

Material Requirement Planning Analysis of Body Massage Cream Products In CV. Denara Duta Mandiri In Denpasar

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ABSTRACT : Inventory management at CV. Denara Duta Mandiri is not running at a maximum level yet so it experiences excess inventory of raw materials. One concept that can be used to plan and control raw materials is the Material Requirement Planning (MRP) system. Purpose of study is to determine the amount of net demand, size of the order, order time, and method that produces the lowest cost for each raw material. Study is conducted on a 1 kg body massage cream product. Data collection by interview and observation. Data analysis techniques used are descriptive and quantitative analysis. Trend projection forecasting had the smallest forecasting error with a forecasting result of 34 kg. Determination of order size or lot sizing obtained best method is part period balancing which results in total inventory cost of Rp. 361,734.29. total cost produced lower than economic order quantity of Rp. 438,348.13 and lot for lot of Rp. 797,500..

KEYWORDS : *Material Requirement Planning, Lot For Lot, Economic Order Quantity, Part Period Balancing*

I. INTRODUCTION AND LITERATURE REVIEW

Manufacturing companies are companies that process raw material inventories into finished goods. Manufacturing is a branch of industry that applies machinery, equipment and labor so that it can process the supply of raw materials into finished goods that have added value. Characteristics of manufacturing companies include product processing, large-scale machinery, production costs, production processes and marketing and sales (Pereira & Gomes Costa, 2017)

The beauty industry in Indonesia has grown rapidly in recent years. This can be seen from the increasingly mushrooming of companies engaged in the industry. The development of the manufacturing industry, especially in the beauty industry, makes companies compete fiercely to meet consumer needs. This competition makes companies are required to complete orders on time in order to satisfy the desires of consumers. This can be supported by planning and controlling the right production system. Production planning is a statement of production plans in the form of aggregates. Production planning is a communication tool between top management and manufacturing. Aggregate planning is a method in production planning. In making aggregate planning, plans are not produced in the form of individual products but in the form of aggregate products (Zoraghi *et al.*, 2015).

Aggregate Planning is a plan that includes the forecast level for a group of finished goods products, inventories, shortages and labor changes. aggregate planning is a preliminary step to the process of planning the needs for more detailed capacity, quantity and timing of output over a certain period of time (usually between 3 months to 1 year) through adjusting the levels of production, employee, inventory and variables that can other controlled. Aggregate planning reflects the company's strategy in terms of service to customers, inventory levels, production levels, number of employees, and others. Aggregate planning is the basis of the master production schedule. The master production schedule presents a comprehensive and more detailed plan by detailing the plans for the production of each final product. The process of preparing a master production schedule for companies that produce for inventory comes from the results of forecasts, while for companies that produce from orders, demand information comes from orders received. Production planning is a guideline for designing master production schedules (Tripathi *et al.*, 2016)

The Master Production Schedule (MPS) is a schedule that specifies what must be produced, usually this is done for the completion of the finished goods and when they are done. The schedule must be adjusted to the overall plan. The overall plan can set the level of output in a broader scope. Plans, usually developed by the

sales and operational planning team, include various types of inputs, including financial data, number of requests from consumers, technical capabilities, labor availability, inventory fluctuations, supplier performance and other considerations. The main things that need to be considered in the master production schedule, namely: the master schedule is carried out on the basis of an aggregate production plan, compile a schedule with general modules if possible, make realistic loading on facilities, submit orders on the basis of time units, monitor inventory levels closely, and reschedule as needed. The master schedule must also integrate demand and supply information into the planning or production master schedule process (Qin, 2015).

Olgun *et al.* (2016) found that effective approaches to system theoretical analysis with inaccurate information and incomplete samples could use cooperative game theory to solve inventory problems as they occur. Selected inventory management is measured according to two categories, namely: purchasing and control inventory and inventory storage and tracking through 16 items selected based on micro businesses that have high-level practices in purchasing and controlling inventory (Ahmad dan Zabri, 2016). Alrjoub and Ahmad (2017) states that by using the Pearson correlation and Generalized Method of Moments (GMM) panel estimates, inventory management can consider from its type that is affecting the company's performance in the long run. In addition, capital costs are also found to moderate the relationship between inventory management and firm performance. The raw material inventory information system is carried out using the Research and Development (R&D) method by making a new system design so that the process of finding data is faster, reports are generated, received by directors and managers quickly because it is web-based, and the regulation and management of raw material inventories is more effective (Hartanto and Utami, 2016).

