

Prediction of Sales and Inventory using the EOQ Method based on Single Exponential Smoothing Forecasting

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Abstract

Along with the development of the era where technology is becoming more sophisticated like today, the need is also increasing. Science and technology have also experienced drastic progress. Forecasting is a method for making estimates of future data involving the use of past data in the form of a systematic model, and the forecasting method used is Single Exponential Smoothing. Planning the Economic Order Quantity (EOQ) method can minimize the occurrence of out of stock so that there is no disruption to processes in a business and is able to save costs due to the efficiency of inventory at the business premises concerned. Implementation of Supply Chain Management (SCM) with a data mining system at CV. Amifa Keluarga Lestari can simplify the management of raw materials by implementing an SCM system which can reduce excess stock purchases. With the Single Exponential Smoothing method, you can predict the number of best sales for the next month in one period by looking at the smallest error. The calculation results show that the most economical order in one order is 1291 Kilograms, and the Total Storage Cost is Rp. 154,919 per Kilogram. The use of EOQ provides a number of benefits in company inventory and sales management, increasing efficiency and reducing risk. It also optimizes operational efficiency by saving time and resources in inventory management.

Keywords: Supply Chain Management, Single Exponential Smoothing, EOQ Method, Forecasting, Inventory

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1. Introduction

Along with the development of the era where technology is becoming more sophisticated like today, the need is also increasing. Science and technology have also experienced drastic progress. An example of technology that is progressing is laptops. Nowadays laptops have become a basic need for people to do business, education, play games and even create games, communicate and so on. Not only that, laptops can also be taken anywhere so that these activities can be done at any time and more easily [1]

All businesses basically plan and control goods with the main aim of minimizing costs and maximizing profits. In planning and controlling goods, the problem is how to organize the most appropriate inventory of goods so as not to disrupt production activities and the costs required are not excessive [2]

Current global competition has given birth to companies that have succeeded in adapting and innovating. This success is also influenced by the ability to utilize technology, communication and information. The global market requires every company to compete, with increasingly high expectations for products and services, and increasingly shorter product life cycles, has encouraged companies to prioritize their focus in their supply chains to achieve competitive advantages that can support direct business processes.

The integration of activities that procure materials and services, convert them into intermediate goods and final products, and deliver them to customers is referred to as supply chain management. This concept prioritizes the transformation of raw goods into finished goods that are sent to customers [3].

Forecasting is a method for making estimates of future data by involving the use of past data in the form of a systematic model. The forecasting model used in forecasting cracker sales is the Time Series or what is usually called a time series and the forecasting method used is Single Exponential Smoothing. The reason the author chose this method is because compared to several other forecasting methods such as Single Moving Average and Double Exponential Smoothing, the Single Exponential Smoothing method provides better forecasting accuracy because it produces fewer errors if the data used has a stationary data pattern [4]

The single exponential smoothing method is a development of the single moving averages method where this forecasting method is carried out by repeating calculations continuously using the latest data and each data is given a weight [5]. Single Exponential Smoothing uses very little past data recording. This model assumes that data fluctuates around a fixed average value, without following a pattern or trend [6].

With an inventory policy implemented in the company, inventory costs can be kept as small as possible. To overcome this problem, a management strategy is needed in the form of forecasting sales and inventory in preparation for meeting customer demand in the coming period. EOQ method planning. This can minimize the occurrence of out of stock so that processes in a business are not disrupted and can save costs due to efficient inventory of goods at the business premises concerned [7].

EOQ is the value of the amount of materials needed during each purchase using the most economical costs [8]. EOQ (Economic Order Quantity) is the number of goods that can be purchased at minimal cost. The aim of this method is to determine the number of orders that can minimize storage costs and inventory ordering costs [9]. Previous research using the EOQ method is widely used, such as raw material inventory [10] [11][12], product sales analysis[13], generic drug inventory[14], and others.

2. Research methodology

To assist in preparing this research so that the steps in solving the problem to be discussed can be arranged clearly, a framework structure is needed. The research framework is in Figure 1.

