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# INVENTORY CONTROL COST REDUCTION FOR INFUSION USING MATERIAL REQUIREMENT PLANNING BASED ON LOT SIZING

DIANA ANDRIANI[1,*], HENDRY HARDIANTO[2], NUGRAHA[3]

[1,2]Industrial Engineering Department, Universitas Komputer Indonesia,
Jalan Dipati Ukur No.112-116, Bandung, 40132, Indonesia
[3]Accounting Education, Universitas Pendidikan Indonesia, Jalan Setiabudi No.229,
Bandung, 40154, Indonesia
*Corresponding Author: diana.andriani@email.unikom.ac.id

**Abstract**

The purpose of this study is to minimize raw materials' inventory control cost due to the excess of raw materials from Normal Saline 100 mL and Ringer Lactate 500 mL infusion. The method used in this research were six lot sizing methods such as Fixed Order Quantity, Fixed Period Requirement, Least Unit Cost, Least Total Cost, Part Period Balancing, and Silver Meal Algorithm. The results showed that the Normal Saline 100 mL infusion product used the Least Unit Cost (LUC) method and resulted in the lowest cost with two order periods. The use of LUC method saves a total of IDR 3,425,000. For the Ringer Lactate 500 mL infusion product, it is proven that the LTC and PPB methods produced the least cost. Orders with the LTC and PPB methods are made after two order periods for Sodium Chloride and Calcium Chloride Dihydrate raw materials, four order periods for Sodium Lactate, and five order periods for Potassium Chloride. The savings made using the TLC and PBB methods amounted to IDR 29,675,000.

Keywords: Inventory control costs; Lot sizing; Material requirement planning.

## 1. Introduction

The mission of industrial companies in general is to meet customer satisfaction by producing products that suit consumer needs. This mission can be achieved if industrial companies can integrate all production and support the activities properly. The success of production cannot be separated from raw materials' planning. The research was carried out at PT. Kalbe Farma, a pharmacy industry which produces infusions that aims to minimize raw materials' inventory control cost. It is due to the excess of raw materials from Normal Saline 100 mL infusion and Ringer Lactate 500 mL infusion using Material Requirement Planning (MRP) based on the lot sizing method. Lot sizing is related to several costs, such as set up, storage, ordering, and the costs of the goods sold [1].

Material Requirement Planning is used in this research based on a lot-sizing method to minimize inventory control cost. However, Material Requirement Planning has also been used to solve other problems in some industries and companies. Material Requirement Planning research has also been carried out at a micro rubber company to identify the advantage of the MRP method [2]. MRP indicates the required materials and when it is needed [3]. MRP has also been used to forecast the accuracy inventory requirement [4]. Material Requirement Planning has also been implemented at Automobile Service Plant to meet demand from customers [5]. Not only in big companies, but also MRP has been implemented at a micro, small, and medium enterprise [6]. Material Requirement Planning has a big impact on the model of Supply Chain Management [7]. Material Requirement Planning can also be optimized by using Goal Programming Model [8]. It also has been implied in a briquette factory that uses several main products and hundreds of raw materials [9].

This study aims to minimize inventory control costs. Inventory control costs are minimized using the lot sizing method. The lot sizing method used in this study is adjusted to the company condition where the order size is fixed. The important part of this research is to analyse the appropriate lot sizing method in minimizing inventory control costs. In addition, we compared the company's method with the results of the calculation using the lot sizing method.

## 2. Research Method

One of the methods used in this study was MRP inventory control. The first step is forecasting which is a technique for determining future production data requirements. It is done by calculating the form of past data along with other required information. The category in predicting a time horizon consists of long, medium, and short-term forecasting. In industry, the demand for production items can be categorized into two types, namely dependent and independent demand. An item is considered to be independent demand if the demand for that item is not influenced by demand for other items. In other words, the demand is only influenced by market factors. Demand for finished products or final products is generally independent, which means that demand is only influenced by market conditions and is not influenced by the demand for other goods produced in the company.

