

Economic Order Quantity Method to Enhance Rice Supplies and Food Security in Indonesia

Rahmad Inca Liperda^{a1*}, Nanda Ruswandi^{b2}, Dea Nurfirda Apriliyani^{c3}

^{a, b.} Program Studi Teknik Logistik, Universitas Pertamina, Jakarta Selatan

^{1*}inca.liferda@universitaspertamina.ac.id, ²nanda.ruswandi@universitaspertamina.ac.id,

³102417019@student.universitaspertamina.ac.id,

*corresponding e-mail

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ABSTRACT

The availability of adequate food to meet basic human needs is a top priority, especially in the context of food security in Indonesia. The government's focus on maintaining a stable supply of rice throughout the year is the key strategy. The research purpose is to enhance rice supply at Bulog warehouse Baru Tempel Lemahbang 202 Blora by implementing the Economic Order Quantity (EOQ) method. The research findings indicate that the optimal size of rice supply order is 15.319.4 tons with 119 orders per year and an annual cost of approximately Rp. 424.484.526. The discussion involves detailed problem-solving aspects of rice inventory at the location using the EOQ method. The data were collected from company's documentation of 12 periods using observation, interview, documentation, and literature studies techniques. Both Descriptive and Quantitative approaches were used in the discussion to provide a comprehensive framework of rice inventory issues. Although the EOQ implementation has proven beneficial in reducing individual rice order cost, evaluating alternative policy is necessary to reduce overall cost in both, short and long term.

Keywords: *economic order quantity food security, rice supply, total inventory cost, warehouse*

A. Introduction

The success of food security in Indonesia can be measured by the fulfillment of food needs across all segments of society and the prevention of famine threats. The right of every Indonesian citizen to obtain food is enshrined in Article 27 of the 1945 Constitution and the Rome Declaration (1996). Limited supplies and rising rice prices, even leading to shortages, can pose a threat to food security, particularly concerning rice as a commodity. In the context of food security, the supply chain aspect, encompassing the

entire process from procurement, production, inventory, to distribution, plays a critical role. The quality of good rice can be assessed based on several components, including a maximum moisture content of 14%, degree of whiteness of 95%, maximum chalky grains of 2%, and maximum broken grains of 10%. Therefore, it is imperative to have adequate rice inventory management that can meet the needs of the community.

Perusahaan Umum (Perum) BULOG is a State-Owned Enterprise (SOE) tasked with handling logistics management, offering services such as inventory management,

rice distribution, and maintaining rice price stability. The logistics services provided by *Perum BULOG* are regulated by a Presidential Decree. Therefore, it is crucial to select an appropriate method for managing rice inventory to achieve *Perum BULOG*'s objectives of minimizing production and operational costs. In fulfilling its duties, *Perum BULOG* maintains several warehouses where they store their raw materials or products before distribution.

The operational and administrative activities are carried out by the division (divisi regional), sub-division (sub-divisi regional), and logistics unit (kansilog). One of the warehouses owned by *Perum BULOG* is *Gudang Bulog Baru Tempel Lemahbang 202 Blora*, which is responsible for managing and meeting the food needs, especially rice commodities, in the distribution program to all segments of the community in *Blora* region. The demand for rice commodity products is placed by the working partners of *Gudang Bulog Baru Tempel Lemahbang 202 Blora*, following the entire contract negotiation procedure in accordance with the applicable policies or Standard Operating Procedures (SOP). In supply chain management, the appropriate strategy is focused on enhancing efficiency and responsiveness to consumer demands (Chopra & Meindl 2007). To achieve this goal, six key factors should be considered: facilities, inventory, transportation, information, resources, and price stability (Trisilawaty, Marimin, and Achsani 2014). Determining the investment in costs, equipment, or production materials directly impacts the company's profits. Therefore, effective inventory management is essential for supporting the company's sustainability.

The Economic Order Quantity (EOQ) method is an approach aimed at minimizing costs and reducing operational expenses for companies (Nur Fitriani, Ria Puspa Yusuf, and I Ketut Rantau 2014). Inventory refers to assets comprising goods owned by a company intended for sale during the regular business

period, items in progress or undergoing production, and raw materials awaiting use in the production process (Assauri 2008). This research is conducted to determine the inventory ordering policy for rice using the EOQ method and to evaluate the total costs incurred by the company in rice inventory procurement using the EOQ method.

