Implementation Of The Just In Time (JIT) Method To Efficiency Raw Material Supply Costs

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Abstract. Inventory control is carried out to obtain savings in inventory costs by keeping the inventory level at an optimal level. One way to reduce inventory levels is to use the Just In Time (JIT) method. The Just In Time (JIT) method reduces inventory levels so as to reduce costs as efficiently as possible based on the fact that Just In Time (JIT) lowers the shipping lot, as a means of applying Just In Time (JIT) within the scope of a large Economic Order Quantity (EOQ) Lot. Based on this research, it can be seen that with the same data but using the Just In Time (JIT) method, the cost of raw material inventory issued is smaller than the costs incurred previously. The total inventory cost incurred before using the method is IDR 32,359,000.00 with the frequency of ordering each raw material 24 times in one period. Meanwhile, with the Economic Order Quantity (EOQ) method, the costs incurred amounted to IDR 17,767,620.00 with the frequency of ordering soybean and palm sugar raw materials 13 times and 20 times in one period. Using the Just In Time (JIT) method costs Rp8,883,810.00 with a frequency of ordering each raw material 4 times in one period. Based on the results of these calculations, the Just In Time (JIT) method costs more efficient inventory.

Keyword: Economic order quantity (EOQ), Just in time (JIT), Inventory control, Total inventory cost

Abstrak. Pengendalian persediaan dilakukan untuk memperoleh penghematan biaya persediaan dengan cara menjaga tingkat persediaan tersebut pada tingkat yang optimal. Salah satu cara mengurangi tingkat persediaan adalah dengan menggunakan metode Just In Time (JIT). Metode Just In Time (JIT) mengurangi tingkat persediaan sehingga dapat menekan biaya seefisien mungkin dengan didasari pada fakta bahwa Just In Time (JIT) menurunkan lot pengiriman, sebagai sarana untuk menerapkan Just In Time (JIT) dalam lingkup Lot Economic Order Quantity (EOQ) besar. Berdasarkan penelitian ini dapat dilihat bahwa dengan data yang sama tetapi menggunakan metode Just In Time (JIT) biaya persediaan bahan baku yang dikeluarkan lebih kecil daripada biaya yang dikeluarkan sebelumnya. Total biaya persediaan yang dikeluarkan sebelum menggunakan metode yaitu sebesar Rp32,359,000.00 dengan frekuensi pemesanan tiap bahan baku 24 kali dalam satu periode. Sedangkan dengan metode Economic Order Quantity (EOQ) biaya yang dikeluarkan sebesar Rp17,767,620.00 dengan frekuensi pemesanan bahan baku kedelai dan gula aren 13 kali dan 20 kali dalam satu periode. Menggunakan metode Just In Time (JIT) mengeluarkan biaya sebesar Rp8,883,810.00 dengan frekuensi pemesanan tiap bahan baku 4 kali dalam satu periode. Bedasarkan hasil perhitungan tersebut metode Just In Time (JIT) biaya persediaan yang dikeluarkan lebih efisien.

Kata Kunci: Economic order quantity (EOQ), Just in time (JIT), Pengendalian persediaan, Total biaya persediaan

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1. Introduction

Inventory is raw material that is waiting to be used in the production process or goods that are in the process of production. Every company needs inventory. There are several methods in inventory processing, one of which is the Just In Time (JIT) method. The Just In Time (JIT) method is a method designed to reduce costs, shorten delivery times and get good quality as efficiently as possible so that companies are able to deliver their products according to consumer desires by eliminating all kinds of waste in the production process. One of the advantages of Just In Time (JIT) is that it is able to save storage space and associated costs both rental costs and insurance costs by reducing the minimum level of inventory.

The Just In Time (JIT) production system is implemented to avoid the occurrence of excess quantity / amount in a production (overproduction), excessive inventory where all supplies of raw materials to be processed into finished goods that arrive on time with the right amount and are ready to be produced according to the amount needed by customers at the right time. Therefore, the stock level of raw materials, auxiliary materials, components, semi-finished materials and finished goods will be maintained at the minimum amount.

