SYNERGY OF EOQ AND JIT METHODS IN THE USE OF RECYCLED WOOD FOR FURNITURE PRODUCTS IN CV LIMASE LARAS

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ABSTRACT

D'best Furniture CV. Limase Laras Yogyakarta is a furniture company with products exported to various countries. The wood raw material used for production is recycled wood which comes from the demolition of quality old houses. The procurement of raw materials is carried out manually with simple estimates, so there is often a buildup of raw materials in the warehouse. This study aims to determine the use of used wood materials / year, apply the EOQ and JIT methods and compare the cost of total inventory with the total cost of company policies. Furthermore, it can find out the efficiency of inventory costs and the efficiency of using raw materials for the environment. The initial stage of research calculates the use of used wood materials / year, carrying out inventory control, namely calculating the quantity of purchases economically, calculating the total cost of inventory of the EOQ method. Furthermore, calculating inventory control and calculating the total cost of inventory using the JIT method. The total inventory cost of each method is then compared with the total inventory cost of the company's policy, calculating the environmental efficiency for the use of scrap wood raw materials. The results of the study can be obtained from the total cost of company policy inventory of IDR 640,174,035, the total cost of inventorying the EOQ method of IDR 564,170,359, the total cost of the JIT method of IDR 559,693,035. The efficiency of the company's methods and EOQ is IDR 75,993,676, the efficiency of the company's methods and JIT is IDR 80,471,000, the use of used wood materials / year is 156 m3, so that the environmental efficiency obtained is 156 m3 of wood materials.

Keywords— *EOQ Method, JIT Method, Recycling*

1. INTRODUCTION

D'best Furniture CV. Limase Laras is a company that produces a variety of furniture such as lounge chairs, mirrors, to wall decorations. The products are exported to various countries such as Australia, America, Africa to European countries. The company in its production process uses wood raw materials used for demolition of houses or houses that are no longer used. To maintain the quality of the products produced, the company uses high-quality used wood raw materials such as teak wood, mahogany, acacia wood and jackfruit wood. The system of controlling the inventory of scrap wood raw materials from suppliers is carried out in a simple way both the quantity and frequency of ordering. The quantity of raw material ordering, the frequency of ordering, to the level of raw material inventory are determined according to production needs using simple estimates. The purchase of raw materials is often excessive, causing the remaining raw materials contained in the storage area. The remaining raw materials require separate maintenance so they require costs and this will result in an increase in the company's total inventory costs. Therefore, the control of raw material inventory needs to be considered before starting the production process[1]. There are several methods and ways to control the inventory of raw materials, two of which are the Economic Order Quantity (EOQ) and Just In Time (JIT) methods. If the production plan is regular then planning raw material needs will be easy to do with the EOQ method but if the company considers that storing inventory in a warehouse is considered a waste then the JIT method can be applied

The Economic Order Quantity (EOQ) method is a policy of supplying raw materials that aims to minimize the cost of ordering and storage from inventory.[2] The Just In Time (JIT) method is an inventory and production control system that requires raw materials to be purchased, and which is produced only to the needs of the customer, so that operational costs can be eliminated to a minimum and inventory is close to zero (zero inventory.[3]The Just In Time (JIT) method considers that inventory is a source of waste so that inventory is sought to zero inventory or close to zero [4]. Based on the description above, the use of EOQ and JIT methods to minimize inventory costs, furthermore, the use of used wood raw materials for production means applying the principles of Green Production so that it can save natural resources or environmental efficiency can be done.

Formulation of Problem

Based on the explanation from the background above, the problems that will be discussed in this study are formulated as follows:
1. What is the total cost of raw material inventory according to the company's policy for / year that must be incurred by the company.
2. What is the total cost of inventory / year using the Economic Order Cuantity (EOQ) method that must be issued by the company.
3. What is the total cost of raw material inventory / year using the Just In Time (JIT) method of the average strategy aspect that must be spent by the company.
4. What is the cost efficiency of company policy – EOQ method, what is the cost efficiency of corporate policy – JIT method aspet strategy average.
5. How much environmental efficiency for natural resources can be obtained.

Research Purpose
1. Application of Economic Order Quantity (EOQ) and Just In Time (JIT) methods to D"best furniture C.V Limase Laras
2. Comparing the cost of total inventory at the company's discretion with the application of EOQ and JIT methods

3. Knowing the cost efficiency of total inventory by applying the EOQ and JIT methods with company policy
4. Knowing the environmental efficiency obtained for one year by using waste wood raw materials for furniture products.