Several related studies have been conducted in this area, including the analysis of rice inventory by (Aditya, Ustriyana, & Suryawardani 2022). This study generated insights into rice procurement flow, analyzing the rice supply system focusing on economic order quantity, safety stock, maximum inventory, reorder point determination, and cost efficiency analysis of rice inventory. Another study by Ardiansah (2017) investigated the planning and control of rice inventory at *Perum BULOG Divisi Regional Jawa Barat* using the economic order quantity (EOQ) and production order quantity (POQ) methods. The findings indicated that in 2016, *Perum BULOG* needed to order 596.677.538.92 kg of rice with a frequency of 71 orders, placing orders every five days in January and every six days from February to December. The total procurement cost was Rp. 4.659.583.712.750.62, and the budget allocated was Rp. 4.681.702.174.406.47, resulting in a cost saving of Rp. 22.118.461.655.86.

Tatuh (2015) conducted an analysis of rice inventory management at *PT. Semarak Kota Bitung* and found that the inventory management at this company is still not efficient, along with non-economic ordering costs. This is evident as the company's inventory costs exceed the results of the analysis using the Economic Order Quantity (EOQ) method, which suggests an optimal rice order size of 4.700 sacks with a total economic inventory cost of Rp. 54.411.370. Furthermore, the study by Wijayanti, Candra, and Sarjono (2011) focused on the analysis of national rice inventory in meeting the national rice needs at *Perusahaan Umum BULOG*. The findings emphasized the need for its rice inventory management to consider domestic

procurement conditions and rice distribution, with rice imports serving as a complementary option only when necessary. It was observed that rice inventory negatively impacts producer prices, indicating the necessity for improvement in domestic procurement implementation.

Based on several explanation from the previous researches, it is necessary to carry out similar research with the purpose to determine the policy for ordering rice supplies using the Economic Order Quantity (EOQ) method and knowing the policy on the total costs incurred for procuring supplies rice implemented by *Gudang Bulog Baru Tempel Lemahbang 202 Blora* with a rice procurement ordering policy using the Economic Order Quantity (EOQ) method.

Inventory is one of the primary commodities in commercial enterprises. Inventory assets are considered crucial current assets in generating profits (Pujiastuti & Lusi Ariyani 2021). Inventory in a company encompasses various types, including finished goods, goods in process, raw materials, auxiliary inventory, expendable inventory, and spare parts (Widodo 2005). Sofyan (2004) explains that inventory comprises all goods held by a company intended for sale at a given time, including products still in progress or in the production line and basic raw materials yet to be incorporated into the production process. The function of inventory involves both the physical flow of products and the overall cost outlays in the process, necessitating appropriate management to regulate both aspects (Arens 2003). In certain circumstances, inventory can be viewed as a capital investment required to store materials from the company's perspective. Inventory can also be interpreted as idle resources or items waiting in line or continuing in the production process within a company's operations or marketing activities (Nasution 2008).

According to Riyanto (2001), several factors can influence the required inventory capacity of a company, including: (1) the quantity needed to avoid inventory shortages

that may slow down the production flow. (2) the planned production quantity. (3) the quantity of raw material purchases made to achieve minimal costs. (4) predictions of future price increases for the raw materials used in the production process. (5) government regulations or policies regarding raw material inventory. (6) storage costs and responsibilities associated with inventory. and (7) the duration of inventory shelf life and potential quality degradation.

According to Rangkuti (2007), the Economic Order Quantity (EOQ) is an inventory management method that considers the economically optimal purchasing quantity through regular ordering to minimize costs each time the ordering process is conducted. The EOQ method has several requirements that must be fulfilled, namely: (1) the demand must be constant and known (2) there should be no inventory shortages (3) only one type of material is ordered and produced within a given period (4) the ordering cost per unit remains constant and (5) the ordered item is unique.

When applying the EOQ method, relevant cost calculations should be considered in accordance with the said method (Almahdi 2019). For instance, purchasing costs need not be taken into account as they are not dependent on the order quantity. Hence, the primary objective of the EOQ method is to minimize inventory costs by considering only the ordering cost and holding cost.

According to Riyanto (2001), the reorder point refers to the level at which a company should place a reorder for the required materials in the production process to ensure a continuous supply of materials when needed. When the inventory level is above the safety stock, the safety stock value is zero. Factors to consider in determining the reorder point include the time taken to use the materials during the procurement lead time.

The Reorder Point formula (ROP) is as follows:

$$ROP = (LT \times D) \quad (1)$$

Where:

ROP: Reorder Point (Ton)

LT: Lead Time (Days)

D: Demand (Ton)

B. Research Method

The data in this research was taken from the collection of rice demand record from *Gudang Bulog Baru Tempel Lemahbang 202 Blora*, which is presented in Table 1.

