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Forecasting Demand and Controlling Raw Fabric Inventory to Prevent Overstock at PT XYZ

Derry Dardanella *, Insyirah Nurul Syifa Maulida, Suhendi Irawan
Industrial Management, School of Vocational Studies, Institut Pertanian Bogor
Jl. Kumbang No.14 Kota Bogor, Jawa Barat 16151, Indonesia

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Abstract

PT XYZ is a company engaged in the textile and garment sector. The problem that occurs is the accumulation of fabric raw materials in the warehouse due to excess inventory compared to the demand received. The purpose of this research is to determine the safety stock to prevent overstock. The research method consists of forecasting along with the parameters MAD, MSE, and MAPE as validation using POM QM software. In addition, production control is carried out using the min-max method to determine the amount of inventory required. The results of the study show that the company can use the exponential smoothing forecasting method with an alpha accuracy level of 0.7, which shows that the forecast for the next period is 6,315,349 yards with a MAD value of 1,278,671 and a MAPE value of 21.76%. Furthermore, the company can reorder (ROP) 2,721,298 yards, safety stock of 1,360,649 yards with a minimum inventory of 7,802,654 yards and a maximum inventory of 15,605,307 yards.

Author Correspondence:
Derry Dardanella
derrydardanella@apps.ipb.ac.id

1. Introduction

Inventory is one of the crucial aspects of supply chain management that affects the smooth operation of a company. Ineffective inventory management can lead to excess stock, resulting in increased storage costs, or conversely, stock shortages that can hinder production and distribution processes (Ballou 2004). Therefore, the application of proper inventory management methods is essential to maintaining a balance between product availability and the operational efficiency of the company.

Silver and Peterson (1998) mentioned that one of the commonly used methods in inventory management is safety stock. Safety stock is a reserve inventory that is kept to anticipate demand uncertainties and lead time of goods procurement. These uncertainties can be caused by various factors such as market demand fluctuations, supply delays, or changes in the production process. Safety stock is an additional inventory kept above the expected demand level to address variations in demand and

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lead time (Heizer and Render 2014). By having safety stock, companies can minimize the risk of stockouts that can disrupt operational smoothness and customer satisfaction.

In the management of safety stock, a quantitative approach is required, taking into account various variables such as historical demand levels, lead time variability, and the desired service level of the company. Additionally, safety stock plays a crucial role in ensuring high service levels to customers and reducing the risk of production stoppages (Chopra and Meindl 2016).

PT XYZ is a company engaged in the textile and garment sector. One of the products produced is finished fabric, including plain, colored, and patterned fabrics. The finished fabric is produced by the Finishing Department of PT XYZ with the main raw material being raw or grey fabric. The problem that occurs at PT XYZ is related to raw material inventory, where there is an accumulation of fabric raw materials in the warehouse due to excess inventory compared to the demand received by the company. Therefore, safety stock is needed to provide the company with guidance to prevent overstock, which can result in a large amount of leftover products.

2. Research Method

Data processing is carried out using quantitative methods. This processing is done as an implementation stage of the analysis of the collected data. The method used to determine production control at PT XYZ consists of forecasting to provide the company with an estimate of future demand. Additionally, production control is performed using probabilistic methods with the min-max method to determine the amount of inventory required by the company.

2.1 Forecasting

Forecasting is used to determine future product demand. Forecasting is a way of predicting something that has not yet happened with the aim of estimating something that will happen in the future using past company data (Indah and Rahmadani 2019). The most commonly used method is the time series method. Time series is a set of data recorded over specific periods such as weekly, monthly, or yearly (Maricar 2019). The forecasting models used include the moving average and exponential smoothing methods with varying degrees of accuracy. Additionally, validation tests are conducted with parameters such as Mean Absolute Deviation (MAD), Mean Squared Error (MSE), and Mean Absolute Percentage Error (MAPE). This forecasting data processing uses the software POM QM ver 5.0 to assist in the calculations and validation tests used.