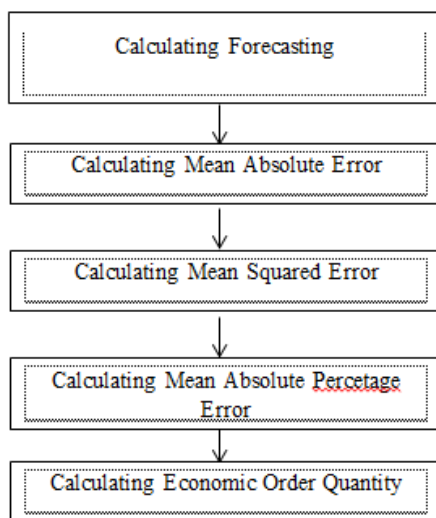


Figure 1. Research Framework

In this method, forecasting is carried out by repeating calculations continuously using the latest data, where each data is given a weight. The α value is the weight value in the Single Exponential Smoothing method. The α value is used to refine the forecasting method. The amount of α is determined using the trial and error method. Where the determination is calculated sequentially with the condition $0 < \alpha < 1$. The α value to be tried is 0.1 to 0.9. In this method, an alpha value has been determined to assist the calculation process in order to obtain appropriate forecasting results. The equation of Single Exponential Smoothing is as follows:

$$St = a * X - 1 + (1 - a) * St - 1$$

Where,

$St+1$ = Forecasting Results

a = Constant value ($0 < a < 1$)

X_t = Actual Value/quantity of goods

St = Experience on the previous day

The overall accuracy of any forecasting model be it moving average, exponential smoothing or others can be explained by comparing the projected values with the actual or observed values. The level of forecasting accuracy can be measured from the following values:

1. Mean Absolute Error (MAE)

Mean Absolute Error (MAE) is one of the methods used to measure the level of accuracy of a forecasting model. The MAE value shows the average absolute error between the forecasting/prediction results and the real value. The MAE formula is explained as follows:

$$MAE = \frac{1}{n} \sum_{i=1}^n |f_i - y_i|$$

Where,

MAE = Mean Absolute Error

f_i = value of forecasting results,

y_i = true value,

n = amount of data

2. Mean Squared Error (MSE).

Mean Squared Error (MSE) is the average sum of squared forecasting errors. By using MSE, the error shows how much the forecasting results differ from the results to be predicted. The formula equation used is Mean Squared Error (MSE).

$$MSE = \frac{1}{n} \sum |X_t - St|^2$$

Information:

MSE = Mean Square Error

X_t = Actual value for the t-th period

St = Forecast value for the t-th period

3. MAPE(Mean Absolute Percentage Error)

Mean Absolute Percentage Error (MAPE) is a calculation using the absolute error in each period divided by the real observation value for that period. Then, average the absolute percentage errors. The smaller the MAPE value, the better the level of prediction accuracy. The formula equation used is Mean Absolute Percentage Error (MAPE).

$$MAPE = \frac{\sum \frac{|X_t - St|}{X_t}}{n} \times 100\%$$

Where

X_t = actual value on day t

S_t = forecasting value on day t

4. Economic Order Quantity (EOQ)

EOQ is the number or size of orders owned, the minimum amount of ordering costs and carrying costs per year. After the minimum number of materials purchased is determined, the next problem that arises is when the company should reorder so that the company does not run out of materials. The formula equation used by Economic Order Quantity (EOQ) is as follows:

$$EOQ = \sqrt{\frac{2SD}{H}}$$

Where,

EOQ = Economic order quantity

D = expected demand per time period

S = Order Order Cost

3. Results and Discussion

This research uses data on sales of CV.Amifa Keluarga Lestari crackers in the period January 2022 to May 2022.