Based on this discussion, it is known that maintaining a balanced inventory level is necessary. Just In Time balances the costs incurred in the production process by streamlining the total cost of inventory. It is then implemented to maintain its inventory levels.

Some research related to inventory control with the Just In Time Method has been done before. [1] Conducted an analysis of inventory control of Catfish cultivation to minimize inventory costs using the Just In Time (JIT) method. In this study it is known that the company’s policy is still not optimal and not efficient for inventory costs compared to using the Just In Time method. The second researcher, analyzed inventory control to improve the efficiency of raw material inventory costs at CV Vedensia Inti Pekasa using the Just In Time method. In this study it was found that the application of Just In Time (JIT) can increase the efficiency of the company’s production costs and cause effectiveness in meeting the needs of raw materials for production.

2. Literature Review

2.1. Inventory

2.1.1. Definition of Inventory

Inventories are goods owned by a company with the aim of being traded within a certain period of time, raw materials waiting to be used for the production process or goods that are in the process
of production [2].

2.1.2. Types of Supplies or Inventory

Types of inventory is divided into 5 types, namely [3]:

1. Raw material supply
2. Supplies of purchased product/component parts
3. Supplies of auxiliary items
4. Supplies of semi-finished goods/processed goods (work in process)
5. Supplies of finished goods/products ready to market (finished good inventory)

2.1.3. Inventory Functions

Inventory functions can be grouped into [4]:

1. Fluctuation Stock is inventory to avoid unpredictable fluctuations in demand, and to avoid errors/deviations in sales forecasts for production time, or delivery of goods.
2. Anticipation Stock is inventory that will meet predictable demand, for example during periods of high demand, but production capacity will not be able to meet demand.
3. Lot-size Inventory is Inventory in larger quantities than required at the time. inventory is created to take advantage of daily updated products (discounts) for bulk purchases/savings from lower unit shipping costs.
4. Pipeline inventory is inventory that is transported from the point of origin to the point of use of the product. For example, goods are shipped from factories to stores which can take several days or weeks.

2.1.4. Inventory Model

There are 2 inventory models, namely:

1. Deterministic inventory model
   In a deterministic inventory model, all influential parameters are known with certainty.
2. Probabilistic inventory model
   In a probabilistic inventory model, the demand for goods is not known in advance. The influencing parameters are uncertain and only represent estimates or estimates.

2.2. Inventory Management

Inventory management is the control of inventory assets and merchandise inventory. Inventory management is useful for overseeing the delivery of goods from producers to warehouses and also overseeing goods in storage facilities until it is time to sell goods [5].
2.3. **Inventory Management System**

Inventory management uses several methods that are useful for maintaining the number of goods and meeting the exact amount of demand for goods. Some inventory management methods are as follows [5]:

1. Manual Stock Review
2. Just In Time (JIT) Method
3. ABC Analysis Method
4. Economic Order Quantity (EOQ) Method

2.4. **Inventory Control**

Inventory control is a set of control policies that determine how much inventory to keep, when to place orders to increase inventory, and how many orders to place [4]. Inventory control is a series of activities that begin with planning raw material requirements [6].

2.5. **Just In Time**

2.5.1. **Definition of Just In Time Method**

The Just in Time System is a demand-pull system that requires goods to flow through the system based on existing demand, not into the system at a certain time based on demand driven [7]. The purpose of implementing the Just In Time (JIT) production system is so that activities related to the production process carried out by the company can take place efficiently and effectively, starting from purchasing raw materials to finished products from the company’s production activities.

