Forecasting for Optimizing New Product Inventory at Nayara Company

Annisa(✉) and Pepi Zulvia

Public Sector Business Administration, Politeknik STIA LAN, Bandung, Indonesia
annisakustendi@gmail.com

Abstract. Inventories that increase the cost of storage and maintenance also increase the potential for decreasing the quality of raw materials, reducing company profits. However, if there is too little inventory, it will affect profits and the Company will fail to optimize production. Nayara company has problems controlling inventory; there is no inventory control method, resulting in stockpiling of inventory in the warehouse. Nayara company must have a calculation method to optimize production by reducing ordering and storage costs. This study uses the time series forecasting method to find out the lowest MAD, MSE, and MAPE values. The results in this study are known that the Linear Regression with Trend forecasting method is a forecasting method with a smaller error value and produces a safety stock of 109 pcs, the optimal order in one message is 166 pcs, the frequency of ordering is 20 times. And Nayara Company must place an order again when the inventory in the warehouse is 263 pcs left to create a controlled inventory condition.

Keywords: Forecasting · Economic Order Quantity (EOQ) · Reorder Point · Safety Stock

1 Introduction

Nayara's Company is engaged in retail that provides women's fashion products and has problems with inventory control. In planning, the Nayara Company still uses estimates or does not yet have a fixed measuring instrument as a concrete reference to avoid losses caused by death stock products or out-of-stock products. Products with the basic ingredients of *batik* cloth are one of the bestsellers products from the Nayara Company with the most sales and are often out of stock.

During the researchers conducted observations and sales data as well as inventory stock data at the Nayara Company, researchers found the following phenomena:

1. Inventory planning that uses intuition makes some products not sell and become death stock.
2. Planning for repeat stock of Bestseller products based on estimates only, causing new problems, namely, out of stock and decreased customer satisfaction.
3. Production planning is delayed due to out-of-stock fabric.

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Companies are expected to forecast future sales increases and decreases using related data to prepare systems to deal with such situations [1].

It is this weakness that Nayara Company must address as a way to optimize profits and production efficiency. One of them is by applying management control and forecasting methods that aim to determine safety stock and optimize inventory costs as well as minimize the occurrence of out stock, which will disrupt the Company's business pace. It is hoped that Nayara Company can prepare the right strategy to be applied to deal with these conditions.

Forecasting is a technique for assessing current data to decide future directions by involving recorded information (historical data) as a perspective. Forecasting is not only a determination of the number of goods to be shipped or sold, but at the same time, useful for managing the stock of finished products.

The method that can be used to forecast product demand is the time series analysis method, namely the moving average, exponential Smoothing and trend projection methods. One method of inventory control that can be applied is Economic Order Quantity [2]. There are two forecasting methods, namely qualitative and quantitative forecasting methods. Qualitative methods rely more on instinct than historical data. This method is also known as an emotional (subjective) forecasting strategy because it is generally used to make ordinary choices or in a state of urgency. In comparison, the quantitative method is a method of determination made in general based on past information that is detailed using a certain strategy. Past information is collected to be explored and dissected with the development of time. Because of the time factor, from the consequences of the investigation, it can be said that something will happen in the future. Obviously, we face uncertainty in this situation, so a component of accuracy or completeness must be considered. Historical data is in the stock taking and sales data section. Looking at the previous data, it is times series data that can be processed [3].

In addition to Forecasting, economic order quantity (EOQ), Safety Stock and Reorder Point (ROP) are methods that can be used to answer Nayara Company's problems. Inventory calculation using the Economic order quantity (EOQ) method will help determine stock issues, making the existing stock ideal. Then the Safety Stock method is used to determine the safety stock, while the Reorder Point (ROP) will determine when the Company places an order by considering the waiting time. This method also limits the redundancy or duplication of bookkeeping that has not been done directly so that the resulting bookkeeping will be more precise.

Based on the explanation above, the author is interested in using the title "Forecasting for Optimizing New Product Inventory at Nayara Company."