The supply of materials or goods can be independent or dependent. Free demand (independent) is directly affected by market demand and the amount of demand outside the company's operations control. The requirements for the free demand supply model consist of: First, the Economic Order Quantity Model; Second, the Production Order Quantity Model and; the third, the quantity discount model. Fahimi *et al.* (2018) The company changed the Supply Chain (SC) model to a second-level model, namely: the inside determining the price and the outside forming the network. The SC model can be applied in many industrial companies because it is independent and competes with franchisees.

Dependent demand is not directly influenced by market demand, but is influenced by the company's operations or production processes. The requirements for the supply model of the dependent request consist of: Main Production Schedule, Specifications or Material List, Availability of Supplies, Circulating Purchase Orders and Waiting Time. Scheduling can be used to determine the time of operational activities so that the completion of product manufacture can be met properly. Many companies / organizations use a variety of software to solve problems related to production planning, inventory control and scheduling (Diwakar and Dalpati, 2016; Shofa and Widyarto, 2017). In this case two kinds of ways that can be done, namely: forward scheduling and backward scheduling. In addition, there are also two other types of scheduling, namely: order scheduling and machine scheduling. One of the concepts that can be used in production planning and control is the Material Requirement Planning (MRP) system.

Material Requirement Planning is a tool for making a production plan to determine the time of order and the amount of material ordered to meet the needs of each component of the product being produced. MRP is a bound demand model that requires a master production schedule, a list of material requirements, inventory availability, outstanding purchase orders, and waiting times. The purpose of the MRP is basically to design a production system that is capable of producing information to support appropriate actions, both in the form of order cancellations, re-ordering, rescheduling and purchasing raw materials for production so as to optimize costs.

Arief *et al.* (2018) found that the MRP technique is good in determining the material or raw material for the product because it has lower procurement costs compared to what the company did before and can make the company reduce the excess in inventory capacity that previously occurred. Anggriana (2015) said the customer does not need to wait a long time for the procurement of raw materials so that delivery time can be saved by using the MRP system. Material Requirements Planning is an appropriate production system used for planning and scheduling because it has a significant impact on reducing production costs, procurement, time savings and improving delivery times and services in a project (Imetieg and Lutovac, 2015). Iasya and Handayati (2015) found that the MRP technique at Grooveline Company could save costs in purchasing raw materials as much as 8.14% from before.

Diwakar & Dalpati (2016) and Torunoglu *et al.* (2017), MRP software has the advantage that it can work on fluctuations in demand, if the demand exceeds within a certain time period, which is not handled by the order quantity (lot size). Under these conditions the MRP software will select the number of orders for times that are in accordance with various requests and will not affect the order quantity of other time periods. MRP software is able to handle all the complexities of the MRP system, providing fast responses to users who have large capacity databases to store information and according to work analysis of all modules such as item entry, assembly, MRP calculation, item detail, single level BOM, master inventory can work with both to provide relevant and best results to match the objectives of the industry. Manufacturing companies use material planning and production

control methods designed to improve company efficiency, by carrying out a step-by-step process to achieve satisfactory results (Bai & Zhu, 2015; Jonsson & Mattsson, 2016).

The growing development of the tourism industry makes Bali as one of the tourist destinations. Many companies engaged in SPA products make competition quite fierce in the industry. Competition between companies in the industry makes an imbalance between supply and demand. CV. Denara Duta Mandiri is a company engaged in the industry also experiencing fluctuations in demand. The increasing number of SPA product offerings is not proportional to the increase in market demand.

