



CONTROL OF EXTERNAL TIRE SPARE PARTS 7.50-16 INEFFICIENCY INVENTORY COSTS BASED ON ECONOMIC ORDER QUANTITY (CASE STUDY AT PT. XYZ - JAKARTA)

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Abstract: This study focuses on inventory control of spare parts outside the prohibition 7.50-16 to streamline inventory costs. The method used is Economic Order Quantity with the type of case study design at the company PT. XYZ with the object of research is the supply of Outer Tire Parts 7.50-16. In data collection, the researcher compares the Traditional or Actual Company Method with the Economic Order Quantity Method in 2019 and 2020. The data that has been collected becomes several references in the calculation so that there is a difference between the two methods. The results show that the Economic Order Quantity method can streamline inventory control beyond 7.50-16 at PT. XYZ.

Keywords: Economic Order Quantity (EOQ), Safety Stock, Reorder Point, Total Inventory Cost, Efficiency

INTRODUCTION

Providing solutions in controlling the inventory of spare parts of a company is very important because if there is no control of the supply of spare parts it can become an obstacle to the production of goods or an obstacle to consumer needs in the form of goods or services produced (Sugiyono 2019). Therefore, the company must wisely procure spare parts inventory because if it is not managed properly, there will be losses. One of the losses incurred is costs that should not be incurred by the company such as damage to goods stored for too long, building costs, and other costs (Ahmad Badawi Saluy, Sugiyono Madelan 2021).

Planning and controlling spare parts are two important things in the company to minimize costs and maximize profits for the company. In minimizing the costs borne by the company, it can use the Economic Order Quantity method. Economic Order Quantity (EOQ) is an inventory system that aims to minimize the total costs incurred to determine the order quantity.

PT. XYZ is a plantation company with an office address in South Jakarta. This company produces Fresh Fruit Bunches (FFB) as the main raw material for producing Crude Palm Oil (CPO). For the production process to run smoothly, PT. XYZ must provide materials and spare parts in the form of Outer Tires 7.50-16 for the Dump Truck unit as the main transport vehicle for FFB at the plantation site. For the procurement of spare parts to be managed properly, the researchers conducted an analysis of spare parts control in this company which in this paper is used as an example of calculation and analysis of spare parts control.

The purpose of controlling spare parts is to (1) determine the optimal number of spare parts purchases based on the Economic Order Quantity method by PT. XYZ. (2) Knowing the effective purchase frequency based on the Economic Order Quantity method by PT. XYZ. (3) Knowing the reorder point or Re-Order Point based on the Economic Order Quantity method by PT. XYZ. (4) Knowing the safety stock based on the Economic Order Quantity method by PT. XYZ. (5) Knowing the distance between efficient orders based on the Economic Order Quantity method by PT. XYZ. (6) Knowing the efficiency of total inventory costs based on the Economic Order Quantity method by PT. XYZ.

Research Problem Formulation

Based on the description above, it can be formulated as follows:

1. What is the most economical purchase of spare parts by PT. XYZ based on the Economic Order Quantity method?
2. What is the effective purchase rate by PT. XYZ based on the Economic Order Quantity method?
3. When to reorder or Reorder Point Spare Parts by PT. XYZ based on the Economic Order Quantity method?
4. How much safety stock should be provided by PT. XYZ based on the Economic Order Quantity method?
5. How long is the efficient distance between orders by PT. XYZ based on the Economic Order Quantity method?
6. What is the efficiency of total inventory costs based on the Economic Order Quantity method by PT. XYZ in 2020?

Research purposes

1. To find out the optimal number of spare parts purchases based on the Economic Order Quantity method by PT. XYZ.
2. To find out the effective purchase rate based on the Economic Order Quantity method by PT. XYZ.
3. To find out the reorder point or Reorder Point based on the Economic Order Quantity method by PT. XYZ.
4. To find out the safety stock based on the Economic Order Quantity method by PT. XYZ.
5. To find out the distance between efficient orders based on the Economic Order Quantity method by PT. XYZ.
6. To determine the efficiency of total inventory costs based on the Economic Order Quantity method by PT. XYZ.