2 Methods

This research is an exploratory descriptive study using a quantitative methodology. Quantitative research is systematic scientific research. The purpose of quantitative research is to develop and use mathematical models, theories, and or hypotheses related to natural phenomena [4]. The data processed in this study consisted of one type of data, namely secondary data. Secondary data is data collected from pre-existing data. In research on inventory control and forecasting at the Nayara Company using Sales data, inventory

data for August 2021 to May 2022 was sourced from the database owned by the Nayara Company.

2.1 Identification of Data Patterns

An easy and important step in choosing an appropriate time series method is matching the data pattern's nature [5] (Fig. 1).

Data patterns can be divided into four, namely:

1. Horizontal pattern, occurs when the data varies around a stable or stationary mean value.
2. A seasonal pattern exists when a data set is affected by seasonal factors (e.g., month or day of the week, quarter).
3. Circulation patterns are when data is affected by long-term economic fluctuations such as economic cycles and business cycles.
4. Trend patterns are displayed when data moves up and down over a long period (Fig. 2).

As for how to determine the right forecasting according to Time Series data according to F. Robert Jacobs & Rischard B. Chase. is:

Simple Moving Average. Historical data in one period amounted to 6 to 12, either monthly or weekly. And having a stable data pattern can use the Simple Moving Average forecasting calculation with forecasting results for the short term.

Weighted Moving Average and Simple Exponential. Historical data in one period containing 5 to 10 data with stable data patterns can use Weighted Moving Averages and Simple Exponential forecasting calculations to determine short-term forecasting results.

Simple Exponential with Trend. Historical data in one period containing 5 to 10 data with stable and trending data patterns can use Simple Exponential with Trend forecasting calculations to determine short-term forecasting results.

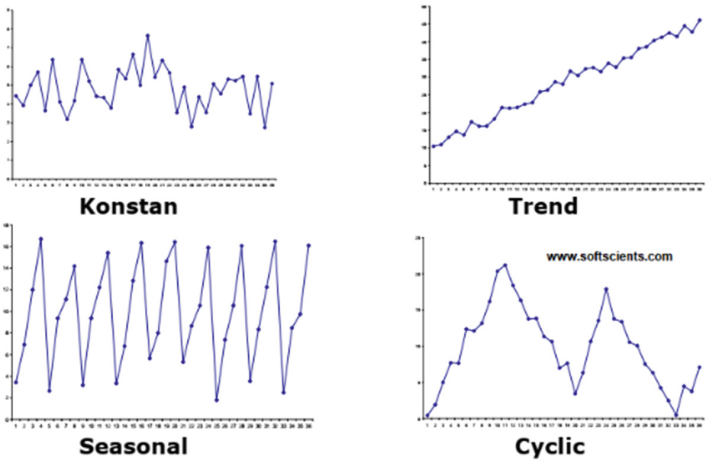

Fig. 1. Draw data pattern.

FORECASTING METHOD	AMOUNT OF HISTORICAL DATA	DATA PATTERN	FORECAST HORIZON
Simple moving average	6 to 12 months, weekly data are often used	Stationary (No Trend or Seasonality)	Short
Weighted moving average and simple exponential smoothing	5 to 10 observations needed to start	Stationary	Short
Exponential smoothing with trend	5 to 10 observations needed to start	Stationary and Trend	Short
Linear regression	10 to 20 observations	Stationary, Trend and Seasonality	Short to Medium
Trend and seasonal model	2 to 3 obeservations per season	Stationary, Trend and Seasonality	Short to Medium

Fig. 2. Guidelines for determining the right forecasting.

Linear Regression. Historical data in one period containing 10 to 20 data with stable, trend and seasonal data patterns can use linear regression forecasting calculations to determine short to medium term forecasting results.

Trend and Seasonal Model. Historical data in one period containing 2 to 3 data with stable, trend and seasonal data patterns can use Trend and Seasonal Model forecasting calculations to determine short to medium term forecasting results.