Table 1 Rice Demand Record Year 2019

Period	Month	Demand (Ton)
1	January	116.643
2	February	92.235
3	March	89.536
4	April	127.924
5	May	130.628
6	June	175.410
7	July	184.410
8	August	181.366
9	September	188.944
10	October	180.431
11	November	178.183
12	December	176.112
Total		1.821.822
Average		151.819

To maintain the confidentiality of cost data incurred by *Gudang Bulog Baru Tempel Lemahbang 202 Blora*, the cost data for ordering and storage in this research were obtained from published journal literature, along with assumptions made by the authors based on various factors. One of the factors considered was the estimated average cost of warehouse expenses obtained through interviews with the warehousing division of *Gudang Bulog Baru Tempel Lemahbang 202 Blora*. The cost estimated breakdown can be found in Table 2.

Based on Figure 1, which depicts the rice demand graph for *GBB Tempel Lemahbang 202* in the year 2019, it can be concluded that the rice demand experiences an initial increase followed by a relatively constant trend in the last seven periods, spanning from June to December. Hence, it is deduced that the rice demand at *Gudang Bulog Baru Tempel Lemahbang 202 Blora* in 2019 can be predicted using the Economic Order Quantity (EOQ) method. This interpretation is supported by the 2019 rice demand data, which exhibits relatively stable and non-drastic fluctuations. The average quantity of rice procured by *Gudang Bulog Baru Tempel Lemahbang 202 Blora* in 2019 is as follows:

Total rice stock requirements for one year/
frequency of procurement for one year
1,821,822 tons / 12 = 151,819 tons

C. Results and Discussion

1. Order Fee

Ordering costs are costs that should be paid by the company to process the procurement of rice from partners. Procurement costs incurred by the *Gudang Bulog Baru Tempel Lemahbang 202 Blora* including:

a. Telephone Fees

It is the cost that needs to be allocated for communication services during the procurement transactions of rice ordering processes. The telephone expenses incurred over 12 periods in the year 2019 amounted to Rp. 4.200.000. Therefore, the telephone cost per ton is:

$$\begin{aligned} \text{Telephone Fees} &= \text{Rp } 4.200.000 / 1.821.822 \text{ tons} \\ &= \text{Rp } 2,305 / \text{tons} \end{aligned}$$

b. Loading and unloading costs

It is the cost that needs to be charged to the company for the labor services used in the transfer of rice from trucks to the warehouse. The loading and unloading cost incurred by the company amounts to Rp 15,000 per ton.

Table 2 Assumption of Costs in Rupiah

Assumption	Details	Information
Telephone Fees	Rp350.000	/month
Loading and unloading costs	Rp15.000	/ton
Letter Document	Rp8.500.000	One year
Transport fee	-	Partner borne
Labor costs	Rp4.500.000	Every employee
Warehouse electricity costs	Rp1.250.000	In one month
Maintenance costs	Rp2.500.000	One Process

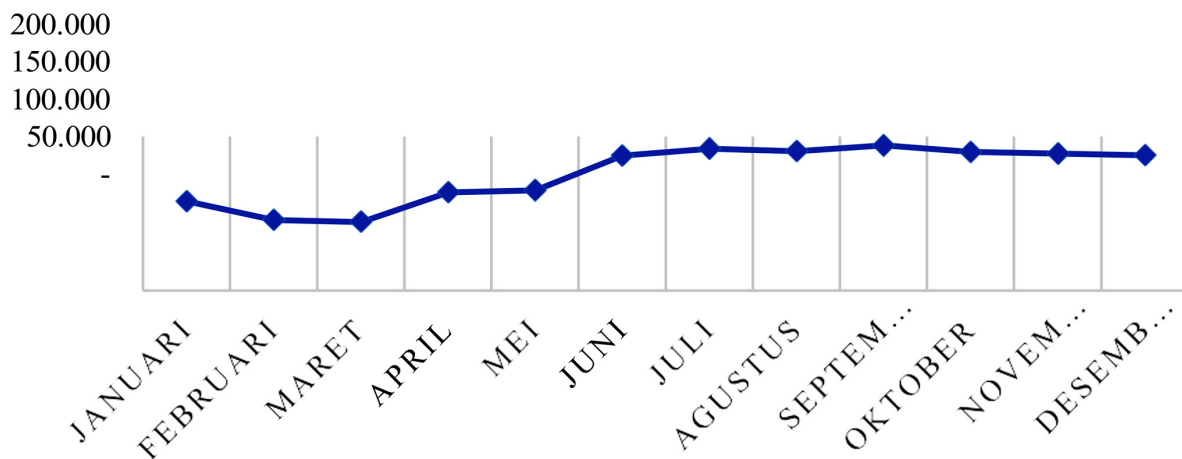


Figure 1. Demand for GBB Paste Lemahbang 202 Rice in 2019

c. Transportation Costs

In accordance with the agreement, the transportation cost at *Gudang Bulog* will be covered by the working partners who deliver their rice to the warehouse.