2.5.2. **Just In Time Characteristics**

There are 5 basic characteristics of Just In Time (JIT) [7], namely:

1. Effect of inventory
2. Factory layout
3. Employee grouping and empowerment
4. Quality Control Group
5. Just In Time and Automation

2.5.3. **Benefits of Just In Time**

Other benefits of just in time are:

1. Reduced investment in factories for inventory and production processes,
2. Reduce risk in inventory,
3. Reduce space or warehouse for storage of goods,
4. Reduce wastage of damaged and defective goods by detecting defects at the source,
5. Reduce direct material costs through the purchase of goods

2.6. Traditional Total Inventory Cost

In general, the elements of inventory costs are storage costs (Holding Cost) and ordering costs (Ordering Cost). The traditional calculation of inventory costs is as follows:

\[ TIC = Ordering\ Cost + Storage\ Cost \]
\[ = (\bar{D} \times C_1) + (N \times C_2) \quad (1) \]

2.7. Economic Order Quantity (EOQ)

Economic Order Quantity (EOQ) is a calculation to meet demand without overspending. The purpose of the Economic Order Quantity (EOQ) model is to minimize the total cost of inventory. Formulate the total cost of inventory using the Economic Order Quantity (EOQ) method by equalizing ordering costs and storage costs. So that,

\[ TC = TC_1 + TC_2 \]
\[ where\ TC_1 = \frac{D}{Q} C_1; \quad TC_2 = \frac{Q}{2} C_2, \quad so \]
\[ TC = \frac{D}{Q} C_1 + \frac{Q}{2} C_2 \quad (2) \]

In obtaining the optimal quantity value (Q), the formula is used:

\[ EOQ(Q) = \sqrt{\frac{2DC_1}{C_2}} \quad (3) \]

2.8. Just In Time Inventory Control (JIT/EOQ)

Just In Time Inventory is the minimum inventory required in a production process perfectly [8]. (Sulistyowati, 2006) argues that the JIT/EOQ formula is based on the fact that Just In Time lowers the shipping lot, as a means to implement Just In Time within the scope of large EOQ lots. The formulation of the Just In Time Inventory Control method is obtained from a decrease in total costs developed through the Economic Order Quantity (EOQ) method with equation 2 where by reducing the shipping lot will affect the average inventory so that it is obtained :

\[ TC_1 = \frac{D}{Q_n} c_1, \quad TC_2 = \frac{Q_n}{2n} c_2 \quad (4) \]
then the equation can be transformed into another form into:

\[ T_{JIT} = \frac{D}{Q_n} C_1 + \frac{Q_n}{2n} C_2 \]  

(5)

To calculate the optimum order quantity using Just In Time, namely:

\[ Q_n = \sqrt{n \times Q} \]  

(6)

2.9. Optimum Ordering Frequency

The optimum order frequency is the size or number of orders placed during one period. The amount of Ordering Frequency is obtained by dividing the total demand by the optimum order quantity,

\[ F = \frac{D}{Q_n} \]  

(7)

2.10. Total Inventory Cost \((T_{JIT})\)

The total cost of inventory with Just In Time \((T_{JIT})\) is the total of the total ordering cost \((TC_1)\) and the total storage cost \((TC_2)\) in one period.

2.10.1. Total message cost \((TC_1)\)

The total order cost will vary based on the frequency of items ordered. Ordering costs are limited by the quantity of goods ordered. If the level of orders placed during a period increases, the ordering cost in that period will also increase. Meanwhile, if the level of orders placed during a period decreases, the ordering cost in a period will also decrease.

\[ TC_1 = \frac{D}{Q_n} C_1 \]  

(8)

2.10.2. Total storage cost \((TC_2)\)

The total storage cost is based on the average inventory or order size placed in storage by subtracting the shipping lots. The more the order quantity increases, the more the storage cost increases in one period and vice versa.

\[ TC_2 = \frac{1}{2} \frac{Q_n}{2n} C_2 \]
\[ = \frac{Q_n}{4n} C_2 \]  

(9)
Then the calculation of the total cost of raw material inventory with the Just In Time method is,

\[ T_{JIT} = TC_1 + TC_2 \]  

or

\[ T_{JIT} = \left( \frac{1}{\sqrt{n}} \right) TC \]  

(10)

(11)

2.11. Normality Test Using the Lilliefors Test

The normality test can be used to determine whether the data obtained is normally distributed or not (Nisrina, 2013). In inventory control, this normality test is carried out to determine the distribution pattern. The distribution pattern will be used to see whether the data to be processed by the Just In Time (JIT) method comes from a normally distributed population or not, so that it can be assumed that the sample to be processed is representative of the population. The lilliefors test can be used for small group data. The lilliefors test transforms the data into Z values so that the area of the normal curve can be calculated as the normal cumulative probability \( F(z_i) \). After that, find the difference between this probability and the empirical cumulative probability \( S(z_i) \).

