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# Production Planning and Inventory Control of Atonic Fertilizer Products Using Static Lot Sizing Method

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**Abstract.** This research was conducted at one national manufacturer that focus on production and distribution of fertilizer products. The name of the firm is PT OAT Mitoku Agrio (OMA), OMA is a company that works as a registration holder, importer of raw materials, formulators, and marketers of Atonic growth regulators and Metallic organic fertilizers that are widely used by farmers in Indonesia. Economic Order Quantity (EOQ) is one of the calculations method used to determine the quantity of company orders with a predetermined frequency and when is the appropriate time for the firm to make a reorder. This method aims to minimize total inventory cost so that inventory efficiency runs well, thus an optimal number of ordering units can be reached with minimum costs. Based on the results of this study, the EOQ method provides the most optimal order quantity with a most minimum cost.

**Keywords:** fertilizer, manufacturer, cost, economic order quantity, inventory, reorder

## 1. Introduction

Technological advances can increase human activity in the industrial sector, it will create fierce competition in the industrial world. This intense industrial competition requires companies to produce quality products at competitive prices and good product delivery to satisfy consumers. The business world is currently faced with increasingly open and tighter competition in its various fields [1]. Competition is not only about productivity but the quality of services provided [2]. According to the UN, the current world population of 7.1 billion is projected to increase to more than 2.2 billion and reach 9.3 billion by 2050. Cereal production in 2010 doubled and reached 2.2 billion tonnes, meanwhile the harvest area is increased. With the current acceleration of population growth, it is considered difficult to increase food production and supply adequate amounts of food simply by expanding the area of agricultural land. From 29 to 51% of agricultural crops grown annually on 1,500,000,000 hectares of arable land (11% of the total land area) are said to be lost during growth, harvest and storage. PT. OAT Mitoku Agrio is a combination of two companies, PT. OAT Agrio Co., Ltd and PT. Mitoku Sukses Makmur which was inaugurated on January 20, 2016. PT. OAT Mitoku Agrio is a company that works as a registration holder, raw material importer, formulator, and marketer of Atonic growth regulators and metallic organic fertilizers which are widely used by farmers in Indonesia.



When producing a product, the most important thing is to plan the product and control the product inventory. Inventory control is an activity in managing inventory to suit your needs and remain stable. This aims to avoid accumulation and to prevent stock outs when the product is needed so that the production process continues to run smoothly and does not suffer losses due to out of stock. Meanwhile, if there is an excess stock it can cause problems, such as material damage due to storage that is too long and the amount of storage costs as a result the total cost (TC) value will also increase. With the data on demand, lead time, pallet capacity, safety stock, storage costs and order costs, and total costs for each product, inventory control can be carried out to reduce product overloads and shortages using the EOQ (Economic Order Quantity) method and the Kanban method. The application of the EOQ method in a company is used to determine the quantity of company orders with a predetermined frequency and when to reorder so that there is no empty stock. Meanwhile, the Kanban method contains the information the company needs in ordering products according to their needs. This method is used to anticipate an increase in orders from consumers, so that production runs smoothly and consumer demand can be fulfilled. Based on the problems that have been described, the purpose of this study is to determine the optimal order quantity of atonic fertilizers using the EOQ and Kanban methods and to determine the total inventory cost of atonic fertilizers using the EOQ and Kanban methods.

Inventory is an important asset for the company, it is necessary to control and plan inventory so that problems do not occur that can burden the company [3]. Inventory is a number of raw materials or goods available for use at any time in the future [4]. Almost all companies engaged in the manufacturing industry certainly have inventories. Inventories in the manufacturing industry consist of various types depending on the type of company and the condition of the materials. Types of inventory are divided into: raw materials, components, work in process, finished products and distribution supplies [5]. Inventory control is an effort to monitor and determine the optimal level of material composition in supporting the smoothness and effectiveness and efficiency of company activities. Inventory is a stock of materials used to facilitate production or to satisfy customer demands, which specifically includes raw material goods, semi-finished materials and finished goods [6]. Inventory has the purpose of protecting against uncertainty, enabling economic production and purchasing, coping with changes in demand or supply, and providing transit [7].

