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COMPARISON OF SINGLE EXPONENTIAL SMOOTHING METHOD WITH DOUBLE EXPONENTIAL SMOOTHING METHOD PREDICTION OF SALT SALES

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ABSTRACT- Predicting the number of product sales in the future aims to control the amount of existing product stock to minimize the shortage or excess of product stock. When one can accurately predict the number of sales, one can manage the fulfillment of consumer demand on time, and the company's cooperation with consumers is adequately maintained to avoid losing sales and consumers. This study aims to analyze the accuracy of predicting the number of sales of salt using the Single Exponential Smoothing (SES) method compared to the Double Exponential Smoothing (DES) method so that a more accurate method will be obtained for predicting the number of sales. The results of testing the comparison of the level of accuracy can be done by evaluating the error value of the forecasting results with the Mean Absolute Percentage Error (MAPE). The lowest MAPE result obtained is in the SES method when the parameter $\alpha = 0.054$ with a MAPE result of 7.932%, which means the accuracy value is very accurate. Whereas with the DES method, the MAPE value is 28.145% while the parameter $\alpha = 0.845$ $\beta = 0.214$, which means the accuracy value is reasonable. Based on the MAPE results obtained using the two methods above, the Single Exponential Smoothing method is more accurate for predicting salt sales. Whereas with the DES method, the MAPE value is 28.145% while the parameter $\alpha = 0.845$ $\beta = 0.214$, which means the accuracy value is reasonable. Based on the MAPE results obtained using the two methods above, the Single Exponential Smoothing method is more accurate for predicting salt sales. Whereas with the DES method, the MAPE value is 28.145% while the parameter $\alpha = 0.845$ $\beta = 0.214$, which means the accuracy value is reasonable. Based on the MAPE results obtained using the two methods above, the Single Exponential Smoothing method is more accurate for predicting salt sales.

Keywords: Prediction, salt sales, Single Exponential Smoothing, Double Exponential Smoothing.

1. PRELIMINARY

One thing that needs to be considered in the sales process is the available product stock. Prediction of total sales To control the amount of product stock so that there is no excess or shortage of product stock in the sales process, projections of total sales are needed. If the number or quantity of sales can be predicted, there is little chance of something like excess or shortage of product stock occurring. Besides being able to control the amount of product stock, the relationship between the company and consumers is also maintained [1].

PT. Sumatra Palm Raya was established on October 29, 1997. PT. Sumatra Palm Raya is a private salt distributor company engaged in the salt iodization industry and packaging of iodized salt for consumption. PT. Sumatra Palm Raya is to serve and provide the needs or interests of customers for salt needs. Therefore, daily salt sales transactions must be balanced with the existing stock of salt. Therefore, it is necessary to have a system that can predict (forecasting) the total sales in the future. A system that can predict sales consists of several types of methods. In this research journal, 66% and the best α in this study is 0.3, and the application of the Single Exponential Smoothing Method in Predicting Bed Sheet Sales "[4] concludes that the percentage error calculation in bed sheet sales is 5.99% with $\alpha = 0.1$. Whereas in the fourth study [1], entitled "Analysis of Single Exponential Smoothing Method With Brown Exponential Smoothing," concluded that the average percentage of prediction errors with the Single Exponential Smoothing method was 1.14% with $\alpha = 0.5$ while the average percentage of errors prediction using the Brown Exponential Smoothing (BES) method is 1.22% with $\alpha = 0.1$.

A study entitled "Inventory Forecasting System Using the Brown Exponential Smoothing Method" [5] concluded that oil goods it has a prediction error percentage of 9.51% with $\alpha = 0.2$. In comparison, outer tire goods it has a prediction error percentage of 9.49%. With $\alpha = 0.1$ [5]. Another study entitled "PAPER SALES PREDICTION USING THE DOUBLE EXPONENTIAL SMOOTHING METHOD" [6] concluded that in forecasting Paper A had an error percentage of 12% with $\alpha = 0.3$, and in predicting HVS A3+, an error percentage of 18% was obtained with $\alpha = 0.6$. And in a study entitled "Forecasting Printing Demand Using the Double Exponential Smoothing Method" [7] concluded that the best α obtained for forecasting printing demand was $\alpha = 0.\ 2$ with a Mean Square Error value of

5712904.8. A subsequent study entitled "Application of the Double Exponential Smoothing Method from Brown for Forecasting the Amount of Water Production" [8] concluded that it has an error percentage of 3% with α = 0.3 for forecasting the amount of water production of Perumda Air Drinking Tirta Raharja in 2013 to the year 2020.