2.2 Sales Forecasting (Forecasting)

Forecasting is the use of statistical techniques as a picture of the future based on the management of historical figures [6]. This is similar to Isaac who stated that Forecasting is thinking about the number of requests for, at least, one item in the future. Forecasting is the art and study of anticipating future events. Forecasting requires taking recorded information and extending it into the future with some numerical model. [7]. In this study, the two most commonly used methods will be used, namely:

Single Exponential Smoothing with Trend Method. The Simple Exponential Smoothing with Trend method accepts two types of weights in the calculation: Alpha level (α) and Beta trend (β). The mathematical calculation of exponential Smoothing with trend is shown below:

$$A_t = \alpha\, Y_t + (1-\alpha)(A_{t-1} + T_{t-1})$$

$$T_t = \beta(A_1 - A_{t-1}) + (1-\beta)T_{t-1}$$

$$F_{t+m} = A_t + T_t m$$

Where:

At = Exponential smoothing value
α = Data smoothing constant ($0 < \alpha < 1$)
β = Smoothing constant of trend estimation ($0 < \beta < 1$)
Yt = Actual value of period t
Tt = Trend estimation
F(t + m) = Trend estimate

Linear Regression with Trend method. The simplest regression model includes the dependent variable and independent factors. The types of Linear Regression models are:

$$Y = a + bX$$

Where:

Y = Exponential smoothing value
α = Smoothing Constant for data ($0 << 1$)
b = Regression coefficient
X = (Variable affecting (time: year, month, day)

2.3 Accuracy of Forecasting Method

For forecasting users, the accuracy of future predictions is paramount, On the other hand, modelers need to consider the goodness of the model for known facts.

MAD (Mean Absolute Deviation). MAD helps to calculate forecasting errors with the same units as the original series.

$$MAD = \sum \left| \frac{A_t - F_t}{n} \right|$$

Where:

At = Actual Demand in Period–t
Ft = Forecast of demand (forecast) in period-t
n = Number of forecasting periods involved

MSE (Mean Square Error). This method handles very large estimation errors because the error is squared.

$$MSE = \sum \left| \frac{A - F}{n} \right|^2$$

Where:

At = Actual Demand in Period–t

Ft = Forecast of demand (forecast) in period-t
n = Number of forecasting periods involved

MAPE (Mean Absolute Percent Error). MAPE handles a certain percentage of errors and provides information about the error rate. The number is too low or too high.

$$MAPE = \sum \left| \frac{A_t - F_t}{n} \right| \times 100$$

Where:

At = Actual Demand in Period–t
Ft = Forecast of demand (forecast) in period-t
n = Number of forecasting periods involved

2.4 Economic Order Quantity (EOQ)

Economic Order Quantity or EOQ for short is a control method that answers two important questions: when and how much to order [8]. EOQ is a method used to determine the optimum amount of material that must be purchased so that all costs associated with providing orders and product storage per year can be minimized [9].

$$EOQ = \sqrt{\frac{2 \times D \times S}{H}} \; or \; EOQ = \sqrt{\frac{2 \times D \times S}{I \times C}}$$

Where:

D = J number of raw material needs per year (units)
S = Ordering cost (rupiah/unit)
H = Storage cost (rupiah/unit) IxC
C = unit price of raw materials (rupiah/unit)
I = Storage cost (% of the value of goods)
TC = Total cost of inventory (Rp/year)
T = Time interval between orders (years, days)
Q = Number of orders (units/orders)
F = Order frequency (times/year)

2.5 Safety Stock

Safety stock is a safety stock; this is to avoid the risk of running out of stock or out of stock during the waiting time for orders or lead time for production.

$$Safety\ Stock = Z \times D$$

Where:

SD = Standard Deviation
Z = Service level

2.6 Reorder Points (ROP)

Reorder Point is the inventory level or the point at which the Company needs to take action to replenish inventory immediately [8]. Reorder Point is a reorder point that the Company must do regarding lead time and safety [1]. Reorder Point is a reorder point or limit on the number of ordered items [10]. From the three factors above, the reorder point can be determined by the following formula:

$$Reorder\ point = (LT \times AU) + Safety\ Stock$$

Where:

AU = Use of goods per unit time
Safety stock = Safety stock
LT = Waiting time

Sales forecasting measurement uses historical data of Nayara Company using POM QM software for windows 5. Forecasting uses several methods, namely exponential Smoothing with the trend and linear regression. And the measurement of forecasting accuracy using Mean Absolute Deviation (MAD), Mean Squared Error (MSE) and Mean Absolute Percentage Error (MAPE). While calculating Economic Order Quantity (EOQ), Safety Stock and Reorder Point using manual calculations.

