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Comparison of continuous review system method and min-max method in soybean inventory control

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ABSTRACT

This study aims to compare the effectiveness of two inventory control methods, namely continuous review system and min-max in controlling soybean raw material inventory in tofu production. The continuous review system method is an inventory control system where raw material inventory is checked continuously while the min-max method is a method that maintains raw materials between the minimum and maximum limits. The data used are data on soybean raw material inventory and needs at the Ali Musa tofu factory in Serdang Bedagai Regency, Indonesia. Based on the results of the analysis of total inventory costs using the continuous review system method, it is IDR 418,978,693 in 2021 and IDR 430,271,763 in 2022. While the total inventory cost using the min-max method is IDR 366,272,031 in 2021 and IDR 367,964,100 in 2022. While the company uses IDR 429,321,708 in 2021 and IDR 445,381,200 in 2022. From the calculations above, the min-max method is more effective in reducing total inventory costs with infrequent ordering frequencies. Since orders are not made regularly, this strategy reduces the number of soybean orders and reduces the cost of ordering. When the reorder limit is reached, the company will place the order. The choice of inventory control method must be adjusted to the needs and operational characteristics of the company. The continuous review system method is better for companies with high and fluctuating raw material needs, while min-max can be used for companies with more stable raw material needs. The findings and the method used in this study could be beneficial for the factory to organize its inventory efficiently.

Introduction

Indonesia's business world is growing rapidly so every company needs to do better to face the competition in the future (Rizal et al., 2020) Industry is an economic activity that produces raw materials or processes them into semi-finished goods or finished goods that add value to the product itself. One of the widely used processing industries is the soybean industry (Yanto et al., 2022). The presence of culinary tourism has a positive impact on the community's economy. Job opportunities are open because manpower is needed for the production and marketing of culinary

products. For example, the residents of Dolok Manampang Village have experienced an increase in the economy thanks to the culinary tourism "Kampung Tahu" (Kecamatan Dolok Masihul, 2023). Soybeans are a food crop that is the main source of plant-based protein (Sirait et al., 2020). Soybeans are also the third most important raw material after rice and corn. This product is rich in protein and the need for soybeans continues to increase in line with the growth of the population and the need for raw materials in the food industry (Astuti et al., 2023).

The relatively small supply of raw materials causes the purchase of raw materials to be more frequent, so that the cost of ordering for the company is higher (Amri, 2020; Agustin, 2020). Inventory has a primay function as the basis for tactical decision making, and includes a buffer function, an economic lot sizing function, and an anticipation function (Purnomo & Riani, 2018). The costs used in inventory control are ordering costs, storage costs and inventory shortage costs (Sanni El Randi & Meirini, 2021).The advantage or advantage of Min-Max method is to make an inventory ordering plan so that you can know and be able to determine the minimum and maximum levels of inventory in the warehouse, so that there is no out-of-stock and excess inventory (Rozaq & Mahbubah, 2022). Method Continuous Review System is a method whereby when the inventory reaches the reorder point, a Q order is placed that comes after a certain waiting time. Method Continuous Review System is a probabilistic inventory model, that is, an inventory model with one or more variables that are probabilistic (Br Sirait & Nasution, 2023).

Tofu is usually produced in small to medium-sized factories (Nadya et al., 2020). Tofu is a healthy soy-based food and is a food that is widely consumed by Indonesian people because it is highly nutritious, affordable, and high source of protein for almost all levels of society (Herdhiansyah et al., 2022). The purpose of this management is to minimize operational costs and optimize the company's performance. Reliable inventory management requires consideration of various inventory factors. Identifying and grouping costs related to inventory requires special attention by management to make the right decisions (Asdi et al., 2017). The purpose of raw material inventory is to ensure that the stock of materials provided is not too small and not too large in very efficient and effective quantities, processes in the company, especially the production process, can be carried out efficiently and effectively, the availability of effective materials affects the smooth production process (Kadafi & Delvina, 2021).