Material Requirement Planning (MRP) is a method of planning and controlling inventory and orders for requests of certain items where the demand is unsustainable and irregular. The MRP system is a system that aims to produce the

right information to take the right action (order cancellation, re-order, and reschedule). This action is also the basis for making new decisions about purchasing or production to improve the decisions that have been made previously. There are four main objectives that characterize the MRP system, which are determine when a job must be completed to meet the demand for the final product, determine the material requirements of each item which the MRP system can precisely determine the priority scheduling system to meet all the minimum requirement for each item, giving an indication of the order or cancellation of an order to be made. Orders need to be made by purchase or made at the factory itself by specifying a reschedule. It aims to provide an indication for rescheduling plans by specifying realistic order priority [10].

The used method in this research is to find the best approach to minimize inventory control costs. This method consists of several steps such as Forecasting, dividing proportion, lot sizing, and Material Requirement Planning. Firstly, forecasting was used to predict the number of products that is produced for the next 12 periods. After the results of forecasting are obtained, the next step is to divide the proportion of each raw materials needed to produce the product. Lot sizing is also used to determine the size or amount that must be provided by the company in carrying out its production each period. The last step is Material Requirement Planning which is used to decide when the company order and count the total cost of the order.

## 3. Results and Discussion

### 3.1. Forecasting

Forecasting method that is chosen for Normal Saline 100 mL infusion was Moving Average with 12 average period. The result of MAPE was 42.19% and Tracking Signal was 0.99. Forecasting Graph of Moving Average method for Normal Saline 100 mL infusion is shown in Fig. 1.

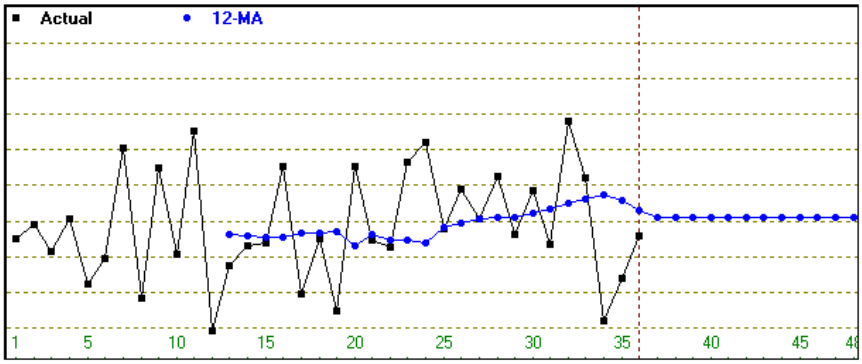


**Fig. 1. Forecasting graph for moving average method.**

Forecasting method that is chosen for Ringer Lactate 500 mL infusion was Moving Average with Linear Trend with moving average period 13. The results of MAPE were 12.20% and Tracking Signal was 0.58. Forecasting Graph of Moving Average with Linear Trend method for Ringer Lactate 500 mL infusion is shown in Fig. 2.

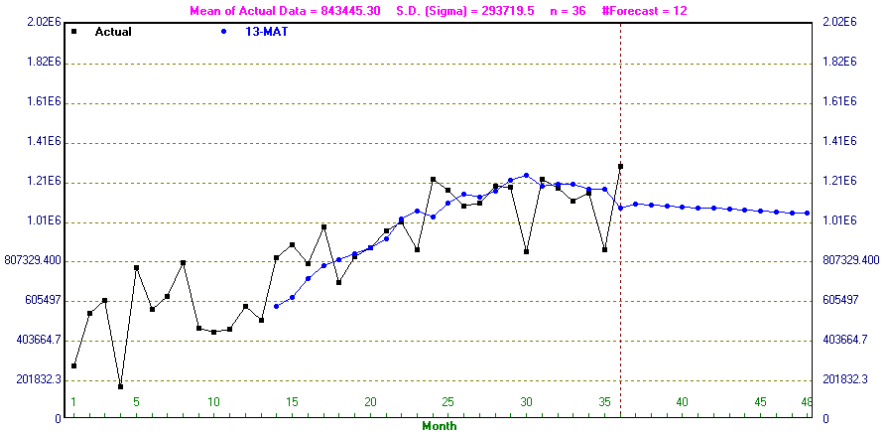


**Fig. 2. Forecasting graph for moving average with linear trend method.**

Forecasting result for Normal Saline Infusion using Moving Average method is shown in Table 1.

