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ANALYSIS OF RICE INVENTORY CONTROL AT PT. DAYA TANI SEMBADA NGAWI DISTRICT

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Abstract

The demand for rice fluctuates significantly along with the increase in population every year, making PT. Daya Tani Sembada, as a premium rice-producing company, must do planning to deal with changes in demand that will occur. This research aims to analyze rice demand forecasting and the optimal rice inventory. The method of determining the sample is purposive sampling, where the Director and Administrative Staff are vital informants. Demand forecasting was analyzed using the Double Exponential Smoothing (Holts) method and inventory control using Economic Order Quantity. The results showed that: 1) forecasting calculations show that the demand for rice in the next period is 33,367.38 tons; 2) inventory control calculations show that the company can prepare premium rice inventory of 29.89 tons, safety stock of 336.03 tons, ROP when rice inventory is at 779.47 tons, and TIC that must prepare amounting to IDR. 5,357,082,020, -, overall, demand for rice has increased by 8,662.58 tons from the previous period so that the company can increase production for the next period by the draft inventory control calculation.
Keywords: Holts Exponential Smoothing, EOQ, forecasting, inventory control

INTRODUCTION

Rice is the staple food consumed by most Indonesians due to the habits of Indonesians who destroy rice as a source of carbohydrates. According to data (Badan et al., 2022a), the population in Indonesia from 2018 to 2022 has increased by 11,612,200 people. In 2018, there were 264,161,600 people; in 2022, there were 275,773,800 people. Along with the increasing population every year, it must be accompanied by an increase in the amount of rice available to meet the basic food needs of the community.

According to data from the Badan Pusat Statistik Jakarta Pusat (2022b), the amount of rice production in Indonesia from 2018 to 2022 continues to fluctuate where the highest show was in 2018 at 59,200,533.72 tons while the lowest production was in 2021 at 54,415,294.22 tons. The increasing population in a country will threaten achieving food security; with enough people, the need for food supply at the national and regional levels will continue to increase. PT. Daya Tani Sembada is a company that processes grain into packaged rice ready to sell. The rice sold by the company is a type of premium rice. The following is data on rice sales in the last few months:

Table 1 Data at PT. Daya Tani Sembada

Time		Sales (tons)
Year	Month	
2022	February	1.114,37
	March	2.000,53
	April	1.468,73
	May	1.413,1
	June	1.591,51
	July	1.856,9
	August	1.940,43
	September	1.774,94
	October	1.971
	November	2.058,07
	December	1.431,56
2023	January	1.939,12
	February	1.591,4
	March	2.453,75
	April	1.996,08
	May	2.480,19
	June	2.292,33
	July	2.875,95

Source: PT. Daya Tani Sembada (2023)

Seeing population growth data that is increasing yearly and company sales that fluctuate every month will potentially decrease the quality of rice if stored for too long and cost efficiency, PT. Daya Tani Sembada, as a premium rice producer, requires careful planning to prepare for the possibilities that will occur in the future. Inventory control does because it can play an important role in determining and ensuring the availability of supplies, especially in rice food needs, both in quantity, quality, and at the right time.

Controlling the rice supply is essential to analyze because rice is one of the leading food commodities and is very strategic in maintaining the country's food security. As a country with a large population and high food demand, Indonesia relies heavily on an adequate supply of rice to fulfill the people's consumption needs. According to the economic aspect, analysis of rice inventory control can help optimize the allocation of resources involved in the supply chain, thereby reducing potential waste and unnecessary costs (Suarna et al., 2022; Solano et al., 2020; Kusumastuti, 2014; Maulidah, 2012).

They are seeing the importance of rice inventory control at PT. Daya Tani Sembada is one of the stakeholders whose role is to meet food needs in Ngawi and maintain the security of quality rice stocks amidst an increase in population and fluctuating demand; the author feels the need for timely, quantity, and quality inventory control. Forecasting rice demand using the Double Exponential Smoothing (Holts) method and controlling rice inventory using the EOQ (Economic Order Quantity) method is considered by the author to be appropriate for controlling inventory, especially at PT. Daya Tani Sembada. The objectives

achieved in this study are to analyze the forecasting of rice demand in the next period and analyze the optimal rice inventory at PT. Daya Tani Sembada.