Table 1. Total Sales Data for 2022

No	Month	Sales Turnover	Actual
1	January	92,990,400	5166
2	February	72,259,760	4014
3	March	74,073,280	4115
4	April	36,681,440	2037
5	May	29,060,080	1614

3.1 Single Exponential Smoothing

In this method, an alpha value has been determined to assist the calculation process in order to obtain appropriate forecasting results

$$S_t = a * X - 1 + (1 - a) * S_{t-1}$$

Forecasting search with alpha value = 0.1

S_{t1} =5166 (the first forecast data still cannot be calculated because there is no forecast data for the previous month).

$$S_{t2} = 0.1 * 5166 + (1 - 0.1) * 5166 = 5166$$

$$S_{t3} = 0.1 * 4014 + (1 - 0.1) * 5166 = 5050.8$$

$$S_{t4} = 0.1 * 4115 + (1 - 0.1) * 5050.8 = 4957.22$$

$$S_{t5} = 0.1 * 2037 + (1 - 0.1) * 4957.22 = 4665.2$$

$$S_{t6} = 0.1 * 1614 + (1 - 0.1) * 4665.2 = 4360.1$$

Forecasting search with alpha value = 0.2

Table 2. Forecasting data alpha 0.2

No	Forecast (St)	Mean Absolute Error	Mean Squared Error	MAPE
1	5166	0	0	0
2	5166	1152	1327104	28.6995517
3	4935.6	820.6	673384.36	19.9416769
4	4771.48	2734.48	7477380.87	134.240548
5	4224.584	2610.54	6815148.81	161.7462206
6	3702.4672			
MEANS		522	272588.41	162

Table 3. Forecasting Results Data for June 2022

No	Forecast	MAE	MSE	MAPE	Alpha(α)
1	4360.7	305	93098,214	189%	0.1
2	3702.6	522	272588.41	162%	0.2
3	3710.4	898	807183.6523	186%	0.3
4	2743.6	753	566870.4564	117%	0.4
5	2404.7	790	624692.6406	98%	0.5
6	2138.7	787	619464.7028	81%	0.6
7	1934.2	748	559339.1529	66%	0.7
8	1782.5	675	455646.6002	52%	0.8
9	1677.94	568	322449.07	39%	0.9

From the table above you can see the results of the sales data forecasting calculations. So the results of forecasting using the *Single Exponential Smoothing method* in June 2022 with the smallest error percentage value are $\alpha = 0.9$ with Forecast results of 1677.094 and MAPE 39.00%.

3.2 Economic Order Quantity

Stages for calculating EOQ and TIC to find out the best total order and efficient costs.

1. Calculating EOQ
2. Calculating TIC

Based on data from the object, it is known:

Table 4. Stock Data

Number of Goods Required (D)	10,000 Kg/month
Order Fee (S)	Rp. 10,000/Kg
Storage Costs (H)	Rp. 120/Kg

Based on the table above we can calculate EOQ and TIC with the following formula:

$$EOQ = \sqrt{2(D.S) / (H)}$$

$$EOQ = \sqrt{2(10000 \times 10000) / (120)} = \sqrt{\frac{200.000.000}{120}} = \sqrt{1.666.666} = 1291$$

$$TIC = \left(\frac{D}{Q} \times S\right) + \left(\frac{Q}{2} \times H\right)$$

$$TIC = \left(\frac{10000}{1291} \times 10000\right) + \left(\frac{1291}{2} \times 120\right)$$

$$= \left(\frac{100.000.000}{1291} \right) + (77.460) \\ = (77.459) + (77.460) = 154.919$$

So, it can be seen that the most economical order in one order is 1291 Kilograms, and the Total Storage Cost is Rp. 154,919 per Kilogram.

3.3 System Testing

1. Raw Material Data Page

On the data page raw materials where *admin users* can add, edit and delete raw material data in Figure 2 below.

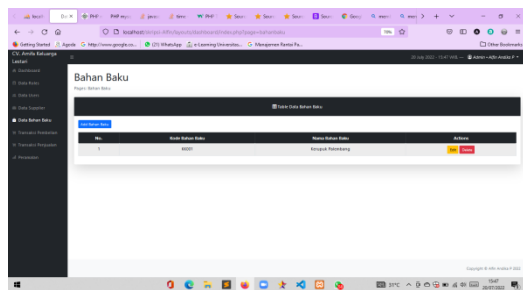


Figure 2. Raw Material Data Page

2. Purchase Transaction Page

On the purchase transaction page where *admin users* can add, edit and delete purchase data in Figure 3 below.