**Table 1. Forecasting results for NS infusion**

| Period | Forecast NS |
|---|---|
| **Jan-20** | 340320 |
| **Feb-20** | 340320 |
| **Mar-20** | 340320 |
| **Apr-20** | 340320 |
| **May-20** | 340320 |
| **Jun-20** | 340320 |
| **Jul-20** | 340320 |
| **Aug-20** | 340320 |
| **Sep-20** | 340320 |
| **Oct-20** | 340320 |
| **Nov-20** | 340320 |
| **Dec-20** | 340320 |

Forecasting result for Ringer Lactate Infusion using Moving Average with Linear Trend method is shown in Table 2.

**Table 2. Forecasting results for RL infusion.**

| Period | Forecast RL |
|---|---|
| **Jan-20** | 1101805 |
| **Feb-20** | 1097574 |
| **Mar-20** | 1093343 |
| **Apr-20** | 1089112 |
| **May-20** | 1084881 |
| **Jun-20** | 1080650 |
| **Jul-20** | 1076419 |
| **Aug-20** | 1072188 |
| **Sep-20** | 1067957 |
| **Oct-20** | 1063726 |
| **Nov-20** | 1059495 |
| **Dec-20** | 1055264 |

### 3.2. Proportion

The proportion of the raw material for Normal Saline 100 mL infusion was 100% sodium chloride which has a mass of 0.9 grams. The next step was to perform calculations using the density formula. The results of the master production schedule for the Normal Saline 100 mL Infusion product is shown in Table 3.

**Table 3. MPS Conversion Results of Normal Saline 100 mL Infusion**

| Period | MPS SC 0.9 gram |
|---|---|
| **Jan-20** | 340320 |
| **Feb-20** | 340320 |
| **Mar-20** | 340320 |
| **Apr-20** | 340320 |
| **May-20** | 340320 |
| **Jun-20** | 340320 |
| **Jul-20** | 340320 |
| **Aug-20** | 340320 |
| **Sep-20** | 340320 |
| **Oct-20** | 340320 |
| **Nov-20** | 340320 |
| **Dec-20** | 340320 |

The proportion of the raw material for Ringer Lactate 500 mL infusion was 62.5% sodium chloride which had a mass of 3 grams, 3.125% potassium chloride which had a mass of 0.1 grams, 2.08% calcium chloride dihydrate which had a mass of 0.15 grams, and 32.29% sodium lactate which had a mass of 1.55 grams. The next step was to perform calculations using the density formula. The results of the master production schedule for the Ringer Lactate 500 mL Infusion product is shown in Table 4.

**Table 4. MPS Conversion Results of Ringer Lactate 500 mL Infusion**

| Period | MPSSC 3 gram | MPS PC 0.15 gram | MPS CCD 0.1 gram | MPS SL 1.55 gram |
|---|---|---|---|---|
| **Jan-20** | 688628 | 34431 | 22954 | 355791 |
| **Feb-20** | 685984 | 34299 | 22866 | 354425 |
| **Mar-20** | 683339 | 34167 | 22778 | 353059 |
| **Apr-20** | 680695 | 34035 | 22690 | 351692 |
| **May-20** | 678051 | 33903 | 22602 | 350326 |
| **Jun-20** | 675406 | 33770 | 22514 | 348960 |
| **Jul-20** | 672762 | 33638 | 22425 | 347594 |
| **Aug-20** | 670118 | 33506 | 22337 | 346227 |
| **Sep-20** | 667473 | 33374 | 22249 | 344861 |
| **Oct-20** | 664829 | 33241 | 22161 | 343495 |
| **Nov-20** | 662184 | 33109 | 22073 | 342129 |
| **Dec-20** | 659540 | 32977 | 21985 | 340762 |

### 3.3. Lot sizing

The selected lot sizing method for the Normal Saline 100 mL Infusion was the Least Unit Cost (LUC) method which consisted of 0.9 grams of sodium chloride as

a raw material, resulting in inventory costs, ordering costs and purchase costs which is shown in Table 5.

