

The Controlling of Raw Materials Inventory using Material Requirement Planning Method in PT Anugrah Mandiri

Dian Siti Sundari, Shanissa Diandi, Danang Prihandoko

Abstract: *The purpose of this study is to determine the most appropriate forecasting to predict the demand for raw materials of laundry in 2017, determine the results of the Material Requirement Planning calculation using lot permits, and to determine the total cost-efficiency of the conventional calculation method with the Material Requirement Planning method. The research method used is quantitative research, descriptive research type, and time horizon is cross-sectional for all data collection. This study uses Exponential smoothing (QM for Windows) forecasting, as an illustration, to determine the number of raw material requirements by using the analysis method, Material Requirement Planning with lot sizing measurements used are Lot for Lot, Economic Order Quantity, and Period Order Quantity. Of the three methods, the analysis results illustrate that the Lot for Lot method produces the lowest total cost of IDR. 56,160,000, compared to the total costs incurred using the company's conventional method of IDR. 175,985,288,2, So, the Material Requirement Planning method can reduce the company's inventory costs*

Keywords : *Economic Order Quantity (EOQ), Forecasting, Lot for Lot, Material Requirement Planning (MRP), Period Order Quantity (POQ).*

I. INTRODUCTION

The manufacturing industry has considerable potential and influence on Indonesia's economic growth and income. Gross Domestic Product (GDP) is one method for calculating national income, which is the overall value of all goods and services produced in the region within a certain period (usually per year). Laundry and Garment is one of the processing industries in the final of textile finishing, which is new technology in the garment trade to change or modify the appearance, comfort, and design of clothing. Raw material inventory control is an important matter within the company to manage the storage and handling functions of inventory to improve customer service that is better and profitable for the company. This is to avoid understocking when needed, and overstocking that will harm the company.

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This research will discuss the supply of raw materials in general washing at PT Anugrah Mandiri. This company is a processing industry company in the field of laundry & garment. The raw materials used for the general washing process are softener, washing soap, bio, and hypo, which are ordered through suppliers. PT Anugrah Mandiri has often faced the demand for a trend that has decreased significantly. The demand for raw materials of general washing cannot meet the amount of inventory available at the company. PT Anugrah Mandiri still estimates and orders raw materials with suppliers only when needed. This causes a shortage (understocking) which affects the production process because they have to wait for the availability of raw materials sent by the supplier with a period of 3 days. Besides recording raw material orders are still done manually or not systemically. For this reason, the company must place an order at the right amount and time (lot size) to not cause loss. Based on these problems, according to [1], using forecasting, the Material Requirement Planning (MRP) method, as well as the lot sizing technique, companies can determine the components of raw materials based on time and cost. So, it can launch production activities or meet customer demand. Also, according to [2], the Material Requirement Planning (MRP) method can control the inventory system (raw material) and provide the necessary material components at the right amount and time. This study is related to the laundry and garment industry company, and previous studies are related to the pharmaceutical industry company.

II. LITERATURE REVIEW

Production or operation is the creation of products and services. Operations management is an activity of creating products and services through the process of transforming inputs into outputs [3]. Operations management is a way of a particular process which includes design and as well as to operate a better production process ([4]). According to [4], the raw material inventory is a stock of goods stored by a company or organization to meet consumer demand. According to [3], raw material inventory is one of the most expensive and vital assets in the company. Also, the good inventory management of raw

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materials is very important to achieve demand from consumers. Therefore, companies must achieve a balance between inventory and level of customer service.

According to [3], forecasting is the art and science of forecasting about future events. According to [4], Forecasting is a prediction of what will happen in the future. Forecasting has a very important position in the planning process, but forecasting is not always able to get a correct prediction, but only an illustration.

According to [3], Material Requirement Planning (MRP) is a bound demand model that uses a list of material requirements, inventory status, estimated revenues, and master production schedules, which are used to determine material requirements to be used.