Considering all the descriptions of the ordering cost components above, the summary of the ordering cost that the company needs to incur for each ton of rice per order can be observed in Table 3.

2. Storage Fee

In the context of *Gudang Bulog Baru*

Tempel Lemahbang 202 Blora, holding cost refers to the expenses incurred due to inventory storage within the warehouse. As the quantity of goods stored in the warehouse increases, the corresponding costs for storage also rising for the company. These holding costs are independent of the procuring goods frequency. Some components of holding costs that companies need to consider include:

a. Labor Costs

The warehouse labor cost represents the expenses arising from the wages paid to the warehouse employees involved in the entire

Table 3 Recapitulation of Order Costs

No.	Type of Cost	Details	Description
1	Telephone Fees	Rp 2.305	one message/ton
2	Loading and unloading costs	Rp 15.000	one message/ton
3	Letter Document	Rp 5	one message/ton
Amount		Rp 15.007	one message/ton

process, including procurement planning, arrangement, and rice storage over 12 periods in the year 2019 at *Gudang Bulog Baru Tempel Lemahbang 202 Blora*. For this calculation, it is assumed that there are 7 warehouse employees with a monthly salary of Rp 4,500,000 each. Thus, the total labor cost for one year can be calculated as follows:

Labor Cost =

$$\text{Rp } 4.500.000 \times 7 \text{ People} \times 12 \text{ Month} \\ = \text{Rp } 378.000.000/\text{Years}$$

b. Warehouse Maintenance Costs

The warehouse maintenance cost refers to the expenses incurred by *Gudang Bulog Baru Tempel Lemahbang 202 Blora* for warehouse maintenance and cleaning services. The cost borne by the company for each maintenance and cleaning session amounts to Rp 2.500.000 per period. Consequently, the total warehouse maintenance and cleaning cost incurred by the company in one year can be calculated by multiplying the cost per period by the number of periods in a year.

Warehouse Maintenance Costs =

$$\text{Rp } 2.500.000 \times 12 = \text{Rp } 30.000.000/\text{Years}$$

c. Electricity Costs

It is the cost incurred by *Gudang Bulog Baru Tempel Lemahbang 202 Blora* related to the electricity consumption used for warehouse lighting and other electrical equipment. The cost is as follows:

Electricity Warehouse Costs =

$$\text{Rp } 1.250.000 \times 12 \\ = \text{Rp } 15.000.000/\text{Years}$$

Based on the comprehensive descriptions of the holding cost components at Gudang Bulog

Baru Tempel Lemahbang 202 Blora mentioned above, the annual summary of holding costs is obtained as shown in Table 4.

3. Economic Inventory Calculation and Total Inventory Cost

When determining the economic order quantity of rice inventory that should be adopted by *Gudang Bulog Baru Tempel Lemahbang 202 Blora* for storage in the warehouse, several specific considerations need to be taken into account, namely: (1) The inventory quantity of rice at the warehouse during the period of 2019 amounted to 1.821.822 tons (D). (2) the ordering cost is Rp 15.007 per ton for each order placed (RC) and (3) the rice storage cost at the warehouse is Rp 233 per ton (HC).

Based on the presented data, the economically optimal order quantity for rice inventory can be calculated using the EOQ method, as shown in Table 5.

According to (Almahdi 2019) work in 2019, the total inventory cost can be calculated by adding the incremental cost components of ordering cost and holding cost while disregarding the cost per unit as it remains constant regardless of the ordering frequency. Hence, the objective to minimize inventory costs can be achieved by minimizing only the ordering and holding costs. The components of these costs are as follows: (1) the quantity of rice inventory held by *Gudang Bulog Baru Tempel Lemahbang 202 Blora* in 2019 was 1.821.822 tons (D) (2) the economic order quantity of rice in 2019 was 15.319.4 tons (Q) (3) the ordering cost or cost of placing an order for rice is Rp 15.007 per ton (S). and (4) the

Table 4 Storage Fees

No.	Type of Cost	Details	Description
1	Labor costs	Rp 378.000.000	/ Years
2	Electricity cost	Rp 15.000.000	/ Years
3	Maintenance Fees and others	Rp 30.000.000	/ Years
Amount		Rp 423.000.000	/ Years
Cost Per Ton		Rp 233	/tons

Table 5 Calculation of the Number of Orders for Economical Rice with the EOQ Method

Demand (Ton)	Storage Cost (Per Ton)	Order Cost (Per Ton)	Working Days (Days)	EOQ (Ton)	Procurement Frequency	Order Period (Days)
1.821.822	Rp.233	Rp.15.007	280	15.319.4	119	2

holding cost or cost of storing rice is Rp 233 per ton (H).

