Available online at:http://publikasi.mercubuana.ac.id/index.php/ijiem

IJIEM (Indonesian Journal of Industrial Engineering & Management)

ISSN (Print) : 2614-7327 ISSN (Online) : 2745-9063

Material Planning with ABC Classification, Min-Max Method, and Continuous Review System Method at PT XYZ

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ARTICLE INFORMATION

Article history:

Received: 24 August 2023
Revised: 2 October 2023
Accepted: 9 November 2023

Category: Research paper

Keywords:
Material planning
ABC classification
Min-max method
Continuous review system method
Supply chain management

DOI: 10.22441/ijiem.v5i1.22661

A B S T R A C T

PT XYZ is a petrochemical manufacturing company that produces industrial raw materials. This company has a stock of inventory materials in its warehouse. The background of this research is based on the company's need to optimize raw material inventory management to ensure the smooth running of the methanol production process and prevent overstock and stock of material. This study analyzed company SAP data, which showed a high average overstock level in CR1-B2-C01 storage during 2018-2022. Forty materials were overstocked, and 22 materials were out of stock. This shows the urgency to classify priority inventory materials, determine the research results in minimum and maximum quantities of materials, and determine reorder points. The research methods used include the ABC classification to classify inventory priorities, the Min-Max method to calculate the minimum and maximum amount of material, and the Continuous Review System method to determine reorder points and the amount of inventory to be provided. Data on purchases and usage of Parker O-Lube and O-Ring Parker materials in CR1-B2-C01 storage during 2018-2022 are used as a basis for planning material requirements. The research results found that by applying the ABC classification, the Min-Max method, and the Continuous Review System method, the company can optimize the management of CR1-B2-C01 raw materials. In investing in raw materials, companies can reduce the risk of unnecessary costs, minimize damage to goods, and prioritize the optimal use of storage space.

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1. INTRODUCTION

Inventory in a company is essential in maintaining a balance between demand and supply of needed goods. However, if the list is not managed correctly, it can lead to wasted high storage costs, sub-optimal use of storage

space, risk of running out of stock, and difficulty caring for and maintaining goods. Therefore, effective inventory control is significant for companies, especially in manufacturing (Atnafu & Balda, 2018).

PT XYZ is a petrochemical manufacturing company that produces industrial raw materials. This company has stock material inventory in its warehouse. As a manufacturing company in the industrial sector, PT XYZ also faces challenges in managing its supplies. A previous study conducted by Atnafu and Balda (2018)found that excess inventory (overstock) can lead to wastage of resources and unwanted costs. It can also affect the company's cash flow and risk causing damage or loss of goods. Therefore, effective inventory control is needed to ensure the efficiency of total inventory costs and more optimal order planning.

In the interpretation of the company's SAP (System Application and Product in Data Processing) data, it can be seen in Picture 1 that the material in CR1-B2-C01 storage during 2018–2022 has a higher average overstock material level compared to 1239 other types of material storage, where out of 70 materials, 40 materials are overstocked and 22 materials that are out of stock, which means the level of urgency for priority grouping for material inventory, minimum and maximum quantities of material, and determination of reorder points must be carried out immediately to avoid overstock or out. Of stock materials in the spare parts warehouse. In the context of PT XYZ, CR1-B2-C01 storage is one of the materials storage that needs special attention. This storage contains Parker O-Lube and Parker O-Ring materials essential in the petrochemical industry. However, inventory management in this storage is not optimal and is still experiencing overstock and out-of-stock problems. In addition, PT XYZ also does not have an optimal inventory planning system to determine the right amount of inventory and when orders should be placed. Therefore, this study aims to develop better inventory planning for CR1-B2-C01 storage at PT XYZ.

