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Sales Forecasting System Using Single Exponential Smoothing

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ABSTRACT

In a trading business, meeting customer demand is very important to do. Fulfilling customer demand can be done with good stock inventory management. Accuracy in carrying out stock management is important to maintain the level of satisfaction of consumers because of the needs being met. In addition, accuracy in carrying out stock management can affect the financial cash flow of a trading business. Over-stocking, over time it will become dead-stock because the goods being sold become obsolete, changes in market tastes, not to mention merchandise that has an expiration date. Meanwhile, too little stock can cause lost of sales because the level of demand from consumers is greater than the amount of existing stock. Forecasting systems can help maximize stock inventory management in meeting customer demand needs. Forecasting is an activity in predicting and predicting something that will happen in the future. Forecasting is done through calculation analysis techniques based on past data references. This data can be in the form of qualitative data and quantitative data. The exponential smoothing method is a forecasting method based on qualitative data from a time series of previous sales trends to predict the future. This method is best used to analyze fluctuating sales trends. To determine the accuracy of forecasting, the results of the forecasting are then analyzed using the MSE and MAPE methods.

1. Introduction

In a trading business, meeting customer demand is very important to do. Fulfilling customer demand can be done with good stock inventory management. Accuracy in carrying out stock management is important to maintain the level of satisfaction of consumers because of the needs being met. In addition, accuracy in carrying out stock management can affect the financial cash flow of a trading business. Over-stocking, over time it will become dead-stock because the goods being sold become obsolete, changes in market tastes, not to mention merchandise that has an expiration date. Meanwhile, too little stock can cause lost of sales because the level of demand from consumers is greater than the amount of existing stock.

The system is a collection of interrelated elements that process input or input to produce an output or output(Kusrini, 2007). The source of information is data, data is a reality that describes an event and real unity.Forecasting is a description of the state of a business in the future(Fachrurrazi, 2015). This picture is important for a business because this picture can be used as a basis in predicting steps or policies to be taken in meeting market demand.Through forecasting, it is expected to minimize uncertainty from the future. So that the minimum value of forecasting error is the goal of the forecasting system(Astuti et al., 2017).

Forecasting systems can help maximize stock inventory management in meeting customer demand needs. Forecasting is an activity in predicting and predicting something that will happen in the future. Forecasting is done through calculation analysis techniques based on past data references. This data can be in the form of qualitative data and quantitative data. Forecasting using quantitative data is forecasting based on an idea, opinion or experience of the seller or it can also be based on consumer survey data. Forecasting using quantitative data is a forecast based on past sales data. Forecasting using quantitative data can be done using causal analysis methods and time-series analysis methods. Causal analysis methods are carried out based on the pattern of the relationship between the variables to be predicted with other variables that influence. Time-series analysis methods are based on data from past time periods.

Single exponential smoothing method is a forecasting method based on quantitative data from a time series of previous sales trends to predict the future(Luh et al., 2019). This method is best used to analyze fluctuating sales trends. With the existence of a forecast, it is hoped that it can help management provide an overview of the situation in the future so that it can be maximized in making policies to face the market in the future.The error measure is the deviation between the actual data and the forecast results(Baktiar et al., 2015).

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Forecasting error testing is carried out because forecasting is in the form of an estimate of a value in the future, because it is still an estimate, there is a high probability of an error in the forecast. This research uses Mean Square Error (MSE) and Mean Absolute Percent Error (MAPE) analysis to determine the level of forecast error.