Method Continuous Review System is an inventory management method that continuously manages the quantity and status of inventory and places orders when the order point is reached again (Hany & Khairani, 2023). Method mechanism Min-Max i.e. when the supply has passed the minimum limits and is close to the limit safety stock, so reorder must be done (Masdani, 2022)**.** The advantage or advantage of this method is to make an inventory ordering plan so that you can know and be able to determine the minimum and maximum levels of inventory in the warehouse, so that there is no out-of-stock and excess inventory (Rozaq & Mahbubah, 2022).

Research conducted by (Sari et al., 2023) Analysis of Palm Oil Inventory Control as Oil Raw Material Using the Continuous Review System, discussing the problem of raw materials that undergo changes during the harvest season. The purpose of this study is to minimize the total cost of palm oil inventory by the method continuous review system. Then on the research by (Rizkina et al., 2022), Inventory Control Analysis Using the Min-Max and Economic Order Quantity (EOQ), regarding inaccuracies in the handling of fresh fruit stock stocks. The purpose of this study is to determine the number of fruit orders that are more economical by comparing the two methods. Research conducted by (Setiawan et al., 2023), Analysis of Product Inventory Control Using the Continuous Review System (Method Q) and Periodic Review System (Method P) to Minimize Inventory Costs. Research by (Octaviani & Fitriani, 2022) with the Min-Max method can save the

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cost of expenditure. Research by (Fadhilah & Saifudin, 2023) with the Min-max method can minimize the amount of final inventory of raw materials.

Then, based on the previous research, the researcher intends to use the Contiuous Review System method and the Min-Max method in controlling soybean inventory as a raw material for tofu production.

Method

This study uses primary data in the form of oral data from people who are trusted by the research subjects related to the variables studied and secondary data which are indirect data source that provide data to data collectors (Beno & Yanti, 2022).There are two types of probabilistic models in inventory control, namely Periodic Review System (model P) and Continuous Review System (model Q). In the method continuous review system, the order time varies, but the number of items ordered is fixed. The method periodic review system is used for a periodic system with the number of items ordered varies but the order time remains the same. (August, 2020). Method Continuous Review System is an inventory management method that continuously manages the quantity and status of inventory and places orders when the order point is reached again (Hany & Khairani, 2023). Method Min-Max It is a method to determine the maximum and minimum levels of inventory. The minimum inventory specifies how much stock should be left in the warehouse to avoid problems such as delivery delays. While the maximum inventory is the maximum amount that can be stored as inventory (Pramuditya, 2023).

Here are the steps in the research process:

1. Collect data on soybean raw material inventory from January 2022 to December 2023
2. The calculation uses the Continuous Review System method to manage the raw material purchasing cost data, ordering cost data, storage cost data, and inventory shortage cost data that has been processed. The steps of data processing using the Continuous Review System method are as follows (Fatma & Pulungan, 2018),
   - Determine the size of the booking lot q_{01}

$$q_{01} = \frac{\sqrt{2AD}}{h} \quad (1)$$

   - Determine the value of the shortage of supplies (α) then specify the reorder point (r_1)

$$\alpha = \frac{hq_{01}}{cuD + hq_{01}} \quad (2)$$

$$r_1 = DL + Z_{\alpha} S\sqrt{L} \quad (3)$$

$$N = SL[f(Z_{\alpha}) - Z_{\alpha}\psi(Z_{\alpha})] \quad (4)$$

   - After the rebooking point (r_1) is obtained, then the value is recalculated q_{02}

$$q_{02} = \sqrt{\frac{2D\left[A + C_u \int_{r1}^{\infty}(X - r_1)\, f(X)dx\right]}{h}} \quad (5)$$

