Application of the Economic Order Quantity (EOQ) Method in Analyzing Rice Inventory Control.

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ABSTRACT

Problems that often occur in the trading business include excess merchandise inventory and insufficient merchandise inventory. In overcoming these problems, inventory management is needed to analyze the optimum level of inventory. The Economic Order Quantity (EOQ) method can answer the problems that are often experienced by these trading businesses. The total cost of merchandise inventory according to UD. Benget Do is IDR 83,644,065, while according to the Economic Order Quantity (EOQ) method, it is IDR 34,345,694.93. It is proven that the number of orders is more optimal with the Economic Order Quantity (EOQ) method with savings in inventory costs of 41% of company costs.

Keywords: Inventory, Merchandise, Economic Order Quantity (EOQ).

1. INTRODUCTION

Sales are activities that affect the amount of inventory, so controlling the amount of inventory must be considered [1]. The amount of inventory that is too large or too small will cause various problems. Lack of inventory will cause stockout so that it will result in customer disappointment and even the company is threatened with losing customers (loss sale). Meanwhile, excess inventory will cause extra costs, such as warehouse costs, and costs in addition to the various risks that will be borne. Therefore we need an optimum inventory policy [2]. Optimum inventory control is influenced by the time of arrival of goods (lead time) [3], so there is a need for precise calculations to avoid delays in goods.

Currently, many companies in the field of Small and Medium Enterprises (SMEs) are established because the opportunities for this business are always wide open because the need for products is in high demand, the price is relatively affordable and will never stop and even will continue to increase [4]. In carrying out company activities and the process of achieving company goals, namely to obtain large profits at low cost, the company tries to make the best use of all its resources or assets [5]. One of the company’s assets and is directly related to income is inventory which is also a current asset where the information is indispensable for decision making by management [6][7].
Creating profit is not easy, many things become obstacles, both internal and external factors. For trading companies, internal constraints that affect it include the problem of availability of merchandise, lack of working capital for operations, less skilled labor and so on. Meanwhile, viewed from external factors, among others, are the intense business competition, low public income, and others

One method that is often used by companies in avoiding the problem of excess and shortage of merchandise is called the Economic Order Quantity (EOQ) method. EOQ is the quantity of goods that can be obtained at minimal cost, or it is often said to be the optimal amount of inventory. In its application, this EOQ model considers both operational costs and financial costs and determines the order quantity that will minimize overall inventory costs. The company also needs to determine the time to reorder merchandise to be used or Reorder Point (ROP), so that the purchase of merchandise specified in the EOQ does not interfere with the smooth running of the company as well as the minimum amount of inventory that must be in the company or safety stock.

UD. Benget Do, which is located in Rawang, Panei Tongah, Simalungun Regency, is one of the companies that carries out rice buying and selling transactions. So far, the company keeps records or purchases and sales transactions are still carried out manually and the inventory of goods is not controlled, so it will take time if you want to produce an inventory report in a short time. With the uncertain amount of demand for merchandise at any time, another problem that arises is not knowing when companies have to buy back merchandise. In this case, the company must experience problems in the form of an increasing number of requests in one period, the occurrence of running out of rice in the warehouse (stockout). To overcome these obstacles, the company must have a safety stock to cope with the increasing demand from the previous period. If there is a stockout, the company will be forced to postpone the delivery of goods.

2. LITERATURE REVIEW

2.1 Definition of Inventory

Common problems in an inventory model stem from events encountered at any time in the business sector, either trade or industry. This incident can be in the form of the availability of goods that are overloaded (exceeding needs) or vice versa lack of goods in meeting demand. Basically, inventory analysis is concerned with the technique of obtaining optimal inventory levels by maintaining a balance of unexpected costs.

Inventory is a model commonly used to solve problems related to controlling goods in a company activity. The hallmark of the corporate model is that the optimal solution is focused on ensuring inventory at the lowest possible cost.

In general, supply is any organizational resource that is stored in anticipation of meeting demand. Inventories are components, materials, or finished products that are available on hand, waiting to be used or sold.

Inventories are raw materials, work in process, finished goods, auxiliary materials, complementary materials, components stored in anticipation of fulfilling demand.

According to Kusuma, inventory is defined as materials or goods that are stored for use or sale in a future period. Inventories can be in the form of raw materials stored for processing, components that are processed, and finished goods that are stored for sale.