III. RESEARCH METHODS

The research method and type of data used in this study are quantitative because the data used and processed are numeric or in the form of numbers. The research approach used is descriptive because this study describes an event that occurred. The time horizon in this study is cross-sectional because the data is taken once for a certain period. Data collected through observation and interviews with PT Anugrah Mandiri to find out the problems that occur and obtain the required data. The data source that researchers obtained was secondary data because the data had been processed and was available by the company. After obtaining the required data, the researchers conducted the forecasting process and then proceeded to the calculation using the Material Requirement Planning (MRP) method. MRP is used to determine the right measurement of time and quantity for raw material inventory and can efficiently total costs have incurred by the company for raw material inventory.

IV. RESULT AND DISCUSSION

Stages of data processing and results in this study are:

1. Forecasting

The results of forecasting are used to find out the number of requests for general washing in 2017 and January 2018. Forecasting is based on general washing requests during the previous period, namely the period 2015 - December 2017. Forecasting this request uses several Time Series Forecasting methods, namely Exponential Smoothing, Least Square, Moving Average, Naïve Method, and Trend Projection.

According to [3], there are quantitative forecasting methods, including:

- Exponential Smoothing

Exponential smoothing is a method of forecasting moving averages with sophisticated weighting but still easy to use. Exponential Smoothing is a moving average forecasting technique that exponentially weighs past data so that the most recent data has a greater weight or scale than the longer observation value. Exponential smoothing can be stated by the following formula:

α is a weight or refinement constant that can be chosen by forecaster that has a value between 0 and 1. The formula equation above can be systematically written as follows:

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

F_t = New Forecasting

F_{t-1} = Previous forecasting

$$\text{Future forecasting} = \text{past forecasting} + \alpha (\text{actual demand} - \text{for the previous period})$$

A = smoothing (weighting) constant ($0 \leq \alpha \leq 1$)

A_{t-1} = Current period's actual request

- Least Square

Regression is a measuring tool that can also be used to measure the presence or absence of correlation between variables. If we have two or more variables, then it is appropriate if we want to learn how those variables are related or predictable. Regression analysis studies the relationships obtained expressed in mathematical equations which state the functional relationships between variables. The functional relationship between one predictor variable and one criterion variable is called a single regression analysis, while the functional relationship that is more than one variable is called multiple regression analysis. Equation obtained:

$$y = a + bx$$

y = the calculated value of the variable to be predicted

a = Y-axis crossing

b = slope of the regression line (or rate of change in y for changes that occur in x)

x = Free variable (time).

To determine the values of a and b , it will be explained in the formula below:

$$b = \frac{\sum XY - n(\sum xy)}{\sum X^2 - n(x^2)}$$

b = slope of the regression line

\sum = Total addition sign

X = Value of free variable that is known

y = Value of known related variables

$$a = y - bX$$

$$X = \frac{\sum X}{n}$$

$$y = \frac{\sum Y}{n}$$

\bar{y} = Average value of y

\bar{x} = Average value of x

- Moving Average

Forecasting using the moving averages method is done by taking a group of observations, looking for averages, then using these averages for the next period. The term moving average is used because every time a new observation data is available, the new average is calculated and used as a forecast. Mathematically, average moves simple (which are predictions of future period demand) are expressed in the following formula:



$$\text{Rata - rata bergerak} = \frac{\sum \text{permintaan dalam periode } n \text{ sebelumnya}}{n}$$

• Naïve Method

The simplest method assumes that the forecasting for the next period is the same as the actual value of the previous period. Thus, the actual data of a period that has just passed is the best tool to predict future conditions (more emphasis on the use of past data to determine or predict future conditions). This method is the simplest because it assumes that the data that has just occurred is the most appropriate prediction for predicting future periods.

• Trend Projection

The forecasting method for time series that corresponds to a trend line on a series of past data points is projected into future forecasting for medium and long-term forecasting.

Equation obtained:

$$y = a + bx$$

Where,

y = the calculated value of the variable to be predicted

a = Y axis crossing

b = slope of the regression line (or rate of change in y for changes that occur in x

x = Free variable (time).