Make a comparison of \( L_0 \) with the table of critical values for the Lilliefors test then the largest difference or \( L_{count} \) is compared with \( L_{table} \) (Noor, 2016). Suppose the sample size is \( n \) with data values 1, 2, ..., \( i \) then the proof steps:

1. Setting the hypothesis
   \( H_0 \): Population data is normally distributed
   \( H_1 \): Population data is not normally distributed

2. Determine the level of significance \( \alpha \)

3. Calculate the raw number of each data \( (X) \)

\[ Z_i = \frac{x_i - \bar{x}}{S} \]  

where,
\( \bar{x} \) = sample average
\( S \) = standard deviation of the sample
\( i = 1, 2, 3, ... \) Calculate the sample average using the formula:

\[ \bar{x} = \frac{\sum_{i=1}^{n} (x_i)}{n} \]  

(13)

Calculate the standard deviation using the formula:

\[ S = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}} \]  

(14)
4. Calculating the cumulative standardized odds:

\[ F(Z_i) = P(Z) \leq Z_i \]  

(15)

5. Calculating \((Z_i)\):

\[ S(Z_i) = \frac{\text{banyaknya } Z \leq Z_i}{n} \]  

(16)

6. Calculating the difference between \(|F(Z_i) - S(Z_i)|\)

7. Find the value that is between the absolute prices \((L_0)\).

3. **Methodology**

3.1. **Types and Sources of Data**

The type of data used in this study is quantitative data, namely data in the form of information or information obtained in the form of numbers. The data source used in this research is secondary data, where researchers quote data from the UNIMED Charismatic journal which discusses the material inventory control of PT Inti Indo Panah Bow in August 2016 - July 2017.

3.2. **Data Collection and Processing**

The next series of steps in working on this case are presented as follows:

1. Literature Study
2. Data Collection
   - The data required are:
     a. The number of orders and usage of raw materials in one period.
     b. Cost of raw material inventory in one period.
     c. Raw material storage costs in one period.
3. Data Processing
   - Data processing was carried out in the following stages:
     a. Conduct a data normality test using the Lilliefors test
     b. Calculating the optimal level of raw material inventory, ordering frequency and total cost of raw material inventory with the Just In Time (JIT) method.
     c. Make a comparison of total inventory costs when using the Just In Time (JIT) method with when not using the Just In Time (JIT) method.
3. Draw conclusions and suggestions.
4. Result and Discussion

4.1. Data Collection

In this study, the data source used is secondary data, where the data collected is data from the UNIMED Charismatic journal which discusses the material inventory control of PT Inti Indo Panah Bow in August 2016 - July 2017 using the Economic Order Quantity (EOQ) method.