Research by(Fachrurrazi, 2015) entitled "Forecasting Drug Sales Using the Single Exponential Smoothing Method at the Bintang Geurugok Drugstore". In this study, drug sales forecasting was carried out using the single exponential smoothing method in which an analysis of the effect of alpha values on forecasting results was carried out, the alpha value which had the minimum error value used for forecasting. Research by(Riyadi, 2015) entitled "Application of Forecasting Drug Sales Using Smoothing Methods (Case Study: Dr Murjani Hospital Pharmacy Installation)". The result of this research is an application that is able to apply the Holt Exponential Smoothing method to forecast drug sales. In addition, the application is also able to provide an output in the form of a forecasting result report for the next few periods accompanied by a forecast error value. Research by(Nangi et al., 2018) entitled "Forecasting Drug Supplies Using the Triple Exponential Smoothing (TES) Method (Case Study: Pharmacy Installation at Muna District Hospital)". In this study, testing errors in forecasting were carried out. To test forecasting, it is done by calculating Mean Squared Error (MSE) and Mean Absolute Percentage Error (MAPE) with the smallest forecast error results obtained when using alpha = 0.1 for fluctuating data. Research by(Putro et al., 2018)entitled "Prediction of the Amount of Water Needs Using the Exponential Smoothing Method (Case Study: PDAM Malang City)". From the research conducted, it was found that the prediction using Single Exponential Smoothing (SES) was better in predicting the amount of PDAM Malang water consumption compared to the Double Exponential Smoothing (DES) and Triple Exponential Smothing (TES) methods seen from the MAPE value obtained.

Based on the above problems, a study was carried out "Sales Forecasting System Using Single Exponential Smoothing" so that it can help predict market demand.

2. Methods

2.1 Single Exponential Smoothing

The Single Exponential Smoothing method is a predictive analysis method that assumes that the data fluctuates around a fixed mean which has a consistent growth pattern. This Single Exponential Smoothing method has an equation as shown in equation (1).

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

where:
Ft = forecast in t period.
Xt = actual value at time t-1
Ft-1 = forecat at time t-1
α = Exponential parameter between 0 – 1

2.2 Mean Square Error

Mean Square Error (MSE) is a way to measure the overall forecast error. MSE is the average of the difference in squares between the predicted and observed values(Riyadi, 2015). The equation of MSE can be seen in equation (2) below.

$$MSE = \frac{\sum(A_t - F_t)^2}{n} \quad (2)$$

where :
At = actual value in t data
Ft = forecast value in t data
n = number of data periods

2.3 Mean Absolute Percent Error

Mean Absolute Percent Error (MAPE) is a calculation method that can be used to determine the error rate of a prediction or forecast. MAPE is the average value of absolute differentiation between the forecast value and the actual value.MAPE is one of the most widely used measures of forecast accuracy(Kim & Kim, 2016). MAPE is calculated as the mean of absolute differentiation expressed as a percentage value. The equation of this MAPE can be seen in equation (3) below.

$$MAPE = \frac{100}{n}\sum\frac{|A_t - F_t|}{A_t} \quad (3)$$

where :
At = actual value in t data
Ft = forecast value in t data
n = number of data periods

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The use of MAPE in the evaluation of predictive results can avoid measuring the accuracy of the actual and predicted values. The criteria for MAPE scores are shown in Table 1(Chang et al., 2007).

Table 1
Criteria for Mape Value

MAPE	Criterias
< 10%	Very Good
10% - 20%	Good
20% - 50%	Enough
>50%	Bad

3. Analysis & Result

3.1 Forecasting With Single Exponential Smoothing Method

In this research, the data used is quantitative data in the form of sales data in the form of a time series between May 2019 and April 2020. Sales data were taken from a micro-trading business engaged in Balinese women's accessories

In Table 1 is the monthly sales historical data of goods with the Brooch category. The sales history data used is from May to April 2020 as shown in Table 2.

Table 2
Sales historical data

Year	Month	Number of Sales
2019	5	263
2019	6	312
2019	7	241
2019	8	197
2019	9	174
2019	10	228
2019	11	210
2019	12	173
2020	1	131
2020	2	263
2020	3	249
2020	4	109

Based on the data in Table 2, forecasting calculations are carried out using the Single Exponential Smoothing method with the formula shown in equation (1). The following is an example of forecasting calculation for month 7 of 2019 using an alpha value of 0.9.

$F_{t+1} = \alpha.X_t + (1-\alpha) F_{t-1}$
$= (0.9 * 241) + ((1-0.9) * 312)$
$=$ **247.61**

3.2 Forecasting Error calculations using the MSE method

Based on the forecasting calculations that were carried out in month 7 of 2019 where the value of 247.61 was obtained, the forecasting error was calculated using the MSE method with the equation shown in Equation (2).