LITERATURE REVIEW

Research related to inventory control carried out by several researchers and used as a source of study to write this research, such as research conducted by Willyanto et al. (2019) entitled "Controlling Sugar Raw Material Supplies in The Bottled Beverage Industry" aims to provide input regarding the method of ordering an economical amount of sugar raw materials to streamline and save costs at PT. XYZ. The methods used in this study are the Economic Order Quantity (EOQ), Period Order Quantity (POQ), and Min-Max methods as tools for analyzing and comparing, as well as the use of cycle forecasting methods, namely Trend Regression, the data used as analysis material is the last one year data. The results of the study state that the EOQ method is the most optimal and lowest total cost compared to the POQ and Min-Max methods, which is IDR.210,777,546; the company can save inventory costs of IDR.5,084,990 or 2.4% by using the EOQ method from the company's calculations.

Research conducted by Tannady et al. (2021) entitled "Production Planning and Inventory Control of Atonic Fertilizer Products Using Static Lot Sizing Method" aims to determine the optimal order quantity of atonic fertilizer and determine the total cost of atonic fertilizer inventory using the EOQ method, Kanban Method, and Holt-Winter Multiplicative Algorithm (HWMA) Method in planning to anticipate and plan for the future. The results of the study state that using the EOQ method is considered more optimal than the Kanban method, where when compared between the two, using the EOQ method will save costs of IDR.903,028,593 from the Kanban method.

According to Adam and Ronald (1996) in the book Widjaja et al. (2022), the definition of Production and Operations Management is the management of the conversion process from input to output in the form of manufactured products and services. Inputs can be in the form of land, workers, investment, management, technology, and others, while the outputs usually include services, consumer goods, and others.

According to Heizer and Render (2016), forecasting is the art and science of predicting future events. Forecasting will involve taking historical data (such as last year's sales) and projecting them into the future with mathematical models. Forecasting can be affected by the product's position in its life cycle. Forecasting by the future time horizon it covers. Forecasting for the short, medium, and long term are the three distinct subcategories that make up the time horizon. According to Makridakis (1999), the patterns of time series data into the following four categories:

1. Horizontal

This pattern occurs when data fluctuates around a constant average value. A product whose sales do not increase or decrease over a specific time belongs to this pattern.

2. Seasonal

   This data pattern occurs when a data series is affected by seasonal factors (e.g., a particular quarter of the year, month, or days of the week).

3. Cyclical

   This data pattern occurs when data is affected by long-term economic fluctuations, such as those associated with business cycles.

4. Trend

   Trend data patterns occur when there is a long-term secular increase or decrease in the data.

According to Rangkuti (2004), inventory is an asset that includes goods owned by the company to sell within a standard business period, an inventory of goods still in the work/production process, or an inventory of raw materials awaiting use in a production process. According to Chrisna and Hernawaty (2018), The company can determine how the inventory should be classified; however, if the company is the kind that buys goods to resell them, then there is only one type of merchandise inventory classification. Suppose the type of company is a manufacturer which processes raw materials into finished materials. In this scenario, the inventory classification into three categories: raw, semi-finished, and finished goods. According to Heizer and Render (2016), the costs involved in inventory management consist of:

1. Storage costs are associated with storing or "carrying" inventory for a specific time. Storage costs include using goods and storage-related costs, such as insurance, additional employees, and interest payments.
2. Ordering costs include the cost of supplies, formulas, order processing, purchasing, and administrative support.
3. Installation cost is the cost to prepare the machine or process to produce the order.