4.1.1. Raw Material Usage Data

Table 1. Raw Material Usage Data

<table>
<thead>
<tr>
<th>Month</th>
<th>Order Soybeans (KG)</th>
<th>Order Aren Sugar (KG)</th>
<th>Usage Soybeans (KG)</th>
<th>Usage Aren Sugar (KG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 2016</td>
<td>9.800</td>
<td>19.600</td>
<td>9.800</td>
<td>19.600</td>
</tr>
<tr>
<td>Sept 2016</td>
<td>11800</td>
<td>23600</td>
<td>11750</td>
<td>23500</td>
</tr>
<tr>
<td>Oct 2016</td>
<td>10500</td>
<td>21000</td>
<td>10400</td>
<td>20800</td>
</tr>
<tr>
<td>Nov 2016</td>
<td>10300</td>
<td>20600</td>
<td>10150</td>
<td>20300</td>
</tr>
<tr>
<td>Dec 2016</td>
<td>10800</td>
<td>21600</td>
<td>10750</td>
<td>21500</td>
</tr>
<tr>
<td>Jan 2017</td>
<td>10500</td>
<td>21000</td>
<td>10600</td>
<td>21200</td>
</tr>
<tr>
<td>Feb 2017</td>
<td>10500</td>
<td>21000</td>
<td>10500</td>
<td>21000</td>
</tr>
<tr>
<td>March 2017</td>
<td>10000</td>
<td>20000</td>
<td>10100</td>
<td>20200</td>
</tr>
<tr>
<td>April 2017</td>
<td>10500</td>
<td>21000</td>
<td>10700</td>
<td>21400</td>
</tr>
<tr>
<td>Mey 2017</td>
<td>9700</td>
<td>19400</td>
<td>9700</td>
<td>19400</td>
</tr>
<tr>
<td>June 2017</td>
<td>10800</td>
<td>21600</td>
<td>11200</td>
<td>22400</td>
</tr>
<tr>
<td>July 2017</td>
<td>10500</td>
<td>21000</td>
<td>10500</td>
<td>21000</td>
</tr>
<tr>
<td>Total</td>
<td>125700</td>
<td>251400</td>
<td>126150</td>
<td>252300</td>
</tr>
<tr>
<td>Average</td>
<td>10475</td>
<td>20950</td>
<td>10512.5</td>
<td>21025</td>
</tr>
</tbody>
</table>

Source : Widyastika and Khairani [9]

4.1.2. Ordering and Storage Cost Data

The cost of ordering soybean and palm sugar raw materials is Rp211.500 and Rp312.500. Storage costs per unit of soybean and palm sugar raw materials are Rp560 and Rp960.

4.2. Data processing

4.2.1. Normality Test with Lilliefors Test

Table 2. Result of normality test with lilliefors test
Based on the above results, it is concluded that:

\[ L_0 = \text{Max} \left| F(Z_i) - S(Z_i) \right| = 0.0909 \]

\[ L_0 = L_{\lambda(n)} \] can be seen in the Lilliefors normality test table with \( n = 12 \) and real level \( \lambda = 0.05 \).

\[
L_0 = L_{\lambda(n)} \\
= L_{0.05(12)} \\
= 0.242
\]

From the table of critical values \( L \) for the Lilliefors test, \( L_{\text{table}} = 0.242 \) is greater than \( L_{\text{hitung}} = 0.0909 \). Then the \( H_0 \) hypothesis is accepted, so the calculation with the just in time method in inventory control can be done. This means that the data on the use of soybean raw materials is normally distributed. For the Lilliefors normality test on the data on the use of palm sugar raw materials, the same calculation is carried out with \( L_{\text{hitung}} = 0.1117 \), so the \( H_0 \) hypothesis is accepted. This means that the data on the use of soy sauce raw materials is normally distributed.

### 4.2.2. Raw Material Inventory Costs based on Company Actuals

Cost of soybean raw material inventory:

\[
TIC = (10512.5 \times Rp560.00) + (12 \times Rp211.500.00) \\
= Rp8.425.000.00
\]

Raw material inventory cost of palm sugar:

\[
TIC = (21025 \times Rp960.00) + (12 \times Rp312.500.00) \\
= Rp23.934.000.00
\]

So, the company’s total inventory of raw materials in the one-year period amounted to \( Rp8.425.000.00 + Rp23.934.000.00 = Rp32.359.000.00 \)
4.2.3. Economical Ordering Quantity (EOQ)

The economic order quantity (EOQ) of soybeans, as follows:

\[
EOQ = \sqrt{\frac{2(126150)(211500)}{560}} = \sqrt{95288303.571} = 9758.31 \\
\approx 9758 \, KG
\]

