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Application of *Economic Production Quantity* (EPQ) Method and *Just in Time* Method (JIT) in Bread Raw Material Inventory Control

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ABSTRACT

Retno bakery Bread Shop is one of the shops that produces various types of bread. This bakery has not used a inventory control system in the production process so it cannot meet customer needs. For this reason, Retno Bkery Bakery needs to control inventory so that the company's performance and profits are more optimal. This study discusses the control of the inventory of each bread raw material such as flour, sugar, milk, yeast, salt, butter and eggs. The purpose of this study is to obtain the results of the total cost of bread raw material inventory using the Economic Production Quantity (EPQ) method and the Just in Time (JIT) method as well as the comparison of the two methods used. The methods used are the Economic Production Quantity (EPQ) and Just in Time (JIT) methods. Based on the results of the study, the percentage difference in cost for each raw material was obtained using the Economic Production Quantity (EPQ) method and the Just in Time (JIT) method, namely for flour raw materials of 42.05%, sugar 47.31%, milk 51.63%, yeast 51.83%, salt 47.65%, butter 51.38% and eggs 51%. Thus, the Just in Time (JIT) method results in a smaller total cost than the Economic Production Quantity (EPQ) method.

Keywords:
Economic Production Quantity (EPQ), *Just in Time* (JIT), Inventory Control, Retno Bakery Shop.

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1. INTRODUCTION

Every company in optimizing its production process must be able to control inventory control. When there is an excess of inventory, it will increase maintenance and storage costs and experience the risk of damaged raw materials, while when there is a lack of inventory, the company cannot meet customer needs. One of them happened to the Retno Bakery Shop which did not use an inventory control system, so it was necessary to carry out inventory control for the production process at the bakery.

The problem that often arises in inventory control is the ineffectiveness and efficiency of inventory due to excess inventory which results in losses, accumulation of raw materials, etc. On the other hand, if there is a shortage of raw material inventory stocks, it will result in not being able to meet consumer demand (Andrean. R, Fendy. S and Nugroho. A, 2019). So that to optimize the supply of raw materials, companies need to control inventory.

Inventory control is the process of regulating the amount of raw materials stored, storage costs, smooth production and profits obtained (Daud. M. N, 2017). Every company must have good skills in managing inventory planning to achieve production process optimization (Lahu. E. P, 2017). Inventory is a strategy that companies use to organize, plan, and control the stock of goods according to consumer demand. The purpose of inventory management is to ensure stock availability, meet customer needs on time, avoid delays in delivery and maintain customer trust to increase satisfaction (Affandi. P, 2019). Some of the methods used for inventory control include *the Economic Production Quantity* (EPQ) method and *the Just In Time* (JIT) method.

The EPQ method is an inventory management model developed for situations where goods or products are produced on a large scale, meaning that the amount of production must be more than consumer demand (Mulyana. E, Febrianti. E and Kulsum, 2015). Meanwhile, the JIT method is a method that produces the production of goods in accordance with consumer demand so that it can save costs more efficiently and potentially increase the Company's profits (Wanayumini and Iskandar, M. A, 2019).

Some previous research related to *the Economic* EPQ and JIT methods includes research conducted by Pradana, V. A and Jakaria, R. B in 2020 obtained results by applying the JIT method which produces raw materials according to consumer needs or demands, which can produce a more optimal and efficient total cost compared to using the EOQ method. Furthermore, the research was conducted by Syahputra, F. A, Dur. S and Rakhmawati, F in 2022 explained that the JIT method is more effective and efficient than the method previously used by the company, because it can significantly reduce the cost of storing raw materials. The next research was by Asmara. T and Fajar, M.Y in 2020 by applying the EPQ method, the company can optimize inventory costs in its production process.