RESEARCH METHODS

1. Demand Forecasting

According to Arsyad (1993), the Hots Double Exponential Smoothing method can forecast data with a trend pattern that works by using two parameters, α and β, to smooth the trend and slope directly using different smoothing constants. This method has three equations, namely:

a. Exponential smoothing series

$$A_t = \alpha Y_t + (1-\alpha)(A_{t-1} + T_{t-1})$$

b. Trend estimation

$$T_t = \beta (A_t - A_{t-1}) + (1-\beta) T_{t-1}$$

c. Forecast at period p

$\hat{Y}_{t+p} = A_t + p\,T_t$

According to Heizer and Render (2016), various measures are used in practice to calculate forecasting errors. Some measures of forecasting error are as follows:

a. *Mean Absolute Deviation* (MAD)

$$MAD = \frac{\sum|Actual - Forecasting|}{n}$$

b. *Mean Squared Error* (MSE)

$$MSE = \frac{\sum|Actual - Forecasting|^2}{n}$$

c. *Mean Absolute Percent Error* (MAPE)

$$MAPE = \frac{\sum_{i-1}^{n} 100\left|\frac{Actual - Forecasting}{Actual}\right|}{n}$$

According to Hutasuhut et al. (2014), there is a range of values that can be used as a measurement material regarding the ability of a forecasting model as follows:

Table 2 MAPE Value Range

Range MAPE	Arti
< 10 %	Very Good Forecasting Model Capability
10 - 20 %	Good Forecasting Model Capability
20 - 50 %	Viable Forecasting Model Capability
> 50 %	Bad Forecasting Model Capability

Source: Hutasuhut et al. (2014)

2. Inventory Control

a. Economic Order Quantity (EOQ)

The Economic Order Quantity (EOQ) formula is as follows:

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

Description:

Q* = Optimal number of units per order (EOQ)

D = Annual demand in units for the inventory item

S = Installation or ordering cost for each order

H = Storage cost per unit per year

b. Safety Stock (SS)

The safety stock formula is as follows:

$SD = \sqrt{\frac{\Sigma(X-\bar{X})^2}{n}}$, dan *Safety Stock* = SD x Z

Description:

SD = Standard Deviation

$\overline{X}$ = Actual usage/need for goods

X = Estimated usage/need for goods

n = Amount of data (For example, monthly data in 1 (one) year, n = 12)

Z = Standard deviation table value for 5% deviation

c. Maximum Inventory (MI)

The maximum inventory formula is:

MI = SS + Q*

Description:

MI = Maximum inventory

SS = Safety Stock

Q* = Optimal order quantity (EOQ)

d. Reorder Point (ROP)

The ROP formula is as follows:

ROP = (LT x d) + SS

Description:

LT = Lead Time

d = Needs per day

SS = Safety stock

e. Total Inventory Cost (TIC)

The TIC formula is as follows:

TIC = $\frac{D}{Q^*}S + \frac{Q^*}{2}H$

Description:

TIC = Total Inventory Cost

Q* = Optimal number of units per order (EOQ)

D = Annual demand in units for inventory items

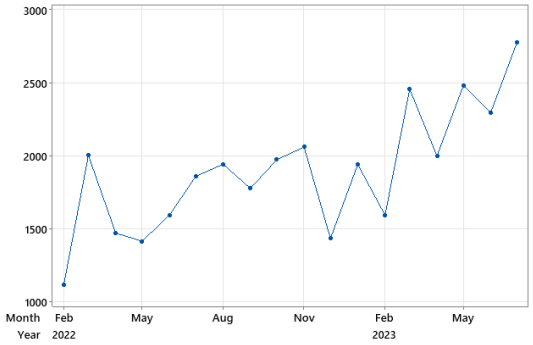
S = Installation or ordering cost for each order

H = Storage cost per unit per year

RESULTS AND DISCUSSION

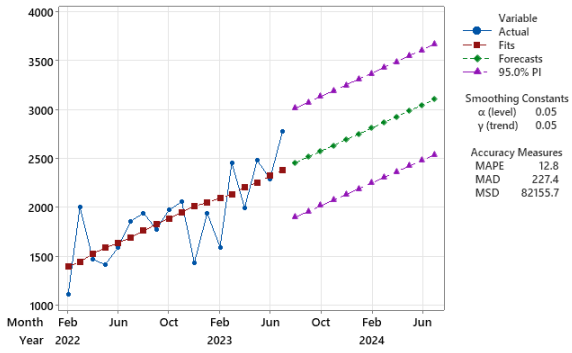
1. Forecasting Rice Demand of PT. Daya Tani Sembada

Forecasting to predict the demand for rice in the next period so that the company can prepare supplies according to consumer demand. Forecasting rice demand in the next period calculating using PT. Daya Tani Sembada's previous rice sales data from February 2022 to July 2023. The time series plot for PT. Daya Tani Sembada's rice sales data is as follows:



The figure above shows that the rice sales data of PT. Daya Tani Sembada is non-stationary because the sales data has a trend pattern, as evidenced in the time series plot, which shows increasing fluctuations or movements from the bottom left to the top right on the rice sales data graph. According to Salwa et al. (2018), stationary means no growth or decline in the data where the data should generally be horizontal along the time axis. Based on the data pattern analysis, the method chosen is Hots Double Exponential Smoothing.