With an order cycle \( F = \frac{126150}{9758} = 12.92 \approx 13 \text{times} \)

The economic order quantity (EOQ) of palm sugar, as follows:

\[
EOQ = \sqrt{\frac{2(252300)(312500)}{960}} = \sqrt{164257812} = 12816.31 \\
\approx 12816 \, Kg
\]

With an order cycle :

\[
EOQ = \frac{252300}{12816} = 19.68 \\
\approx 20 \text{ times}
\]

4.2.4. Total Inventory Cost with EOQ

Inventory costs using the EOQ method, obtained:

\[
TC = (\frac{126150}{9758} \times Rp211.500.00 + \frac{9762}{2} \times Rp560.00) \\
= Rp2.732.580.00 + Rp2.733.360.00 \\
= Rp5.465.940.00
\]

Using the same calculation, the cost of inventory using EOQ on palm sugar raw materials is obtained Rp12.301.680.00. So that the total cost of soy sauce raw material inventory is Rp5.465.940.00 + Rp12.301.680.00 = Rp17.767.620.00.
4.2.5. Optimal Ordering Quantity (JIT)

The optimal order quantity (JIT) of soybeans, as follows:

\[ Q_n = \sqrt{13 \times 9762} = 35197.39 \approx 35200 \text{ Kg} \]

The optimal order quantity (JIT) of palm sugar, as follows:

\[ Q_n = \sqrt{20 \times 12816} = 57314.89 \approx 57315 \text{ Kg} \]

4.2.6. Ordering Frequency

Based on the ordering cycle using the Just In Time Inventory Control method, it is obtained:

Soybean order frequency:

\[ F = \frac{126150}{35197} = 3.58 \approx 4 \text{ times} \]

Order frequency of palm sugar:

\[ F = \frac{252300}{57315} = 4.40 \approx 4 \text{ times} \]

4.2.7. Total cost of Inventory with Just In Time (JIT)

After knowing the order quantity using the Just In Time (JIT) method, the total optimum inventory cost will be calculated using the Just In Time (JIT) method. The total cost of soybean raw material inventory is:

\[ T_{JIT} = \left( \frac{1}{\sqrt{4}} \right) \times Rp5,465,940.00 = (0.5)(Rp5,465,940.00) = Rp2,732,970.00 \]

Using the same calculation, the cost of palm sugar raw material inventory is obtained at Rp6,150,840.00. So the total inventory of the company’s raw materials in the period of one year using the Just In Time (JIT) method is Rp2,732,970.00 + Rp6,150,840.00 = Rp8,883,810.00.
4.3. **Conclusion**

Based on the processing and analysis of inventory control in reducing the cost of soy sauce raw material inventory at PT. Bow Inti Indo Panah in August 2016 - July 2017 from the previous chapter, the following conclusions can be drawn:

<table>
<thead>
<tr>
<th>No</th>
<th>Subject</th>
<th>Company Actual</th>
<th>EOQ</th>
<th>JIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Order Quantity (Kg)</td>
<td>Soybeans Aren 10512,5</td>
<td>Soybeans Aren 9762</td>
<td>Soybeans Aren 35197</td>
</tr>
<tr>
<td>2</td>
<td>Ordering Frequency</td>
<td>Soybeans Aren 24 kali</td>
<td>Soybeans Aren 13 kali</td>
<td>Soybeans Aren 4 kali</td>
</tr>
</tbody>
</table>

1. Using the Just In Time (JIT) method, it is known that from the data analyzed, ordering is not optimal so that it has not made minimum inventory costs.

2. To obtain the minimum inventory cost, it is influenced based on the specified inventory level. Comparison of total inventory costs before data is processed, when using Economic Order Quantity (EOQ) and using the Just In Time (JIT) method is as follows: The optimal total inventory cost carried out by the company for one year is Rp32.359.000.00. When using the Economic Order Quantity (EOQ) method is Rp17.767.620.00. Meanwhile, when using the Just In Time (JIT) method is Rp8.883.810.00.

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