According to Ristono, inventory is a technique related to determining the amount of material inventory that must be held to ensure the smooth running of production operations, as well as determining the procurement schedule and the number of orders for raw materials that should be made by the company. Determination of the schedule and the number of orders that must be ordered is a basic statement that must be answered in inventory control.

Inventory is a resource that is used to meet current or future customer needs. One potential management problem is inventory. Inventory consists of four types, namely raw material inventory, work in process, maintenance goods inventory, and finished goods inventory. The function of
Inventory is to maintain a balance of demand with the supply of raw materials and the time needed to process supplies, avoid inflation and price changes, avoid shortages of stock due to weather, shortages of suppliers, quality problems, and delivery, and keep operations running smoothly[21].

Inventory is translated from the word “inventory” which is a pile of goods (raw materials, components, semi-finished products, or final products, etc.) which are intentionally stored as reserves (safety or buffer-stock) to deal with scarcity while the production process is in progress.

2.2 Types of Supplies
Assauri, S [22] suggests that inventories are differentiated or grouped according to the type and position of the goods in the order in which the product works, namely:

a. Raw materials stock, which is an inventory of tangible goods used in the production process. Goods can be obtained from natural sources or purchased from suppliers or companies that produce raw materials for the factories that use them.

b. Inventory of product parts or parts purchased (purchased parts / component stock) is an inventory of goods consisting of parts received from other companies, which can be directly assembled with other parts, without going through the previous production process.

c. Supplies of supporting materials or supplies (supplies stock), namely supplies of goods or materials needed in the production process or used in the production process to help the success of production or that are used in its work.

2.3 Inventory Control
Inventory control is a very important action in calculating the optimal amount of inventory required and when to start ordering again. Inventory control is a management function that can be solved by applying quantitative methods. This concept can be applied to both small scale industry and large scale industry[23][24].

Inventory control is an effort to monitor and determine the optimal level of material composition to support the smoothness and effectiveness and efficiency of company activities. Inventory control needs to be considered because it relates to costs that must be borne by the company as a result of inventory[25]. So that the existing inventory must be balanced with the needs, because excess inventory has the risk of causing damage to products and high storage costs[26]. Likewise, on the contrary, if too little will disrupt the smooth running of production, therefore, it is necessary to have a balance in the procurement of inventory so that it can reduce costs to a minimum and the production process can run smoothly[27].

2.4 Economic Order Quantity (EOQ) Model
This method was first introduced by Ford Harris of Westinghouse in 1915. This method is an inspiration for inventory experts to develop other methods of inventory control. This method is developed on the fact that there are variable costs and fixed costs from the production process or ordering goods.

If an item is ordered from a supplier, regardless of the quantity of goods ordered, the cost of the order (telephone, delivery, administration, etc.). The amount is always the same. This means that the cost of ordering does not depend on the number of orders but on the number of times the number of orders[28].

If a good is produced, the company has to set it up” machine and other production facilities, must make plans, etc. whose costs will not be different for different production quantities.

Another fact, there are costs that change if the number of units produced or ordered changes. This cost is directly proportional to the quantity produced. Included in this category are the price of goods, storage costs, storage costs, and others[29].

According to Gitosudarmo,[30] EOQ is the most economical volume or amount of purchase to be carried out at every purchase. To fulfill that need, the most economical fulfillment of the need (purchase) can be calculated, namely a number of items that will be obtained by purchasing using minimal costs. EOQ is the number of orders that can minimize the total cost of inventory, optimal
purchasing. To find out how many total items are fixed to be purchased in each purchase to cover needs during one period [31].

The classic EOQ method provides the most basic form of inventory analysis. This model provides a means of determining how much to order (order quantity) and when to place an order so that costs related to inventory can be minimized [32]. The basic assumption of these models is that demand is known with certainty and is constant [33].