• Calculating forecast errors

According to [3] stated that in forecasting, there are three most absolute error calculations, namely the mean absolute deviation (MAD), the mean squared error (Mean Squared Error - MSE), and the average absolute percent error (Mean Absolute Percent Error - MAPE), where there is a calculation for each:

1. Mean Absolute Deviation

MAD is the first measure of forecasting errors for a model. This value is calculated by taking the absolute number of values for each forecasting error divided by the number of data period n.

$$\text{MAD} = \frac{\sum (\text{actual forecasting})}{n}$$

2. Mean Square Error

MSE is the second method to measure overall forecasting errors. MSE is the average difference between the predicted value and the observed value. The disadvantage of using MSE is that it tends to accentuate large deviations because of squaring.

$$\text{MSE} = \frac{\sum (\text{forecasting error})^2}{n}$$

3. Mean Absolute Percentage Error

The problem with MAD and MSE is that their value depends on the magnitude of the element predicted. If the element is counted in thousands, then the MAD and MSE values can be very high. To avoid this problem, this research use MAPE. MAPE is calculated as the average absolute difference between predicted and actual values, expressed as a percentage of actual values.

$$\text{MAPE} = \frac{100 \sum (\text{aktual}_i - \text{ramalan}_i) / \text{aktual}_i}{n}$$

Based on the comparison of forecasting methods used in Table- I, the smallest MAD, MSE, and MAPE values are generated from forecasting using exponential smoothing $\alpha = 0.70$. Therefore, forecasting results by using exponential smoothing with $\alpha = 0.70$, namely with MAD value 47,663.46, MSE 4,794,277,000, MAPE 82,676%, and Standard Error 71,308.05, forecasting results for January 2017 123,327, Then it can be concluded that exponential Smoothing with $\alpha = 0.70$ is the most appropriate method to be used in forecasting requests for General Washing in the next period

Table- I: Comparison Method of Forecasting

No	Forecasting Method	MAD	MSE	MAPE	Stand ar Error	Results Foreca sting Januar y 2017 (Unit)	Results Foreca sting Januar y 2018 (Unit)
1	Exponential Smoothing $\alpha = 0.70$	47,663.46	4,794,277,000	82.676%	71,308.05	123,327	70,697.27
	Exponential Smoothing $\alpha = 0.50$	53,523.08	5,003,779,000	87.847%	72,849.42	115,258.2	72,515.09
	Exponential Smoothing $\alpha = 0.90$	48,414.11	4,815,666,000	85.484%	71,466.95	128,351.7	68,786.63
2	Least Square	54,205.43	4,918,029,000	74.759%	72,161.8	122,127.9	103,895.1
3	Moving Average	59,215.3	5,803,238,000	96.77%	79,566.36	111,526.6	136,635.7
4	Naïve Method	49,728.57	4,928,195,000	87.763%	72,297.13	129,821	67,065.5
5	Trend Projection	54,205.43	4,918,029,000	74.759%	72,161.8	122,127.9	103,895.1

2. Master Production Scheduling

From the forecasting data obtained in the exponential smoothing method with $\alpha = 0.70$, is used as a comparison data for 2017 public washing requests with 2017 public washing demand forecasting, which is then used as the Production Master Schedule (JIP).

Table- II: Parent Production Schedule

Mont h	General Washing Forecasting Data Request 2017 (Pcs)	2017 General Washing Reque st Data (Pcs)
17-Ja n	123,327	122,574
17-Fe b	122,800	177,853
17-M ar	161,337	239,034
17-Ap r	215,725	223,775
17-M ay	221,360	327,620
17-Ju n	295,742	175,790
17-Jul	211,776	28,354
17-Au g	83,380	78,441
17-Se p	79,923	49,954

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17-Oct	58,973	62,295
17-Nov	61,298	86,833
17-Dec	79,173	67,065
TOTAL	1,714,813	1,639,628

$$MAD = \frac{\sum (\text{actual forecasting})}{n}$$

3. Calculation of Raw Material Requirements

The bill of Materials for general washing work is:

Table- III: Raw Material Requirements

Raw Material	Needs of General Washing Raw Materials per pcs (Kg)
Softener	0.009 kg
Soap	0.009 kg
Raw Material	Needs of General Washing Raw Materials per pcs (Kg)
Bio	0.015 kg
Hypo	0.003 kg

For the calculation of the raw material of the data on the company and the data demand forecasting demand in the period from 2017 can be seen in the table- IV below:

Table- IV: Calculation of Raw Material Requirements from "2017Demand Forecasting Data"

Month	General Washing Forecasting Data Request 2017 (Pcs)	Softener = 0.009 Kg	Washing Soap = 0.009 Kg	Bio = 0.015 kg	Hypo = 0.003 Kg
Jan 17	123,327	1,109.94	1,109.94	1,849.91	369.98
Feb 17	122,800	1,105.20	1,105.20	1,842.00	368.40
Mar-17	161,337	1,452.03	1,452.03	2,420.06	484.01
Apr-17	215,725	1,941.52	1,941.52	3,235.87	647.17
May 17	221,360	1,992.24	1,992.24	3,320.00	664.08
Jun-17	295,742	2,661.68	2,661.68	4,436.13	887.23
Jul 17	211,776	1,905.98	1,905.98	3,176.63	635.33
Aug-17	83,380	750.42	750.42	1,250.71	250.14
Sep-17	79,923	719.31	719.31	1,198.84	239.77
Oct-17	58,973	530.75	530.75	884.59	176.92
Nov-17	61,298	551.68	551.68	919.47	183.89
Dec-17	79,173	712.55	712.55	1,187.59	237.52
TOT	1,714,813	15,433	15,433	25,722	5,144.4

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Source: Processed by Researchers (2018)

Table-V: Calculation of Raw Material Requirements from

"2017 Demand Data"

Month	2017 General Washing Request Data (Pcs)	Softener = 0.009 Kg	Washing Soap = 0.009 Kg	Bio = 0.015 kg	Hypo = 0.003 Kg
Jan 17	122,574	1,103.17	1,103.17	1,838.61	367.72
Feb 17	177,853	1,600.68	1,600.68	2,667.80	533.56
Mar-17	239,034	2,151.31	2,151.31	3,585.51	717.10
Apr-17	223,775	2,013.98	2,013.98	3,356.63	671.33
May 17	327,620	2,948.58	2,948.58	4,914.30	982.86
Jun-17	175,790	1,582.11	1,582.11	2,636.85	527.37
Jul 17	28,354	255.19	255.19	425.31	85.06
Aug-17	78,441	705.97	705.97	1,176.62	235.32
Sep-17	49,994	449.95	449.95	749.91	149.98
Oct-17	62,295	560.66	560.66	934.43	186.89
Nov-17	86,833	781.50	781.50	1,302.50	260.50
Dec-17	67,065	603.59	603.59	1,005.98	201.20
TOTAL	1,639,628	14,756.65	14,756.65	24,594.42	4,918.88

Source: processed by researchers (2018)

Material Requirement Planning (MRP) method can help to plan and control raw material inventory at PT. Anugrah Mandiri. Lot Size used to calculate each item is Lot-for-Lot (LFL), Economic Order Quantity (EOQ), and Period Order Quantity (POQ). Based on the problems that occur in the company, it is evident that using the Material Requirement Planning (MRP) method can help companies in determining the time and amount to carry out a raw material inventory, and can streamline the total costs incurred by PT Anugrah Mandiri in the supply of raw materials.

According to [3], there are various ways to determine the lot size in an MRP system, namely:

1. Lot for Lot (LFL)

Lot for Lot (LFL) method is a method that produces what is needed. This decision is consistent with the objectives of the MRP system. The objective is to meet the requirements of a dependent request. Thus, the MRP system must produce units only as needed, without safety stock and no anticipation of further orders. When regular orders are economical and just-in-time production techniques are applied, then the LFL technique will be very efficient. However, when installation costs are significant, the LFL will be expensive.