a. Moving Average

Moving average is a method of calculating the moving average by considering the actual past demand data to determine future demand. The moving average used with one year of data involves different values of nn according to the smallest error level. MA is very effective for data with random fluctuations without clear trends or seasonal patterns (Irawan et. al, 2024). The formula for moving average is:

$$Ft+1= \frac{D_t + D_{t-1} + \cdots + D_{t-n+1}}{n}$$

Explanation:

F_{t+1} = Forecasting for the next period

D_t = Actual data for the current period

n = Number of periods being averaged

b. Exponential Smoothing

The Exponential Smoothing (ES) method uses weights that decrease exponentially for historical data, where more recent data is given greater weight (7). In the exponential smoothing method, weights are assigned, where the weight used is denoted by alpha as the smoothing constant. The value of $\propto$ can be chosen between 0 and 1, with $0 < \propto < 1$ being applicable. The use of $\propto$ values can be seen from several conditions, namely: a. Values of $0.1 < \propto < 0.3$ are used if in a stable demand condition or the data pattern is in a condition of average demand or usage b. If there are patterns of usage or demand that fluctuate or have high fluctuation trends, it is recommended to use values of $0.3 < \propto < 0.5$ c. If usage or demand patterns show trends with low fluctuation levels, values of $\propto$ used are from 0.6 to 0.8 (Virona 2018). The formula for exponential smoothing is as follows:

$$Ft+1= \alpha Dt+(1-\alpha)Ft$$

Explanation:

F_{t+1} = Forecasting for the next period

D_t = Actual data for the current period

Ft = Forecasting for the current period

α = Smoothing constant ($0 < \alpha < 1$)

2.2 Error Measurement or Error Rate

In forecasting and statistical analysis, measuring errors or error rates is crucial to evaluate the accuracy of predictive models. Here are a few common error measurement methods:

a. Mean Absolute Deviation (MAD)

This value is calculated by summing the absolute values of each forecasting error and dividing by the number of data periods.

$$MAD=\sum \frac{|Dt-Ft|}{n}$$

Explanation:
Dt = actual demand for period t
Ft = forecasted demand for period t
n = number of periods.
|Dt−Ft| = The absolute difference between the actual value and the forecast

b. Mean Square Error (MSE)

This is the average of the squared differences between the forecasted and observed values.

$$MSE=\sum \frac{(Dt-Ft)^2}{n}$$

Explanation:
Dt = actual demand for period t
Ft = forecasted demand for period t
n = number of periods

c. Mean Absolute Precent Error (MAPE)

This is the average of the absolute differences between the forecasted and actual values, expressed as a percentage of the actual values.

$$MAPE = \frac{1}{n} \sum_{t=1}^{n} \left|\frac{Dt-Ft}{Dt}\right| x100\%$$

Explanation:
n = number of periods
Dt = actual demand for period t
Ft = forecasted demand for period t

2.3 Probabilistic inventory control models

Probabilistic methods are suitable for demand that is not precisely known, and ordering time is carried out constantly (Qulub and Puspanantasari 2023). After that, inventory policy calculations are carried out using a probabilistic model due to fluctuating raw material demand. This inventory control policy is carried out by calculating the safety stock and reorder point (ROP) values, which serve as references for the company in reordering and maintaining inventory security. The determination

of the Z-value is obtained from the normal distribution table by specifying the service level and the expected stock-out probability. The determination of the service level value is based on the company's capability or expectation in meeting customer demand needs (Hendradewa and Mochammad 2022). To determine the safety stock and reorder point values, the following formulas can be used (Eunike et. al, 2021):

a. Determining Safety Stock with Fixed Lead Time and Variable Demand

Safety Stock=Z x σ x √LT

Explanation :
LT : Lead time
Z : Constant Obtained Based on Service Level
σ : Standard deviation

b. Determining Reorder Point (ROP) with safety stock

ROP=(D x LT)+SS

Explanantion:
ROP : Reoder point
D : Demand
LT : Lead Time
SS : Safety Stock

c. Minimum Inventory

Minimum Inventory is the lowest stock level in the warehouse or the point at which a reorder must be placed. The minimum stock level is the same as the reorder point (ROP). The formula for calculating minimum inventory is as follows:

Minimum Inventory = (D x LT) + SS

d. Maximum Inventory

Maximum Inventory refers to the maximum amount of inventory that has been calculated and is allowed to be stored in the warehouse. When stock reaches the maximum value, the company does not need to place orders or add more inventory. This can be applied to raw materials with high demand to prevent shortages. The formula for calculating maximum inventory is as follows:

Maximum Inventory = 2 (D x LT) + SS

Explanation :
D : Average Demand in periods
LT : Lead time
SS : Safety Stock

3. Results

PT. XYZ is a company engaged in the textile and garment sector that produces plain, colored, and patterned fabrics sourced from raw or grey fabric. The raw material inventory is the sum of the remaining raw materials in the warehouse plus the raw materials ordered at the beginning of each period. The demand in the following data represents the requests from the production division to be processed into finished products. The data on the inventory and demand for raw or grey fabric can be seen in Table 1.

Table 1 The Data on Inventory and Demand for Grey Fabric

Month	Grey Fabric (yard)	
	Inventory	Demand
October 2022	24.657.890	7.514.075
November 2022	24.439.577	8.447.044
December 2022	23.255.008	8.910.742
January 2023	22.410.698	9.354.415
February 2023	21.807.559	9.139.538
March 2023	21.583.652	8.367.121
April 2023	19.020.758	4.318.924
May 2023	22.661.931	10.055.216
June 2023	21.526.388	10.865.144
July 2023	23.982.359	9.952.256
August 2023	23.555.602	8.687.208
September 2023	23.276.506	7.728.684
Total	**272.177.926**	**103.340.367**

The difference between inventory and demand can help in understanding the surplus or shortage of grey fabric. The data shows that PT XYZ experiences an excess inventory of 2 to 3 times the demand. The grey fabric raw materials stored in the warehouse have different types, namely woven grey fabric (woven fabric) and knitting grey fabric (knit fabric). The woven grey fabric (woven fabric) consists of rayon, cotton, and polyester. The demand graph for the fabric based on its type can be seen in Figure 2.

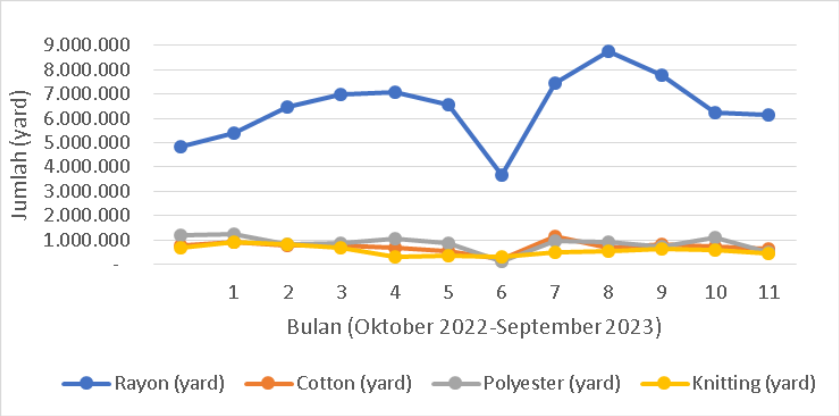

Figure 2 Demand for Fabric by Type

Based on the data and graph in Figure 2, it is known that the largest type of fabric used as raw material is Rayon fabric. Therefore, this research focuses on observing the type of fabric used, which is Rayon fabric. The inventory is obtained from the initial stock in the warehouse added with incoming raw materials. The comparison between the inventory and demand for Rayon fabric can be seen in Table 2.

Table 2 The Inventory and Demand for Rayon Fabric

Month	Rayon Fabric (Yard)	
	Inventory	Demand
October 2022	17.459.271	4.841.548
November 2022	16.713.598	5.373.653
December 2022	15.735.416	6.460.672
January 2023	15.387.049	6.985.754
February 2023	15.274.310	7.081.108
March 2023	15.044.623	6.565.315
April 2023	11.299.058	3.659.618
May 2023	14.385.942	7.459.354
June 2023	14.070.797	8.742.947
July 2023	16.702.824	7.760.069
August 2023	16.467.693	6.232.626
September 2023	16.856.522	6.141.395
Total	185.397.103	77.304.059