2. METHOD
A. Data Collection
1. Data on the inventory of used wood raw materials in 2021
2. Data on the price of used wood raw materials
3. Data on the cost of ordering used wood raw materials
4. .Data on raw material storage costs
5. Data on the frequency of bookings made by the company

B. Data Processing
1. Calculating the Total Cost of Inventory Company policy according to formula 1
2. Calculating Total Inventory Costs using the EOQ method according to formula
3. Calculating Total Inventory Cost using JIT Method according to formula 20

3. RESULT AND DISCUSSIONS
After conducting research by asking various related parts of the company, the data that has been collected will then be used to calculate the cost of raw material inventory with company policies, as well as with the Economic Order Quantity and Just In Time methods and to find out the efficiency of natural resources that can be saved. The data collected include the following:
1. Raw Material Inventory Data and Raw Material Prices in 2021

The following is the raw material inventory data for 2021 use and the price / m3 is presented in Table 1 as follows:

Table 1: Raw Material Inventory and Raw Material Prices/m3 in 2021

Month	Quantity of Raw Material(m³)	Price/m3 (IDR) (Rp)	Total (IDR) (Rp)
January	14	5.316.667	74.433.338
February	7	5.316.667	37.216.669
March	4	5.316.667	21.266.668
April	8	5.316.667	42.533.336
May	4	5.316.667	21.266.668
Jun	10	5.316.667	53.166.670

Jul	12	5.316.667	63.800.004
August	20	5.316.667	106.333.340
September	8	5.316.667	42.533.336
Oktober	8	5.316.667	42.533.336
Nopember	6	5.316.667	31.900.002
Desember	4	5.316.667	21.266.668
Total	105		Rp 558.250.035

Data Source: D'best Furniture CV. Limase Laras

2. Ordering and Storage Costs of Raw Materials and Frequency of Ordering/ Year

Data on the cost of ordering and storing raw materials in the Company for the period 2021 is presented in Table 2 as follows:

Table 2 : Components of Raw Material Ordering and Storage Costs in 2021

Raw Material	Cost Component				Booking Frequency (f)
	Booking Fee (Rp)		Storage Cost (Rp)		
Scrap Wood	Telp & internet	102.000	Electricity	47.000	
	Administration (ATK)	129.630	Packing and Repairing werehouses	673.571	27
Total		231.630		720.571	27

Data Source: D'best Furniture CV. Limase Laras

3. Data Processing

Based on data from tables 1 and 2, data processing is then carried out, namely calculating the total cost of inventory both based on company discretion and using the EOE and JIT methods and then calculating the existing efficiency :

a. Inventory Control at the discretion of the Company
Based on the data of table 1, table 2 and table 3, the total cost of inventory can be calculated, according to the cost of total preparation according to formula [5] as follows:
$OT = Ob + Op + OS$

Information:

OT = Total Cost
Ob = Cost of purchase
OP = Message cost
Os = Storage cost

According to the cost of buying is the number of units of goods purchased multiplied by the price of goods / units such as the formula [5] as follows:
$O_b = D \times p$

Based on table 2 data, the cost of buying wood is 105 m3 = Rp. 58,250,035.,

Cost message can be calculated according to formula [5] as follows :
Message cost = booking frequency multiplied by the booking fee
= 27 x IDR 231,630 = IDR 6,254,010
The cost of saving can be calculated according to the formula [5] as follows:
Saving Fee = 720,571 × 105 = Rp 75,660,000.

Total cost of inventory = OT = Ob + Op + OS
$OT = Ob + Op + Os$
= 558,250,035+6,254,000 + 75,660,000
= IDR 640,164,035

b. Environmental Efficiency
Based on data from table 1 of raw material inventory for furniture products using scrap wood materials as much as 105 m3 for 2021, this means that the company has implemented the principle of green production. As is well known that the working principle of green production is to apply the principle of efficiency of natural resource users for the continuity of production [6]. Environmental efficiency can occur because the use of wood raw materials is not taken from cutting down trees in the forest, but raw materials utilize waste wood

for the continuity of the production process. Companies that do not take their raw materials directly from the forest as natural resources, then the company participates in protecting the environment so that it is sustainable and not damaged quickly.