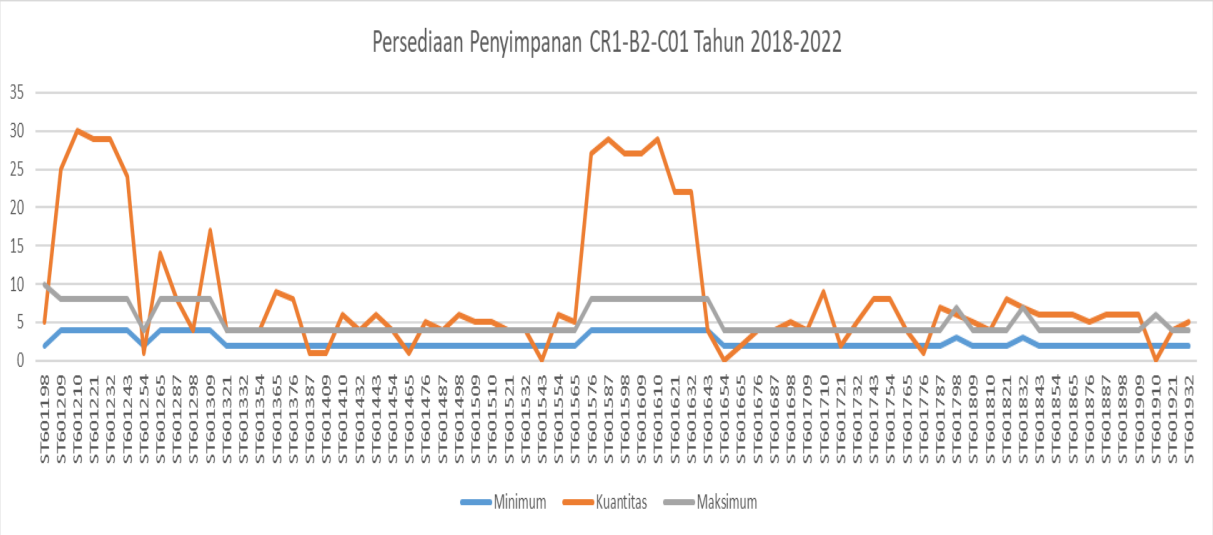

Figure 1. PDCA based improvement.
Source: https://www.innovationservices.philips.com/

First, this study aims to classify the priority of raw material stock materials in CR1-B2-C01 storage using ABC classification analysis. Second, determine the amount of stock material ordered based on minimum and maximum inventory according to budget requirements using the Min-Max method. Third, determine the optimal number of orders and order intervals using the Continuous Review System method. By achieving these goals, PT XYZ will be able to increase efficiency in its inventory management, reduce unnecessary costs, and minimize the risk of stockouts or excessive storage buildup.

Based on the literature review, effective

inventory control is very important in the manufacturing industry. Previous research by Atnafu and Balda (2018)showed that excess inventory can lead to waste of high storage costs and other costs such as ordering costs and stockout costs. Therefore, this research is expected to contribute to developing science in inventory control, especially in the context of PT XYZ. In conclusion, effective and efficient inventory control is important in maintaining the company's smooth operations. As a manufacturing company in the industrial engineering sector, PT XYZ faces challenges in managing its inventory, especially in storage CR1-B2-C01. This study aims to develop better inventory planning using the ABC classification, Min-Max, and Continuous Review System methods. It is hoped that this research can benefit PT XYZ in increasing the efficiency and effectiveness of inventory control and reducing unnecessary costs.

2. LITERATURE REVIEW

According to Groebner and Shannon (1991), inventory refers to the material components or finished products that are in the warehouse or in the hands of the company, which are ready for use or sale. Inventory is an important part of a company's working capital, which is always moving and constantly changing. The issue of investing in inventories needs to be actively studied, as it is in other assets. Determining the amount of investment or the allocation of capital in inventory directly impacts company profits. Errors in determining the amount of investment in inventory can reduce company profits. Inventory is one aspect that is very active in the company and also plays an important role as a high-value investment and significantly influences the company's operational activities. Inventory management aims to strike a balance between holding and purchasing costs and reduce costs in the event of a supply shortage. To achieve this goal, it is necessary to develop an inventory management system taking into account the context of the functionality of the inventory management system and the type of stock records and inventory reports required. This consideration also includes the selection of raw materials to be stored as standard raw materials, as well as the exact time and amount of reordering. Inventory management systems need to be developed taking into account the context of the functionality of the inventory management system and the type of stock records and inventory reports required. This consideration also includes the selection of raw materials to be stored as standard raw materials, as well as the exact time and amount of reordering. Inventory management systems need to be developed taking into account the context of the functionality of the inventory management system and the type of stock records and inventory reports required. This consideration also includes the selection of raw materials to be stored as standard raw materials, as well as the exact time and amount of reordering.

Inventory or stock management is an important area in operations management because it can affect production efficiency and company costs. Too much inventory can increase storage costs and the risk of decreasing the value of goods, while too little inventory can cause production delays and lost customers. Therefore, inventory management must be carried out effectively by taking into account factors such as customer demand, delivery time, inventory costs, and risks. Inventory management involves managing the movement of goods from suppliers to warehouses, and then onto production lines. It includes several activities such as forecasting demand, setting stock levels, ordering supplies, and controlling stock. The ultimate goal of inventory management is to minimize the total costs associated with inventory while ensuring sufficient inventory is available to meet customer demands. Effective inventory control methods can help companies achieve their inventory management goals. Stock control, which is one of the most critical activities in inventory management, involves setting stock levels and ordering stock when necessary (Gera et al., 2022).