It is important for industry and business actors to have data planning needs that will support all operational processes that are carried out in the future [8]. Forecasting is a process for estimating some future needs which include needs in terms of quantity, quality, time and location needed in order to meet demand for goods and services [7]. Forecasting is the art and science of predicting future events that require historical data and projecting them into the future with some form of systematic model [9].

EOQ is one of the easiest methods to use in determining the optimal number of order quantities [10]. The use of the EOQ method assumes that demand is constant, and supply is bad at a constant level until it reaches zero, as follows 1) The company knows exactly how many inventory items will be used, 2) The use of inventory or sales made by the company remains constant and does not change throughout the period, 3) When the supply reaches zero level, the inventory replenishment order is placed without delay [11]. EOQ can be searched using the following formula [12]:

$$EOQ = \sqrt{\frac{2 \times D \times S}{H}} \dots\dots\dots 1)$$

- D : The number of units needed during a certain period
- S : Cost of the order each time ordered
- H : Storage price per unit per year
- Q : Economic Order Quantity

To find out the frequency of delivery with a known number of order quantities, use the following formula:

$$F_n = \frac{D}{Q} \dots\dots\dots 2)$$

A reorder point (ROP) is a time taken to order a product or material back, so that when the ordered material is received it is on time according to the desired capacity in the warehouse [12]. In calculating ROP, the following formula can be used:

$$ROP = (d \times L) + SS \dots\dots\dots 3)$$

d : Rate of demand  
L : Lead time  
SS : Safety stock

Each companies are required to calculate the maximum inventory stored, because the capacity of a warehouse for each company is different. To find out the maximum inventory in warehouse storage, it can be calculated using the following formula:

$$MI = Q + SS \dots\dots\dots 4)$$

MI = Maximum Inventory

The concept of Just In Time in raw material inventory is used for production activities when the supplier or supplier is brought in exactly when the material is needed in the production process. In the Kanban method, it demands an optimal amount of time and inventory to avoid stock outs [12]. To determine the number of Kanban cards, the supplier can determine using the following formula:

$$N = \frac{d \times (c + Wp + \alpha)}{K} \dots\dots\dots 5)$$

N : Number of Kanban  
D : Daily needs  
c : Order cycle  
Wp : Order time  
K : Pallet capacity  
A : Safety coefficient

To determine an economical amount of Kanban, it is necessary [12]: 1) Daily Needs. To produce a product, it is necessary to know how much is needed per day, 2) Delivery Frequency. The number of shipments required in a given period can be calculated using the following formula:

$$fp = \frac{\sum fp}{K} \dots\dots\dots 6)$$

K : Capacity of palette

Total Inventory Cost (TIC) is the sum of the total costs contained in the inventory during one period [11]. TIC can be calculated using the following formula:

$$TIC = (D \times P) + \left(\frac{D \times S}{Q}\right) + (I \times H) \dots\dots\dots 7)$$

D	: Request
P	: Purchase price
Q	: Order quantity
S	: Cost of one order
I	: Average inventory
H	: Cost of saving

## 2. Research Methodology

The object of research carried out by the researcher was Atonik fertilizer product at PT. OAT Mitoku Agrio. The data used in this study are data on demand for Atonik fertilizer products in 2018, lead time data for Atonik fertilizer products in 2018, safety stock data for Atonik fertilizer products at PT / OAT Mitoku Agrio, data on purchase costs, storage costs, and message costs. Atonik fertilizer products in 2018, the service level value set by the company is 98%, the safety coefficient value set by the company is 5%, data on pallet capacity on Atonik fertilizer products and interviews with related parties at PT. OAT Mitoku Agrio.