Forecasting calculations for the Hots Double Exponential Smoothing method in this study using Minitab software with a constant value ($\alpha = 0.05$ and $\beta = 0.05$) resulted in a MAD of 227.4, which is the average value of the forecasting error between actual data and forecasting, MSE of 82,155.7 which is the average value of the squared forecasting error, and the MAPE obtained is 12.8% which according to Hutasuhut et al. (2014) the value range of 10-20% can be said to have good forecasting ability. The results of rice demand forecasting, when presented in graphical form, are as follows:



Based on calculations using the Hots Double Exponential Smoothing method, the total demand for premium rice in the next period is 33,367.38 tons, more significant than the previous 24,704.8 tons. The increase in demand obtained from the forecasting results is due to rice sales at PT. Daya Tani

Sembada, in the last few months, has shown fluctuations that tend to increase, so there is a high probability of an increase in the coming period. It is also in line with data from the Badan Pusat Statistik Jakarta Pusat (2022a) regarding the increase in population in Indonesia every year, where the increase in population will cause an increase in the level of essential food consumption to support the sustainability of life so that it hopes that with this forecasting the company will be able to meet demand which can indirectly create food security.

2. Rice Inventory Analysis of PT. Daya Tani Sembada

a. Economic Order Quantity (EOQ)

The calculation of optimal rice inventory refers to the rice demand forecasting data as variable (D) or the annual demand for inventory items. Forecasting rice demand is presented in the following table:

Table 3 Forecasting Rice Demand at PT. Daya Tani Sembada

Time		Forecasting (tons)
Year	Month	
2023	August	2.456,14
	September	2.515,14
	October	2.574,13
	November	2.633,13
	December	2.692,12
2024	January	2.751,12
	February	2.810,11
	March	2.869,11
	April	2.928,1
	May	2.987,1
	June	3.046,09
	July	3.105,09
Total		33.367,38

Source: Data collaged (2023)

EOQ is calculated based on the total demand for rice from August 2023 to July 2024, the cost of ordering raw materials, and the cost of storing inventory. The order costs used in this calculation are loading labor and transportation costs. The details of the ordering costs incurred by PT. Daya Tani Sembada are as follows:

Table 4 Ordering Cost Details per Transport at PT. Daya Tani Sembada

Description	Cost (IDR)
Loaders	900.000

Transport	1.500.000
Total	2.400.000

Source: PT. Daya Tani Sembada (2023)

The cost of storing rice inventory incurred by PT. Daya Tani Sembada consists of the cost of warehouse supervisory personnel for four people, pest control using Rentokil services, and land building tax.

Table 5 Storage Cost Details per Year at PT. Daya Tani Sembada

Description	Cost (IDR)
Warehouse Supervisor	144.000.000
Pest Control	34.536.000
Land & Building Tax	700.000
Total	179.236.000

Source: PT. Daya Tani Sembada (2023)

The EOQ calculation for optimal rice inventory based on inventory requirements, ordering costs, and storage costs is as follows:

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

$$Q^* = \sqrt{\frac{2\ (33.367{,}38)\ (2.400.000)}{(179.236.000)}}$$

$$Q^* = \sqrt{\frac{160.163.424.000}{179.236.000}} = \sqrt{893.59}$$

$Q^* = 29{,}89$ tons

$$\text{Order frequency} = \frac{D}{Q^*}$$

$$= \frac{33.367{,}38}{29{,}89}$$

$= 1.116.34 \approx 1.116$ times

Based on these calculations, PT. Daya Tani Sembada can order an inventory of 29.89 tons of GKP in each order and with a frequency of 1,116 times.