Forecasting is a method for reducing uncertainty about something that will happen in the future, for example, demand or sales, which in this case are uncertain (Gasperz, 2001 in (Masdani, 2022)). The characteristics of good forecasting are having low costs, high accuracy, good response, fast response, and simple (Smith, 1989 in (Masdani, 2022)).

Inventory Control based on cost optimization using Continious Review (P and Q model). In

this research, the main problem is high cost for inventory and It's different from this research is stock out and stock in. (Tuffahati, 2023 in (Pratama 2023)). Forecasting methods generally utilize past data to predict future data. There are two types of forecasting methods, namely qualitative methods and quantitative methods. Qualitative methods are used when historical data are very limited or even non-existent and are often used in planning new product sales. Meanwhile, quantitative methods are used to predict future demand based on existing historical data. Forecasting with quantitative methods is grouped into time series methods (time series) and causal methods (non-time series). The causal method (nontime series) uses the assumption that factors are predicted to have a causal relationship with several independent variables. While the method of time series (time series). The time series method uses past data to forecast or predict future data. Several types of forecasting methods for the time series method used in this study are the Naive Method, Moving Averages, Exponential Smoothing, and Additive Composition. The Naive Method's forecasting model is based exclusively on historical observations of sales or other variables, such as revenue and cash flow. This model does not attempt to explain the causal relationship that underlies the variables to be predicted. The smoothing technique is a higher form of the Naive model. Two common forms of smoothing techniques are Moving Averages and Exponential Smoothing. Moving Averages are averages that are updated as new information is received. With Moving Averages, a manager uses only the most recent observations to calculate the average, which is used as a prediction for the next period. Exponential Smoothing uses a weighted average of past data as a basis for predictions. Additive Composition is a method for breaking down time series data into its components: trending, seasonal, and irregular. This can be useful for understanding patterns in data and for making predictions. The basic difference is that the Naive forecasting technique only uses historical observations without considering causal relationships, whereas the smoothing technique involves calculating updated averages or weighted averages of past data to make predictions. Besides that, (Shim & Siegel, 2012). The following is how to calculate each formula from the forecasting method.

1. *Moving Averages*: For each point in time researcher determine the average (perhaps with weights) of the observed values surrounding a given time. For example, at time t, a "moving average centered with length 3" with the same weight will be the average of values at times t - 1, t, and t + 1(Penn State's Department of Statistics, 2023).
2. *Exponential Smoothing*: The basic forecasting formula for single exponential smoothing is often expressed as
   $$x_{t+1} = \alpha x_t + (1 - \alpha) x_t \quad (2.1)$$
   where is the estimated value at time t+1, is the observed value at time t, and α is the smoothing parameter. $x_{t+1} x_t$
3. *Additive Decomposition*: The following structure is used in the basic solving model:
   $$x_t = \text{Trend} + \text{Seasonal} + \text{Random} \quad (2.2)$$
   where is the observed value at time t, Trend represents the trend component, Seasonal represents the seasonal component, and Random represents the random component x_t(Penn State's Department of Statistics, 2023).
4. Naive Method: According to this method, the forecast one step ahead is equal to the most recent actual value:
   $$\hat{y}_t = y_{t-1} \quad (2.3)$$
   where is the estimated value at time t and is the observed value at time t−1$\hat{y}_t y_{t-1}$(Svetunkov, 2022).

The forecasting method that has the smallest forecasting error value will be considered a suitable method to use (Makridakis et al., 1999). There are many methods for calculating forecasting errors. This study uses three forecasting accuracies, namely MADE (Mean Absolute Deviation Error), MSE (Mean Squared Error), and MAPE (Mean Absolute Percentage Error) which are methods used to measure prediction accuracy. By calculating MADE, MSE, and MAPE, you can determine how accurate the predictions are from the data being analyzed (Bollapragada et al., 2021). This method is widely used in data analysis, such as in machine learning and data mining.