Furthermore, research conducted by Badruzzaman, F. H, et al. in 2017 obtained the results of the EPQ method being more efficient than the method previously used by the company, because it was able to reduce the cost of raw material inventory efficiently. The next research was conducted by Tipaka. Y, Paendong. M and Mongi. C in 2017 obtained results that by applying EOQ and EPQ methods, companies can reduce inventory costs. But when compared, the EPQ method has proven to be more efficient in minimizing overall costs than the EOQ method. Thus, companies can optimize inventory more effectively using the EPQ method. Based on the description above, the author is interested in conducting research on the Application of Economic Production Quantity (EPQ) and Just In Time (JIT) Methods in Controlling Bread Raw Material Inventory with the aim of finding out the total cost of bread raw material inventory using the two methods and comparing the results.

2. LITERATURE REVIEW

2.1 Supplies / Inventory

Inventory is a strategy carried out by the company to regulate, plan and control inventory so that the inventory owned by the company is balanced with consumer demand with the aim of minimizing the total costs incurred and improving the quality of the goods produced. In order for inventory to be managed properly, companies should provide materials that are not too much or not too little, therefore inventory control is needed (Juniarti. A. T and Luxviyanta, C. A, 2021).

2.2 Metode *Economic Production Quantity* (EPQ)

The EPQ method is a method of development of an inventory model where raw materials are massively produced and used as finished products. The EPQ method applies that the quantity produced should be more compared to the amount of customer demand. (Ekawati. H, Adytia. P and Yunita, 2020).

The Steps determine the total inventory cost using the EPQ method (Tipaka. Y, Paendong. M and Mongi. C, 2017):

1. Calculating the optimal production rate with the formula:

$$Q = \sqrt{\frac{2DS}{H\left(1-\frac{d}{p}\right)}} \quad (1)$$

where:
D : Number of requests (units);
S : Ordering costs (Rp.);
H : Storage costs (Rp.);
p : Average production (units);
d : Average demand size (units).

2. Calculate the maximum inventory with the formula:

$$I_{max} = Q\left(1-\frac{d}{p}\right) \quad (2)$$

where:
I_{max} : Maximum inventory (units);
Q : Optimal production (units).

3. Calculate the total cost of inventory with the EPQ method with the formula:

$$TC = \frac{D}{Q}S + \frac{I_{max}}{2}H \quad (3)$$

where:
TC : *Total cost.*

2.3 Method *Just In Time* (JIT)

The JIT method is a method by applying a reduction in costs to prepare inventory so that costs are more economical and efficient (Sholehudin. M, 2017). The Steps for Completing the JIT method (Widiastuti. S et al, 2023):

1. Calculate order quantity with formula:

$$Q^* = \sqrt{\frac{2OD}{C}} \quad (4)$$

where:
D : Number of requests (units);
C : Storage costs (Rp.);
O : Booking costs (Rp.).

2. Calculate the optimal number of shipments with the formula:

$$n = \frac{D}{2a} \quad (5)$$

where:
a : Average production of raw materials (units).

3. Calculate order quantity with formula:

$$Q_n = \sqrt{n}\ x\ Q^* \quad (6)$$

4. Calculate the optimal shipping quantity with the formula:

$$q = \frac{Q_n}{n} \quad (7)$$

5. Calculating the frequency of ordering raw materials with the formula:

$$N = \frac{D}{Q_n} \quad (8)$$

6. Calculating the total cost of inventory using JIT:
   a. Calculate inventory cost with the formula:

$$T^* = \frac{D}{Q^*}O + \frac{Q^*}{2}C \quad (9)$$

b. Calculate the total inventory cost of the JIT method with the formula:

$$T_{jit} = \frac{1}{\sqrt{N}} (T^*) \quad (10)$$

2.4 RESEARCH METHODS

The type of research used is quantitative research. The data used in this study is data on bread raw materials at Retno Bakery Bakery.

The stages in conducting research are:

a. The data used in this study are secondary data obtained through interviews with the owner of the Retno Bakery Bakery, namely bread raw material data from January 2023 to December 2023;
b. Calculating storage costs and ordering costs for each bread raw material used;
c. Calculate the Q value of the EPQ method based on Equation (1);
d. Calculate the maximum inventory of the EPQ method based on Equation (2);
e. Calculate the total cost of EPQ method inventory based on Equation (3);
f. Calculate the total cost of JIT method inventory with Steps:
   1. Calculate the optimal quantity based on Equation (4);
   2. Calculate the optimal number of shipments based on Equation (5);
   3. Calculating order quantity based on Equation (6);
   4. Calculating the shipping quantity based on Equation (7);
   5. Calculating the frequency of bookings based on Equation(8);
   6. Calculate the total cost of the JIT method based on Equations (9) and (10).
g. Comparing the total cost of inventory results using the EPQ method and the JIT method;
h. Analyze and draw conclusions.