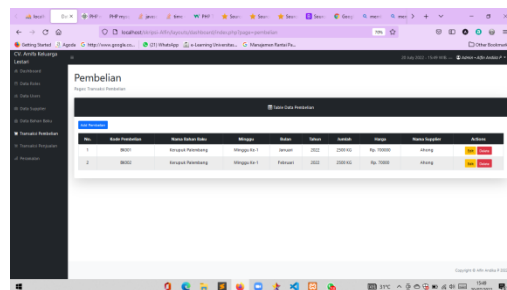


Figure 3. Purchase Transaction Page

3. Sales Transaction Data Page

The image below is the sales transaction page where *admin users* can add, edit and delete sales data. In Figure 4 below

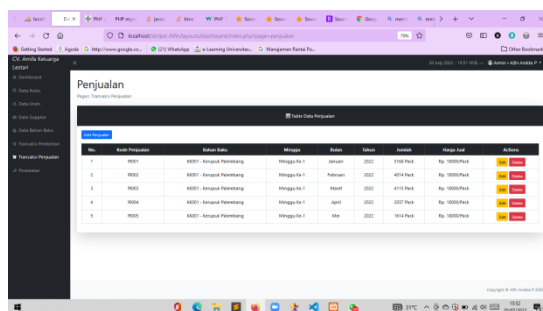


Figure 4. Sales Transaction Data Page

4. Forecasting Calculation Page

The image below is the admin page for adding forecasting data to predict next month's sales.

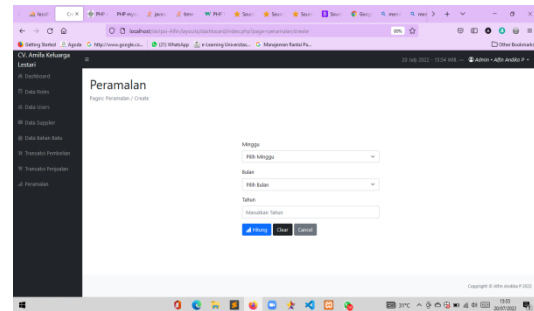


Figure 5. Calculate Forecasting Page

5. Forecasting Results Page

The image below is a page for calculating sales forecasting to predict sales for the following month.

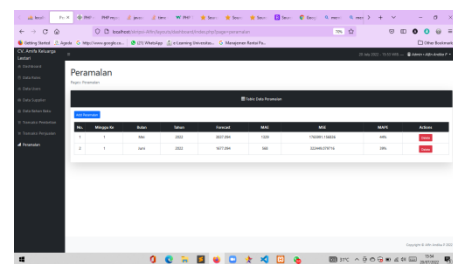


Figure 6. Forecasting Results Page

6. Print Page

On this page the owner can print a report on the results of purchase transactions and forecasting results that have been calculated.

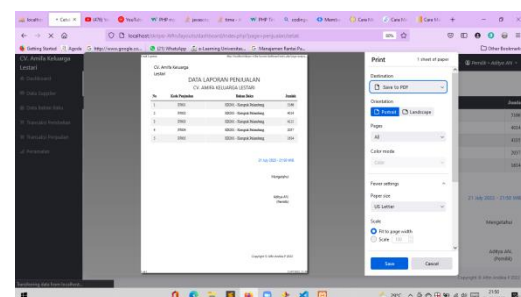


Figure 7. Sales Transaction Print Page

4. Conclusion

Based on direct research and analysis carried out at CV. Amifa Keluarga Lestari can conclude that the implementation of Supply Chain Management with a data mining system can make it easier to manage raw materials by implementing an SCM system which can reduce excess stock purchases which can cause excess stock so that expenditure costs increase. The system is equipped with a sales transaction menu for each month so that predictions will be calculated from the previous month's sales. And with the *Single Exponential Smoothing method*, you can predict the number of best sales for the next month in one period by looking at the smallest error.

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