Following are the formulas for calculating MADE, MSE, and MAPE (Ahmar, 2020; Bollapragada dkk., 2021):

MADE = 1/n * Σ|actual - predicted| (2.4)
MSE = 1/n * Σ(actual - predicted)2 (2.5)
MAPE = 1/n * Σ|actual - predicted| / actual * 100% (2.6)

Information:
n = amount of data
actual = actual value
predict = predicted value

Based on The ABC Classification Method is a widely used inventory control technique that categorizes inventory items based on their value. This method classifies inventory stock materials into three categories, namely A, B, and C, based on their contribution to the total inventory value. (Krajewski et al., 2018; Russell & Taylor, 2019). The use of the ABC Classification method in inventory management has significant benefits in directing management's attention to determine the most important types of goods that need to be prioritized. In practice, it is unrealistic to monitor low-priced items with the same level of care as very high-priced items.

Based on Happy (2006), here are the steps for analyzing the ABC classification with the Pareto chart.

1. Calculate the amount of absorption of funds for each type of stock material per year (Mi), namely by multiplying the amount of use of each type of stock material per year (Di) with the unit price of stock material (pi), mathematically it can be stated:
   $M_i = D_i \times p_i$ (2.7)
   Information:
   Mi: Absorption of material stock i per year
   At : Total usage of material stock i per year
   pi : Unit price of stock material i
2. Calculate the total amount of absorption of funds for all types of stock material (M).
   $M = \sum M_i$ (2.8)
   Information:
   M : Total absorption of funds for all types of stock material
3. Calculate the percentage of absorption of funds for each type of stock material (Pi)
   $P_i = M_i/M \times 100\%$ (2.9)
   Information:
   Pi : Percentage of absorption of funds for each type of stock material
4. Sort the percentage of absorption of funds in the order of the percentage of absorption of funds, starting from the largest percentage of absorption of funds to the smallest.
5. Calculate the cumulative value of the percentage of absorption of funds and the cumulative value of the percentage of stock material types based on the order.
6. Classify stock material based on the cumulative value calculation results based on the established criteria.

According to (Prasetyawan & Nasution, 2008), Pareto classifies goods in the ABC inventory analysis with the following general criteria: (1) Class A: Goods with units of 10%–20% of the total, but the investment value is 30%–70% of the total annual inventory investment. (2) Class B: Goods with units of 20%–30% with an investment value of 20%–30% of the total annual inventory investment. (3) Class C: Goods with units of 30%–70% with an investment value of 10%–20% of the total annual inventory investment. The concept of the Min-Max method was developed based on a simple thought to maintain the continuity of a factory, certain types of goods in a minimum quantity should be available in stock so that at any time something is damaged, it can be replaced immediately. There should not be too many items available in the inventory, there is a maximum so that the cost is not too expensive. (Indrajit and Djokopranoto, 2003 in (Rizky et al., 2017)). How the Min-Max method works based on Fadilillah et al. (2008) in Rizki et al. (2017) namely: If the inventory has passed the minimum limits and is approaching the Safety Stock limit, then a Reorder must be made, so the minimum limit is the Reorder Level limit, the maximum limit is the company or management's willingness to invest money in the form of raw material inventory. So in terms of the maximum and minimum limits used to be able to determine the Order Quantity.

According to Vollmann et al. (2004), lead time is the time required to complete a task or produce a product from start to finish. The formula for calculating lead time is as follows:

Lead Time= Production Time + Raw Material Order Time + Raw Material Delivery Time + Inspection Time + Delivery Time to Customer (2.10)

While the formula for Average Usage of Materials per period or Average Usage of

Materials per Period is based on Vollmann et al. (2004) are as follows:

Average Usage of Materials per Period= (Starting number of items + Final item amount) / 2 / Period number (2.11)

According to Indrajit and Djokopranoto (2005) in Ariesty and Andari (2016), the calculation of the Min-Max method is as follows:

1. Safety Stock
   SS = (Maximum consumption–T)×L(2.12)
   Information:
   Q: The average usage of goods per period
   L: Lead Time
2. Minimum Stock (Minimum Inventory) = Re Order Point (ROP)
   Min = (T × L) +SS. (2.13)
   Information:
   Min: Minimum Stock
   Q: Average usage per period
   L: Lead Time
   SS: Safety Stock
3. Maximum Stock (Maximum Inventory)
   Max = 2 × (H × W) (2.14)
   Information:
   Max: Maximum Stock
   Q: Average usage per period
   L: Lead Time
4. Number of Messages Returned
   Q = Max – Min (2.15)
   Information:
   Q: Stock back order rate

In the Continuous Review System method, commonly called the Q model, inventory status is monitored continuously at the inventory level or the stock level(Prasetyawan & Nasution, 2008). By using the Q model, you can determine where the order lot value is, and which value is always the same every time you place an order. In this study, the optimal ordering lot value is q01. The steps for using the Q model method in solving problems with the Hadley-Within method are as follows (Fatma & Pulungan, 2018).