Table 1. Demand for Body Massage Cream

No.	Months (Year)	Total
1	September 2018	110 kg
2	October 2018	44 kg
3	November 2018	22 kg
4	December 2018	44 kg
5	January 2019	66 kg
6	February 2019	88 kg
7	March 2019	66 kg
8	April 2019	44 kg
9	May 2019	22 kg
10	June 2019	66 kg
11	July 2019	44 kg
12	Augustus 2019	22 kg

Source : CV. Denara Duta Mandiri, 2019

Table 1. shows that the demand for body massage cream fluctuations in the CV. Denara Duta Mandiri. These fluctuations result in companies experiencing problems with raw materials. Raw materials used in producing body massage cream include aqua, mineral oil, stearic acid, triethanolamine, steary alcohol, fragrance, glycerin, dimethicone, olea europaea fruit oil, methylparaben, propylparaben, labels and pots. Body Massage Cream is a massage cream that can help relax the body and is beneficial for moisturizing and softening the skin. This product is used by various SPA centers and is used by consumers. Body Massage Cream has several scent variants namely jasmine, rose and vanilla as well as 100 gram and 1 kg packaging variants.

CV. Denara Duta Mandiri uses a make to order system as seen from customer orders, sometimes the company also has a small inventory of finished products when there are many orders. However, in the past year, there has been a fluctuation in demand for body massage cream products, thus making companies often excess in the supply of raw material products. Excess inventory of raw materials makes companies spend a lot of money to store these raw materials. Body massage cream raw materials have excess inventory as indicated by the difference between supply and demand for raw materials. This happens due to the lack of using material planning methods and forecasting methods, so that when producing and buying raw materials the company can reach the most optimal point. Related to the problems that occur in the CV. Denara Duta Mandiri as described above, the system that can be used to overcome these problems is Material Requirement Planning (MRP), it is expected that with this system market needs can be predicted well, production planning and planning for material requirements can reach the most optimal point or as minimal as possible.

The purpose of this study is to determine and determine the amount of net needs for each of the raw materials for body massage cream products in CV. Denara Duta Mandiri, Knowing and determining the optimal order size for each raw material for body massage cream products in CV. Denara Duta Mandiri and Knowing and determining the minimum costs used in making body massage cream products in CV. Denara Duta Mandiri.

II. METHODS

The design of this research is descriptive research with a quantitative approach. This study was intended to obtain an overview and information regarding the application of the MRP system to be carried out in CV. Denara Duta Mandiri by using the four basic steps of the MRP, namely netting, lotting, offsetting, and explosion to find out the number of needs and the right time to order raw materials and determine the minimum inventory costs.

The object of this research is material requirement planning on Body Massage Cream products in CV. Denara Duta Mandiri. In addition to body massage cream products, there are several SPA products that are also produced by CV. Denara Duta Mandiri starts from body lotion, body scrub cream, body scrub powder, body butter cream, bath salt, bath soap, and other SPA products. The SPA products to be analyzed in this study are 1 kg Body Massage Cream products. The variables analyzed in accordance with the main problem and objectives

to be achieved in this study are: 1) Bill of Materials (BOM) 2) Master Production Schedule (MPS) 3) On Hand Inventory 4) Netting 5) Lotting 6) Offsetting

The type of data used in this research is quantitative data and qualitative data. In this study quantitative data in the form of data related to inventory include product sales data, bill of materials, lead time, actual inventory data, and inventory costs. Meanwhile, qualitative data in the form of product structure and types of raw materials used are aqua, mineral oil, stearic acid, triethanolamine, steary alcohol, fragrance, glycerin, dimethicone, olea europaea fruit oil, methylparaben, and propylparaben. The packaging used is label and pot. The amount of production per month of this product is uncertain depending on market demand or customer demand. Primary data in this study were obtained through measurement of variables related to research, namely product structure, bill of materials (BOM), and inventory costs. Secondary data is data that refers to information collected from existing sources, such as literature related to research and company documentation. Company documentation data includes sales data, actual inventory data, lead time, and the amount of raw materials for each production. Data collection methods using interview and observation techniques