4. RESULTS AND DISCUSSION

4.1. Data Description

The data used in this study is the inventory of raw materials used to make torn bread at the Retno Bakery bakery. Types of raw materials include wheat flour, sugar, milk, yeast, salt, butter, and eggs. Data on raw material inventory, prices and all costs incurred by the bakery can be seen in Table 1 below:

Table 1. Raw Material Demand and Bread Production Data

Moon	Raw Material/month							Production Quantity/pcs
	Flour (kg)	Sugar (kg)	Milk (Kg)	Yeast (Kg)	Salt (Kg)	Mentega (Kg)	Egg (Kg)	
Jan-23	4.500	409	300	95	95	540	900	18.000
Feb-23	4.495	408	299	94	94	539	899	17.980
Mar-23	4.531	412	301	96	96	544	906	18.124
Apr-23	4.434	403	298	93	93	532	887	17.736
May-23	4.146	377	293	92	92	497	829	16.584
Jun-23	4.660	424	303	97	97	559	932	18.640
Jul-23	4.543	413	301	96	96	545	909	18.172
Agt-23	4.270	388	295	93	93	512	854	17.080
Sep-23	4.328	393	297	94	94	519	866	17.312
Oct-23	4.781	435	306	98	98	574	956	19.124
Nov-23	4.158	378	293	92	92	499	832	16.632
Des-23	4.805	437	306	99	99	576	961	19.220
Total	**53.651**	**4.877**	**3.592**	**1.139**	**1.139**	**6.436**	**10.731**	**214.604**
Average	**4.471**	**406**	**299**	**95**	**95**	**536**	**894**	**17.884**

Source: Retno Bakery Bakery, 2023

The fees incurred by the bakery include the cost of ordering and storage costs. For ordering costs, which can be seen Table 2 below:

Table 2. Ordering Costs in rupiah

Type of Cost	Cost/Month	Cost/Year
Telephone	55.000	660.000
Unloading	225.000	2.700.000
Delivery	1.150.000	13.800.000
Total		**17.160.000**

Source: Retno Bakery Bakery, 2023

After the goods arrive at the bakery, the store stores them in a storage warehouse. For storage cost can be found in the following Table 3:

Table 3. Storage Cost in rupiah

Type of Cost	Cost/Month	Cost/Year
Electricity Costs	820.000	9.840.000
Rent a Shophouse	1.200.000	14.400.000
Total		**24.240.000**

Source: Retno Bakery Bakery, 2023

Based on Table 2, the cost of ordering at a bakery in a year is Rp. 17,160,000, bakeries make two different types of orders. As for the first type of order, the order for flour, sugar and salt is done every week, which means that if there are 48 orders in a year. Meanwhile, the second type of order is ordering milk, yeast, butter and eggs every 15 days, which means that if there are 24 orders in a year.

4.2 Inventory Cost Calculation

The ordering cost for one order can be obtained by the following Steps:

1. Calculate the cost of message obtained:

$$\text{Message costs} = \frac{Total\ Order\ Cost}{Total\ Order\ Frequency}$$
$$= \frac{\text{Rp. } 17.160.000}{72}$$
$$= Rp.\,238.333.$$

So, the order cost for one order is Rp. 238.333.

2. Calculating the cost of ordering flour, sugar and salt based on Table 2:

$$\text{Message costs} = \frac{one\ time\ ordering\ fee}{Lots\ of\ raw\ materials}$$
$$= \frac{\text{Rp. } 238.333}{3}$$
$$= Rp.\,79.444.$$

So, the order cost for flour, sugar and salt is Rp. 79.444 for one order.