3 Results and Discussion

3.1 Data Pattern

As previously explained, this study uses Sales Data specifically for the *batik* product category for 10 months from August 2021 to May 2022. From the data held, a graph can be made to determine the nature of the data pattern that can determine whether the data pattern is constant or contains trending, seasonal, or cyclical elements. The results of the data pattern from the previous period's sales can be seen in the graph (Fig. 3).

From the pattern above, it is known that the sales data pattern of the Nayara Company is a trend data pattern which tends to be negative. Since the data pattern is already known, two forecasting methods have been selected that can use the trend data pattern as shown in Fig. 3, as a comparison to minimize errors in forecasting calculations. The two methods are:

1. Exponential Smoothing with Trends.
2. Linear Regression with Trend.

3.2 Exponential Smoothing with Trend Method

At this stage, the data is tested using trend-based exponential Smoothing to determine the MAD, MSE, and MAPE values. But specifically for the calculation of Exponential Smoothing with Trend, you must first find the Alpha and beta values to find out the smallest error value. Calculation details can be seen in Table 1.

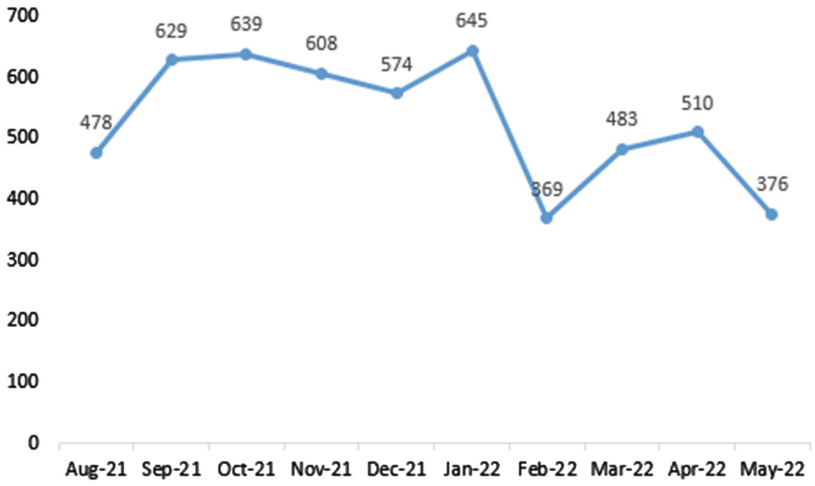

Fig. 3. Product sales data for *Batik* category.

Table 1. Determination of Alpha (A) and Beta (B) values.

Error measures	MAD	MSE	MAPE	Forecast next period
α0,1 β0,9	96.562	12700.8	19.37%	488.293
α0,2 β0,8	86.251	12361.9	18.18%	466.919
α0,3 β0,7	80.894	12307	17.50%	440.762
α0,4 β0,6	83.685	12594.4	18.21%	418.746
α0,5 β0,5	89.332	13165.8	19.36%	402.185
α0,6 β0,4	93.495	13863.3	20.24%	390.143
α0,7 β0,3	96.002	14529	20.82%	381.859
α0,8 β0,2	96.848	15052.2	21.12%	377.342
α0,9 β0,1	96.173	15356.26	21.11%	376.462

It can be seen in Table 1 that it is known that the values if alpha 0.3 and Beta 0.7 have MAPE results of 17.50%, MSE 12307 and MAD 80,894 are the smallest compared to other Alpha and Beta values. And when viewed from the results, this includes the category of good forecasting. See Fig. 4.