1. Calculate the value of q01
   $$q_{01} = \sqrt{\frac{2AD}{h}} \quad (2.16)$$
   Information:
   q0n: the nth material order lot size
   A: product ordering fee (Rp)
   D: average demand/month
   h: product storage cost (Rp)
2. Based on the q01 value that has been obtained, look for the magnitude of the possible shortage of inventory (α) with the following equation:
   $$\alpha = \frac{hq_{01}}{hq_{01}+C_u D} \quad (2.17)$$
   Information:
   α: the value of inventory shortages
   Cu: Cost of product shortage/stockout (Rp)
3. Then look for the value of Zα which can be seen through the normal distribution table and calculate the value of r1 with the following equation:
   $$r_1 = DL + Z_a S\sqrt{L} \quad (2.18)$$
   Information:
   L: lead times
   Z_a: the value of the possibility of a shortage of inventory
   S : standard deviation of demand
   rn: Reorder point or the nth material reorder point
4. Finally, determine the order interval with the following equation.
   $$\text{order interval} = \frac{q_{01}}{D} \quad (2.19)$$

3. RESEARCH METHOD

This research was conducted in several stages, as seen in Figure 2. First, problems in PT XYZ related to inventory control were determined. The main problems identified were the absence of an optimal inventory planning system and a lack of basis for determining the exact quantity and timing of orders. A literature study was then carried out to understand better inventory management, including methods such as the ABC classification, the Min-Max method, and the Continuous Review System method. The research objectives were set to determine the priority of stock material, minimum and maximum inventory quantities, and optimal order quantities and order intervals.

Furthermore, data related to inventory control problems at PT XYZ was collected. Primary data was obtained through interviews with warehouse supervisors who have worked at PT XYZ since 2019. The data needed includes raw material names, sales data, ordering cost data, holding cost data, stockout cost data, and price data for each raw material.

The ABC Classification Method is used to classify stock materials in storage CR1-B2-C01 based on investment value. This method

involves calculating the total absorption of funds for each type of stock material each year, then the investment value is sorted and accumulated sequentially. Classes A, B, and C are determined based on the price percentage represented by each class.

Demand forecasting uses purchasing and material usage data at CR1-B2-C01 storage. Data patterns were analyzed to determine the appropriate forecasting method, and the method with the lowest forecasting accuracy was selected as the best forecasting method. By using the Min-Max method, the minimum and maximum inventory points are determined based on a predetermined equation.

Finally, the Continuous Review System method finds optimal orders and order intervals by considering inventory costs. After calculating, recommendations can be given regarding materials that should be prioritized and materials that need to be ordered immediately.

The research results will be evaluated and concluded based on the objectives and recommendations set. Conclusions and suggestions will also be given for further research or improvement at PT XYZ.

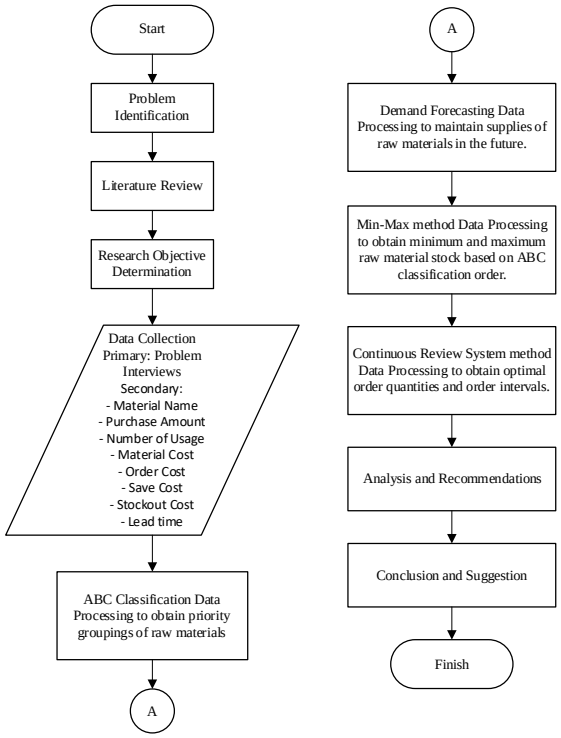

Figure 2. Methodology flowcharts

4. RESULT AND DISCUSSION

The results and discussion of this study discuss several methods and approaches in planning material requirements CR1-B2-C01, namely the ABC Classification, demand forecasting, the Min-Max method, and the Continuous Review System method.