$MSE = (Actual\ Value - Forecasting\ Value)^2$
$= (241-247.61)^2$
$=$ **43.7**

3.3 Forecasting Error calculations using the MAPE method

Based on forecasting calculations that have been carried out in month 7 of 2019 where the value is 247.61, the forecasting error is calculated using the MAPE method with the equation shown in Equation (3)

$MAPE = (Actual\ Value - Forecasting\ Value\ |\ /\ Actual\ Value) * 100\%$
$= (|241-247.61| / 241) *100\%$
$= 0.03 *100\%$
$=$ **3%**

3.4 Forecasting Result

Following are the results of periodic forecasting from May of 2019 to April of 2020 as shown in Table 3.

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Table 3
Forecasting result

Year/Month	Actual Value	Forecast Value	Error Value	MSE	MAPE
2019/5	263	263	0	0	0%
2019/6	312	307.1	4.9	24	2%
2019/7	241	247.61	-6.61	43.7	3%
2019/8	197	202.06	-5.06	25.6	3%
2019/9	174	176.81	-2.81	7.9	2%
2019/0	228	222.88	5.12	26.2	2%
2019/1	210	211.29	-1.29	1.7	1%
2019/2	173	176.83	-3.83	14.7	2%
2020/1	131	135.58	-4.58	21	3%
2020/2	263	250.26	12.74	162.4	5%
2020/3	249	249.13	-0.13	0	0%
2020/4	109	123.01	-14.01	196.4	13%
Average Value				43.6	3%

Based on the data in Table 3, it is known that the results of periodic sales forecasting from May of 2019 to April of 2020, the MSE value of the forecasting results is 43.6, while the MAPE value of the forecasting results is 3%.

The following is the comparison of forecasting testing with trials based on alpha values. The test was carried out using the alpha value = 0.9 consecutively reduced by 0.1 to alpha = 0.1. The test results based on the alpha value are shown in Table 4.

Table 4
Comparison of forecasting tests based on alpha value

Alpha Value	MSE	MAPE
0.9	43.62	3%
0.8	538.49	9%
0.7	2051.11	19%
0.6	4581.50	29%
0.5	8129.64	40%
0.4	12695.54	50%
0.3	18279.20	60%
0.2	24880.62	70%
0.1	32499.79	81%

Based on the results of the comparisons in Table 4, it can be seen that the forecasting test using the alpha value = 0.9 has the smallest error value with an MSE value = 43.62 and a MAPE value = 3%.

3.5 Login Page

The following is a display of the login page to enter the system as shown in Fig 1.

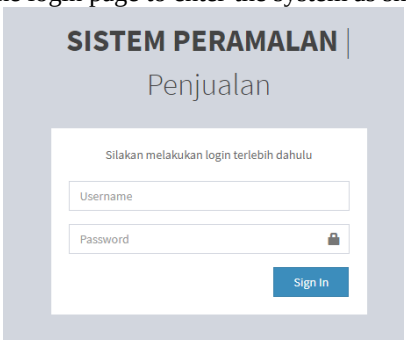

Fig 1. Login Page

3.6 Sales Data Interface

The following is a display of the sales transaction data page as shown in Fig 2

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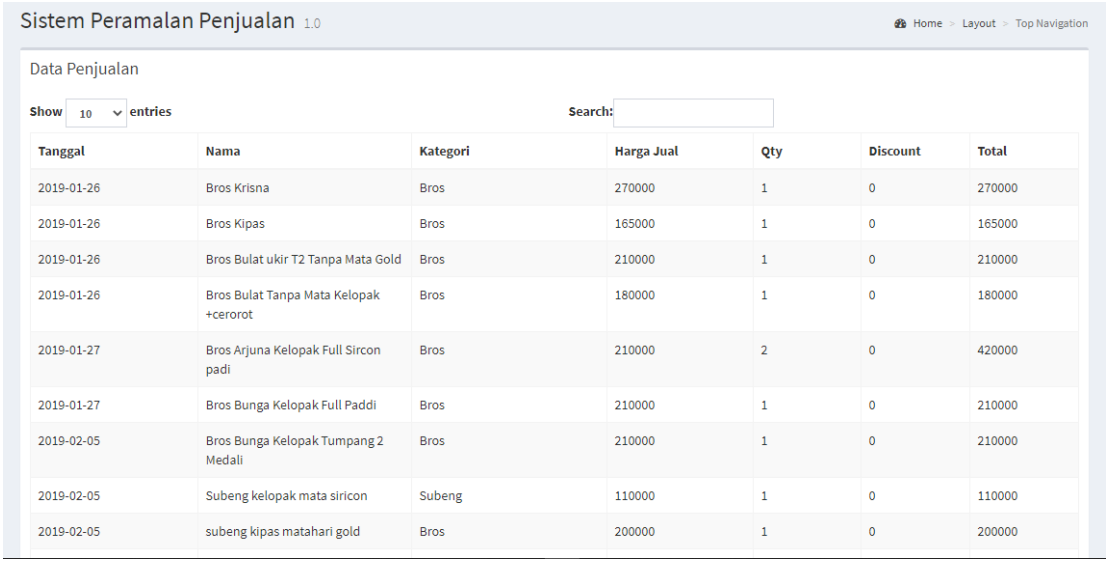

