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Raw Material Inventory System Using Multi-Item Single Supplier in a Furniture Company

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Abstract. Inefficient management of raw material inventory can lead to high storage costs or stock shortages that hinder production. This study was conducted at Techno Art, a company that manufactures portable fitting rooms with raw materials supplied by a single supplier. The current ordering system is carried out separately for each item without a scheduled plan, resulting in a high frequency of orders and increased operational costs. This research designs a multi-item inventory system using the Joint Replenishment method with a model P approach to determine the basic ordering interval and the interval for each item in order to minimize inventory costs. The implementation of this method has proven to reduce costs, decrease ordering frequency, and maintain the availability of raw materials in accordance with production requirements.

1 Introduction

Inventory is the stock of goods or resources used in the company's production and operational processes, and often becomes the largest asset in the financial statements [1]. Inventory is a stock of materials intentionally kept to facilitate the production process and to meet customer demand [2]. Therefore, the company seeks to keep inventory levels low while still being able to meet consumer demand. The primary objective of inventory management is to balance inventory investment with customer satisfaction [3].

The problem faced by the company is that it often experiences shortages or surpluses of raw materials. This results in high ordering costs due to repeated orders and high storage costs due to excess raw materials. This condition indicates the need to evaluate the raw material planning and procurement system to ensure it is more efficient and purposefully effective in supporting the smooth running of the production process. Inventory control is a strategy formulated to determine the type of materials or goods that need to be ordered, the right time to place an order, the quantity that should be ordered, and how much needs to be stored [4].

The method used in this problem is the periodic review (P) model approach with joint replenishment. In this approach, the evaluation of inventory levels is conducted at specific time intervals on a regular basis [5]. This model can be applied to either a single type of item or multiple items simultaneously. The P model approach is related to determining the amount of operating stock that needs to be provided and its safety reserve. In the P model,

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the ordering time interval is fixed, but the order quantity can vary to meet consumer demand. [4].

2 Methodology

The joint replenishment inventory model using the Periodic Review or Model-P approach in a multi-item inventory system requires good coordination in the ordering process between items [5]. Determining the ordering interval in a multi-item system tends to be more complex compared to a single-item system, and generally results in solutions that are near optimal. A multi-item model allows simultaneous restocking of inventory for several items at once [6].

The data used in this study are historical demand data, bill of materials, raw material prices, ordering costs, holding costs, lead time, and service level. The initial step in data processing is conducting a normality test on product demand data using the Kolmogorov-Smirnov test..

The periodic review model determines several decision variables, namely the basic ordering interval (T), the ordering interval for each type of raw material (Ti^*), the inventory level (ILi), and the total combined inventory cost (OT). The determination of the basic ordering interval is carried out through the following steps:

Iteration 1:

Step 1: determine the value of Ti^* using the following equation:

$$T_0 = \sqrt{\frac{2\,a_i}{h_i D_i}} \quad \text{dan} \quad T_i^* = \sqrt{\frac{2\,a_i}{h_i\left(D_i + \frac{z_i \sigma_i}{\sqrt{k_i T_0 + L_i}}\right)}} \tag{1}$$

Step 2: identifying the value of Ti^* that has the smallest value and is denoted as item 1 with the notation $ki = 1$.

Step 3: determine the value of T from the value of T_0 using the following equation:

$$T_0 = \sqrt{\frac{2\,(A + a_1)}{h_1 D_1}} \quad \text{dan} \quad T = \sqrt{\frac{2\,(A + a_1)}{h_i\left(D_1 + \frac{z_1 \sigma_1}{\sqrt{T_0 + L_1}}\right)}} \tag{2}$$

Step 4: determine the value of k *item* using the following equation:

$$\sqrt{(k_i - 1)k_i} \le \frac{T_i^*}{T} \le \sqrt{(k_i + 1)k_i} \tag{3}$$

Step 5: determine the value of T and nilai T_0 using the following equation:

$$T_0 = \sqrt{\frac{2\,(A + \sum_{i=1}^{n} \frac{a_i}{k_i})}{\sum_{i=1}^{n} h_i k_i D_i}} \quad \text{dan} \quad T = \sqrt{\frac{2\,(A + \sum_{i=1}^{n} \frac{a_i}{k_i})}{\sum_{i=1}^{n} h_i k_i \left(D_i + \frac{z_i \sigma_i}{\sqrt{k_i T_0 + L_i}}\right)}} \tag{4}$$

Step 6: Calculating the total combined cost with the equation as follows:

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$$OT = \frac{A}{T} + \frac{a_i}{T} + \frac{\sum_{i=1}^{n} \frac{ai}{ki}}{T} + \frac{D\,(T_i + L_i)h_i}{2} + z_i \sigma_i h_i \sqrt{T + L_1} + \sum_{i=1}^{n} \left[\frac{DTk_i h_i}{2} + z_i \sigma_i h_i \sqrt{k_i T + L_1} \right]$$

(5)

Iteration 2:

Iteration 2 starts from Step 4.

