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Optimization of Drug Supplies to Achieve Efficiency in Hospital

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Abstract:- This study will plan and control the optimum supply of medicines at Ananda Hospital in order to meet drug prescriptions by doctors. To meet the prescription of drugs by doctors, a good drug inventory planning system is needed. This inventory is grouped with the ABC Classification method to obtain Category A drug brands, such as: Folamil Genio, Cefxon Injection, Osfit DHA, and Lancit Tablet. After that, the inventory group will be forecasted with the Exponential Smoothing, Moving Average, and Linear Regression methods. From the results of forecasting by selecting several methods for each drug, the output will be validated close to the actual and chosen from the method the highest level of optimization. Then the category A drug is controlled by selecting three of the most optimum methods between the Economic Order Quantity (EOQ), the Periodic Order Quantity (POQ), and the Min-Max method. The result is that the EOQ method has an efficiency level of 28.77%, the POQ method has an efficiency level of 28.76%, and the Min-max method produces an efficiency level of 28.4%. From the results of the study it was found that recommendations for Ananda Hospital in controlling inventory using the Economic Order Quantity (EOQ) method.

Keyword:- *Inventory, EOQ, POQ, Min-Max, Exponensial Smoothing, Moving Average.*

I. INTRODUCTION

Inventory has an important role for the smooth running of a hospital's business processes and if there is an errors in managing inventories have an impact on the costs incurred by the Hospital. Many hospitals have failed to develop their businesses because of the inflated cost of inventory. So inventory control is needed to optimize inventory costs so that the Hospital can reduce total inventory costs(TIC). Drug supplies need more attention to prevent shortage or excess supply of drugs so the hospital outcome expenses can be effective and efficient. One of the factors that can improve the optimal inventory of drug needs to reduce the level of loss is controlling the amount of drugs.

Ananda Purwokerto Hospital cooperates with several suppliers of drug companies to maintain the availability of drugs, but there are still inventory problems that require optimal handling. Some types of drugs exceed the limit and there are also some types of drugs that are inadequate with the need for drug at the hospital. In the previous year inventory, from October 2017 to September 2018 found 117 drug brand which got overstock events and 294 drug brand which got stockout events from the total of drugs about 1964 type.

With the conditions and phenomena as above, it is considered important to do more in-depth research on this matter. For this reason, we need an inventory management system that is in accordance with the conditions of the hospital and hoped to be able to help Ananda Hospital Purwokerto to manage the needs and improve the operational efficiency of the hospital. And can make a change to the inventory management system so that optimal conditions are achieved.

This study aims to analyze inventory control with forecasting from demand data a year earlier to determine the number and when to order to the suppliers accurately in order to reduce stock out and be able to optimize sales. This inventory will be grouped with the ABC Classification method to determine the priority of inventory fulfillment. After that, the supply group will be forecasted by selecting three methods which will then compare each drug the level of accuracy and choose from the method the highest accuracy. Then the demand forecasting results are then controlled by selecting the three most optimum methods between the Economic Order Quantity (EOQ), the Periodic Order Quantity (POQ), and the Min-Max method.

II. LITERATURE REVIEW

Inventory Management is defined as a method used by organization to regulate, store and replace inventory, to maintain an adequate supply of goods at the same time to minimize costs (Deveshwar, Dhawal, 2013). According to Heizer and Render (2014), Inventory is one of the most expensive assets of many companies, reflecting as much as 50% of the total capital invested. If the inventory is greater than the profit, it will increase the interest expense as well as the increase in storage costs and maintenance costs of inventory. Whereas if the inventory is smaller than profits, the company lacks the supply of goods to continue the business process so that profits decrease due to loss of consumers. And on the other hand, Inventory Management can control the objectives of a company's inventory by observing inventory levels and then forecast demand then schedule a logistics process.

➢ *Inventory Cost*

Inventory management is a technique for managing the balance between inventory costs. Inventory costs represent costs arising from inventories. According to Heizer and Render (2014) the costs arising from inventory are as follows:

1. *Holding Cost*

Holding costs are costs associated with storing in a certain period of time.

2. *Ordering Cost*

Ordering costs are costs expenses by organization to carry out the process of purchasing goods from suppliers or preparation costs (setup costs) if the items are produced within the organization.