3. Calculating the cost of ordering milk, yeast, butter and eggs based on Table 2:

$$\text{Message costs} = \frac{one\ time\ ordering\ fee}{Lots\ of\ raw\ materials}$$
$$= \frac{\text{Rp. } 238.333}{4}$$
$$= Rp.\,59.583.$$

So, the order fee for milk, yeast, butter and eggs is Rp. 59.583 for one order.

4. Calculating the storage cost per unit of raw materials based on Table 3:

$$\text{Storage Costs} = \frac{Total\ storage\ costs}{Total\ raw\ material\ requirements}$$
$$= \frac{\text{Rp. } 24.240.000}{77.845}$$
$$= Rp.\,311/\text{kg}.$$

So that the cost of inventory of each raw material can be written into the following Table 4:

Table 4. Inventory Cost Data

Raw Materials	Storage Costs (Rp/Kg)	Ordering Costs (Rp/Kg)
Flour	Rp. 311	IDR 79.444
Sugar	Rp. 311	IDR 79.444
Milk	Rp. 311	IDR 59.583
Yeast	Rp. 311	IDR 59.583
Salt	Rp. 311	IDR 79.444
Butter	Rp. 311	IDR 59.583
Egg	Rp. 311	IDR 59.583

4.3 Solutions using *Economic Production Quantity* (EPQ)

The following are the steps to determine the total inventory cost of each raw material using the EPQ method:

a. Flour Raw Material

It is known that the total demand for flour (D) is 53,651 kg and the average demand for flour (d) as much 4.471 kg, then:

$$Q_{tepung} = \sqrt{\frac{2DS}{H\left(1-\frac{d}{p}\right)}}$$

$$= \sqrt{\frac{2(53.651)(Rp.79.444)}{Rp.311\left(1-\frac{4.471}{17.884}\right)}}$$

$$= 6.045 \text{ kg.}$$

So, the optimal production rate of flour in one period is 6.045 kg.

Next, calculating the maximum inventory is obtained:

$$I_{max} = Q\left(1-\frac{d}{p}\right)$$

$$= 6.045\left(1-\frac{4.471}{17.884}\right)$$

$$= 4.534 \text{ kg.}$$

So, the maximum supply of flour obtained in one period is 4.534 kg.

So that the total cost of inventory is obtained:

$$TC = +\left(\frac{D}{Q}S\right)\left(\frac{I_{max}}{2}H\right)$$

$$= +\left(\frac{53.651}{6.045}Rp.79.444\right)\left(\frac{4.534}{2}Rp.311\right)$$

$$= \text{Rp. } 1.410.124.$$

So, the total cost of flour inventory for one period is Rp. 1.410.124,-.

For the calculation of raw materials for sugar, milk, yeast, salt, butter and eggs, the same calculation is carried out which can be seen in Table 5 below:

Table 5. Total Raw Material Inventory Cost

Raw Materials	Optimal Production Rate (Kg)	Maximum Inventory (Kg)	Total Inventory Cost (Rp)
Gula	1.597	1.561	485.345
Milk	1.183	1.163	361.761
Ragi	662	658	204.834
Salt	765	761	236.618
Mentega	1.594	1.546	480.978
Egg	2.080	1.976	614.665

4.4 Solutions using *Just In Time* (JIT)

The following are the steps to determine the total inventory cost of each raw material using the JIT method:

a. Flour Raw Material

It is known that the total demand for flour (D) is 53.651 kg, so:

$$Q^* = \sqrt{\frac{2OD}{C}}$$
$$= \sqrt{\frac{2(79.444)(53.561)}{311}}$$
$$= 5.231\ kg.$$

So, the minimum order quantity of flour in one period is 5.231 kg.

Furthermore, calculating the optimal number of deliveries is obtained:

$$n = \frac{D}{2a}$$
$$= \frac{53.561}{2(17.884)}$$
$$= 1{,}497 \approx 1 \text{ time.}$$

So, the result is obtained as a result of the optimal number of flour shipments 1 time.