2. Economic Order Quantity (EOQ)

The Economic Order Quantity (EOQ) method is the method most often used as a lot measurement technique. EOQ is useful when having relatively constant demand. However, demand can change every period in the MRP system. Inventories will be received in units of time.



Moreover, running out of inventory can be completely avoided. EOQ uses statistical average techniques. The EOQ model is:

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

Remarks =

D: Demand / Request

S: Ordering Cost

H: Holding Cost

3. Periodic Order Quantity (POQ)

The Periodic Order Quantity (POQ) method is a method that orders the quantity during the specified time between orders, such as every three weeks. POQ is an order quantity that includes certain requests for certain intervals. The quantity of each order is to recalculate the time of occurrence of the order and never leave more inventory. The POQ model is:

$$POQ = \sqrt{\frac{2S}{DH}}$$

Description:

D: Demand / Request

S: Ordering Cost

H: Holding Cost

Table- VI: Comparison Results of Lot Size

Raw Material	Lot-for-Lot (LFL)	Economic Order Quantity (EOQ)	Period Order Quantity (POQ)	The Best Choice
Softener	IDR. 12,090,000	IDR. 19,984,313.65	IDR. 41,080,107.09	Lot For Lot
Bio	IDR. 15,990,000	IDR. 51,346,986	IDR. 43,670,842.49	Lot for Lot
Hypo	IDR. 15,990,000	IDR. 4,887,845.04	IDR. 2,460,000.00	Period Order Quantity

4. Conventional Accounting Results

Based on Table- VII, the calculation of raw materials every month with conventional methods. Softener raw materials have a total cost of IDR. 43,501.19 6.4, Bio IDR 90,982,984.2, Hypo IDR. 8,283,498, and Washing Soap IDR. 33,217,609,8.

Table- VII: Results of Conventional Calculations

No	Raw material	Demand for Raw Materials (A)	Storage Fee (B)	Booking Fee (C)	Order Frequency (D)	Conventional Results (A x B) + (C x D)
1	Softener	14,756	IDR. 2,611.9	IDR. 155,000	32	IDR. 43,501,196,4
2	Bio	24,594	IDR. 3,299.3	IDR. 205,000	48	IDR. 90,982,984
3	Hypo	4919	IDR. 8,283.498	IDR. 205,000	37	IDR. 8,283,498
4	Washing soap	14,756	IDR. 2,062.05	IDR. 155,000	18	IDR. 33,217,609,8
TOTAL						IDR. 175,985,288,2

5. The Level of Conventional Efficiency and MRP

Based on Table- VIII, the author calculates the efficiency level from the conventional calculation using the MRP method, and it can be seen that each of these raw materials can efficiently supply the raw material supply by 72% softer, Bio 82%, Hypo 70%, and Washing Soap 63%.

Table- VIII: The Level of Conventional Efficiency and MRP

No.	Raw Material	Efficiency Level
1	Softener	72%
2	Bio	82%
3	Hypo	70%
4	Washing soap	63%

V. CONCLUSION

Based on the results of this study, it was concluded that, the most appropriate forecasting method to predict the demand for each raw material at PT Anugrah Mandiri is an Exponential Smoothing method with $\alpha = 0.7$. This is based on the test results where the smallest MAD, MSE, and MAPE results are obtained using QM for Windows. This shows that by forecasting, the company will be better prepared to meet demand and expedite the production process. The exact Lot Sizing technique method for calculating Softener, Bio, and Washing Soap raw materials is the Lot for Lot, Softener method of IDR. 12,090,000, Bio in the amount of IDR. 15,990,000, and Laundry Soap in the amount of IDR. 12,090,000., While for Hypo raw material, the proper Lot Sizing method is the Period Order Quantity method, which is IDR. 2,460,000. The level of efficiency from conventional calculations using the Material Requirement Planning method is known that each of these raw materials can efficiently supply raw material inventory by softer 72%, Bio 82%, Hypo 70%, and 63% washing soap.

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Furthermore, this research can be a reference for testing the Material Requirement Planning (MRP) method in other industries or companies. So, it can compare research results and further expand and deepen research.

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