3. *Setup Cost*

Setup costs are costs expenses to prepare machines or processes to produce orders. This fee also includes time and labor to clean and replace equipment.

4. *Shortage Cost*

Shortage costs are costs that must be incurred as a consequence of shortages or scarcity of inventory.

➢ *Economic Order Quantity (EOQ)*

Economic Order Quantity is one method used in determining the optimal quantity of ordering (Syamsuddin, 2011: 294). To determine the number of orders that are economical according to the EOQ method are:

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

Where:
Q = Number of optimum order (EOQ)
D = Annual Demand
S = Setup Cost per Order
H = Annual Holding Cost

➢ *Periodic Order Quantity (POQ)*

In this study, the POQ method is to determine the optimal interval order of drug supply orders. Because the POQ itself is a method that has a situation where an organization can accept its availability throughout the period. (Divianto, 2011).

$$\mathbf{POQ} = \frac{\mathbf{1}}{\bar{\mathbf{D}}}\sqrt{\frac{\mathbf{2PD}}{\mathbf{S}}}$$

Where:
POQ = Interval Order
P = Ordering Cost
$\bar{D}$ = Average Demand per Period
D = Annual Demand
S = Annual Holding Cost

➢ *Min-Max Method*

In this study, we use the minimum-maximum inventory model as a material for consideration of the drug supply control of Ananda Hospital in Purwokerto because the minimum-maximum inventory method has a large analysis condition of non-fixed orders and requires safety stock.

According to Bertazzi, L., Bosco, A, Lagana, D (2016), the minimum-maximum inventory method can be determined by:

End Year Stock = (Total Purchase-Total Usage) + Early Year Stock

1. Safety Stock = (Maksimum Usage – Average Usage) x Lead Time
2. Minimum Stock = (Average Usage x Lead Time) + Safety Stock
3. Maksimum Stock = 2 x (Average Usage x Lead Time) + Safety Stock

III. RESEARCH METHOD

This study will analyze and optimize inventory levels and provide recommendations on inventory control methods to Ananda Purwokerto Hospital. Based on the review of the theoretical basis, the framework can be followed in the study as follows:

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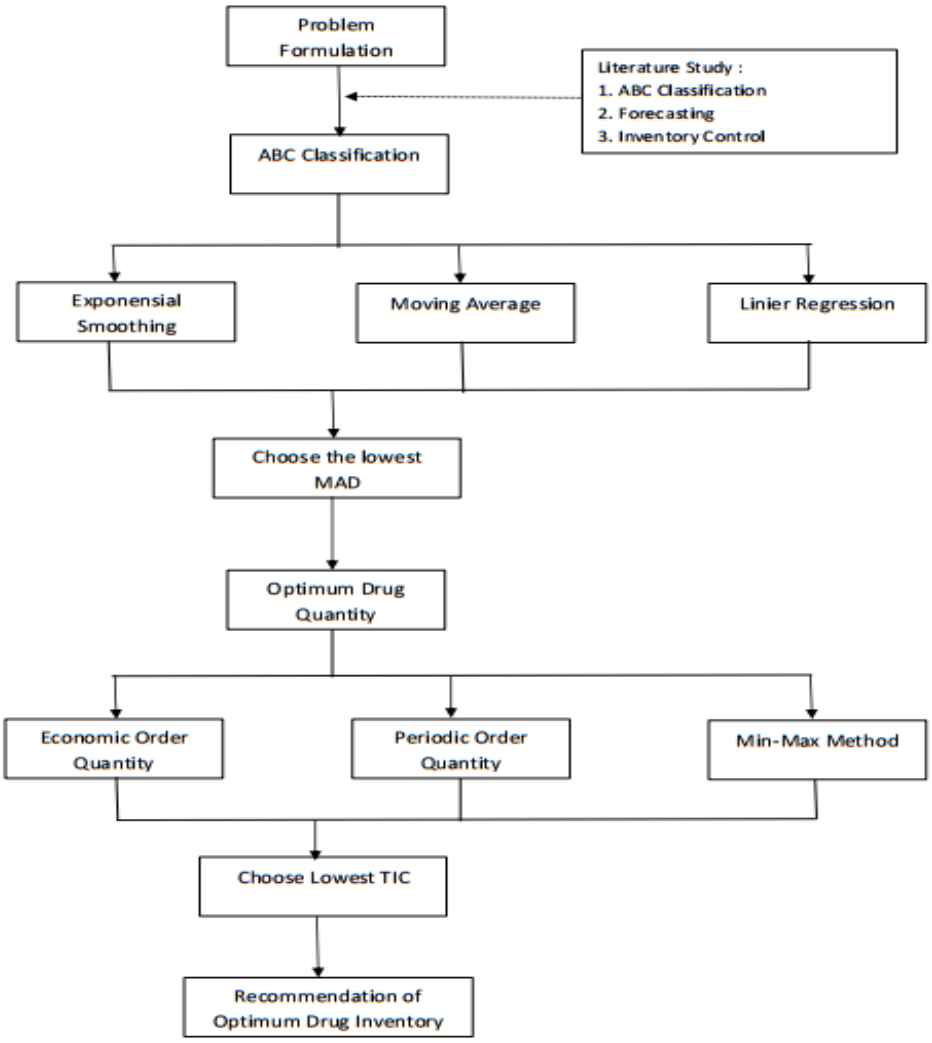