**Table 5. Lot sizing's cost of normal saline 100 mL infusion.**

| Sodium Chloride 0.9 gram (Rp) | | | | |
|---|---|---|---|---|
| **Method** | **Inventory Cost** | **Order Cost** | **Purchase Cost** | **Total Cost** |
| **Company** | 96,113,483 | 60,000,000 | 938,000,000 | 1,094,113,483 |
| **LUC** | 77,688,483 | 75,000,000 | 938,000,000 | 1,090,688,483 |

The selected lot sizing method for the Ringer Lactate 500 mL Infusion was the Least Total Cost (LTC) and Part Period Balancing (PPB) method which consisted of 0.9 grams of sodium chloride, 0.15 grams of potassium chloride, 0.1 grams of calcium chloride dihydrate, and 1.55 sodium lactate gram resulting in storage costs, ordering costs and purchase costs which is shown in Table 6.

**Table 6. Lot sizing's cost of ringer lactate 500 mL infusion**

| Raw Materials | Method | Inventory Cost (Rp) | Order Cost (Rp) | Purchase Cost (Rp) | Total Cost (Rp) |
|---|---|---|---|---|---|
| **Sodium Chloride 3 gram** | **Company** | 224,260,444 | 45,000,000 | 1,407,000,000 | 1,676,260,444 |
| | **LTC and PPB** | 192,435,444 | 60,000,000 | 1,407,000,000 | 1,659,435,444 |
| **Potassium Chloride 0.15 gram** | **Company** | 25,766,213 | 45,000,000 | 196,000,000 | 266,766,213 |
| | **LTC and PPB** | 34,516,213 | 30,000,000 | 196,000,000 | 260,516,213 |
| **Calcium Chloride Dihydrate 0.1 gram** | **Company** | 199,230,150 | 45,000,000 | 1,134,000,000 | 1,378,230,150 |
| | **LTC and PPB** | 174,030,150 | 60,000,000 | 1,134,000,000 | 1,368,030,150 |
| **Sodium Lactate 1.55 gram** | **Company** | 83,159,771 | 30,000,000 | 180,000,000 | 293,159,771 |
| | **LTC and PPB** | 86,759,771 | 30,000,000 | 180,000,000 | 296,759,771 |

### 3.4. Material requirement planning

The next step after doing lot sizing was to place an order on the MRP table using the calculated lot sizing. The MRP results for the Normal Saline 100 mL Infusion is shown in Table 7.

**Table 7. MRP results of normal saline 100 mL infusion.**

| Method | Sodium Chloride 0.9 gram (Rp) |
|---|---|
| **FOQ** | 1,142,238,483.20 |
| **FPR** | 1,094,113,483.20 |
| **LUC** | 1,090,688,483.20 |
| **LTC** | 1,094,113,483.20 |
| **PPB** | 1,094,113,483.20 |
| **SM** | 1,142,238,483.20 |

The MRP results for the Ringer Lactate 500 mL are shown in Table 8. The savings based on the lot sizing method used and the company method for the Normal Saline 100 mL infusion product is shown in Table 9. As for the savings based on the lot sizing method used and the company method for the Ringer Lactate 500 mL infusion product is shown in Table 10.