The data processing stage is by calculating the total demand for Atonik fertilizer products and calculating the daily requirement for atonic fertilizer products, calculating forecasting methods using Minitab 18 software, calculating inventory costs, ordering quantity, safety stock, reorder points, and average inventory, the Kanban method. calculating the amount of Kanban needed, the quantity for one Kanban, and the average inventory, calculating and comparing the results of the total inventory cost on the EOQ method and the Kanban method and analyzing and providing advice on the chosen method.

## 3. Discussion and Analysis

Capacity of pallet for atonic fertilizer is twenty units. While the table of demand data on atonic fertilizers in 2018 can be seen from table 1.

Table 1 Demand of Atonic Fertilizer

Month	1	2	3	4	5	6	7	8	9	10	11	12
Demand	35	32	40	35	35	35	30	30	32	30	31	43

The inventory cost data for atonic fertilizers are as follows, the purchase cost is IDR 15,000 per unit, the ordering cost is IDR 45,500,730 per order, the saving cost is IDR 4,319.65 per unit per year. The multiplier of the service level value assumes 98% based on this value, the multiplier factor value is 2.05. In planning, companies need to forecast to anticipate and plan for the future. Forecasting calculations are done using Minitab 18 by looking at 3 methods, namely: Single Exponential Smoothing with Trend (SEST), Double Exponential Smoothing with Trend (DEST), and Holt-Winters Multiplicative Algorithm (HWM). Based on the data from forecasting calculations, the selected HWM forecasting method has an MAD value of 0.0717 and an MSE of 0.0217. Table 2 is the result of forecasting in the Holt-Winter Multiplicative Algorithm (HWMA) method.

Table 2 Forecast Result of HWMA

Month	1	2	3	4	5	6	7	8	9	10	11	12
Demand	35.38	31.69	39.84	34.99	35.01	35.00	30.00	29.99	31.99	30.00	31.00	43.00

Based on the EOQ calculation, the most economical order value is 2932 units, the frequency of delivery of atonic fertilizer products is one time / period and the order cycle time is 247 days. To determine the safety stock, it is necessary to know the standard deviation of the use of atonic fertilizers by assuming the service level value is 98% so that the possibility of running out of stock is 2%. The first step begins by calculating the standard deviation value of 4.1166 then determining the safety stock value, which is

3,039 units. After obtaining the safety stock value, then determine the reorder point value, maximum inventory and the average inventory level of 3,637 units, 5,971 units and 4,505 units. By knowing the total annual requirement and pallet capacity, then the frequency of delivery of atonic fertilizer products can be calculated, which is 21 times per year. The number of days used for 1 message on atonic fertilizer products. Delivery time (Wk) of atonic fertilizer products is three days. After knowing the delivery time and order time, the order cycle for atonic fertilizer products is obtained, which is nine days. To determine the cycle time, it takes 30 minutes to load the goods onto the pallet (C). So that the cycle time is obtained is 0.0803 days. Determining the number of kanban cards with atonic fertilizer products, the result is 0.7572 or rounded up to one kanban card. Total order is 40 units (one kanban card). In atonic fertilizer products, the results of the calculation of safety stock and the average inventory level are 173 units and 183 units. The total inventory cost using the EOQ method is IDR 31,909,236.5, while the kanban method results in a total inventory cost of IDR 934,937,830.

#### 4. Conclusion

The frequency of purchasing atonic fertilizers when using the EOQ method is one time / period with an order quantity of 2932 units, whereas when using the Kanban method the frequency of delivery is 21 times / period with an order quantity of 20 units. From the results of the above calculations, the EOQ method provides the most optimal order quantity by spending IDR 31,909,237 while for the Kanban method the company must pay IDR 934,937,830. If the EOQ method is applied in the company, it will save IDR 903,028,593. We recommend that the company consider to adopt EOQ as their method so that there is no excess or shortage of stock.

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