Prediction of Flower Board Sales Using the Double Exponential Smoothing Method concluded that the resulting error percentage was 5.45% with parameter α = 0.5 for the forecast of flower board sales [9]. And in the previous study, entitled "IMPLEMENTATION OF SINGLE EXPONENTIAL SMOOTHING (SES) IN CALCULATION OF THE AMOUNT OF MINERAL WATER DEMAND" [10], concluded that in forecasting semester I of 2020 using the Single Exponential Smoothing (SES) method with α = 0.9 is 2,177,634 330 ml short neck mineral water unit. Meanwhile, the calculation of the Mean Absolute Deviation (MAD) α = 0.9 has a value of 1,860 error units that occur in forecasting demand data in the semester I of 2022.

Based on these problems, the authors took research with the title "Comparison of the Single Exponential Smoothing Method with the Double Exponential Smoothing Method of Prediction of Salt Sales" for stock inventory prediction as the main objective of comparing the two methods in order to choose which way is most appropriate for predicting stock procurement in companies.

2. RESEARCH CONTENT

2.1 Methodology Flow

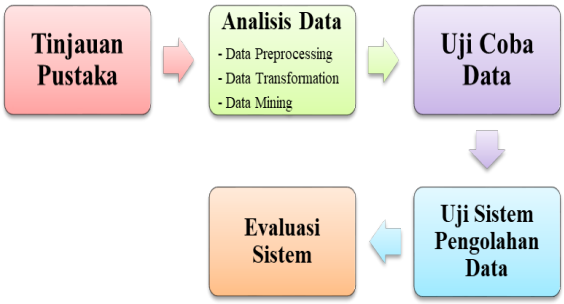

Figure 1. Methodology Flow

2.2 Literature Review

At the literature review stage, the researcher collects the data needed for mining. This study uses salt sales data from January 2020 to December 2021, which is stored in the PT. Sumatra Palm Raya.

1. Algorithm

Single Exponential Smoothing Method

The weighting of this method is carried out exponentially, decreasing towards older values. Where the newer observation value has relatively greater weight than the older value. In this method, the exponential weighting moves mostly from the previous observation value. Trend and season do not affect this method. The following is the formula for this method:

$\hat{Y}t+1 = \alpha Yt + (1-\alpha)\ \hat{Y}t$ . . . . . (1)

Information:

$\hat{Y}t+1$ = forecast value for the next period

Yt = demand for period t

$\hat{Y}t$ = forecasting value for period t

α = smoothing weight factor ($0 < \alpha < 1$)

To predict the value of the next period, demand data and forecasting data from the previous period are needed [2].

2. Double Exponential Smoothing Method

This method has the concept of adding multiple smoothing values for single smoothing values and only using one parameter. The formula used in this method namely:

a. Calculating a single smoothing value (single smoothing)
$S't = \alpha Xt + (1 - \alpha)S't\text{-}1$ . . . . . (1)

b. Calculating the value of double smoothing (double smoothing)
$S''t = \alpha S't + (1 - \alpha)S''t\text{-}1$ . . . . . .(2)

c. Determine the value of the smoothing constant
$\alpha t = 2S't - S''t$ . . . . . (3)

d. Determine the value of the trend coefficient
$bt = \alpha/(1\text{-}a) + (S't - S''t)$ . . . . . (4)

e. Do fortune-telling
$Ft+m = \alpha t + bt\ (m)$ . . . . . (5)

Information:

S't : Single smoothing value
S''t : Double smoothed value
αt : Smoothing constant value in period t
bt : Trend coefficient value in period t
α : Smoothing parameter where;
m : The number of future periods to be forecasted
Ft+m : Forecasting the m period

This method can be used when the data shows a trend and does not consider the seasonal component [11].