**Table 8. MRP results of ringer lactate 500 mL infusion.**

| Method | Sodium Chloride 3 gram (Rp) | Potassium Chloride 0.15 gram (Rp) | Calcium Chloride Dihydrate 0.1 gram (Rp) | Total (Rp) |
|---|---|---|---|---|
| **FOQ** | 1,682,585,443.60 | 346,266,212.50 | 1,387,830,150.00 | 3,746,741,576.60 |
| **FPR** | 1,676,260,443.60 | 266,766,212.50 | 1,378,230,150.00 | 3,614,416,576.60 |
| **LUC** | 1,659,435,443.60 | 291,166,212.50 | 1,368,030,150.00 | 3,623,191,576.60 |
| **LTC** | 1,659,435,443.60 | 260,516,212.50 | 1,368,030,150.00 | 3,584,741,576.60 |
| **PPB** | 1,659,435,443.60 | 260,516,212.50 | 1,368,030,150.00 | 3,584,741,576.60 |
| **SM** | 1,682,585,443.60 | 346,266,212.50 | 1,368,030,150.00 | 3,746,741,576.60 |

**Table 9. Lot sizing methods' comparison of normal saline 100 mL infusion.**

| Method of Company (Rp) | LUC (Rp) | Savings (Rp) |
|---|---|---|
| **1,094,113,483** | 1,090,688,483 | 3,425,000 |

**Table 10. Lot sizing methods' comparison of ringer lactate 500 mL infusion.**

| Method of Company (Rp) | LTC (Rp) | PPB (Rp) | Savings (Rp) |
|---|---|---|---|
| **3,614,416,577** | 3,584,741,577 | 3,584,741,577 | 29,675,000 |

Based on Table 9, it is shown that the LUC method is chosen because it produces the smallest total cost. LUC method was chosen because of the calculation of the cost per unit to determine the order period, where orders with the LUC method are made with 2 order periods apart. Meanwhile, the method of the company order based on 3 order periods. The calculation of the LUC method reduces the inventory costs incurred by the company so that the LUC method produces the smallest costs.

Table 10 showed that the LTC and PPB methods are chosen because they produce the smallest total costs. The LTC and PPB methods were chosen because of the determination of the order period based on the cost of the order and the EPP Orders with LTC and PPB methods. It was made between 2 order periods for raw materials of Sodium Chloride and Calcium Chloride Dihydrate, 4 order periods for Sodium Lactate, and 5 order periods for Potassium Chloride. Meanwhile, the method of the company order based on 3 order periods. The calculation of the LTC and PPB methods reduces the storage costs incurred by the company for raw materials of Sodium Chloride and Calcium Chloride Dihydrate. In addition, the LTC and PPB methods also reduce the order costs incurred by the company for Potassium Chloride and Sodium Lactate raw materials so that the LTC and PPB methods produce the lowest costs.

Based on the results, Material Requirement Planning has proven that it can minimize the cost incurred by the company. Material Requirement Planning minimizes the holding cost of components, backlogging cost, and setup cost [11]. Material Requirement Planning system can also be used to project scheduling method with time [12]. Material Requirement Planning can also be used to solve the shortage of raw materials in a company [13]. Material Requirement Planning play a big role in Inventory Control [14]. Software to help Material Requirement Planning system has been developed with C language to develop efficient and user friendly inventory management tools [15]. Material Requirement Planning can also be used to determine the amount of net demand, order size, and order time [16].

Material Requirement Planning has also been developed further to Enterprise Resource Planning [17].

## 4. Conclusion

The research conducted on the Normal Saline 100 mL Infusion product proved that the LUC method produced the smallest total cost with an order period of 2 months. The LUC method with an order period of 2 months reduces the inventory costs incurred by the company. LUC method minimizes costs by IDR 3,425,000. Research conducted on the Ringer Lactate 500 mL Infusion proved that the calculation of the LTC and PPB method resulted in the lowest cost. LTC and PPB method resulting in different order periods for each raw material to optimize the cost that is incurred by the company. The LTC and PPB methods result in optimal order costs, storage costs, and purchase costs by determining the message period. LTC and PPB method minimize costs by IDR 29,675,000.

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