Fig 1: flow diagram of research

IV. DATA PROCESSING

In this study, the data obtained from the hospital for analysis needs are as follows:

A. Assumption

Assumptions obtained from hospital observations:

i. Lead Time, this is means the distance between the order of the drug and the drug coming to the hospital by the supplier, which during this time the supplier always delivered medicine ontime. The waiting time for this drug varies between 2 to 3 days, so that in this study the waiting time was set to be 3 days 0.43 weeks.
ii. Ordering Drug is instant and comprehensive. Medicinal supplies orders are sent at one time at a time adjusted to the truck's capacity so as to get the efficiency of shipping costs.
iii. Quantity discounts are not provided.
iv. Pharmacy Warehouse employees of Ananda Purwokerto Hospital go to work 6 days a week so for one year employees enter 312 days

B. Sample

The sample data that will be used for the study are 14 brands of drugs that have the highest level of inventory problems both overstock and stockout from October 2017 to September 2018. These drugs include:

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Drug Nama	Order	Cost(Rp)	Class
Cefxon Injeksi	1	510.937.350	A
Osfit DHA	2		A
Lancid Tablet	3		A
Tolamil Genio	4		A
Mecobalamin Tablet	5	127.635.240	B
Regivell Inj	6		B
Cefixime 100 cap	7		B
ODR 4 MG Inj	8		B
Omerazole Tablet	9	89.203.655	C
Lantus unsulin	10		C
Betahistin tab	11		C
sucralfat syrup	12		C
bisoprolol 5 MG	13		C
Cetirizib tablet	14		C

Table 1:- Results for ABC Drug Category Selection

From the results of ABC Classification above, the components included in category A are the percentage of inventory value of 70% with a cost of Rp. 510,937,350 with 4 drugs, while category B is 18% with a total investment cost of Rp. 127,635,240 which have 4 types of drugs, then in category C is the percentage of inventory value of 12% with a total investment cost of Rp. 89,203,655 which has 6 types of drugs.

V. RESULT

➢ *Optimum Demand*

Looking at the existing data patterns, the methods expected to be suitable are Single Exponential Smoothing, Moving Average and Linear Regression. The three methods will be tested for accuracy by calculating the value of MAD, which each produces a different value of MAD resulting in different amounts of demand

Drug Name	Exponensial Smoothing	Moving Average	Linier Regression
Folamil Genio	312	430	591
Cefxon Injeksi	25	9	20
Lancid Tablet	108	76	155
Osfit DHA	347	543	407

Table 2:- Comparison of MAD Forecasting Methods for Category a Drugs

From the results of the MAD test on the comparison of forecasting methods based on historical data on production consumption, it can be seen that for the drug brand Folamil Genio, the best forecasting method is the Exponential Smoothing method because it has the smallest MAD. Consecutively for the Cefxon Injection brand, the best method is the Noving Average forecasting method, for the Lancid Tablet drug brand, the best method is the Moving Average forecasting method, while for the Osfit DHA drug brand, the best method is the Exponential Smoothing forecasting method. So it will get the optimum number of demand / requests for drugs with the selected forecasting method presented in the table below :