Based on Table 2, it can be seen that the company experiences excess raw material inventory of Rayon fabric (overstock) as it exceeds the average raw material inventory. The difference between inventory and demand at PT. XYZ requires inventory control to ensure there is no overstock, which would necessitate the company to provide or create new storage facilities to store the raw materials

Based on interviews with the company, it was found that the company does not have a forecasting method to determine the potential future demand. This leads to the

company ordering large quantities of raw materials, resulting in very high raw material inventory levels. The significant difference between the inventory and demand for Rayon fabric indicates that the company needs to implement forecasting to get an idea of the potential future demand. The results of data processing and validation tests using the software POM QM ver 5.0 can be seen in Table 3.

Table 3 Forecasting Results and Validation Test Values

Forecasting Model	Result	MAD	MSE	MAPE
Moving Average (N=3)	6.711.363	1622236	33926370	27,27
Moving Average (N=4)	7.219.259	1442600	29072020	24,91
Moving Average (N=5)	7.267.279	1320684	25034290	23,18
Exponential Smoothing (α = 0,3)	6.660.436	1343892	23849790	22,11
Exponential Smoothing (α = 0,5)	6.539.477	1283858	24483820	21,77
Exponential Smoothing (α = 0,7)	6.315.349	1278671	25636870	21,76

Based on Table 3, it can be seen that the method yielding the smallest error is the exponential smoothing method with an alpha parameter value of 0.7, resulting in a MAD of 1,278,671 and a MAPE of 21.76%. This forecasting method can be used by the company to determine the amount of raw rayon fabric that should be provided before production, enabling better control over the ordering or usage of rayon fabric at the beginning of the production period.

The inventory control method used is probabilistic with the min-max method. The reason for using the probabilistic method is due to fluctuating demand, known lead time, and the independent characteristics of raw materials, as the demand for one raw material does not affect others. In the min-max concept, inventory is continuously reviewed, meaning whenever inventory reaches the reorder level, an order will be placed (Cahyani and Kartika 2020). In this study, a service level value of 98% with a Z value of 2.05 is used. The standard deviation (σ) of rayon fabric demand is 1,360,649 yards. The results of the calculations for the Reorder Point (ROP), safety stock, minimum inventory, maximum inventory, and estimated demand for the next period can be seen in Table 4.

Tabel 4 Data Processing Calculation Results

Parameter	Hasil (Yard)
ROP with Safety stock	2.721.298
Safety Stock	1.360.649
Minimum Inventory	7.802.654
Maximum Inventory	15.605.307
Forecast	6.315.349

Based on Table 4, the company can reorder rayon fabric when the remaining raw material in the warehouse is 2,721,298 yards, with a safety stock amount of 1,360,649 yards. Additionally, the minimum inventory capacity that the warehouse can accept

is 7,802,654 yards, and the maximum storage capacity is 15,605,307 yards of rayon fabric. This calculation is necessary for PT XYZ to avoid overstock, which can lead to increased inventory costs and the need to add new storage facilities to accommodate the ordered raw materials.

4. Conclusions

Based on the comparison of the moving average and exponential smoothing forecasting methods with several accuracy criteria, it was found that the method with the smallest error is the exponential smoothing method with an alpha parameter value of 0.7, resulting in a MAD of 1,278,671 and a MAPE of 21.76%. This forecasting method can be used by the company to determine the amount of raw rayon fabric that should be provided before production, enabling better control over the ordering or usage of rayon fabric at the beginning of the production period.

In the data processing for inventory control using the min-max method with a service level of 98% and a Z value of 2.05, the standard deviation (σ) of rayon fabric demand is 1,360,649 yards. The company can reorder when the remaining raw material in the warehouse is 2,721,298 yards, with a safety stock amount of 1,360,649 yards. Additionally, the minimum inventory capacity that the warehouse can accept is 7,802,654 yards, and the maximum storage capacity is 15,605,307 yards of rayon fabric. These calculations are necessary for PT XYZ to avoid overstock, which can lead to increased inventory costs and the need for additional storage facilities to accommodate the ordered raw materials.

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