THEORETICAL REVIEW

Inventory

Opinion (Yuliana, Topowijono, and Sudjana 2016) all goods or materials needed in production and distribution are called inventories. According to (Assauri 2018) the reasons for the need for inventory by a company are as follows:

1. Efficient time to complete production which aims to move products from one process to another.
2. Prepare the material needed to expedite and complete production.
3. The schedule needed to monitor the required material.

The inventory functions according to (Rangkuty 2017) are as follows:

1. The function of decoupling is that the company does not depend on one supplier to meet customer demands.
2. Economic Lot Sizing function makes the cost per unit cheaper with the need for consideration of savings or purchase discounts.
3. Anticipation function, forecasting, or forecasting of the company if the company faces fluctuations in demand.

Several things need to be considered in determining the number of variable costs and determining inventory policies that can minimize costs. According to (Rangkuty 2017) are as follows (1) Storage costs (holding costs/carrying costs) are costs required for all aspects related to carrying inventory over a certain time. (2) Ordering costs include costs such as labor, processing orders, and also the form in the order. (3) Setup costs are costs used to prepare machines or processes to produce orders.

Method Economic Order Quantity (EOQ)

EOQ (Economic Order Quantity) is an optimal method of purchasing Materials that is carried out at every purchase by minimizing inventory costs. EOQ calculation is as follows:

Analysis Economic Order Quantity (EOQ)

To be able to determine the optimal number of orders or purchases for each order, it is necessary to calculate the economic optimal purchase quantity or Economic Order Quantity (EOQ). By knowing all the values of these variables, we can find an effective inventory for a spare part (Heizer and Render 2015) as follows:

$$EOQ = \sqrt{\frac{2 \cdot D \cdot S}{H}}$$

Information :

- EOQ = Optimal Order Quantity (Q*)
- D = Annual demand for inventory items in units
- S = Ordering cost per order
- H = Storage cost per unit per year

Purchase Rate

To calculate the number of orders made annually, it is necessary to analyze the purchase rate about the results of calculations using the EOQ method. (Heizer and Render 2015). The formula is as follows:

$$I = \frac{D}{Q}$$

Information :

- I = Purchase rate
- D = Demand in a year
- Q* = Optimum number of items per Order

Total Cost of Spare Parts

The total cost is the cost resulting from the sum of the setup costs and storage costs (Heizer and Render 2015) as follows:

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

Information :

- TIC = Total Inventory Cost
- D = Annual inventory demand in units
- Q* = Optimum number of items per order
- S = Cost of installation or order of each order
- H = Cost of holding or storage per unit per year

Reorder Point Analysis

The reorder point can be determined by specifying the user as long as there is a lead time and adding it to the usage for a certain period as safety stock (Heizer and Render 2015). The formula is as follows:

$$ROP = d \times L$$

Information :

- ROP = Reorder Point (units)
- D = Spare Part Usage per day (units/day)
- L = Lead time for order new (day)

Analysis of Safety Stock

Safety stock is an inventory that is reserved as a safeguard against the continuity of the company's production process. Safety stock is needed because, in reality, the number of Spare Parts needed for the production process is not always exactly as planned (Heizer and Render 2015):

$$S = \sqrt{\frac{\sum_i^n = i (xi - \bar{x})^2}{n - 1}}$$

Safety Stock = number of standard deviations: number of times of use

Information :

- S = Standard deviation
- x_i = Actual usage Pemakaian
- \bar{x} = Average usage
- N = Number of data

Analysis of Time Between Orders

The time gap between orders is the difference in time when one order is placed with the next order (Heizer and Render 2015). The time gap between orders can be calculated by the formula:

$$T = \frac{W}{N}$$

$$N = \frac{D}{Q^*}$$

The time gap between orders can be calculated by the formula:

Information :

- T = Time interval between orders
- W = Number of working days in a year
- Q* = Optimum number of items per order
- D = Annual demand for inventory items in units

Previous Research

Based on the results of the study that controlling the supply of Outer Tire Spare Parts 7.50-16 inefficient inventory costs using Economic Order Quantity there are similarities with previous research. The following is the similarity of spare parts inventory control of 7.50-16 using the EOQ method with previous research:

- a. The research conducted by Eyverson Ruauw with the research title "Control of Raw Material Inventory Using the Economic Order Quantity Method (a case study on the Grenda Bakery Lianti business, Manado)", which has the conclusion that after using the EOQ method that there are savings in ordering, storage and inventory by 20%.
- b. Research conducted by Candra Yulian, Topowijono, and Nengah Sudjana with the title "Implementation of the Economic Order Quantity Model to Minimize the Cost of Raw Material Inventory". In this study, it can be concluded that with the EOQ method it can be seen the optimal number of orders, order rates, and safety stock, as well as savings in inventory costs of 15% from the actual company.
- c. The research was investigated by Yazid Ilham, Dirarini, and Louis with the title "Control of Raw Material Inventory with Economic Order Quantity Method at Dwi Jaya Bakery". In this study, it was concluded that the EOQ method can determine the optimal quantity, order rate, reorder point, safety stock, and savings on inventory costs of 18% of the actual company.

RESEARCH METHODS

Research design

The type of research used in this research is descriptive quantitative research. In addition, this research is a type of research that discusses and explains the influence between variables using the Economic Order Quantity (EOQ) Analysis method.

Research variable

Variable	Dimensions	Indicator	Measurement	scale
Inventory Control	<i>Economic Order Quantity Inventory Control</i>	The quantity Required for a certain period (D). Ordering fee per order (S). Spare parts storage costs in the warehouse (H).	pcs/message	pcs
	<i>Rate</i>	The quantity required during a certain period (D). Optimum quantity per order (Q*)	Rate/years /pcs	Rate/years /pcs
	<i>Reorder Point</i>	Demand per day (d). Order lead time new in days (L).	pcs	pcs
	<i>Safety Stock</i>	The standard deviation of the amount of usage. amount of time usage.	pcs	pcs
		Distance between order (T). Number of working days in a year (W). Optimum amount per order (Q*). The quantity needed for certain period (D)	Day/message	Day/message
Efficiency Cost Inventory	Set Up Cost	All costs issued in order to hold ordering goods. Depends on how many times the order is placed.	Rp./Order/pcs	Rp/Order/pcs
	Holding Cost	Inventory level average. Storage costs per unit per year.	Rp./Years/pcs	Rp./Years/pcs

Analysis Method

The research data were analyzed using the Economic Order Quantity (EOQ) method, order rate analysis, total inventory costs, reorder point analysis, safety stock analysis, distance, and time analysis (Expected Time Between Orders).

RESEARCH RESULTS AND DISCUSSION

This section contains data in a simple form, analysis, and research results that are displayed in the form of tables or graphs to facilitate verbal results. Purchase of 7.50-16 Outer Tire Parts in 2019 and 2020

Table 1. Purchase of Outer Tire Parts 7.50-16 in 2019 and 2020

Years	Purchase Amount (pcs)	
	2019	2020
Jan	0	0
Feb	20	100
Mar	105	0
Apr	125	224
Mei	1	60
Jun	0	0
Jul	100	0
Aug	0	0
Sept	0	26
Oct	125	0
Nov	160	0
Dec	0	0
Total purchase	636	410
Average per month	53	34

The table above explains that not every month the company places an order. In 2019 the company ordered spare parts with a total quantity of 636 pcs in 7 orders and 4 times in 2020 with a total of 410 pcs. The company makes orders with fluctuating amounts because the number of orders depends on the initial stock owned by the company, which is 582 Pcs in 2019 and 588 pcs in 2020 while for the use of Outer Tire Spare Parts 7.50-16 can be seen in table 2

TABLE 2. USE OF OUTER TIRE PARTS 7.50-16

Month Total Usage (pcs)	Years	
	2019	2020
Jan	46	39
Feb	40	78
Mar	79	28
Apr	54	86
May	62	59
Jun	39	57
Jul	59	66
Aug	49	23
Sep	3	-

Oct	93	-
Nov	37	-
Dec	103	26
Total Usage	664	462
Usage Average per Month	55	39

As shown in the table above, the largest use of external tires occurred in December 2019, which was 103 pcs due to the number of external tires that had to be replaced by the number of kilometers and the condition of the outer tires that were not suitable for use. Meanwhile, the lowest usage of outer tires occurred in September 2019 as many as 3 pcs. The highest number of Outer Tire usage in 2020 was in April as many as 86 pcs and the lowest was in September, October, November which was 0 pcs because in the 3rd month the peak harvest was taking place which required oil palm fruit to be transported immediately. and arrived at the factory to maintain the quality of the fruit.