III. RESULTS AND DISCUSSION

Based on interviews with the owner of CV. Denara Duta Mandiri body massage cream products always have an excessive supply of raw materials and the company does not know how much to produce because production is seen or predicted from market demand, if the demand fluctuates it can cause excess in raw material inventory. The problem of excess raw material causes inventory costs so that the object in this study is 1 kg body massage cream. Finished products or goods, namely 1 kg body massage cream are at level 0 or top level, whereas at level 1 or below there are massage cream and packaging as a sub-component of the product, then proceed to level 2 which is a sub-component of the body product There are aqua massage cream, mineral oil, stearic acid, triethanolamine, steary alcohol, fragrance, glycerin, dimethicone, olea europaea fruit oil, preservatives, pots and labels. Then at level 3 there are sub-components of preservatives namely methylparaben and propylparaben. In this study, the discussion will be emphasized on the planning of raw material requirements, namely planning of items that are at levels 2 and 3. At component level 1 there is 1 kg of massage cream and 1 unit of packaging made by the company. Component level 2 is a sub-component of packaging and massage cream. Sub-components of the package are 1 pot and 3 labels. Massage cream has the following sub-components 260 ml of aqua, 375 grams of mineral oil, 248 grams of stearic acid, 36 grams of triethanolamine, 42 grams of steary alcohol, 10 ml of fragrance, 21 grams of glycerin, 12 grams of dimethicone, 5 grams of olea europaea fruit oil and 3, 51 grams of preservatives. All components at level 2 are purchased from suppliers except preservatives. Component level 3 is 2.72 grams of methylparaben and 0.79 grams of propylparaben purchased for preservative raw material.

Table 2. Comparison of MAD, MSE, and MAPE

No.	Methods	MAD	MSE	MAPE
1	<i>Moving Average</i>	22,81	752,89	58,64%
2	<i>Exponential Smoothing</i>	34,16	1716,70	109,70%
3	<i>Trend Projection</i>	20,67	575,06	51,48%

Source: Data Processed, 2019

The calculation result of demand forecasting with the help of POMQM software for Windows Version 5.2 shows that the forecasting result on September 2019 requests using trend projection is better than the moving average and exponential smoothing methods, because it has the smallest error indicated by MAD, MSE, and MAPE values. The forecast results for September 2019 using the trend projection method produce a demand of 34 kg. The results of forecasting the demand for 1 kg body massage cream in September 2019 were obtained using trend projection using the least square method. The forecasting data is the basis for making the Master Production Schedule, a description of the planning period of a request, including forecasting, backlogs, supply / supply plans, ending inventory and the promised quantities available. The body massage cream production in the company uses the make to order and make to stock methods. However, the data obtained at the moment there are no finished orders, JIP is made only based on forecasting. Based on forecasting results, a JIP of 34 kg was obtained in September 2019.

The Production Master Schedule for the month will be divided into a weekly Production Master Schedule to facilitate the calculation process. In 1 month there are 4 weeks and the number of production in the first week is more than the second, third and fourth week. Table 3. is a table of the Master Production Schedule per week in September 2019.

Table 3. Weekly Production Schedule, September 2019

	Week 1	Week 2	Week 3	Week 4	Total
<i>Body Massage Cream 1 kg</i>	10	8	8	8	34

Source: Data Processed, 2019

MRP analysis in this study was done manually, because the number of items or product components that exist is relatively small. In the MRP analysis process, there are stages that need to be applied one by one. Following are the application of the stages in the process of analyzing the material requirements planning for a 1 kg body massage cream product

Table 4. Calculation of Product Net Needs

No.	Products	Weeks			
		1	2	3	4
1	<i>Body Massage Cream 1 kg</i>	10	8	8	8
2	Pot	0	0	6	8
3	Label	0	9	24	24
4	<i>Aqua (ml)</i>	0	0	1560	2080
5	<i>Mineral oil (gram)</i>	0	0	2250	3000
6	<i>Stearic acid (gram)</i>	0	0	1488	1984
7	<i>Triethanolamine (gram)</i>	0	180	288	288
8	<i>Steary alcohol (gram)</i>	0	210	336	336
9	<i>Fragrance (ml)</i>	0	0	60	80
10	<i>Glycerin (gram)</i>	0	0	126	168
11	<i>Dimethicone (gram)</i>	0	0	72	96
12	<i>Olea europaea fruit oil (gram)</i>	0	0	30	40
13	<i>Methylparaben (gram)</i>	0	0	16,32	21,76
14	<i>Propylparaben (gram)</i>	0	0	4,74	6,32