3.3 Linear Regression with Trend Method

The results of the forecasting can be seen in the Table 2.

The Table 2 shows the results of the forecast using the Linear Regression with Trend method to get the MAD, MSE and MAPE values. And the values obtained are MAD 68.284, MSE 6727.905 and MAPE 13.968%, which are in the Good category. See Fig. 5.

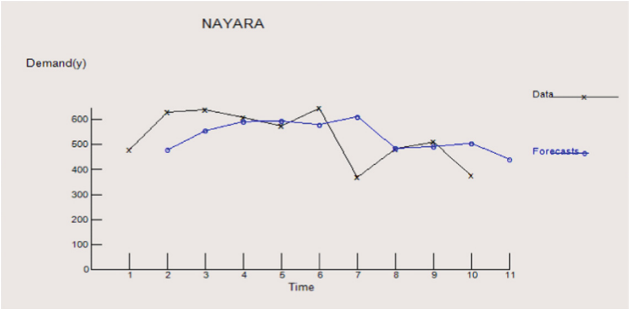

Fig. 4. Comparative results of exponential smoothing with trend.

Table 2. Calculation of forecasting linear regression with trend.

Measure	Value
Error Measures	
MAD	68,284
MSE	6727,905
MAPE	13,968%
Forecast Next Period	425.2

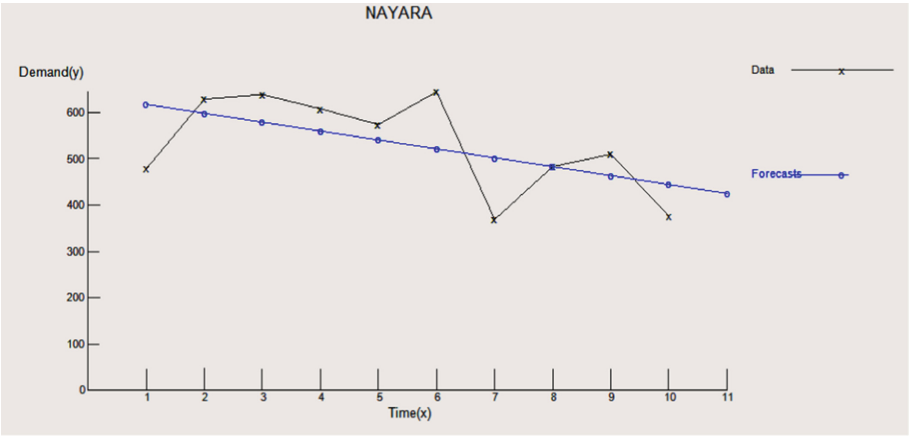

Fig. 5. Comparative results of the linear regression with trend method.

3.4 Analysis of the Best Forecasting Method

Based on the two forecasting models that have been analyzed, namely Linear regression with Trend and Exponential Smoothing with trend, by comparing the average error values of each model, namely (See Table 3).

Table 3. Comparison of the smallest error value.

Model	MAPE	MSE	MAD	Note
Exponential Smoothing with trend (α 0,3 β 0,7)	17,59%	12307	80.894	Good
Linear regression with Trend	13,968%	6727,905	68,284	Good

Table 4. Forecasting results for the next 10 months (pcs).

Month	Forecasting results	Rounded results
Jun-22	425,200	425
Jul-22	405,946	406
Aug-22	386,691	387
Sep-22	367,437	367
Oct-22	348,182	348
Nov-22	328,927	329
Dec-22	309,673	310
Jan-23	290,418	290
Feb-23	271,164	271
Mar-23	251,909	252
Total	3.385,547	3.386
Average		339

It is concluded that the method that has the smallest error value is Linear regression with Trend with MAPE 13.968%, MSE 6727.905 and MAD 68.284. Which is included in the category of good forecasting. In the next stage, forecasting is carried out for the next 10 months as shown in Table 4.