Thus, mathematically the total cost of inventory can be expressed as follows:

\[
\text{Total Inventory Cost} = \text{Purchase Cost} + \text{Order Fee} + \text{Storage Fee} + \text{Shortage Fee} \tag{1}
\]

Suppose the demand for a good is constant over time with the unit rate per year, the cost incurred when an order is submitted is \( P \), the annual storage cost per unit of goods is \( s \), the purchase price per unit is \( H \), and the highest inventory level occurs when the order quantity \( Q \) units are shipped.

\[
\text{Ordering costs are costs incurred when an order is submitted, so that the cost of ordering for a year is}
\]

\[
P \times \frac{D}{Q} = \frac{pD}{q} \tag{3}
\]

Information:
- \( P \): Purchase costs
- \( D / Q \): Ordering Frequency in a Year
- \( D \): The demand rate per the planning time
- \( Q \): Economical ordering quantities
Storage costs are costs incurred for maintaining goods while the goods are stored, so that the amount of storage costs for a year is

\[
\text{Cost of Storage} = S \times \frac{Q}{2} = \frac{SQ}{2}
\]

Information:
- \( S \): Cost of storage per unit of goods
- \( \frac{Q}{2} \): The average number of items stored
- \( Q \): Economical ordering quantities

By substituting equations (3) and (4) into equation (2), the total cost of inventory for the EOQ inventory model is obtained.

\[
TIC = \frac{PD}{Q} + \frac{SQ}{2}
\]

Furthermore, to find the value of \( Q \) so that the minimum total cost of inventory is obtained, it must be obtained.

\[
\frac{dTIC}{dQ} = 0
\]

\[
\frac{dTIC}{dQ} = \frac{d}{dQ} \left( \frac{PD}{Q} \right) + \frac{d}{dQ} \left( \frac{SQ}{2} \right) = 0
\]

\[
-\frac{PD}{Q^2} + \frac{S}{2} = 0
\]

\[
\frac{PD}{Q^2} + \frac{S}{2} = \frac{S}{2}
\]

\[
2PD = Q^2 \cdot S
\]

\[
Q^2 = \frac{2PD}{S}
\]

So in order for the total cost of inventory to be minimum, the number of orders the company must submit is

\[
Q = \sqrt{\frac{2PD}{S}} \text{ unit.}
\]

3. RESULTS AND DISCUSSION

3.1 Data source

The data used in this research is secondary data. The data taken is rice demand data for January-December 2016 at UD. Benget Do, whose address is Rawang, Panei Tongah, Simalungun Regency.

3.2 Data processing

In data processing, there are several steps taken, namely:

a. Determine an economical order and the number of orders must be made per period
b. Determine the amount of safety stock
c. Determine the Reorder Point
d. Determine the maximum inventory (Maximum Inventory)
e. Determine the total cost of merchandise inventory
Comparing the total cost of merchandise inventory with the total cost of merchandise inventory according to the EOQ method

3.3 Request for Rice Merchandise

Demand data for merchandise shown for one year from January to December 2016 can be seen in the following table:

| No. | Month   | Request |
|-----|---------|---------|
| 1   | January | 38,980  |
| 2   | February| 36,000  |
| 3   | March   | 33,500  |
| 4   | April   | 29,000  |
| 5   | May     | 40,000  |
| 6   | June    | 48,770  |
| 7   | July    | 45,150  |
| 8   | August  | 39,000  |
| 9   | September| 45,000  |
| 10  | October | 49,000  |
| 11  | November| 39,000  |
| 12  | December| 37,000  |

Amount 478,400

Average 39,867

Based on table 1, it is known that the total demand for rice merchandise in 2016 was 478,400 Kg with an average demand of 39,867 Kg.

3.4 Rice Merchandise Ordering Fees

The following table details the amount of each cost for one year from January to December 2016.

| Cost component | Value (Rp) |
|----------------|------------|
| Telephone      | 400,000    |
| Transportation of merchandise and placement in a warehouse | 5,922,500 |
| Amount         | 6,322,500  |

Source: UD.Benget Do

3.5 Paddy Merchandise Storage Costs

Storage costs incurred by the company are costs that arise as a result of maintaining the storage area. UD storage costs. Benget Do can be seen in the following table:

| Year | Percentage of storage costs (%) | Price of merchandise per Kg (Rp) | Storage fee per Kg (Rp) |
|------|---------------------------------|----------------------------------|-------------------------|
| 2016 | 5%                              | 3900                             | 195                     |

3.6 Calculation of Inventory Costs using the EOQ Method

The EOQ method or it can be called an economical order quantity is a specific method for determining merchandise inventory. The EOQ method is an amount that provides a balance between storage costs and ordering costs in order to obtain a minimum total cost (Russel et al. 2011).