The order interval value for item i can be obtained using the following equation:

$$Ti = ki \times T \quad (6)$$

Inventory level determination is carried out to meet requirements during the ordering interval, while also anticipating potential demand fluctuations both within that period and during the lead time. To cope with this demand uncertainty, it is necessary to increase safety stock.

$$\textit{Safety Stock}\ (SS) = zi\sigma i \sqrt{T_i + L_i} \quad (7)$$

$$\textit{Inventory Level}\ (IL) = Di\,(kiT + Li) + zi\sigma i \sqrt{T_i + L_i} \quad (8)$$

The calculation of the total inventory cost is the cost obtained from calculating the T value obtained in the second iteration.

$$OT = \frac{A}{T} + \frac{a_i}{T} + \frac{\sum_{i=1}^{n} \frac{ai}{ki}}{T} + \frac{D\,(T_i + L_i)h_i}{2} + z_i \sigma_i h_i \sqrt{T + L_1} + \sum_{i=1}^{n} \left[\frac{DTk_i h_i}{2} + z_i \sigma_i h_i \sqrt{k_i T + L_1} \right]$$

(9)

3 Result and Discussion

Currently, the product with the highest demand is the portable fitting room, which comes in two sizes, 1.2 x 1.2 meter dan 1.5 x 1.5 meter. The demand data for both products over the course of one year can be seen in Table 1. The bill of materials for both products is shown in Figure 1.

Table 1. Product Demand Over 1 Year.

Period	Fitting Room Portable 1.2 x 1.2 (unit)	Fitting Room Portable 1.5 x 1.5 (unit)
1	25	12
2	23	15
3	20	16
4	17	13
5	20	15
6	17	13
7	21	14
8	16	12
9	15	15
10	30	20
11	10	20

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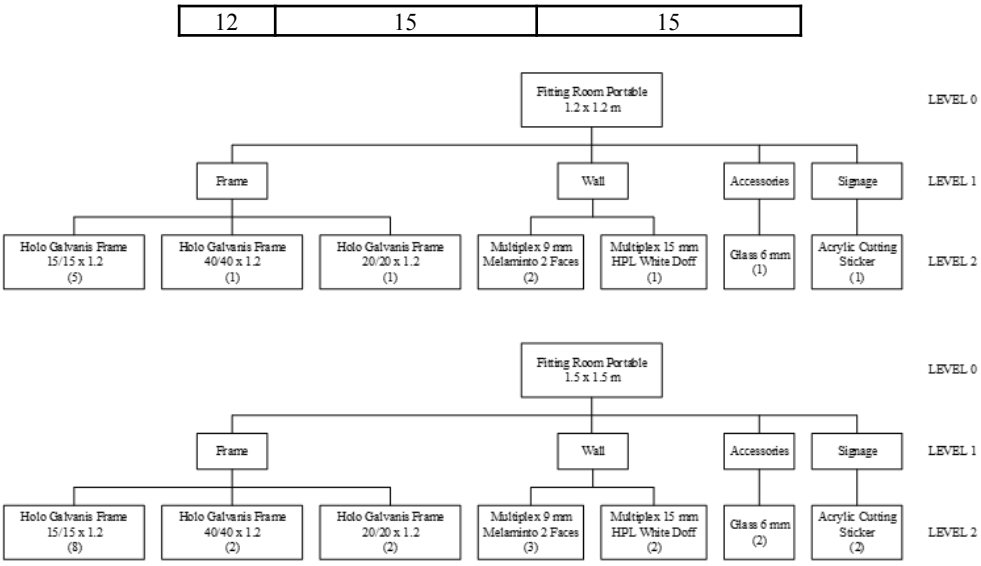

Figure 1. Bill of Material

The price of each raw material for both products can be seen in Table 2.

Table 2. Raw Materials Price.