Set Up Cost

Ordering Fees are costs incurred each time an order includes telephone costs, administration fees, and loading and unloading costs. More details about the ordering fee can be seen in Table 3.

TABLE 3. COST COMPONENTS OF ORDERING PARTS MATERIALS TIRE 750-16 PER ORDER IN 2019 AND 2020

Cost component	Spare Part outer tire 7.50-16 (Per Order)	
	2019	2020
Call Charges	3.200	3.500
Administrative Costs	75.270	131.520
Loading and Unloading Fee	5.266	15.164
Total	83.736	150.184

The table above shows that the total cost of ordering each time an order is made in 2019 is Rp. 83,736 and increased in 2020 with a total of Rp. 150,184. Telephone charges are used to communicate or coordinate with suppliers of goods. For the telephone fee itself, it is obtained from the length of communication at times with the telephone tariff that has been determined every year. Meanwhile, administrative costs are required for correspondence or other documents that are needed, as a condition or complement to an order. Meanwhile, unloading costs are costs incurred for the wages of someone who moves goods from the vehicle to the storage warehouse for more

Holding Cost

PT. XYZ consists of the cost of warehouse implementation salaries, electricity costs, warehouse maintenance costs. More details can be seen in table 4.

TABLE 4. COST COMPONENTS FOR STORAGE OF OUTER TIRE PARTS 750-16 IN 2019 AND 2020

Cost Component	Spare Part Outer Tires 7.50-16 (Rp. /Years)	
	2019	2020
Warehouse Executor Salary Cost	137.124	237.824
Electricity cost	17.599	20.349
Warehouse Maintenance Cost	40.270	46.563

Total	194.993	304.735
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In the table above, the total cost of storing spare parts in 2019 is Rp. 194,993 and in 2020 the total storage cost is Rp. 304,735 means that there is an increase in storage costs every year.

Data analysis

Spare Parts Needs Analysis based on the calculation of the EOQ method The following are the stages that are passed in the calculation of the Economic Order Quantity method:

Economic Order Quantity (EOQ)

Optimum purchase quantity in 2019 and 2020.

$$EOQ = \sqrt{\frac{2.S.D}{H}}$$

$$EOQ = \sqrt{\frac{2.83736.664}{194993}} = 24$$

It has been determined that in 2019 the optimal quantity is 24

$$EOQ = \sqrt{\frac{2.150184.462}{304735}} = 21$$

While in 2020 the optimal quantity is 21

Determination of Purchase Rate

Purchase rate analysis is used to calculate how many orders are made each year. By using reference from the calculation results of the EOQ method (Hansen 2013)

Table 5. Determination of Purchase Rate

Years	Spare Part	Demand (D)	EOQ (Q*)	Rate
		a	b	c = a / b
2019	Outer Tires 750-16	664	24	28
2020	Outer Tires 750-16	462	21	22

Based on the table above, it is known that the order rate in 2019 was 28 while in 2020 it was 22.

Total Inventory Cost Based on Company Actual

The calculation of the total cost of inventory based on the company's actual conditions during 2019 and 2020 and the total cost of inventory based on the company's actual conditions are presented in the table below:

TABLE 6. TOTAL INVENTORY COST BASED ON ACTUAL COMPANY

Year	Spare Part	Set Up Cost / Year (Rp)	Holding cost/ Years (Rp)	Total Inventory (Rp)
		a	b	c = a + b

2019	Outer Tires 750-16	586.155	14.396.964	14.983.119
2020	Outer Tires 750-16	600.736	19.477.639	20.078.376

Ordering costs are costs that are obtained from the total cost of ordering components multiplied by how many orders are in one year while storage costs are obtained from the total cost of storage components multiplied by the average inventory. Based on the results of the analysis of the company's actual total inventory costs, the total inventory in 2019 was Rp. 14,983,119 while in 2020 it was Rp. 20. 078.376.

Total Inventory Cost Based on Economic Order Quantity Method.