c. Inventory Control by Economic Order Quantity (EOQ) Method

Based on the data of table 1, table 2 and table 3 to calculate the purchase of preparations economically can be used formula [5] as follows :

$$Q^* = \sqrt{\frac{2AD}{h}} = \sqrt{\frac{2\,(231.630\,)(105)}{720571}}$$

$$= \sqrt{67.5052} = 8{,}22 \text{ m}^3$$

Frequency of purchases = 105/8.22 = 12.78 = 13 times

To calculate the Total Inventory Cost, the formula [5] can be used as follows:

$$O_T = Dp + \sqrt{2ADh}$$
$$= 105\,(5{,}316{,}667) +$$
$$\sqrt{2\,(231.630)105\,(720{,}571)}$$
$$= 558{,}250{,}035 + 5{,}920{,}323 = 564{,}170{,}358$$

d. Inventory Control With Just In Time (JIT) Method

In the control of raw material inventory by the Just In Time (JIT) Method, it must be determined in advance the average inventory level (a) and the annual inventory cost. The average inventory level (a) can be calculated by summing the initial inventory and the final inventory divided by two. Based on the company's data, the company's initial inventory is 0 m3 and the final inventory is 13.66 m3, the average inventory level can be calculated by formula [7] as follows:

a = ((initial inventory +end inventory))/2 = (0 + 13.66)/2 = 6.83 m3

Based on the calculation results, the average inventory level a is 6.83 m3. Once known the average inventory level can then be determined the annual inventory cost. To calculate the annual inventory cost, data on ordering costs per order, total raw material orders per year, unit unit storage costs, and quantity of raw materials per order are required. Based on inventory control with the D'best Furniture CV company policy method. Limase Laras is known to cost orders per message of Rp. 231,630, storage costs per- m3 of raw materials of Rp. 720,571, and the quantity of raw materials per message of 3.89 m3. Then the annual inventory cost can be calculated by the formula [5] as follows:

$$T^* = (C \times q0)/2 + (O \times D)/q0 = (720{,}571 \times 3.89)/2 + (231{,}630 \times 105)/3.89 .... (16\ )$$

$$= 1{,}401{,}511$$
$$+ 6{,}252{,}224 = \text{IDR } 7{,}653{,}734$$

The calculation results obtained an annual inventory cost of Rp. 7,653,734.

After the annual inventory cost is known, then the JIT method raw material inventory calculation[7] can be carried out using four aspects, namely the lot aspect of order quantity (n), the minimum capacity level of inventory (m), the average inventory level (a), and the percentage of cost savings expected by the company (p).

1. Calculating the inventory of the Just In Time (JIT) method based on the aspect of the booking lot (n)

If it is assumed that the Company wants to reduce the quantity of orders and shipments of raw materials to 36 times for the purchase of raw materials by 105 m3, the following calculations can be made:

JIT Order Quantity (Qn)

The Order Quantity Formula at the raw material requirement level (105 m3) in the JIT method is as follows.

$$Qn = \sqrt{(n \times q^*)} = \sqrt{(36 \times 105\,)} = \sqrt{3780} = 61.4817 \text{ m3}$$

The results of the calculation are known to the total quantity of raw material orders amounting to 61.4817 m3.

Calculating annual total costs in JIT

The formula for the total annual inventory cost [9] at the level of raw material needs (105 m3) with an annual cost of Rp 7,635,734 is as follows.

$$T_{jit} = 1/\sqrt{(n\,)}\ T^* = 1/\sqrt{36}\ (7{,}635{,}734) = \text{Rp } 1{,}275{,}622$$

So that the total annual cost of JIT is Rp 1,275,622,-

Furthermore, the optimal delivery quantity can be calculated

The optimal delivery quantity (q) is the number of units each time of delivery at the raw material requirement level (105 m3) calculated according to formula [7] as follows:

$$q = Qn/n = 105/36 = 2.9167 \text{ m3}$$

The calculation results are known The optimal delivery quantity is 2.9167 m3.

Cost savings(S)

Cost savings (S) are total cost savings [7] for one year at the level of raw material requirements (105 m3) with formula 20 as follows:

$$S = (\,1 - 1/\sqrt{n}\,) \times (T^*) = (1 - 1/\sqrt{36}\,) \times (7{,}635{,}734\,)$$
$$= \text{IDR } 6{,}378{,}112$$

Total inventory cost

Based on company data and JIT method inventory calculations, it is known that the price of raw materials per-m3 is IDR 5,316,667, the total purchase of raw materials is 105 m3, and the cost of JIT inventory is IDR

1,275,622, then the total cost of JIT method inventory can be calculated [5] as follows:

$O_T = Dp + T_{JIT} = (105 \times 5.316.667) + 1.275.622 = $ Rp 559.525.657

The result of the calculation of the total inventory cost based on the aspect of the order lot (n) is IDR 559,525,657.