Types of Raw Materials	Price/Unit (IDR)	Unit
Holo Galvanis Frame 15/15 x 1.2	120,000	Bar
Holo Galvanis Frame 40/40 x 1.2	110,000	Bar
Holo Galvanis 20/20 x 1.2	90,000	Bar
Multiplex 9 mm Melaminto 2 Faces	190,000	Sheet
Multiplex 15 mm HPL White doff	125,000	Sheet
Glass 6 mm	185,000	Sheet
Acrylic Cutting Sticker	50,000	Sheet

The booking cost consists of major and minor charges. Major order cost (A) is a fixed cost that arises each time a joint order is placed, in the form of the cost of transporting raw materials from the supplier to the company. The cost is IDR 50,000 for a truck and IDR 25,000 for a pickup truck for a single delivery. The minor ordering cost (a) is the additional cost for each item in a combined order, including a telephone charge of IDR 5,245 (average duration of 5 minutes at a rate of IDR 1,049/minute) and an administration fee of IDR 10,000, bringing the total minor ordering cost to IDR 15,245 per order. The holding cost (hi) for each type of raw material can be seen in Table 3.

Table 3. Holding Cost.

Types of Raw Materials	Holding cost (IDR)
Holo Galvanis Frame 15/15 x 1.2	550.00

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Types of Raw Materials	Holding cost (IDR)
Holo Galvanis Frame 40/40 x 1.2	504.17
Holo Galvanis 20/20 x 1.2	412.50
Multiplex 9 mm Melaminto 2 Faces	870.83
Multiplex 15 mm HPL White doff	572.92
Glass 6 mm	847.92
Acrylic Cutting Sticker	229.17

The lead time for ordering all raw materials is one day or 0.0147 months. The service level is the probability of no stockouts occurring within a given period. The company sets a service level of 95%, which reflects the likelihood that raw material availability remains consistently maintained.

Hypothesis testing using the Kolmogorov-Smirnov distribution test showed that the demand data is normally distributed. Determination of the Basic Ordering Interval using the Joint Replenishment Method. The calculation for determining the basic order interval requires data on ordering costs, holding costs, average raw materials, standard deviation, service level, and lead time.

Iterasi 1.

Step 1.

Determining the values of T_0 and T_i* for each raw material can be seen in Table 4.

Table 4. Value of T_0 dan T*i**.

Types of Raw Materials	T_0	T_i*
Holo Galvanis Frame 15/15 x 1.2	0.507	0.435
Holo Galvanis Frame 40/40 x 1.2	1.110	0.997
Holo Galvanis 20/20 x 1.2	1.227	1.107
Multiplex 9 mm Melaminto 2 Faces	0.649	0.564
Multiplex 15 mm HPL White doff	1.041	0.932
Glass 6 mm	0.856	0.759
Acrylic Cutting Sticker	1.407	1.276

Step 2.

Identify the smallest Ti* value of an item, which is denoted as item 1 with k1=1, and the other items are denoted as items 2, 3, 4, ...n. Based on the calculation results, the identification of the smallest Ti* value from the three types of raw materials can be seen in Table 5.

Table 5. Summary of Ti* Calculation.

Item k_i	Types of Raw Materials	T_0	T_i*
Item 1	Holo Galvanis Frame 15/15 x 1.2	0.507	0.435
Item 2	Multiplex 9 mm Melaminto 2 Faces	0.649	0.564
Item 3	Glass 6 mm	0.856	0.759

Item 4	Multiplex 15 mm HPL White doff	1.041	0.932
Item 5	Holo Galvanis Frame 40/40 x 1.2	1.110	0.997
Item 6	Holo Galvanis 20/20 x 1.2	1.227	1.107
Item 7	Acrylic cutting sticker	1.407	1.276

Step 3.
Determining the T value. The smallest Ti* value belongs to the Holo Galvanis Frame 15/15 x 1.2 meter raw material.

$$T_0 = \sqrt{\frac{2\,(50.000 + 13.750)}{870{,}83\ x\ 81{,}750}} = 1.046\ months$$

$$T = \sqrt{\frac{2\,(50.000 + 13.750)}{870{,}830\,(81{,}750 + \frac{1{,}645\ x\ 14{,}046}{\sqrt{1{,}046 + 0{,}0147}})}} = 0.929\ months$$

Step 4.
Determining the values of the other items, namely k2, k3, k4, and so on. The determination of the ki values is carried out through trial and error. If ki = 1, then $\sqrt{(1-1)1} \leq \frac{0{,}468}{0{,}929} \leq \sqrt{(1+1)1}$. The value of k1 = 1 satisfies the equation, so k1 = 1. A summary of the Step 4 calculation results can be seen in Table 6.