Source: Data Processed, 2019

Lotting process is the process of determining the optimal lot size as a basis for knowing exactly the amount of raw materials needed for the production process. In this study, the determination of lot size will be calculated using three lot sizing methods, namely Lot for Lot, Economic Order Quantity, and Part Period Balancing. The calculation is done one by one from the three lot sizing methods for each raw material. This was done to determine the comparison of the effectiveness and efficiency of the three methods for each raw material. The method with a minimum total cost of each raw material will be the recommended method to be applied.

Table 5. Results of Lot Size Calculation, Lot for Lot Method September 2019

No.	Raw Materials	Lot Size per Week				Total Inventory Cost
		1	2	3	4	
1	Pot	0	0	6	8	Rp 55.000
2	Label	0	9	24	24	Rp 82.500
3	<i>Aqua</i>	0	0	1560	2080	Rp 55.000
4	<i>Mineral oil</i>	0	0	2250	3000	Rp 55.000
5	<i>Stearic acid</i>	0	0	1488	1984	Rp 55.000
6	<i>Triethanolamine</i>	0	180	288	288	Rp 82.500
7	<i>Steary alcohol</i>	0	210	336	336	Rp 82.500
8	<i>Fragrance</i>	0	0	60	80	Rp 55.000
9	<i>Glycerin</i>	0	0	126	168	Rp 55.000
10	<i>Dimethicone</i>	0	0	72	96	Rp 55.000
11	<i>Olea europaea fruit oil</i>	0	0	30	40	Rp 55.000
12	<i>Methylparaben</i>	0	0	16,32	21,76	Rp 55.000
13	<i>Propylparaben</i>	0	0	4,74	6,32	Rp 55.000
Total Inventory Cost						Rp 797.500

Source: Data Processed, 2019

The lot for lot method focuses on minimizing storage costs, so purchases are made according to the needs needed for each period (week) so that the costs incurred by lot for lot are only ordering costs. Table 5. is the final result of the lot size calculation using the lot for lot method for each raw material. The results of the final calculation of the total inventory cost using the lot for lot method for all raw materials amounted to Rp 797,500. Each raw material has a different cost, this is because the amount of different net needs and resulting in the ordering time of each different raw material. Orders are made to meet the net needs every week. This is done to avoid inventory that can result in storage costs.

Table 6. Final Results of Lot Size, Economic Order Quantity Method September 2019

No.	Raw Materials	Lot Size per Week				Total Inventory Cost
		1	2	3	4	
1	Pot			353		Rp 32.765
2	Label		1.059			Rp 37.715
3	Aqua			69.728		Rp 34.420,8
4	Mineral oil			59.213		Rp 39.192,6
5	Stearic acid			52.230		Rp 36.294,78
6	Triethanolamine			7.338		Rp 36.582,5
7	Steary alcohol		14.770			Rp 32.498,6
8	Fragrance			2.090		Rp 36.359,6
9	Glycerin			12.533		Rp 30.662,75
10	Dimethicone			4.417		Rp 32.551,96
11	Olea europaea fruit oil			3.530		Rp 30.140
12	Methylparaben			1.892		Rp 30.178,91
13	Propylparaben			992		Rp 28.985,63
Total Inventory Cost						Rp 438.348,13