So to determine the amount of economical ordering costs, the following formula is used:

$$EOQ = \sqrt{\frac{2PD}{S}}$$

Where:

$P =$ The cost of each order
\[ D = \text{demand rate per planning time} \]
\[ S = \text{storage cost per planning time} \]

4. CONCLUSION

Based on the results of research and discussion as well as data obtained from UD. Benget Do, then the following conclusions can be drawn: Request for rice merchandise at UD. The optimal Benget Doyang according to the EOQ (Economic Order Quantity) method in 2016 for each time of rualization is 176,131.76 Kg. The safety stock quantity according to the Economic Order Quantity (EOQ) in 2016 was 9628.047 Kg. at UD. Benget Do does not have safety stock while selling, only looking at the number of merchandise. Safety stock is needed by companies to control inventory in the warehouse. The total cost according to the Economic Order Quantity (EOQ) method is IDR 34,345,694.93 and according to company policy is IDR 83,644,065. The total cost of merchandise inventory issued by UD. In 2016, Benget Do according to the EOQ method was smaller than company policy. So that the EOQ method is more efficient and saves costs when applied to the company.

REFERENCES

[1] V. Gaur and S. Kesavan, “The effects of firm size and sales growth rate on inventory turnover performance in the US retail sector,” in Retail Supply Chain Management, Springer, 2015, pp. 25–52.
[2] Y. Sheffi, The power of resilience: How the best companies manage the unexpected. mit Press, 2015.
[3] E. Arifan, J. Fichtinger, and J. M. Ries, “Impact of transportation lead-time variability on the economic and environmental performance of inventory systems,” Int. J. Prod. Econ., vol. 157, pp. 279–288, 2014.
[4] N. M. P. Bocken, M. Farracho, R. Bosworth, and R. Kemp, “The front-end of eco-innovation for eco-innovative small and medium sized companies,” J. Eng. Technol. Manag., vol. 31, pp. 43–57, 2014.
[5] L. Wu and J.-L. Chen, “Knowledge management driven firm performance: the roles of business process capabilities and organizational learning,” J. Knowl. Manag., 2014.
[6] E. AbuKhousa, J. Al-Jaroodi, S. Lazarova-Molnar, and N. Mohamed, “Simulation and modeling efforts to support decision making in healthcare supply chain management,” Sci. World J., vol. 2014, 2014.
[7] C. R. Lohri, E. J. Camenzind, and C. Zurbrügg, “Financial sustainability in municipal solid waste management–Costs and revenues in Bahir Dar, Ethiopia,” Waste Manag., vol. 34, no. 2, pp. 542–552, 2014.
[8] M. R. Shaharudin, S. Zailani, and K. C. Tan, “Barriers to product returns and recovery management in a developing country: investigation using multiple methods,” J. Clean. Prod., vol. 96, pp. 220–232, 2015.
[9] L. Rickards, J. Wiseman, and Y. Kashima, “Barriers to effective climate change mitigation: the case of senior government and business decision makers,” Wiley Interdiscip. Rev. Clim. Chang., vol. 5, no. 6, pp. 753–773, 2014.
[10] A. Shuen, P. F. Feiler, and D. J. Teece, “Dynamic capabilities in the upstream oil and gas sector: Managing next generation competition,” Energy Strateg. Rev., vol. 3, pp. 5–13, 2014.
[11] X. H. Meng, S. X. Zeng, X. M. Xie, and G. Y. Qi, “The impact of product market competition on corporate environmental responsibility,” Asia Pacific J. Manag., vol. 33, no. 1, pp. 267–291, 2016.
[12] A. R. Nia, M. H. Far, and S. T. A. Niaki, “A fuzzy vendor managed inventory of multi-item economic order quantity model under shortage: An ant colony optimization algorithm,” Int. J. Prod. Econ., vol. 155, pp. 259–271, 2014.
[13] S. H. R. Pasandideh, S. T. A. Niaki, and B. M. Vishkaei, “A multiproduct EOQ model with inflation, discount, and permissible delay in payments under shortage and limited warehouse space,” Prod. Manuf. Res., vol. 2, no. 1, pp. 641–657, 2014.
[14] C. K. Jaggi, S. Tiwari, and A. Shafi, “Effect of deterioration on two-warehouse inventory model with imperfect quality,” Comput. Ind. Eng., vol. 88, pp. 378–385, 2015.
[15] L. E. Cárdenas-Barrón, K.-J. Chung, and G. Treviño-Garza, “Celebrating a century of the economic order quantity model in honor of Ford Whitman Harris,” Elsevier, 2014.
[16] D. J. Papageorgiou, G. L. Nemhauser, J. Sokol, M.-S. Cheon, and A. B. Keha, “MIRPLib—A library of maritime inventory routing problem instances: Survey, core model, and benchmark results,” Eur. J. Oper. Res., vol. 235, no. 2, pp. 350–366, 2014.
[17] A. Martel and W. Klibi, Designing value-creating supply chain networks. Springer, 2016.
[18] O. H. D. Isaksson and R. W. Seifert, “Inventory leanness and the financial performance of firms,” Prod. Plan. Control, vol. 25, no. 12, pp. 999–1014, 2014.