Table 6. Summary of The Step 4 Calculation.

Types of Raw Materials	$\sqrt{(k_i - 1)k_i}$	T_i^*/T	$\sum\sqrt{(k_i - 1)k_i}$
Holo Galvanis Frame 15/15 x 1.2	0	0.464	1.414
Multiplex 9 mm Melaminto 2 Faces	0	0.602	1.414
Glass 6 mm	0	0.810	1.414
Multiplex 15 mm HPL White doff	0	0.995	1.414
Holo Galvanis Frame 40/40 x 1.2	0	1.064	1.414
Holo Galvanis 20/20 x 1.2	0	1.181	1.414
Acrylic cutting sticker	0	1.362	1.414

Step 5.
Determining the values of T_0 and T using equation (4) with the following results:

$$T_0 = \sqrt{\frac{2\,(50.000 + 96.250}{350.109}} = 0.886\ months$$

$$T = \sqrt{\frac{2\,(50.000 + 96.250}{388.734}} = 0.995\ months$$

Step 6.
Determining the total cost (OT) with a result of IDR 528,463,671.

The next iteration starts from Step 4 to 6. If the total cost is the same as in the previous iteration, the iteration calculation is stopped. In this study, the iterations used went up to Iteration 3 with results as shown in Table 7.

Table 7. Results of All Iterations.

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Iteration	T (months)	OT (IDR)
1	0.886	528,463.671
2	0.850	524,754.589
3	0.850	524,754.589

The determination of the order interval value for each type of raw material is obtained from the multiplication of the value of ki with T, with the results as shown in Table 8.

Table 8. Ordering Interval for Each Raw Material.

Types of Raw Materials	k_i	T (months)	T_i (months)	T_i (days)
Holo Galvanis Frame 15/15 x 1.2	1	0,850	0,850	20,390
Multiplex 9 mm Melaminto 2 Faces	1	0,850	0,850	20,390
Glass 6 mm	1	0,850	0,850	20,390
Multiplex 15 mm HPL White doff	1	0,850	0,850	20,390
Holo Galvanis Frame 40/40 x 1.2	1	0,850	0,850	20,390
Holo Galvanis 20/20 x 1.2	1	0,850	0,850	20,390
Acrylic cutting sticker	2	0,850	1,699	40,780

The inventory level is set to meet demand during the ordering interval and to anticipate fluctuating demand during the ordering interval and lead time. The results of the safety stock (SS) and inventory level (IL) calculations can be seen in Table 9.

Table 9. Safety Stock (SS) and Inventory Level (IL).

Types of Raw Materials	SS	IL
Holo Galvanis Frame 15/15 x 1.2	55	247
Multiplex 9 mm Melaminto 2 Faces	22	96
Glass 6 mm	12	56
Multiplex 15 mm HPL White doff	12	56
Holo Galvanis Frame 40/40 x 1.2	12	56
Holo Galvanis 20/20 x 1.2	12	56
Acrylic cutting sticker	17	186

The total inventory cost is the cost obtained from the calculation of the T value acquired in the second iteration, which is IDR 528,463.671.

Based on the calculation of the ordering interval for each raw material, raw material orders will be placed 15 times over the course of one year. Currently, the company places orders for raw materials 92 times a year because it does not take into account the inventory levels and the usage of raw materials.

Conclusion

This study used a joint replenishment inventory model with a P-model approach, resulting in a uniform ordering interval of 0.850 months (20 days) for all raw material types. The design results showed an ordering frequency of only 15 times per year, significantly lower than the company's

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system, which reached 92 times with different details for each raw material. This condition allows the company to save on total inventory costs.

References

1. R. Jacob, Operation and Supply Chain Management, (2018)
2. R.G. Schroeder, Operations Management: Contemporary Concepts and Cases, (2000)
3. J. Heizer, B. Render, C. Munson, Operation Management: Sustainability and Supply Chain Management, (2017)
4. S.N. Bahagia, Sistem Inventory, (2006)
5. A. Eynan, D.H. Kropp, Periodic Review and Joint Replenishment in Stochastic Demand Environments, IEEE Transactions, **30**. pp. 1025-1033, (1998)
6. J.S. Noh, J.S. Kim, B. Sarkar, Stochastic Joint Replenishment Problem with Quantity Discounts and Minimum Order Constraints, Operational Research, **19** (1), (2019)