Drug Brand	Actual Demand (unit)	Forecast Demand (unit)	Method
Folamil Genio	18489	18472	Exponensial Smoothing
Cefxon Injeksi	1309	1321	Moving Average
Lancid Tablet	6004	5953	Moving Average
Osfit DHA	24993	25261	Exponensial Smoothing

Table 3:- Comparison of Actual Demand with Forecasting Demand Category a Drugs

From the selected forecasting method, can be estimate of the number of requests / demand for Category A drugs in 2019. The results of drug forecasting can be concluded that the forecasting method works by averaging fluctuating actual demand data to make it smoother to become forecast to next period, so it will reduce fluctuating values so that it approaches the results the actual one. Although the results are not too far apart, with different order frequencies and order quantities, it can cause significantly different inventory costs.

➢ *Optimum Cost*

From total annual inventory costs side, inventory control methods can reduce inventory costs. As an example in the EOQ method in the study by Mathew et al (2013) with a good forecasting method, and EOQ calculated based on forecasting results, inventory costs can be reduced by 20 percent. In this study, the calculation shows that the method of estimating material requirements with average values per week and the frequency of ordering each month is not enough to make a good demand plan viewed in terms of the total annual inventory costs that arise.

Total inventory costs are calculated by the components of the number of needs and the number of orders per message. From the inventory control analysis, it will also be examined the level of economical ordering.

Drug Brand	Method	Optimum Order (unit)	Time to Order
Folamil Genio	EOQ	479	ROP =400
	POQ	479	Every 8 Days
	Min-Max	660	minimum stock = 1060
Cefxon Injeksi	EOQ	128	ROP = 24
	POQ	128	Every 30 Days
	Min-Max	47	minimum stock = 58
Lancid Tablet	EOQ	272	ROP = 93
	POQ	272	Every 14 Days
	Min-Max	213	minimum stock = 249
Osfit DHA	EOQ	560	ROP = 631
	POQ	560	Every 7 Days
	Min-Max	902	minimum stock = 1029

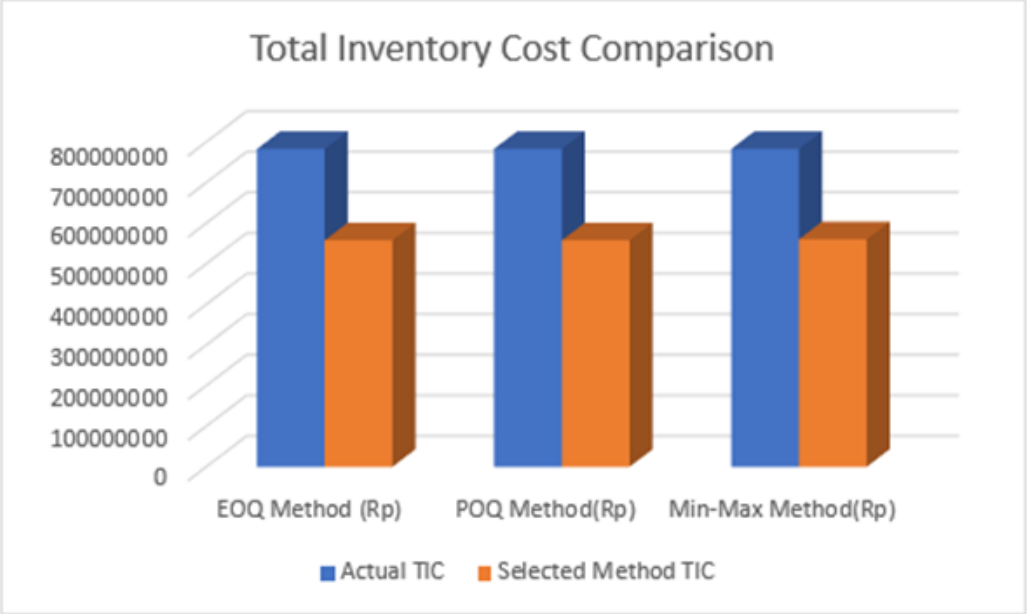
Table 4:- Comparison of Optimum Orders with Time of Order Between Control of Inventory Method of Drug Category A