First, an ABC classification is carried out to determine the priority of raw materials based on the percentage of funds absorption from each stock material. Based on the calculation results, it was found that there were 7 types of raw materials (10% of the total) that were included in group A with an investment value of 63%, 14 types of raw materials (20% of the total) that were included in group B with a certain investment value, and 49 types of raw materials (70% of the total) were included in group C with an investment value of 9.4%. The Pareto chart also shows that group A has the largest amount of raw materials and a higher investment value, while group C has a large amount of raw materials, but the investment value is not too high. This ABC classification is important for identifying raw material inventory management priorities.

The following is an example of the calculation results for the ST601198 material.

1. Calculate the amount of absorption of funds for each type of stock material per year.
$$M_1 = D_1 \times p_1$$
Total absorption of ST601198 material funds () = IDR 3,394,400M_1
2. Calculate the total amount of funds for absorption for all types of stock material (M).
$$M = \sum M_1$$
$$M = IDR\ 5.193.472.235$$
3. Calculate the percentage of absorption of funds for each type of stock material (Pi).
$$P_i = M_i/M \times 100\%$$
$$P_i = \frac{IDR\ 3.394.400}{IDR\ 5.193.472.235} \times 100\% = 0{,}07\%$$

Next, sort the materials based on the percentage of funds absorption according to the percentage of funds, starting from the largest percentage of funds to the smallest of all materials, calculating the cumulative percentage value, and classifying the categories.

Table 1. Results of classification of raw materials based on ABC classification

Group	Investment Value	%Investments	Number of Raw Materials	Percentage Amounts
A	IDR 3,272,211,225	63.0%	7	10.0%
B	IDR 1,431,032,431	27.6%	14	20.0%
C	IDR 490,228,579	9.4%	49	70.0%
Total	IDR 5,193,472,235	100.00%	70	100.00%