2.3 Data Analysis

Data processing is done before entering the process of analyzing data. The data processing process is carried out first to ensure that the research data used is straightforward and comprehensive. Data analysis aims to assess the testable quality of the data and develop testable hypotheses. Several data analysis processes, including:

a. Data Preprocessing
Data preprocessing is the process of cleaning data (data cleaning). Data cleaning aims to eliminate or delete incomplete, irrelevant, and inaccurate data.
b. Data Transformation
The data transformation process is where data is transformed and consolidated in a form suitable for data mining. The purpose of this process is that the data, specifically numeric, is in the range of 0-1 so that the data distribution is not too far away. Meanwhile, categorical data will be converted into numeric.
c. Data Mining
This section is the process of finding interesting patterns or information in the selected data. The search is carried out with specific techniques or methods. Techniques, plans, or algorithms in data mining vary greatly. In this study, the authors used the Single Exponential Smoothing Method and the Double Exponential Smoothing Method in analyzing salt sales.

2.4 Testing on Python

Data testing was carried out to see whether the existing data was feasible or not to be used as an instrument in this study. The trials were carried out with the Python programming language. Python is a programming language used to create applications and computer commands and perform data analysis.

2.5 Test the Data System in Python

The data system test is the execution stage carried out by the software program on the data in a comprehensive and integrated manner. This stage aims to determine whether this Data Mining research can be carried out according to system specifications.

2.6 Evaluation

The evaluation section is the last part that is carried out to determine the pattern or information found, whether it is by or contrary to previous facts or hypotheses. Patterns or information that is formed will produce knowledge presented in the form of visualization. The results of this stage will influence the decision of the Data Mining to be carried out.

3. RESULTS AND DISCUSSION

3.1 Results of Implementation of Single Exponential Smoothing (SES)

In this study, Single Exponential Smoothing (SES) regarding the sale of salt has been implemented. Several processes in data collection have been carried out during the research period. The data collected recap one year's salt sales data in 2021.

The results of predicting salt sales using the SES method for small-size salt obtained the best alpha of 0.054, and the prediction of many sales for the next three months is shown.

```
21    13113.610902
22    13113.610902
23    13113.610902
Name: $\alpha=0.05400153600087762$, dtype: float64
```

Figure 1. Prediction Results of Sales of Small-Size Salt with the SES Method

The results of predicting salt sales using the SES method for medium-size salt obtained the best alpha of 0.037, and the prediction of the number of sales for the next three months is shown.

```
21    7885.3544
22    7885.3544
23    7885.3544
Name: $\alpha=0.037669664228764 25$, dtype: float64
```

Figure 2. Predicted Sales of Medium Size Salt with the SES Method

The results of predicting salt sales using the SES method for large salt obtained the best alpha of 0.005, and the prediction of the number of sales for the next three months is shown.

```
22    3688.897839
23    3688.897839
24    3688.897839
Name: $\alpha=0.005$, dtype: float64
```

Figure 3. Prediction Results of Large Salt Sales with the SES Method

3.2 Results of Implementation of Double Exponential Smoothing (DES)

In this study Double Exponential Smoothing (DES) regarding the sale of salt has been implemented. Several processes in data collection have been carried out during the research period. The data collected recap one year's salt sales data in 2021.

The results of predicting salt sales using the DES method for small salt obtained the best alpha of 0.845 and the best beta of 0.214 and predictions of many deals for the next three months.

```
21    10286.436289
22     9661.801107
23     9037.165925
Name: Holt's linear trend, dtype: float64
```

Figure 4. Predicted Sales of Small-Size Salt with the DES Method

The results of predicting salt sales using the DES method for medium-size salt obtained the best alpha of 0.640 and the best beta of 0.480 and predictions of many deals for the next three months.

```
21    6353.755569
22    5703.588444
23    5053.421320
Name: Holt's linear trend, dtype: float64
```