Source: Data Processed, 2019

The Economic Order Quantity (EOQ) method is a widely used and commonly used inventory control technique. EOQ will also determine the optimal number of inventory units for the company, so that the company can minimize costs incurred for procurement of inventory. The results of the final calculation of total inventory costs using the economic order quantity method for all raw materials amounted to Rp 438,348.13. Each raw material has different costs, this is because the amount of different net needs and resulting in the time of ordering and storing each of the different raw materials. Orders and storage are carried out to meet the weekly clean needs. Part Period Balancing Method is a method that balances a portion of the period in the process of determining the lot size for raw material requirements that vary each week or period. This method uses the Economic Part Period (EPP) approach to find the lot size or requirement for each period. The accumulated value of inventory or needs for each period that is close to the EPP value will be the basis of the lot size of each raw material and can minimize inventory costs. Next is the calculation of the EPP value of steary alcohol raw materials.

$$EPP = \frac{Rp.27.500}{Rp.0,36} = 76.388,89 \dots \dots \dots (1)$$

The results of these calculations obtained the EPP value of raw material steary alcohol of 76,388.89 part period. This value will determine the optimal lot size of steary alcohol raw materials in September 2019. The following table determines lot size using EPP.

Table 7. EPP Value Approach

No.	Period (Weekly)	Needs	Storage time	Part Period	Accumulation of Part Periods
1	1	0	0	0	0
2	2	210	0	0	0
3	2,3	336	1	336	336
4	2,3,4	336	2	672	1.008

Source: Data Processed, 2019

EPP value approach for determining the size of the lot, in the first line there is no order to meet the needs of steary alcohol, so there are raw materials or inventory stored. In the second line, an order is made to meet the needs of the second week steary alcohol. On the third line, orders are made to meet the needs during the period there are 336 grams that have not been used and stored for 1 period. The accumulated part period is obtained from the calculated part period value plus the previous part period, for example in the fourth week section

period or the fourth row of 672 grams added to the previous week section period and the result in the accumulation of the fourth week period is 1,008 gram. And so on until the accumulated period with the closest EPP value is 76,388.89. When the accumulated period is approaching the EPP value of 76,388.89 part period, an order will be made. Based on the lot calculation approach that has been carried out, the order for September 2019 of 882 grams is used to meet the needs for the next 2 weeks. The plan for the needs and the total cost of steary alcohol raw material inventory is calculated as follows.

Table 8. Table of MRP with PPB Technique in September 2019 (weekly)

No.	Week	1	2	3	4
1	Net needs	0	210	336	336
2	Plans (lot size)	0	882		
3	Inventory Projection	0	672	336	0

Source: Data Processed, 2019

Based on calculations using the PPB method ordering raw materials for steary alcohol is done once within a period of 3 weeks. Orders are made in the second week which is done simultaneously to meet the needs of the third and fourth week. Costs incurred in ordering steary alcohol raw materials amounted to Rp 27,500, while storage costs arising from storing steary alcohol raw materials amounted to Rp 120.96, the total inventory cost of steary alcohol raw materials using PPB method was Rp 27,620.96.

The final calculation of total inventory costs using the part period balancing method for all raw materials amounts to Rp 361,734.29. Each raw material has different costs, this is because the amount of different net needs and resulting in the time of ordering and storing each of the different raw materials. Orders and storage are carried out to meet the weekly clean needs

Table 9. Final Results of Lot Size Calculation for Part Period Balancing Method in September 2019

No.	Raw Materials	Lot Size per Week				Total Inventory Cost
		1	2	3	4	
1	Pot			14		Rp 27.620
2	Label		57			Rp 27.980
3	Aqua			3.640		Rp 27.708
4	Mineral oil			5.250		Rp 28.100
5	Stearic acid			3.472		Rp 27.837,28
6	Triethanolamine		648			Rp 28.940
7	Steary alcohol		882			Rp 27.983,84
8	Fragrance			140		Rp 27.842,4
9	Glycerin			294		Rp 27.542
10	Dimethicone			168		Rp 27.610,4
11	Olea europaea fruit oil			70		Rp 27.530
12	Methylparaben			38,08		Rp 27.530,89
13	Propylparaben			11,06		Rp 27.509,48
Total Inventory Cost						Rp 361.734,29

Source: Data Processed, 2019

Lot sizing calculations using the lot for lot method, economic order quantity, and part period balancing produce a total inventory cost that is different from each other. The three methods will be compared which one has the least total inventory cost for each raw material. So, each raw material must have the same technique. The following table shows the comparison of the total inventory costs of the three lot sizing methods for each raw material.