4. Reorder Point Calculation (ROP)

During the rice procurement process, *Gudang Bulog Baru* experiences lead time, which is the time interval between placing an order for the product and its receipt at the warehouse, with a maximum duration of 5 days. Considering the total annual demand of 1.821.822 tons over 280 working days, the Re-order Point (ROP) is determined as shown in Table 6.

This research elaborates the discussion focusing on practical aspects and government policies. Here are some elaborations of the discussion that encompasses both aspects:

On the practical side, the Research Design involves the application of the Economic Order Quantity (EOQ) method for ordering rice supplies at *Bulog Warehouse* in the New *Tempel Lemahbang 202 Blora* has significant practical implications. Through observation and study, optimal ways of managing inventory can be identified, ensuring that orders are placed with cost efficiency in mind. This directly impacts warehouse operations and rice stock management, avoiding excess inventory that could lead to wasteful resource use.

In the context of government policies, this research contributes to the development of rice inventory policies at the national level. With data obtained from the official documentation of the company, the government could understand trends in rice inventory

over the past 12 periods at *Bulog Warehouse* in the New *Tempel Lemahbang 202 Blora*. This information can serve as a basis for the government to formulate more effective food inventory policies, including distribution policies and national stock management.

Data collection method involves direct observation, interviews with warehouse divisions, documentation, and literature review which is not only provide a quantitative overview but also practical insights into warehouse operations. These results can be used as a foundation for practical decision-making in optimizing logistics processes and inventory management. With a descriptive approach in the discussion method, this research not only presents figures but also provides a comprehensive overview of daily activities at *Bulog Warehouse* in the New *Tempel Lemahbang 202 Blora*. This information can serve as a basis for stakeholders, both at the company and government levels, to identify practical improvement opportunities in inventory and logistics management. Therefore, the results of this research not only contribute to quantitative understanding but also provide a practical perspective and policy relevance for those involved in inventory management and food policy.

The selection of the year 2019 as the record data year could be based on several fundamental reasons, primarily because the data was collected before the onset of the COVID-19 pandemic. Some reasons that could be explained are as follows: (1) normal Condition before the Pandemic: The year

Tabel 6 Calculation ROP

Lead Time (Days)	Lead Time (Per/years)	Demand (280 Days)	ROP (LT x D)
5	0.017857143	1.821.822 Ton	1.533 Ton

2019 reflects normal condition before the COVID-19 pandemic altered many aspects of life and business. By using data from that year, researches can understand the situation before the significant impact of the pandemic. (2) data Stability and Consistency: Data from the year 2019 may be considered more stable and consistent as it is not influenced by drastic changes that occurred during the pandemic. This can provide a more solid foundation for analysis and comparison (3) initial Reference for Comparison: Data from the year 2019 can serve as an initial reference for comparing the impact of the pandemic on various parameters, whether in terms of inventory, distribution, or stock management. This allows the identification of significant changes after the pandemic. (4) policy and Operational Continuity: Policies and operational procedures in 2019 may differ from the period during the pandemic. By understanding the previous condition, researches can assess changes better that may occur in response to unforeseen events such as a pandemic. (5) focus on Specific Aspects: The research emphasizes specific aspects that are not directly affected by the pandemic, such as the calculation of Economic Order Quantity (EOQ) in inventory management, using data from 2019 can provide a purer understanding of relevant variables.

D. Conclusion

Based on the analysis and discussion, it can be concluded that the implementation of the Economic Order Quantity (EOQ) method in rice procurement at *Gudang Bulog Baru Tempel Lemahbang 202 Blora* could enhance efficiency and reduce inventory costs. In the year 2019, the company placed rice orders 12 times, with an average order quantity of 151.819 tons. However, by employing the EOQ calculation, the company can increase the ordering frequency to 119 times per year, with a reduced quantity ordered each time. Additionally, the EOQ calculation helps the

company to reduce rice inventory costs by Rp 424.482.526 annually. Nevertheless, the implementation of EOQ requires adjustments and reassessment to minimize the company's annual expenditures effectively. The company should also consider the readiness of suppliers or working partners to meet the rice demand in *Gudang Bulog Baru Tempel Lemahbang Blora*.

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