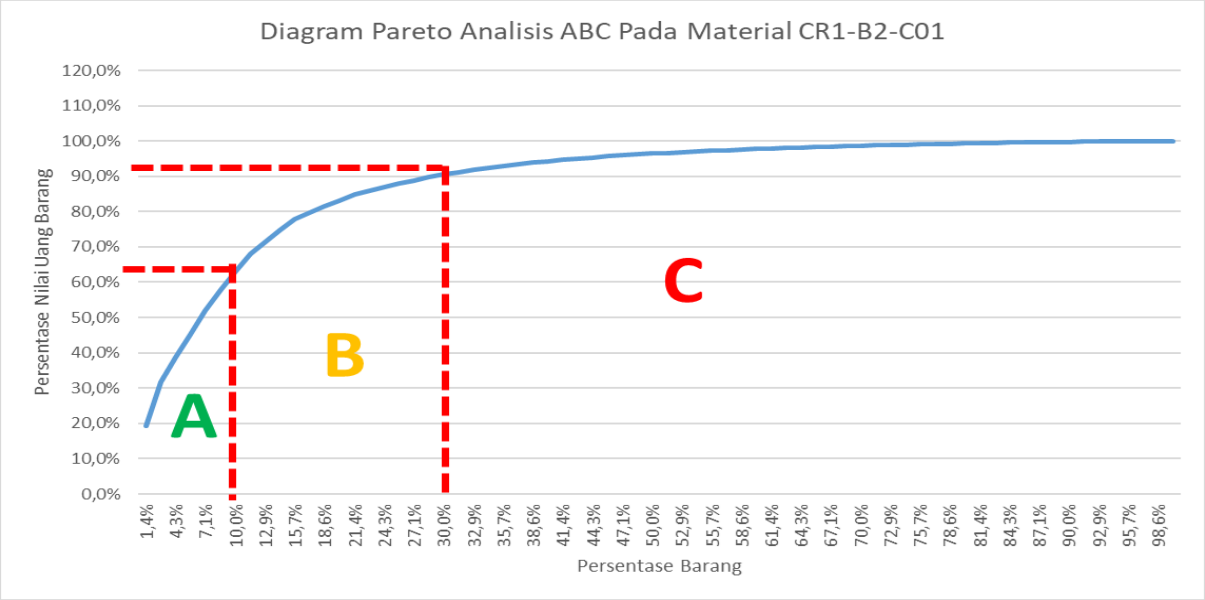

Figure 3. ABC classification Pareto chart

Figure 3 shows the Pareto diagram for the ABC classification of CR1-B2-C01 materials. On the x-axis, there is the percentage of goods obtained from units per total unit of goods. For example, if 70 units of material make up the first percentage item, there will be a first plot on the y-axis showing the cumulative percentage of the item's value. From this Pareto graph, it can be concluded that group A has the most amount of raw materials compared to groups B and C. In addition, group A's investment value is also higher than groups B and C. Therefore, group A has the most raw materials, and a small but high investment value. Meanwhile, group C has many raw materials, but the investment value is low. However, Raw materials in group C are prone to running out of stock because the demand for this group could be better, so it is not considered too important, and the control is less stringent. To overcome this problem, it is necessary to carry out careful planning to avoid stock outs which can cause losses due to the purchase of raw materials. For this reason, inventory planning is carried out using the Min-Max method to determine each material's minimum and maximum stock quantities. Before carrying out the supply planning, demand forecasting for the next five years is also carried out based on historical data for 2018-2022. Careful planning is necessary to avoid stockouts that can cause losses due to purchasing raw materials. For this reason, inventory planning is carried out using the Min-Max method to determine each material's minimum and maximum stock quantities. Before carrying out the supply planning, demand forecasting for the next five years is also carried out based on historical data for 2018-2022. careful planning is necessary to avoid stockouts that can cause losses due to purchasing raw materials. For this reason, inventory planning is carried out using the Min-Max method to determine each material's minimum and maximum stock quantities. Before carrying out the supply planning, demand forecasting for the next five years is also carried out based on historical data for 2018-2022.

Furthermore, demand forecasting is carried out to maintain inventory while applying the Min-

Max method and the Continuous Review System method based on the results of the ABC classification. Using historical demand data for 5 years, demand forecasting is carried out for the next 5 years. The forecasting methods used include the Naïve Method, Exponential Smoothing Moving Averages, and Additive Decomposition. Based on the results of a comparison of the accuracy metrics of MADE, MSE, and MAPE, it was found that the Additive Decomposition method has the highest level of accuracy. Using the Additive Decomposition method, forecasting the demand for the next 5 years for CR1-B2-C01 storage is carried out. Table 2 shows the output of the results of the four forecasting methods to compare which forecasting method is best for demand forecasting using the Python programming language. Based on the average MADE, MSE, and MAPE, it can be seen that the Moving Averages method has a MADE value of 9.16, MSE of 204.62, and MAPE of 28.41%. This metric indicates moderate forecast accuracy. The Exponential Smoothing method has a lower MADE of 3.95, MSE of 38.24, and MAPE of 12.15%. This metric shows a higher forecasting accuracy compared to the Moving Averages method. The Additive Decomposition method shows MADE 0, MSE 0, and MAPE 0%. This metric demonstrates excellent forecasting accuracy. Naive Method has MADE 10.84, MSE 283.76, and MAPE 33.7%. This metric shows the lowest forecasting accuracy compared to the other three methods.

Table 2. Results of accuracy of CR1-B2-C01 storage forecasting method

Forecasting Accuracy	Moving Averages	Exponential Smoothing	Additive Decomposition	Naive Methode
MADE	9,16	3.95	0	10.84
FOLDER	204,62	38,24	0	283.76
MAPE	28.41%	12.15%	0%	33.7%

After that, the Min-Max method determines the minimum and maximum amount of stock for each raw material. In carrying out orders for raw materials at PT XYZ, there is no specific calculation regarding the number of orders. The number of orders depends on the minimum number of raw materials used. Therefore, the analysis of the Min-Max method for each raw material is based on the percentage of funds absorption in the ABC classification. The calculation results of the Min-Max method show the minimum and maximum amount of stock that needs to be maintained so that inventory control can be planned appropriately. The following is an example of the calculation results for the ST601198 material.

1. Safety Stock

SS = (Maximum consumption - T) × L

SS = (2.5-1.88) × 2.87 = 1.78 ≈ 2 units

Minimum Inventory = Re Order Point (ROP)

Min = (T × W) +SS

Min = (1.88 × 2.87) + 2 = 7.4≈ 7units

2. Maximum Inventory

Max = 2 × (H × W)