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[19] H. Guhlich, M. Fleischmann, and R. Stolletz, "Revenue management approach to due date quoting and scheduling in an assemble-to-order production system," *OR Spectr.*, vol. 37, no. 4, pp. 951–982, 2015.

[20] D.-P. Song, J.-X. Dong, and J. Xu, "Integrated inventory management and supplier base reduction in a supply chain with multiple uncertainties," *Eur. J. Oper. Res.*, vol. 232, no. 3, pp. 522–536, 2014.

[21] A. Mirkouei, P. Mirzaie, K. R. Haapala, J. Sessions, and G. S. Murthy, "Reducing the cost and environmental impact of integrated fixed and mobile bio-oil refinery supply chains," *J. Clean. Prod.*, vol. 113, pp. 495–507, 2016.

[22] M. A. Millstein, L. Yang, and H. Li, "Optimizing ABC inventory grouping decisions," *Int. J. Prod. Econ.*, vol. 148, pp. 71–80, 2014.

[23] G. Wang, A. Gunasekaran, E. W. T. Ngai, and T. Papadopoulos, "Big data analytics in logistics and supply chain management: Certain investigations for research and applications," *Int. J. Prod. Econ.*, vol. 176, pp. 98–110, 2016.

[24] M. Leyer and J. Moormann, "How lean are financial service companies really? Empirical evidence from a large scale study in Germany," *Int. J. Oper. Prod. Manag.*, 2014.

[25] M. Vanderroost, P. Ragaert, F. Devlieghere, and B. De Meulenaer, "Intelligent food packaging: The next generation," *Trends Food Sci. Technol.*, vol. 39, no. 1, pp. 47–62, 2014.

[26] K. Verghese, H. Lewis, S. Lockrey, and H. Williams, "Packaging’s role in minimizing food loss and waste across the supply chain," *Packag. Technol. Sci.*, vol. 28, no. 7, pp. 603–620, 2015.

[27] S. M. Takon and F. A. Atseye, "Effect of working capital management on firm profitability in selected Nigerian quoted companies," *Int. J. Econ. Commer. Manag.*, vol. 3, no. 10, pp. 414–438, 2015.

[28] C.-T. Chang, Y.-Y. Chou, and Z.-Y. Zhuang, "A practical expected-value-approach model to assess the relevant procurement costs," *J. Oper. Res. Soc.*, vol. 66, no. 4, pp. 539–553, 2015.

[29] A. Bozorgi, J. Pazour, and D. Nazzal, "A new inventory model for cold items that considers costs and emissions," *Int. J. Prod. Econ.*, vol. 155, pp. 114–125, 2014.

[30] D. Battini, A. Persona, and F. Sgarbossa, "A sustainable EOQ model: Theoretical formulation and applications," *Int. J. Prod. Econ.*, vol. 149, pp. 145–153, 2014.

[31] P. Maniatis, "Investigating factors influencing consumer decision-making while choosing green products," *J. Clean. Prod.*, vol. 132, pp. 215–228, 2016.

[32] S. Pazhani, J. A. Ventura, and A. Mendoza, "A serial inventory system with supplier selection and order quantity allocation considering transportation costs," *Appl. Math. Model.*, vol. 40, no. 1, pp. 612–634, 2016.

[33] M. Soysal, J. M. Bloemhof-Ruwaard, R. Haijema, and J. G. A. J. van der Vorst, "Modeling an inventory routing problem for perishable products with environmental considerations and demand uncertainty," *Int. J. Prod. Econ.*, vol. 164, pp. 118–133, 2015.

[34] S. Zanoni, L. Mazzoldi, and M. Y. Jaber, "Vendor-managed inventory with consignment stock agreement for single vendor–single buyer under the emission-trading scheme," *Int. J. Prod. Res.*, vol. 52, no. 1, pp. 20–31, 2014.