From the table above, it can be seen that the EOQ and POQ methods have the same Optimum Order level because basically the POQ method is a derivative of the EOQ method, but the difference is the POQ method can present the optimum order frequency based on the day. From the min-max method, when ordering time drug comes when the quantity of medicine touches the minimum amount of drug stock according to the results of the analysis. So that from the three analyzes in this study, each method will got different result of Total Inventory Cost (TIC) which can be seen in the table below:

No	Drug Brand	Actual Cost (Rp)	EOQ Method (Rp)	POQ Method (Rp)	Min-Max Method (Rp)
1	Tolamil Genio	119.190.259	71.304.760	71.304.760	73.919.874
2	Cefxon Injeksi	364.722.259	280.864.005	280.918.009	282.475.346
3	Lancid Tablet	146.492.259	89.317.215	89.300.680	87.602.205
4	Osfit DHA	152.712.259	116.364.163	116.384.326	116.429.479
Total		783.117.037	557.850.142	557.907.775	560.426.904
Eficiency			28,77%	28,76%	28,40%

Table 4:- Comparison of Total Inventory Cost before Optimization with Total Inventory Cost After Optimization of Category A drugs

In table above, the comparison of the three methods produces a difference in total inventory costs which is smaller than the total actual cost. So it can be concluded that all inventory methods can optimize inventory costs at Ananda Hospital. However, in this study, will choose method with the most appropriate and the most optimum so that it can reduce inventory costs. The EOQ method has the highest efficiency value of the actual inventory cost of 28.77%, while the POQ method is ranked second with a difference that is not so large compared to EOQ which has an efficiency level of 28.76%, and the Min-max method produces a level the smallest efficiency of all is 28.4%.



	EOQ Method (Rp)	POQ Method(Rp)	Min-Max Method(Rp)
Actual TIC	783117037	783117037	783117037
Selected Method TIC	557850142	557907775	560426904
difference	225266895	225209262	222690133

Fig 2:- Comparison of Total Inventory Costs

Based on data above, the actual total cost of inventory against the results of comparison of inventory control analysis, there is a change in inventory costs to be more efficient. Previously the hospital's actual cost of category A drug supplies was Rp. 783,117,037 therefore using the comparison of inventory control analysis in the EOQ method has the smallest Total Invensoty Cost (TIC) of Rp. 557,850,142 with a difference with the actual inventory value of Rp. 225,266,895 while the POQ can produce Total Inventory Cost (TIC) which is Rp. 557,907,775 with a difference with the actual inventory value of Rp. 225,209,262, and the Min-max method produces the largest inventory cost. Min-max method controls inventory by maintaining quantity from the minimum level ordered as a ROP limit, from the minimum limit that can make Total Inventory Cost (TIC) bigger. With the Min-max method, the Total Inventory Cost (TIC) of Rp. 560,426,904 with a difference with the actual inventory value of Rp. 222,690,133.

The results of this study will become a reference and recommendation for Ananda Purwokerto Hospital in controlling inventory by using the Economic Order Quantity (EOQ) method because of the highest inventory cost savings compared to the Periodic Order Quantity(POQ) method and Min-Max method. From the EOQ method, it can be described the level of Reorder Point and the safety stock to make it easier to control inventory so that the cost of inventory can be optimum.

VI. CONCLUSION AND SUGGESTION

From the results of the analysis and discussion in the this study, there are several things that can be concluded and suggested:

a. In this study effective inventory control and can optimize the supply of drugs in Ananda Purwokerto Hospital is to use the EOQ method. This method presents the order time when the number of drugs touches the Reorder Point.
b. Use ABC analysis in planning that aims to identify components according to the value of use and value of investment so that effective management can concentrate on the small number of components but has a large investment value.
c. Inventory control methods that have been calculated and obtained the best method, should always be controlled periodically so that data is always accurate and actual. So that it can be useful for management in making service decisions and strategies in the future.

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