Max = 2 × (1.88× 2.87) = 10.79 ≈ 11 units

3. Number of Messages Returned

Q = Max – Min = 11-7 ≈ 4 units

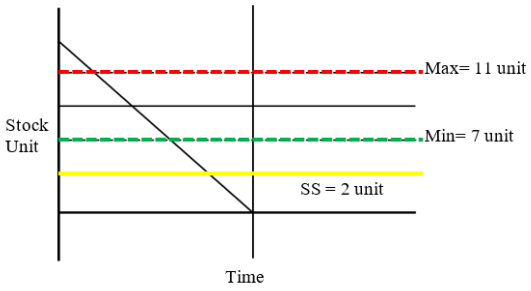

Figure 4. Graph of ST601198 min-max material calculation results

The calculation above is an example of raw material stock material with material code ST601198, where based on the calculation, a safety stock of 2 units is obtained, a minimum stock of 7 units, a maximum stock of 11 units, and the number of reorders is 4 units. Rounding up to maximum stock and safety stock and rounding down to minimum stock is done to maintain service level by maintaining availability to meet user needs. In Picture 4 is a graph of the calculation results of the Min-Max method for material with code ST601198, it can be seen in the Picture that with a safety stock of 2 units marked with a yellow line, this material over time when the stock decreases will place an order when it reaches the minimum point, namely 7 units. Finally, the Continuous Review System method (Q model) is used to determine the optimal order quantity and order interval. This method is carried out by considering the priority of ABC classification, demand

forecasting results, and inventory costs such as ordering costs, holding costs, and stock-out costs. The results of the calculation of the Q model show the optimal number of orders and order intervals for each raw material based on the percentage of absorption of funds in the ABC classification. The order interval for category A is faster than the other categories, due to the high priority of purchasing materials. The following is an example of the calculation results for the ST601198 material. Rounding up the order lot value and reorder point is done to maintain the service level.

1. Calculate the value of q_{01}

$$q_{01} = \sqrt{\frac{2AD}{h}}$$

$$q_{01} = \sqrt{\frac{2 \times 62.300 \times 1{,}88}{40.710}} \approx 3\ unit$$

2. Based on the q_{01} value that has been obtained, then look for the magnitude of the possible shortage of inventory (α) with the following equation:

$$\alpha = \frac{hq_{01}}{hq_{01} + C_u D}$$

$$\alpha = \frac{40.710 \times 3}{40.710 \times 3 + 38.940 \times 1{,}88} = 0{,}6248$$

3. Then find the value of Z_α which can be seen through the normal distribution table. The value of 1-α from the previous calculation is 0.3752, so the finding of Z_α for the closes value in the table is -0,32 as shown in Picture 5 (as an alternative, use the formula =(NORM.S.INV(1-α)) in Microsoft Excel), then calculate the value of r_1 with the following equation :

$$r_1 = DL + Z_a S\sqrt{L}$$

$$r_1 = 1{,}88 \times 2{,}87 + (-0{,}32)0{,}44\sqrt{2{,}87} \approx 6\ unit$$

Z	.00	.01	.02	.03
-0.4	.34458	.34090	.33724	.33360
-0.3	.38209	.37828	.37448	.37070
-0.2	.42074	.41683	.41294	.40905
-0.1	.46017	.45620	.45224	.44828
-0.0	.50000	.49601	.49202	.48803

Figure 5. Zα value based on probability in the normal distribution table

4. Next, find the ordering interval with the following equation.

$$ordering\ interval = \frac{q_{01}}{D}$$

$$ordering\ interval = \frac{3}{1{,}88} = 1{,}59\ months$$

Based on the calculations, for stock raw materials with material code ST601198, the optimal lot size or order quantity is 3 units, then the reorder point is carried out during an interval of 1.59 months when the number of material units is 6. Using the method approach described above, CR1-B2-C01 material requirement planning can be carried out more effectively and efficiently. By knowing raw material priorities, forecasting demand, determining minimum and maximum stock quantities, and determining optimal order quantities and order intervals, companies can optimize raw material inventory control and avoid out-of-stock or overstock. This will help companies increase efficiency, reduce wastage of resources, and increase responsiveness to user needs.

5. CONCLUSION

In this study, it was found that the method approach used, namely the ABC classification, demand forecasting, the Min-Max method, and the Continuous Review System method, can assist in planning CR1-B2-C01 material requirements at PT XYZ. Through the ABC classification, companies can identify raw material inventory management priorities. The results of demand forecasting using the Additive Decomposition method also provide a high level of accuracy. The Min-Max method helps determine the minimum and maximum amount of stock that needs to be maintained. While the Continuous Review System method (model Q) provides the optimal number of orders and order intervals based on ABC classification priorities, demand forecasting results, and inventory costs. By applying this method approach, PT XYZ can streamline their material planning process, reduce excess inventory, and improve overall supply chain efficiency."

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