Comparison of total inventory costs for the three lot sizing methods. In the part period balancing (PPB) method, the total value of inventory costs is smaller than the lot for lot (LFL) and economic order quantity (EOQ) methods for each raw material. Then, the results of the method of part period balancing (PPB) which will be the basis of the next process is offsetting.

Table 10. Comparison of Total Inventory Cost of the Three Methods

No.	Raw Materials	Lot Sizing		
		Lot For Lot	Economic Order Quantity	Part Period Balancing
1	Pot	Rp 55.000	Rp 32.765	Rp 27.620
2	Label	Rp 82.500	Rp 37.715	Rp 27.980
3	Aqua	Rp 55.000	Rp 34.420,8	Rp 27.708
4	Mineral oil	Rp 55.000	Rp 39.192,6	Rp 28.100
5	Stearic acid	Rp 55.000	Rp 36.294,78	Rp 27.837,28
6	Triethanolamine	Rp 82.500	Rp 36.582,5	Rp 27.940
7	Steary alcohol	Rp 82.500	Rp 32.498,6	Rp 27.983,84
8	Fragrance	Rp 55.000	Rp 36.359,6	Rp 27.842,4
9	Glycerin	Rp 55.000	Rp 30.662,75	Rp 27.542
10	Dimethicone	Rp 55.000	Rp 32.551,96	Rp 27.610,4
11	Olea europaea fruit oil	Rp 55.000	Rp 30.140	Rp 27.530
12	Methylparaben	Rp 55.000	Rp 30.178,91	Rp 27.530,89
13	Propylparaben	Rp 55.000	Rp 28.985,63	Rp 27.509,48
Total Inventory Cost		Rp 797.500	Rp 438.348,13	Rp 361.734,29

Source: Data Processed, 2019

The offsetting process is the process of determining the right and optimal ordering time for raw materials by looking at the lead time owned by each raw material. This process is the same as making an MRP table for each raw material for each period. The MRP table is made based on the results of the lot sizing method calculations previously done. The part period balancing method was chosen to be the most optimal method because it has a smaller total inventory cost than the lot for lot method and economic order quantity. Following are the final results of determining the order time or MRP of each raw material.

Table 11. Final Results of MRP Raw Materials 1 kg Body Massage Cream products

No.	Raw Material	Quantity	Waktu Pemesanan
1	Pot	14 unit	Week- 3 Day- 4
2	Label	57 unit	Week- 2 Day- 3
3	Aqua	3.640 ml	Week- 3 Day- 4
4	Mineral oil	5.250 gram	Week- 3 Day- 1
5	Stearic acid	3.472 gram	Week- 3 Day - 1
6	Triethanolamine	648 gram	Week - 2 Day- 1
7	Steary alcohol	882 gram	Week - 2 Day- 1
8	Fragrance	140 ml	Week- 3 Day - 1
9	Glycerin	294 gram	Week- 3 Day - 1
10	Dimethicone	168 gram	Week- 3 Day - 1
11	Olea europaea fruit oil	70 gram	Week- 3 Day - 1
12	Methylparaben	38,08 gram	Week- 3 Day - 1
13	Propylparaben	11,06 gram	Week- 3 Day - 1

Source: Data Processed, 2019

Forecasting results using trend projection have the smallest forecasting error when compared with moving averages and exponential smoothing. Forecasting results using trend projection obtain forecasting results of 34 kg which are then used as a reference in making the master production schedule. Based on the master production schedule, production planning is determined using the Material Requirement Planning (MRP) system.

Material Requirement Planning (MRP) is a tool for making production planning to determine the time of ordering and the amount of material ordered to meet the needs of each component of the product to be produced. The stages in the MRP system are netting, lotting, and offsetting. Research conducted by Abrianto and Riandadari (2017) states that through the application of the lotting technique which is the process of MRP can guarantee the availability of materials when needed and can minimize inventory and inventory costs in a project. The results of the study are consistent with research conducted by Dewi and Saroso (2016), Irawan and Syaichu (2017), Kusumawati and Setiawan (2017), Malinda *et al.* (2017), Prayogo and Riandadari (2016), Susatyo and Triana (2016), Theresia and Salomon (2015), Wahyuni and Syaichu (2015).