2. Calculating the Just In Time (JIT) method inventory based on the aspect of the minimum capacity level of inventory (m)

If it is assumed that the Company has a minimum inventory capacity level (m) of 20 m3 at the level of raw material needs with an amount of 105 m3, the following calculations can be [9] made:

The frequency of sending can be with formula [7] as follows.

$Nm = \{ (\{Q^*\})/m \}2 = \{ ((105))/20 \}2 = 27.5625 = 28$ times delivery

Based on calculations, it is known that the frequency of delivery is 28 times in one year.

Calculating JIT Order Quantity (Qn):

The ordering quantity at the level of raw material requirement in the JIT method is calculated according to formula [7] as follows.

$Qn = \sqrt{n} \times Q_* = \sqrt{28} \times 105 = 53.7965$ m3

Annual total cost in JIT

The formula for the total annual inventory cost at the level of raw material needs (105 m3) with an annual cost of Rp. 7,635,734 and a delivery frequency of 28 times is as [9] follows:

$T_{JIT} = 1/\sqrt{n} \times T^* = 1/\sqrt{28} (7,635,734) = $ Rp 1,443,018

Optimal delivery quantity

The optimal delivery quantity (q) is the number of units each time of delivery at the raw material requirement level (105 m3) which can be calculated according to formula [7] as follows:

$q = Qn/n = 105/28 = 3.8095$.

The calculation results are known The optimal delivery quantity is 3.8095 m3.

Cost savings(S)

Cost savings (S) is the total cost savings for one year at the level of raw material needs (105 m3) with an annual cost of Rp 7,635,734, cost savings can be calculated using formula [7] as follows:

$S = (1 - 1/\sqrt{n}) \times (T^*) = (1 - 1/\sqrt{28}) \times (7,635,734) = $ Rp 6,192,716 .

The result of calculating the total cost savings for one year is IDR 6,192,716.

Total inventory cost

Based on company data and JIT method inventory calculations, it is known that the cost of raw materials per-m3 is IDR 5,316,667, the total purchase of raw materials is 105 m3, and the cost of JIT inventory is IDR 1,443,018, then the total inventory of the JIT method can be calculated the total inventory cost according to formula [5] as follows.

$OT = Dp + Tjit = (105 \times 5.316.667) + 1.443.018 = $ Rp 559.693.035

The calculation results are known to the total inventory cost based on the aspect of the minimum inventory capacity level (m) of RP 559,693,035.

3. Calculating the Just In Time (JIT) method inventory based on the aspect of the average inventory level (a)

If it is assumed that the company targets an average inventory level (a) of 6.83 m3 at the level of raw material needs with an amount of 105 m3, it can be calculated the frequency of delivery according to the formula [9] as follows:

$Na = \{ (Q^*)/2a \}2 = \{ 105/2X6,83 \}2 = 59.0854 = 59$ times delivery ..

Based on calculations, it is known that the frequency of delivery is 59 times in one year.

Order Quantity (Qn)

At the level of raw material needs (105 m3) with a delivery frequency of 59 times, the order quantity can be calculated according to the formula [7] as follows.
$Qn = \sqrt{n} \times Q_* = \sqrt{59} \times 105 = 78.7083$ m3 .
The results of the calculation are known to the total quantity of raw material orders of 78.7083 m3

Annual total cost in JIT

At the level of raw material needs (105 m3) with an annual cost of Rp. 7,635,734 and a delivery frequency of 59 times, the total cost in JIT is calculated according to formula [9] as follows:
$Tjit = 1/\sqrt{n} (T^*) = 1/\sqrt{59} (7,635,734) = $ Rp 993,373 .
The calculation results are known JIT annual total cost of Rp 993,373.

Optimal delivery quantity

The optimal delivery quantity (q) is the number of units each time the shipment is at the level of raw material needs (105 m3) then the optimal delivery quantity (q) can be calculated according to formula [7] as follows:
$q0 = Qn/n = 105/59 = 1.7797 - 1.78$ m3 .
The calculation results are known JIT annual total cost of Rp 993,373.

Optimal delivery quantity

The optimal delivery quantity (q) is the number of units each time the shipment is at the level of raw material needs (105 m3) then the optimal delivery quantity (q) can be calculated according to formula [7] as follows:

q_0 = Qn/n = 105/59 = 1.7797 - 1.78 m3 ..

The results of the calculation are known that the optimal delivery quantity is 1.78 m3.