Figure 5. Predicted Sales of Medium Size Salt with the DES Method

Predicting salt sales using the DES method for large salt obtained the best alpha of 0.550 and the best beta of 0.330 and predictions of many deals for the next three months.

```
22    3117.352203
23    2994.605012
24    2871.857820
Name: Holt's linear trend, dtype: float64
```

Figure 6. Predicted Sales of Large Salt by the DES Method

3.3 Accuracy Analysis

The Mean Absolute Percentage Error (MAPE) function is used. MAPE values can be interpreted into 4 categories, namely:

1. Very accurate = <10%
2. Good = 10% - 20%
3. Fair = 20% - 50%
4. Inaccurate = >50%

```
def mape(actual, pred):
    actual, pred = np.array(actual), np.array(pred)
    return np.mean(np.abs((actual - pred) / actual)) * 100
```

Figure 7. Function Mean Absolute Percentage Error (MAPE)

The actual data in the function above is data taken from small_test_QTTY, medium_test_QTTY, or large_test_QTTY. Pred data is data taken from the results of Single Exponential Smoothing predictions or the results of Double Exponential Smoothing predictions.

As shown in Figure 8, a MAPE yield of 7.932% has been obtained for small sizes using the Single Exponential Smoothing method.

```
mape(kecil_test_QTTY, fcast1_kecil)

7.932799410533156
```

Figure 8.Small Size MAPE Results with the SES Method

For medium-size MAPE results using the Single Exponential Smoothing method is 10.650%.

```
mape(sedang_test_QTTY, fcast1_sedang)

10.650688185298037
```

Figure 9. Medium Size MAPE Results with the SES Method

For large-size MAPE results using the Single Exponential Smoothing method is 13.401%.

```
mape(besar_test_QTTY, fcast1_besar)

13.401685539150785
```

Figure 10. Extensive Size MAPE Results with the SES Method

For small size MAPE results using the Double Exponential Smoothing method is 28.145%.

```
mape(kecil_test_QTTY, fcast2_kecil)

28.145119846882043
```

Figure 11.Results of Small Size MAPE with DES Method

For medium-size MAPE results using the Double Exponential Smoothing method is 35.204%.

```
mape(sedang_test_QTTY, fcast2_sedang)

35.20442942534152
```

Figure 12.Medium Size MAPE Results with the DES Method

For large-size MAPE results using the Double Exponential Smoothing method is 23.228%.

```
mape(besar_test_QTTY, fcast2_besar)

23.22815413518221
```

Figure 13. Extensive Size MAPE Results with the DES Method

From all the MAPE results above, it can be seen that the prediction results using the Single Exponential Smoothing method are better than those using the Double Exponential Smoothing method. For example, the following table shows the difference between MAPE between the Single Exponential Smoothing method and the Double Exponential Smoothing method.

Table 1. MAPE Differences Between the SES Method and the DES Method

Size	MAPE	
	SES method	DES method
Small	7.932 %	28.145 %
Currently	10,650 %	35.204 %
Big	13,401 %	23.228 %

Source: SES Method and the DES Method

4. CONCLUSION

After calculating salt sales predictions using two methods, Single Exponential Smoothing, and Double Exponential Smoothing, which are more accurate in their calculations with the smallest MAPE value, analyses using Single Exponential Smoothing on the sale of small-size salt α = 0.054 yield MAPE 7.932%, medium-size salt α = 0.037 yields MAPE 10.650%, and large size salt α = 0.005 yield MAPE 13.401%. Whereas with Double Exponential Smoothing on the sale of small size salt α=0.845; β=0.214 MAPE yield 28.145%, and medium size salt α=0.64; β=0.48 MAPE yield 35.204%, and for large size salt α=0.55; β=0.33 MAPE yield 23.228%. Therefore, according to the calculation above, it can be concluded that the predicted results of the Single Exponential Smoothing Method are more accurate.

5. CONCLUSION

The proof of the calculations that have been done, it can be concluded that the Single Exponential Smoothing method is more accurate in predicting salt sales compared to the Double Exponential Smoothing Method. For the development of further research, it is hoped that the researcher will add other than the methods described in this study.

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