The total inventory cost is the sum of the total ordering costs and the total holding costs. The following is a table of total inventory costs based on the EOQ method:

TABLE 7. TOTAL INVENTORY COST BASED ON EOQ METHOD

Year	Spare Part	Set Up Cost /Year (Rp)	Holding Cost /Year (Rp)	Total Inventory Cost (Rp)
2019	Outer Tires 750-16	2.328.282	4.656.563	6.984.845
2020	Outer Tires 750-16	3.251.465	6.502.930	9.754.395

The table above is the result of an analysis of the total inventory cost based on the Economic Order Quantity (EOQ) method and it is found that the total inventory cost in 2019 is Rp. 6,984,845.- while in 2020 it is Rp. 9,754,395.-

Determination of Safety Stock in 2019 and 2020

The use of spare parts every month is not exactly constant. The amount of usage may increase to meet the production process, that's when safety stock is needed. Safety stock is an additional inventory held to maintain the continuity of production from the possibility of a shortage of spare parts. This can be seen in the following table:

TABLE 8. DETERMINATION OF SAFETY STOCK

Year	Standard Deviation	Total Time Usage (month)	Safety Stock (Pcs)
	a	b	c = a/b
2019	27	1	27
2020	31	1	31

Based on the table above, the analysis results from the calculation of the Safety Stock in 2019 were 27 while in 2020 it was 31.

Determination of reorder points for 2019 and 2020

The reorder point can be determined by specifying the user as long as there is a lead time and adding it to the usage for a certain period as safety stock (Render, 2011). The following is the determination of the re-order point.

TABLE 9. REORDER POINT FOR 2019 AND 2020

Year	Spare Part	Lead Time (day)	Usage Average/day (pcs)	Reorder Point (pcs)
		a	b	c = a x b
2019	Outer Tires 7.50-16	26	2,2	58
2020	Outer Tires 7.50-16	23	1,5	36

In the table above, the results of the analysis of the Reorder Point calculation have been determined in 2019 as many as 58 pcs while in 2020 as many as 36 pcs

Expected Time Between Orders

The time gap between orders is the difference in time when one order is placed with the next order. By calculating the time gap between orders, we can estimate how long spare parts inventory is stored in the warehouse. This is especially important to prevent a decrease in the quality of Spare Parts due to being stored for too long. The following is the calculation of the time gap between orders for 2019 and 2020.

TABLE 10. CALCULATION OF THE DISTANCE BETWEEN ORDERS

Year	Spare Part	amount Working days /Year (w)	EOQ (Q*)	Demand / Year (D)	Distance time Delivery Order (T=WQ*/D)
2019	Outer Tires 750-16	298	24	664	11
2020	Outer Tires 750-16	299	21	462	14

Based on the results of the calculation of the time interval between orders, it is known that the time gap between orders in 2019 is 11 days while in 2020 it is 14 days.

Comparison of the Company's Total Cost of Actual Spare Parts Inventory with the EOQ Method

The actual method used by the company can be compared with the EOQ method. By knowing the results of the comparison, the company will know which method is effective to produce minimum costs and this is a more effective method for the company. The comparison can be presented in the following table:

TABLE 11. COMPARISON OF THE TOTAL COST OF THE COMPANY'S ACTUAL SPARE PARTS INVENTORY USING THE EOQ METHOD.

Description	Spare Part Outer Tires 7.50-16	
	2019	2020
I. Company Actual		
1.Set Up Cost	586.155	600.736
2.Holding cost	14.396.964	19.477.639
3.Total Inventory Cost (1+2)	14.983.119	20.078.376
II. EOQ Method		
4.Set Up Cost	2.328.282	3.251.465

5.Holding cost	4.656.563	6.502.930
6.Inventory Cost (4+5)	6.984.845	9.754.395
III Difference		
7.Set Up Cost (1-4)	- 1.742.127	- 2.650.729
8.Holding cost (2-5)	9.740.400	12.974.709
9.Inventory Cost (3-6)	7.998.274	10.323.980
Total Savings	7.998.274	10.323.980

From the data obtained at PT. XYZ that by using the EOQ method the company can save costs of Rp. 7,998,274 in 2019 and Rp. 10,323,980 in 2020. The cost of ordering with the EOQ method results in a larger order cost of Rp 2,328 .282 in 2019 and 2020 of Rp.3,251,465 compared to orders using the Company's Actual, this is due to the order rate made to order Spare Parts using the EOQ method more often than the Company's Actual which has been doing so far.