Cost savings(S)

Cost savings (S) is the total cost savings for one year at the level of raw material needs (105 m3) with an annual cost of Rp 7,635,734 can be calculated according to formula [7] as follows:

S = (1 - 1/√n) x (T*) = (1 - 1/√59) x (7,635,734) = Rp 6,642,361 .

The result of calculating the total cost savings for one year is IDR 6,642,361.

Total inventory cost

Based on company data and JIT method inventory calculations, it is known that the cost of raw materials per- m3 is IDR 5,316,667, the total purchase of raw materials is 105 m3, and the cost of JIT inventory is IDR 993,373, then the total inventory of the JIT method can be calculated The total inventory cost can be calculated according to the following [5] formula.

OT = Dp + Tjit = (105×5.316.667) + 993.373 = Rp 559.243.408 .

The results of the calculation of total inventory costs based on the aspect of the average inventory level (a) of Rp 559,243,408.

4. Calculating inventory costs of Just In Time (JIT) method based on aspects of percentage of total cost savings (p)

If it is assumed that the Company wants a total cost savings of 85% of the total inventory cost of RP 7,635,734 at the level of raw material needs of 105 m3, then the delivery frequency can be calculated according to [9] formula as follows:

The frequency of delivery can be with formula 15 as follows:

Np = 1/((1-p)) 2 = 1/((1-0.85))2 = 1/(0.0225) = 44 times

The frequency of delivery is 44 times in one year, the quantity of JIT (Qn) orders can be calculated according to formula [7] as follows:

Qn = √n × Q∗ = √25 × 105 = 67.9706 m3 .

a.   Annual total cost in JIT

The total annual inventory cost at the raw material requirement level (105 m3) with an annual cost of Rp 7,635,734 and a delivery frequency of 44 times is calculated according to formula [9] as follows:

Tjit = 1/√n (T*) = 1/√25 (7,635,734) = Rp 1,527,146

b.   Optimal delivery quantity

The optimal delivery quantity (q) is the number of units each time of delivery at the level of raw material requirement (105 m3) which can be calculated according to the formula [7] as follows:

Q = Qn/n = 105/44 = 2.3864 m3 .

The result of the calculation of the optimal delivery quantity is 2.3864 m3.

Cost savings(S)

Cost savings (S) is the total cost savings for one year at the level of raw material needs (105 m3) with an annual cost of Rp 7,635,734 calculated according to the formula [7] as follows:

S = (1 - 1/√n) x (T*) = (1 - 1/√(25)) x (7,635,734) = Rp 6,108,587 .

c. Total cost of inventory costs

Based on company data and JIT method inventory calculations, it is known that the cost of raw materials per-m3 is IDR 5,316,667, the total purchase of raw materials is 105 m3, and the cost of JIT inventory is IDR 1,527,146, the total inventory of the JIT method can be calculated Total inventory costs according to the formula [5] as follows:

O_T = Dp + T_{JIT} = (105×5.316.667) + 1.527.146 = Rp 559.777.181

The calculation results are known total inventory costs based on aspects of the percentage of total cost savings (p) of RP 559,777,181

Recapitulation of JIT method inventori Control :

1. Based on the order lot (n) can be done by applying the delivery of raw materials 36 times and the quantity of raw materials of 2.92 m3 per shipment. The total cost of one-year raw material inventory is IDR 559,525,657.
2. JIT method inventory control based on minimum capacity (m) can be done by applying delivery. The total cost of one-year raw material inventory is IDR 559,693,035.
3. JIT method inventory control based on average inventory level (a) can be done by applying raw material shipments 59 times and raw material quantity of 1.78 m3 per shipment. The total cost of one-year raw material inventory is Rp 559,243,408.
4. JIT method inventory control based on cost savings (p) can be done by applying 44 times the delivery of raw materials and the quantity of raw

materials of 2,3864 m3 per shipment. The total cost of one-year raw material inventory is Rp 559,401,165.

CONCLUSION

Based on the results of the research and calculations above, it can be concluded as follows:

1. Total inventory cost company policy Rp 640.164.035 , order quantity (q0) = 3.89 m3 and order frequency (f) = 27 times
2. Total cost of EOQ method inventory = Rp 564,170,359, order quantity (q0) = 8.22m3 and ordering frequency (f) = 13 times
3. Total inventory cost JIT method average inventory strategy (a) = Rp 559.243.408 , order quantity (q0) = 1.78 m3 and booking frequency (f) = 28 times
4. Efficiency of company policies – EOQ method = Rp 75,993,679 Efficiency of company policy – JIT method = Rp 80.920627
5. Environmental efficiency for natural resources = 105 m3

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