Fig 2. Sales Transaction Page Views

3.7 Forecasting Data Interface

The following is a display of the login page to enter the system as shown in Fig 3.

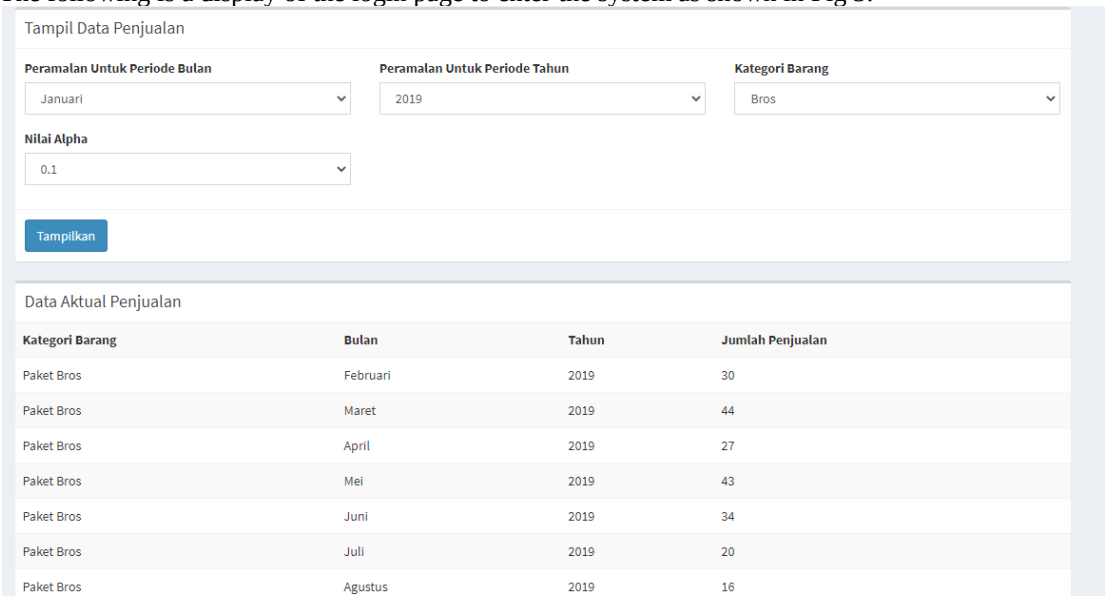

Fig 3. Forecasting Data Interface

4. Conclusion

Based on the research that has been done, the following is the conclusions from this research:

The sales forecasting system created using the Single Exponential Smoothing method can be implemented and can display forecasting results based on time periods, categories of goods, and alpha value. Sales forecasting process is carried out based on sales data in a specified time period. After the forecasting value is obtained, the forecasting process error is calculated using the MSE and MAPE methods.

Based on the alpha value comparison process carried out in succession from 0.1 to 0.9 alpha value, it is known that with an alpha value of 0.9 has the minimum error rate. The results of testing the forecasting process carried out, obtained an MSE value of 43.6, while the MAPE value obtained was 3% which had very good criteria when periodically forecasting sales from month 5 of 2019 to month 4 of 2020.

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