If you look at the storage costs carried out on the Actual Company, it will be very much different from the storage calculated using the EOQ Method. The Company's Actual Storage Fee is Rp. 14,396,964 while, using the EOQ Method, it is only Rp. 4,656,563 in 2019 and 2020 the actual storage cost of the company was Rp. 19,177,983 and Rp. 6,502,930 on the EOQ method. This is because the more orders are made, the fewer storage costs are needed because there is no accumulation of spare parts in the warehouse

CONCLUSION AND SUGGESTION

Conclusion

Based on the results of research and discussion, the following conclusions can be drawn:

1. With the Economic Order Quantity Method, the optimal number is obtained in each order so that inventory costs can be more efficient.
2. With the Economic Order Quantity Method, you can find out the Order Rate so that it can be seen how many times an order can be made each year.
3. The Economic Order Quantity method can find out when the Reorder Point should be made by the company so that the supply of spare tire parts is always there so that it does not hamper the production process.
4. Safety stock can be determined precisely so that the amount of safety stock of spare parts for outer tires 7.50-16 is not excessive or insufficient.
5. The Economic Order Quantity method has a more measurable waiting time interval compared to the actual company.
6. With calculations using the Economic Order Quantity method, there are savings in the cost of spare parts inventory for tires 7.50-16 which greatly affects the profits earned by the company.
7. There are similarities in previous studies consisting of the objects studied, namely inventory control, using the EOQ method, and minimizing inventory.
8. It can be seen in previous research that there is a similarity in the method in this study which states that the EOQ method can reduce inventory costs.

Suggestion

In connection with these conclusions, the suggestions that can be put forward in this study are as follows:

1. In calculating the quantity using the Economic Order Quantity method, the optimal number of each order is found, namely 24 pcs in 2019 and 21 pcs in 2020, while the traditional method only looks at the average quantity per order of 46 and 57. Therefore, suggestions researchers

- to companies to be able to implement the EOQ method so that the amount of inventory is optimal.
2. Based on the company's actual that the order rate was made 7 times in 2019 and 4 times in 2019 because, the small number of order rates causes high storage costs, on the contrary, based on the EOQ method, it is known that the order rate is more often done, which is 28 times in 2019 and 22 times in 2020 Thus, leading to savings in storage costs. Therefore, researchers suggest to companies apply the EOQ method so that storage costs are efficient.
 3. Based on the EOQ method, the reorder point was found at 58 pcs in 2019 and 36 pcs in 2020, while the company did not find a reorder point. So that researchers suggest for companies be able to apply the EOQ method to find out the reorder point.
 4. Based on the EOQ method, the number of safety stock was found, namely 27 in 2019 and 31 in 2020 which is a safety stock as long as the order has not arrived at the company so that the production process can be carried out, while the company does not have a safety stock so that the production process can stop. Researchers suggest to companies apply this EOQ method to determine the amount of safety stock.
 5. Based on the EOQ Method, the time gap between orders is not too long, which is only 11 days in 2019 and 14 days in 2020. Meanwhile, the actual time between orders for the company is quite long, namely 39 days in 2019 and 45 days in 2020. researchers suggest to the company to implement the EOQ method to obtain the time gap between orders that is faster than the actual company.
 6. Based on this EOQ method, one of the most important benefits is the cost efficiency of spare parts inventory. It is known that there are savings between the actual company and the EOQ method, namely in 2019 there were savings of Rp. 7,998,274 and in 2020 amounted to. Rp. 10,323,980. researchers suggest to companies apply the EOQ method to companies to obtain efficiency in inventory costs.
 7. Previous research has proven that with the EOQ method there is a systematic calculation so that it can facilitate companies in controlling the supply of spare tire parts 7.50-16
 8. Previous research concluded that with the EOQ method there is cost efficiency that can affect the profits earned by the company. Therefore, the researcher suggests to the company to apply the EOQ method to the inventory control of spare parts for tires 7.50-16 for the cost efficiency of spare parts for tires 7.50-16.

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