The lotting process can be calculated using the lot sizing method, namely lot for lot, economic order quantity, and part period balancing. The results of calculations of the three methods obtain part period balancing

as the best method. Part period balancing method produces a total inventory cost of Rp. 361,743.29 which is the lowest cost compared to the two other methods. The results of this study are consistent with research conducted by Monica and Setiawan (2019) and Martha and Setiawan (2018) who found that the best lot lizing method used was part period balancing because it produced a lower total inventory cost than the lot for lot method. Based on these descriptions, MRP can assist companies in increasing production efficiency and effectiveness. The use of MRP provides improvements by decreasing inventory costs, efficiency, and more accurate information (Santin *et al.*, 2015).

From the results of this study, the excess inventory of products and raw materials in the product occurs due to the absence of planning in determining the production capacity and forecasting for future product demand. So there is an investment that is embedded in inventory and results in increased inventory costs or the occurrence of waste costs. The existence of these problems was addressed by this research through the application of the MRP system that starts from the process of netting, lotting, and offsetting into the production process.

In the netting process, it can be seen the net needs of the product and each of its raw materials for a calculated period. Before netting is done, it is necessary to know the master production schedule, so as to reduce the problem of excess inventory and determine production capacity. After the clean needs are identified, lotting is done. Lotting process is the process of determining the optimal order size for each product raw material. This lotting process will provide an overview for the company about how much raw material must be ordered to meet production needs and does not occur excess or lack of inventory.

The final process of the MRP system in this research is offsetting. In this process the company can find out the right time to order raw materials by making an MRP table based on the lead time of each raw material and also the results of the previous steps namely netting and lotting. This MRP table will be an illustration for companies related to the right time to release orders or place an order for raw materials for the product so that there is no delay in raw materials or shortages of raw materials.

This study also shows the trend projection forecasting method produces the smallest forecast error (standard error of the estimate) compared to the moving average and exponential smoothing method and the part balancing period method produces lower costs than lot for lot and economic order quantity. Material Requirement Planning (MRP) with the lot sizing method in this study may not necessarily produce the same results in future research, due to differences in MRP input data that is different in each company..

IV. CONCLUSION

Demand forecasting can be calculated using three methods: moving average, exponential smoothing, and trend projection. The trend projection method has the smallest standard error so the calculation results are used as a basis for determining the amount of production. Forecasting the demand for body massage cream in September 2019 is 34 kg, so the total net requirement for each raw material in this period is 14 pots, 57 sheets of labels, 3,640 ml of aqua, 5,250 grams of mineral oil, 3,472 grams of stearic acid, 756 grams of triethanolamine, 882 grams of steary alcohol, 140 ml of fragrance, 294 grams of glycerin, 168 grams of dimethicone, 70 grams of olea europaea fruit oil, 38.08 grams of methylparaben, and 11.06 grams of propylparaben. Determination of order size is calculated using three lot sizing methods, namely lot for lot, economic order quantity and part period balancing. The part period balancing method is the basis for determining the optimal number of orders. The number of orders for each raw material is as follows, 14 pots, 57 sheets of labels, 3,640 ml of aqua, 5,250 grams of mineral oil, 3,472 grams of stearic acid, 756 grams of triethanolamine, 882 grams of steary alcohol, 140 ml of fragrance, 294 grams of glycerin, 168 grams of dimethicone, 70 grams of olea europaea fruit oil, 38.08 grams of methylparaben, and 11.06 grams of propylparaben. Determination of order size uses three lot sizing methods, namely lot for lot, economic order quantity and part period balancing. Based on the calculation results of the three lot sizing methods, it shows that the period balancing part gets the lowest total inventory cost of Rp. 361,734.29 between two other methods.

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