the forecasting process. The entire process is complete and the forecast results are ready to use.

3.5 Determination of Parameter α (Alpha)

The α (alpha) parameter in the *Single Exponential Smoothing method* is a smoothing constant that has a value between 0 and 1. The α value functions to determine the weighting level between the latest actual data and previous data in the forecasting process.

The determination of the α value is carried out using the *trial and error method* , namely by testing several α values to obtain forecast results with the smallest error rate. The α value that produces the smallest error is selected as the best parameter in the forecasting process.(Marlim & Hajjah, 2022a; Nuryani dkk., 2022) .

In this study, the α value used was tested in several variations, such as 0.1; 0.2; 0.3; up to 0.9, then the α value that provided the best level of accuracy was selected based on the error test results.

3.6 Error Measurement (MAD, MSE, and MAPE)

Forecasting results were evaluated using three error measurement methods: MAD, MSE, and MAPE. Using more than one error measure aims to provide a more comprehensive evaluation of model accuracy (Marlim & Hajjah, 2022b).

MAPE is used as a primary indicator because it provides results in easy-to-interpret percentage form. In previous research, MAPE values were often used as a basis for determining the best forecasting method (Utami dkk., 2024).

To measure the level of accuracy of forecasting results, several error measurement methods are used, namely:

1. *Mean Absolute Deviation* (MAD)
MAD is used to measure the average absolute error between the actual value and the forecast result.
2. *Mean Squared Error* (MSE)
MSE is used to measure the average of the squared errors, thus giving a larger penalty to large errors.
3. *Mean Absolute Percentage Error* (MAPE)
MAPE is used to measure the level of error in percentage form, so it is easier to interpret.

This approach is in line with comparative research on forecasting methods which states that the choice of method must be adjusted to the characteristics of the data and error evaluation (Aziza, 2022).

The use of multiple error methods aims to obtain more accurate and comprehensive evaluation results in determining forecast quality (Marlim & Hajjah, 2022b). A smaller error value indicates a higher level of accuracy in the forecasting method used.

3.7 Research Flow

The research flow is a systematic stage carried out in this research, which includes:

1. Cigarette sales data collection
2. Data processing and cleaning
3. Data pattern analysis (*time series*)
4. *Single Exponential Smoothing* method
5. Determination of the value of parameter α
6. Calculation of forecasting results
7. Accuracy evaluation using MAD, MSE, and MAPE
8. Analysis and interpretation of results

This stage is carried out systematically to ensure that the research process is structured and produces valid output and can be used as a basis for decision making in managing inventory (Aziza, 2022).

4. DISCUSSION

The forecasting process in this study was conducted using Google Colaboratory as a Python-based computing environment. The use of computational tools in data analysis allows for systematic calculations and minimizes manual errors.

The SES method is applied by testing several α values to obtain the best results. This approach is consistent with previous research which states that the selection of the α parameter significantly influences forecasting results (Nuryani dkk., 2022).

Test results show that a value of $\alpha = 0.3$ produces the smallest error. This indicates that weighting the most recent data produces predictions that are closer to actual conditions, in accordance with the characteristics of the SES method, which adjusts prediction values based on the most recent data (Santoso dkk., 2021b).

The MAPE value obtained was 5.93%, indicating a low error rate. Other research also shows that the SES method can produce low error rates in various forecasting situations, such as product sales, production, and inventory. (Manalu dkk., 2022)

When compared to other studies using different forecasting methods, such as *Double Exponential Smoothing* or regression-based methods, the accuracy of the results is significantly influenced by the data patterns (Rosita & Moonlight, 2024) used. Therefore, the selection of the SES method in this study is considered appropriate because it fits the characteristics of the data, which lacks strong trends.

Furthermore, several studies have shown that the SES method is superior to other methods for highly volatile data because it can quickly adapt to changes (Ena, 2023). This reinforces the research findings that the SES method is effective for sales forecasting in small businesses.

Thus, the use of the SES method implemented through Google Colab not only provides ease of calculation, but is also able to produce accurate forecasts and can be used as a basis for decision-making related to inventory management.

This research utilizes cigarette sales data obtained from Toko Bali Jaya as its research data. The data consists of 12 monthly periods and serves as the basis for the forecasting process using the *Single Exponential Smoothing method*.

4.1 Sales Data

Cigarette sales data at Toko Bali Jaya shows a fluctuating pattern with no consistent trend. This is evident in the irregular increases and decreases in sales over each period. The highest sales volume occurred in July at 1,844, while the lowest was in June at 1,578.

Furthermore, there were significant changes in several periods, such as sharp increases from June to July and from October to November. Conversely, there was a drastic decline in December after experiencing an increase in the previous month.

This situation indicates that cigarette sales data has a high degree of volatility, making it difficult to predict based solely on intuition or memory. Therefore, a forecasting method is needed that can accommodate fluctuating data, such as *Single Exponential Smoothing*.