3.5 Economic Order Quantity (EOQ)

The formula for calculating the economic order quantity (EOQ) is as follows:

$$EOQ = \sqrt{\frac{2 \times D \times S}{H}} \; or \; EOQ = \sqrt{\frac{2 \times D \times S}{I \times C}}$$

Is known:

1. Determine the amount of raw material needs (inventory) per year/period (pcs) (D). According to the Linear Regression with Trend forecasting results that have been selected based on the smallest nominal MAD, MSE and MAPE Total demand for the next 10 months is 3,386 Pcs

2. Calculating the ordering cost (S). Calculates the cost of ordering by dividing the total cost of ordering for one year by the frequency of orders.

$$= \text{(Rp. 9.120.000)}/76 = \text{Rp. } 120,000$$

3. Calculating storage costs (H). Calculates storage costs by multiplying the percentage of storage costs by the price per unit.

$$= 20\% \times \text{Rp. } 147,000$$
$$= \text{Rp. } 29,400/\text{pcs}$$

So we get:

$$EOQ = \sqrt{\frac{2 \times D \times S}{H}} = \sqrt{\frac{2 \times 3.386 \times 120.000}{29.400}} = \sqrt{\frac{812.640.000}{29.400}}$$
$$= \sqrt{27.641} = 166,255$$

Rounded up to 166 pcs.

The next step is to calculate the order frequency. EOQ refers to the most economical purchase of the same quantity for each order. Companies can determine whether to manage inventory for a period by dividing the need for that period by the number of purchases for each order. So the order frequency is as follows:

$$f = \frac{3.386}{166} = 20.397$$
rounded 20 times

It is known from the calculation of the number of economic orders that the optimum number of orders for each order is 166 pcs with a purchase frequency for one period of 20 orders.

3.6 Safety Stock

Safety Stock is an inventory that must be in the warehouse expected if there is a fluctuating or erratic demand, so that when that happens the Company can fulfill consumer requests. Before determining the safety stock, it is necessary first to find the standard deviation of the forecasting results for 10 months using the Linear regression method with the formula:

$$Standard\ Deviation = \sqrt{\frac{(x - \bar{x})^2}{n - 1}}$$

Then it is assumed that the Nayara Company fulfills the demand as much as 90% with a reserve inventory of 10%, then Z is obtained using the normal table with a standard deviation of 1.87.

Then the inventory of observers or safety stock is:

$$\text{Safety Stock} = \text{Z} \times \text{SD}$$
$$= 1.87 \times 58.292$$
$$= 109,006 \sim 109 \text{ pcs}$$

It is known that the number of safety stock in the Nayara Company is 109 pcs.

3.7 Reorder Points

ROP is the point where companies need to place orders for products or materials to facilitate inventory that needs to be controlled.

The reorder point is defined by adding the lead time when ordering with safety stock. To calculate the reorder point is as follows:

$$ROP = (LT \times AU) + Safety\ Stock$$

Is known:

1. Demand rate per unit of time (AU)

The following is the calculation to find the level of demand per unit by dividing the number of requests in the period by the number of working days:

$$AU = \frac{D}{\text{number of working days per period}}$$
$$AU = \frac{3.386}{312}$$
$$AU = 10.85$$

Rounded up 11 pcs.

2. Grace time (LT)

This is the time it takes the Company to wait for the raw goods to arrive, and the waiting time is usually 14 days.

3. Safety Stock (SS)

The amount of safety stock known from the previous calculation is 109 pcs.

$$\begin{aligned} ROP &= (LT \times AU) + SS \\ &= (14 \times 11) + 109 \\ &= 263\ pcs \end{aligned}$$

So, it can be seen that Nayara Company must place an order again when the inventory in the warehouse is 263 pcs left.

3.8 Cost Comparison (Total Cost)

The total cost is intended to prove that with the optimal number of purchases the results of the previous calculation can minimize over stock and spending on ordering costs and storage costs.

To be clear, the following is a comparison of inventory calculations using the Economic Order Quantity (EOQ) method, safety stock, reorder point and total cost with Nayara Company policy. Details of the comparison are shown in Table 5.

Table 5. Comparison of Inventory Calculation Based On Economic Order (EOQ) method and based on company policy.