Furthermore, calculating the order quantity, delivery quantity and frequency of ordering flour raw materials is obtained:

$$Q_n = \sqrt{n}\ x\ Q^*$$
$$= \sqrt{1{,}497}\ x\ 5.231$$
$$= 6.400 \text{ kg.}$$

So, the result of the quantity of flour orders for one period is 6.400 kg.

$$q = \frac{Q_n}{n}$$
$$= \frac{6.400}{1{,}497}$$
$$= 4.275\ kg.$$

Thus, it was obtained that the optimal quantity of flour delivery was 4.275 kg.

$$N = \frac{D}{Q_n}$$
$$= \frac{53.651}{6.400}$$
$$= 8{,}38 \approx 8 \text{ time.}$$

So, the optimal frequency of ordering flour raw materials is 8 times.

So that the total cost of inventory is obtained:

To calculate the cost of flour inventory, the following formula is used:

$$T^* = + \frac{D}{Q^*} O \frac{Q^*}{2} C$$
$$= + \frac{53.561}{5.231}(79.444)\frac{5.231}{2}(311)$$
$$= Rp.813.439 + Rp.813.420$$
$$= Rp.1.626.859.$$

From the total cost of the value is then calculated using the following JIT method: $Rp.1.626.859$

$$T_{jit} = \frac{1}{\sqrt{N}}\ (T^*)$$
$$= \frac{1}{\sqrt{8}}\ (Rp.1.626.859)$$
$$= Rp.575.182.$$

So, the total cost of flour inventory for one period is Rp.575.182,-.

For the calculation of raw materials for sugar, milk, yeast, salt, butter and eggs, the same calculation is carried out which can be seen in Table 6 below:

Table 6. Total Raw Material Inventory Cost

Raw Materials	Order Quantity (Kg)	Number of Shipments (times)	Order Quantity (kg)	Shipping Quantity (kg)	Order Frequency (times)	Total Inventory Cost (Rp)
Gula	1.598	1	582	4.279	8	173.563
Milk	1.173	1	371	3.170	10	115.378
Ragi	661	1	116	3.742	10	64.971
Salt	763	1	134	4.323	8	83.877
Mentega	1.570	1	664	3.709	10	154.442
Egg	2.028	1	1.111	3.703	10	199.424

After calculating using *the Economic Production Quantity* (EPQ) and *Just In Time* (JIT) methods, the following results were obtained:

Table 7. Comparison of Total Costs of Both Methods in rupiah/one message

Raw Materials	EPQ	JIT	Total Cost Difference	Percentage of Total Cost Difference
Tepung	1.410.124	575.182	834.942	42,05%
Gula	485.345	173.563	311.782	47,31%
Milk	361.761	115.378	246.383	51,63%
Ragi	204.834	64.971	139.863	51,83%
Salt	236.618	83.877	152.741	47,65%
Mentega	480.978	154.442	326.536	51,38%
Egg	614.665	199.424	415.241	51%

Based on Table 7, it can be seen that the total cost result using *the Just In Time* (JIT) method has a smaller cost compared to using *the Economic Production Quantity* (EPQ) method.

5. CONCLUSION

Based on the discussion, it can be concluded that the total cost using the *Economic Production Quantity* (EPQ) method for flour raw materials is IDR. 1.410.124, sugar IDR. 485.345, milk IDR. 361.761, yeast IDR. 204.834, salt IDR. 236.618, butter IDR. 480.978 and eggs IDR. 614.665. Meanwhile, the *Just In Time* (JIT) method for flour raw materials amounted to IDR. 575.182, sugar IDR. 173.563, milk IDR. 115.378, yeast IDR. 64.971, salt IDR. 83.877, butter IDR. 154.442 and eggs IDR.199.424 with the percentage difference in cost for each raw material, namely for flour raw materials of 42,05%, sugar 47,31%, milk 51,63%, yeast 51,83%, salt 47,65%, butter 51,38% and eggs 51%. So that the total cost of inventory of each raw material using the *Just In Time* (JIT) method is more optimal than the *Economic Production Quantity* (EPQ) method.

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