b. Safety Stock (SS)

Calculation of safety stock, which aims to calculate the amount of safety stock to avoid stockouts. According to Purnomo and Riani (2018), safety stock calculates the standard deviation and allowable error values of 5% or 1.65. The results of the calculation table are as follows:

Table 6 Standard Deviation Calculation

Time		X	$\overline{X}$	$(X-\overline{X})$	$(X-\overline{X})^2$
Year	Month				

2023	August	2.456,14	2.780,61	-324,47	105.280,78
	September	2.515,14	2.780,61	-265,47	70.474,32
	October	2.574,13	2.780,61	-206,48	42.633,91
	November	2.633,13	2.780,61	-147,48	21.750,35
	December	2.692,12	2.780,61	-88,49	7.830,48
2024	January	2.751,12	2.780,61	-29,49	869,66
	February	2.810,11	2.780,61	29,5	870,25
	March	2.869,11	2.780,61	88,5	7.832,25
	April	2.928,1	2.780,61	147,49	21.753,3
	May	2.987,1	2.780,61	206,49	42.638,12
	June	3.046,09	2.780,61	265,48	70.479,63
	July	3.105,09	2.780,61	324,48	105.287,27
	Total	33.367,38			497.700
	Average	2.780,61			

Source: Data Collaged (2023)

The results of the calculation of the standard deviation value are as follows:

$$SD = \sqrt{\frac{\Sigma(X-\bar{X})^2}{n}}$$

$$SD = \sqrt{\frac{497.700}{12}}$$

$$SD = \sqrt{41.475}$$

SD = 203,65 tons

The safety stock calculation is as follows:

SS = SD x Z

SS = 203,65 x 1,65

SS = 336,03 tons

Based on the above calculations, the rice inventory at PT. Daya Tani Sembada uses a safety stock of 336.03 tons of rice to avoid stockouts.

c. Maximum Inventory (MI)

Maximum Inventory calculation aims to determine the largest amount of inventory that can be held by the company in order to avoid losses due to the potential decline in the quality of rice owned with the following calculations:

MI = SS + Q*

MI = 336,03 + 29,89

MI = 365.92 tons

Based on the above calculations, the maximum amount of inventory the company can hold is 365.92 tons to avoid losses due to a potential decrease in the quality of rice owned.

d. Reorder Point (ROP)

The ROP calculation aims to determine the right time to reorder raw materials before the company's inventory runs out; the ROP calculation considers the Lead Time variable for the availability of rice inventory, which is four days. The reorder the following formula calculates the point:

ROP = (LT x d) + SS

ROP = (4 x $\frac{33.367,38}{288}$) + 336,03

ROP = (4 x 115.86) + 336,03

ROP = 463,44 + 336,03

ROP = 779,47 tons

Through the above calculations, PT. Daya Tani Sembada can reorder grain raw materials when the rice inventory in the warehouse is 779.47 tons; this calculation aims to maintain inventory so that it is reasonable and sufficient.

e. Total Inventory Cost (TIC)

The TIC calculation aims to determine the inventory costs that the company must prepare to meet demand needs in the next period. The TIC calculation is as follows:

TIC = $\frac{D}{Q^*}S + \frac{Q^*}{2}H$

TIC = $\frac{33.367,38}{29,89}2.400.000 + \frac{29,89}{2}179.236.000$

TIC = 2.678.400.000 + 2.678.682.020

TIC = 5.357.082.020

Based on the above calculations, the total cost of the company's responsibility for carrying out trade goods inventory using EOQ inventory analysis for one period ahead is IDR.5.357.082.020,- where this cost consists of ordering costs and rice storage costs.

CONCLUSION

It is forecasting the demand for premium rice from August 2023 to July 2024 at PT. Daya Tani Sembada was carried out using the Holts Double Exponential Smoothing method and resulted in a more significant amount of rice demand than in the previous period; this is in line with the increasing population, which has the potential to cause an increase in food consumption in Indonesia. The increase in rice demand allows the company to expand the partnership network to grain suppliers through farmers, farmer groups, or intermediaries to maximize production capacity daily, accompanied by inventory control using the Economic Order Quantity method so that the production process can run smoothly.

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