Calculation	Purchase amount	Order frequency	Safety stock (pcs)	Reorder point (pcs)	Total inventory cost (pcs)
Company police	339	76	-	-	4,983,300
Forecasting & EOQ	166	20	109	263	2,887,910

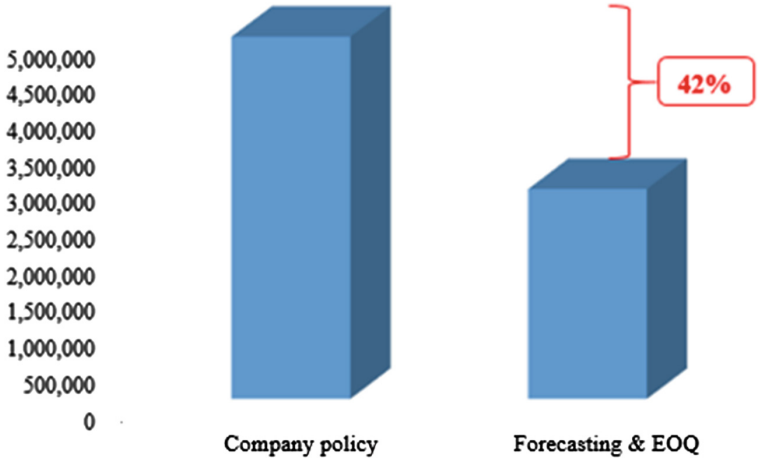

Fig. 6. Comparison of inventory calculations based on the Economic Order Quantity (EOQ) method and based on company policies.

From the results of the analysis (See Fig. 6), it can be seen that inventory management based on the Nayara Company policy is not effective. On the other hand, inventory management based on forecasting is continued using the EOQ (Economic Order Quantity) method which is more effective in inventory management. By using the EOQ (Economic Order Quantity) method, the Company can determine the optimal inventory of 166 pcs per order, where the total frequency of orders is 20 times in one period, where previously it was 76 times. But please note for the frequency of this order between company policies and EOQ calculations are different. Where once, the frequency of ordering 76 times was made for purchasing fabric raw materials, which are not necessarily all of the raw fabric materials used directly in the same month. Meanwhile, what is calculated by EOQ is the frequency of orders where in one order it is expected to produce 166 pcs of new products.

Set safety stock and reorder points calculated based on sales forecasts to reduce excess stock and shortage of inventory. With the aim that the production process runs smoothly without worrying about the high costs that will be incurred. From the above calculation results, Nayara Company can reduce costs by 42% if using the economic

order quantity (EOQ) method. Of course, this will make Nayara Company finances more optimal by reducing costs caused by excess production for new products.

4 Conclusions and Recommendations

4.1 Conclusion

From the results of the research that has been done, the following conclusions can be drawn: First, the time series forecasting method with the lowest fixed values of MAD, MSE, and MAPE is the Linear Regression with Trend forecasting method with a MAPE value of 13.968%, MSE 6727.905 and MAD 68.284 which are included in the Good forecasting category. The forecast value generated is Linear Regression with Trend forecasting. Second, the number of Safety Stock that Nayara Company must have is 109 Pcs to maintain product availability. Third, Inventory control Nayara Company uses the EOQ (Economic Order Quantity) method, the Company can determine the optimal order of 166 pcs per order with a large order frequency of 20 times. So it can be concluded that the Nayara Company in one order to manufacture new products must produce 166 pcs. And Nayara Company must place an order again when the inventory in the warehouse is 263 pcs left to create a controlled inventory condition.

4.2 Recommendations

There are recommendations that can be submitted in the form of: First, Sales planning using the time series method is expected to always be applied by the Nayara company. This predictive method helps companies make better plans. The best method can be re-adjusting the data pattern you have. It is recommended that more historical data be used so that data patterns can be seen. Second, Nayara Company is expected to maintain safety stock to maintain stock stability and meet consumer demand, which will definitely increase shopping satisfaction. Third, Inventory control methods such as EOQ and ROP are expected to continue because using these methods can reduce over stock and storage costs.

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