Table 1. Number of Sales of 10 Types of Cigarettes Each Month for 1 Year

Month	Total Sales (Xt)
Jan	1797
Feb	1628
Mar	1697
Apr	1630
May	1704
June	1578
Jul	1844
August	1644
Sep	1667
Oct	1621
Nov	1833
Des	1582



Table 1 shows cigarette sales data at Toko Bali Jaya showing a fluctuating pattern without a clear trend. This is indicated by significant increases and decreases in sales over several periods. This situation makes it difficult to accurately determine inventory levels when relying solely on estimates, so forecasting methods are needed to assist decision-making.

4.2 Comparison of α Values

Table 2. Explanation of the Comparison Table of α Values against MAPE

No	α	MAPE (%)
1	0.1	6.97%
2	0.2	6.25%
3	0.3	5.93%
4	0.4	5.98%
5	0.5	6.10%
6	0.6	6.27%
7	0.7	6.63%
8	0.8	7.01%
9	0.9	7.47%

Based on the results of testing several α values in Table 2, it was found that $\alpha = 0.3$ produced the smallest MAPE value, at 5.93%. This indicates that this α value is the best parameter in the Single Exponential Smoothing method for cigarette sales data at Toko Bali Jaya. An α value that is too small or too large results in a higher error rate, so choosing the right α value significantly affects the level of forecasting accuracy.

4.3 Single Exponential Smoothing Calculation

The initial step is carried out by determining the smoothing constant value (α) of 0.3. Next, the initial forecast value is initialized by equating the initial forecast value with the first actual data. The calculation process is then repeated for each period using the Single Exponential Smoothing formula until the forecast value is obtained for all data. The calculation process uses ($\alpha = 0.3$), the formula and Initialize the following:

$$F_1 = X_1 = 1797 \quad (3)$$

Information:

F_1 = Forecast value in the first period
 X_1 = Actual data in the first period (1797)

These results show that the forecast value in March is influenced by the actual data of the previous month as well as the previous forecast results with certain weights based on the α value used.

Table 3. Results of Error and Absolute Calculations Percentage Error (APE)

Month	X_t	F_t
Jan	1797	1797
Feb	1628	1797
Mar	1697	1746.30
Apr	1630	1731.51
May	1704	1701.06
June	1578	1701.94
Jul	1844	1664.76
August	1644	1718.53
Sep	1667	1696.17
Oct	1621	1687.42
Nov	1833	1667.49
Des	1582	1717.15

Table 3 shows the results of cigarette sales forecasting calculations using the *Single Exponential Smoothing method* with a smoothing constant value ($\alpha = 0,3$). This table presents a comparison between actual data (X_t) and forecast results (F_t) for each period.

4.4 Calculation of Error and MAPE

To determine the accuracy of the method used, the error between the actual value and the forecasted result is calculated. The error is calculated as the difference between the actual data (X_t) and the forecasted result (F_t). Furthermore, to measure the error level in percentage form, the Absolute Percentage Error (APE) is used. The formula used is as follows:

$$Error = | X_t - F_t |$$

$$APE = \left| \frac{X_t - F_t}{X_t} \right| \quad (4)$$

Information:

X_t = Actual data in the period t
 F_t = Forecast value in the period t
 $Error$ = Difference between actual data and forecast results
 APE = Absolute Percentage Error (percentage of absolute error)

Based on equation (4), the *error value* is calculated as the absolute difference between the actual data (X_t) and the forecast results (F_t). The absolute value is used to avoid negative values so that all errors are calculated in positive form.

Furthermore, equation (4) also shows that the *Absolute Percentage Error (APE)* value is obtained by comparing the difference between the actual data and the forecast results against the actual data. This value is used to determine the error rate in percentage form for each period.

After all APE values are obtained, the Mean Absolute Percentage Error (MAPE) value is calculated to determine the average level of forecast error.

$$MAPE = \frac{1}{n} \sum APE \times 100\% \quad (5)$$

Information :

MAPE = Mean Absolute Percentage Error

n = Number of data/period

$\sum APE$ = Total number of APE values

Based on equation (5), the Mean Absolute Percentage Error (MAPE) value is obtained by calculating the average of all APE values, then multiplying by 100% to get the result in percentage form.

The MAPE value is used as an indicator to measure the accuracy of a forecasting method. The lower the MAPE value, the higher the accuracy of the forecasting method.

Table 4. Results of Comparison of α Values to MAPE

Month	Xt	Ft	Error	APE
Feb	1628	1797	169.00	0.1038
Mar	1697	1746.30	49.30	0.0291
Apr	1630	1731.51	101.51	0.0623
May	1704	1701.06	2.94	0.0017
June	1578	1701.94	123.94	0.0785
Jul	1844	1664.76	179.24	0.0972
August	1644	1718.53	74.53	0.0453
Sep	1667	1696.17	29.17	0.0175
Oct	1621	1687.42	66.42	0.0410
Nov	1833	1667.49	165.51	0.0903
Des	1582	1717.15	135.15	0.0854

Based on the calculation results, the following values are obtained:
 MAPE=5.93%

Table 4 shows the results of the error and *Absolute Percentage Error (APE)* calculations from the *Single Exponential Smoothing method* with a smoothing constant value ($\alpha = 0,3$). This table is used to evaluate the level of accuracy of the forecasting results by comparing the actual value (X_t) and the forecasted results (F_t).

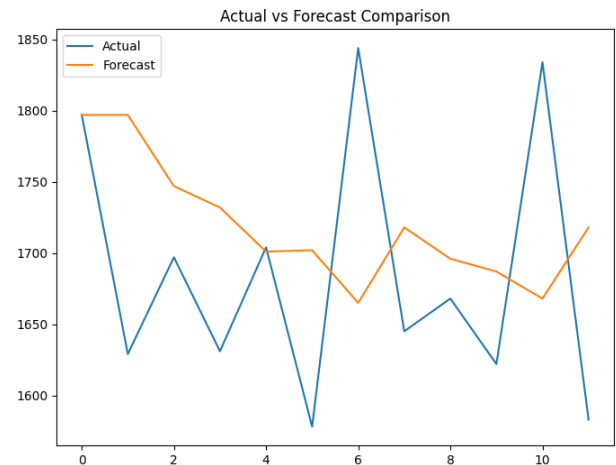


Figure 2. Comparison of Actual Data and Forecast Results

The graph shows that the forecasting results are able to follow the fluctuating pattern of the actual data. However, in some periods, such as July and November, the forecasting results tend to lag behind the actual data due to significant sales spikes. This indicates that the *Single Exponential Smoothing method* has limitations in responding to extreme data changes.

Based on the calculation results, the error values varied in each period. Small error values indicate that the forecast results are close to the actual data, while large errors occur in periods with significant data changes. The *Mean Absolute Percentage Error (MAPE)* value of 5.93% indicates that the *Single Exponential Smoothing method* has a very good level of accuracy in forecasting cigarette sales at Toko Bali Jaya.

4.5 Analysis of Results

Based on the calculation results, the value of $\alpha = 0.3$ produces the smallest MAPE value, namely 5.93%. This indicates that this value of α provides the best level of accuracy compared to other α values.

Single Exponential Smoothing method is able to track fluctuations in cigarette sales data that lack significant trends. However, in some periods, such as July and November, significant discrepancies were observed between actual and forecasted values. This was due to significant sales spikes, making the SES smoothing method less responsive to drastic changes.

The MAPE value of 5.93% is considered very good, as it is below 10%. This indicates that the *Single Exponential Smoothing method* is very suitable for forecasting cigarette sales at Toko Bali Jaya.

The results of this study align with previous research, which found the *Single Exponential Smoothing method* to be effective for data that lacks strong trends and tends to fluctuate. However, this method has limitations in responding to sudden data changes, so in certain situations, other, more adaptive methods are needed.



Despite this, the forecasting method successfully demonstrated its ability to track fluctuating sales data patterns. In some periods, the forecast results differed relatively little from the actual data, indicating that the method adequately reflects current sales conditions.

This study is limited by the amount of data used, which only covers a 12-month period, preventing a more in-depth analysis of long-term patterns. Furthermore, this study uses only one forecasting method without comparing it with other methods.

Overall, the *Single Exponential Smoothing method* is suitable for sales data that lacks strong trends and tends to fluctuate. With its low error rate, this method can be used as a tool to estimate sales volume in the following period and support decision-making in inventory management.

Thus, the results of this forecast can be used as a basis for determining the amount of cigarette inventory in the next period to be more effective and efficient.

5. CONCLUSION

Based on the research results, the Single Exponential Smoothing method can be used to forecast cigarette sales at Toko Bali Jaya using available historical data. The calculations demonstrated that this method can produce predicted values that are close to actual data, thus providing a basis for supporting inventory management.

The test results show that the best parameter value is obtained at $\alpha = 0.3$ with a relatively low forecasting error rate. This indicates that the method used is quite suitable for the characteristics of sales data, which tends to fluctuate. Therefore, the forecasting approach applied in this study can contribute to the decision-making process, particularly in determining more planned and efficient inventory levels.

6. SUGGESTION

Future research could focus on using data from a longer time span to more comprehensively identify sales patterns and improve forecasting accuracy. Furthermore, the Single Exponential Smoothing method can be further enhanced by comparing it with other forecasting methods, such as Double Exponential Smoothing or other approaches, to determine the most appropriate method for the characteristics of the data used.

In addition, if possible, future studies may also develop a more detailed forecasting approach by conducting monthly calculations for each cigarette product, particularly focusing on the top five best-selling cigarette brands. The forecasting process should be carried out separately for each cigarette brand in order to obtain more specific and accurate forecasting results based on the sales characteristics of each product.

On the other hand, the results of this study also have the potential to be further developed in the form of a system or application that can be used directly by shop owners, so that the forecasting process is not only analytical, but can also be implemented practically to

support decision making related to inventory management..

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