   - Recalculated the value α and r_2

$$r_2 = DL + Z_{\alpha} S\sqrt{L} \quad (6)$$

- Compare values r_1 and r_2. If the relative price is equal to then the completed iteration will be obtained $r_1 = r_2$ and $q_1 = q_2$. Calculate the total cost of inventory with the formula:

$$O_r = Dp + \frac{AD}{q_0} + h\left(\frac{1}{2}q_0 + r - DL\right) + \left(\frac{CuDN}{q_0}\right) \quad (7)$$

D : Soybean demand quantity
h : Soybean storage fee
Cu : Produck shortage cost
A : Soybean order fee
L : Booking lead time
P : Soybean price per kilogram
N : Total soybean shortage
r : Reorder point
q_0 : Lot size per order

3. The calculation uses the Min-Max method to control the minimum supply and maximum supply. The steps for data processing using the Min-Max method are as follows (Rachmawati & Lentari, 2022),
   - Determine safety stock

$$SS = Sd \times \sqrt{LT} \quad (8)$$

   - Determining minimum and maximum stock

$$\text{Minimum Stock} = (T \times LT) + SS \quad (9)$$

$$\text{Maximum Stock} = 2 \times (T \times LT) + SS \quad (10)$$

   - Determines the number of orders in a single message (Q)

$$Q = 2 \times T \times LT \quad (11)$$

   - Determining ROP (Reorder Point)

$$ROP = (T \times LT) + SS \quad (12)$$

   - Determine the frequency of bookings in a year

$$F = \frac{D}{Q} \quad (13)$$

SS : Safety Stock
LT : Lead Time
Q : Reorder rate
ROP : Reorder point
F : Frequency of bookings
D : Request
S : Period message fee
H : Storage fee

10.12928/bamme.v4i2.11670

4. The total cost of inventory made will be evaluated from the results of data processing using the method, compared and the lowest cost of the company's method will be selected. The mathematical models of the continuous review system method and the min-max method are as follows,

$$O_T = O_b + O_p + O_s + O_k \quad (14)$$

$$TIC = \left(\frac{D}{Q} \times S\right) + \left(\frac{Q}{2} \times H\right) \quad (15)$$

Results and Discussion

Continuous Review System Analysis

Calculation steps with the continuous review system:

1. Calculating the value lot size order q_{01} by using Equation (1)
   a. Value q_{01} for 2021:

$$q_{01} = \sqrt{\frac{2AD}{h}}$$

$$q_{01} = \sqrt{\frac{2(124{,}000)(41{,}350)}{1{,}524}}$$

$$q_{01} = 2{,}594Kg$$

   b. Value q_{01} for 2022:

$$q_{01} = \sqrt{\frac{2AD}{h}}$$

$$q_{01} = \sqrt{\frac{2(124{,}000)(42{,}600)}{1{,}557}}$$

$$q_{01} = 2{,}604Kg$$

2. Count α and r_1 by using equation (2)
   a. Year 2021

$$\alpha = \frac{hq_{01}}{CuD}$$

$$\alpha = \frac{(1{,}524)(2{,}594)}{(2{,}000)(41{,}350)} = 0.0478$$

   b. Year 2022

$$\alpha = \frac{hq_{01}}{CuD}$$

$$\alpha = \frac{(1{,}557)(2{,}604)}{(2{,}000)(42{,}600)} = 0.04758$$

3. To find the sorted points using equation (3) based on the usual normal distribution table of 0.0478 and 0.04758 have the value Z_α= 1.62
   c. Year 2021

$$r_1 = DL + Z_\alpha S\sqrt{L}$$

$$r_1 = (41{,}350)(0.0300) + 1.62\left(3{,}046\sqrt{0.0300}\right)$$

$$r_1 = 2{,}095.2kg$$

   d. Year 2022

$$r_1 = DL + Z_\alpha S\sqrt{L}$$

$$r_1 = (42{,}600)(0.0304) + 1.62\left(416.7\sqrt{0.0304}\right)$$

$$r_1 = 1{,}412.74kg$$

4. From table B obtained$f(Z_\alpha) = 0.1109$ and $\psi(Z_\alpha) = 0.0232$so that the value of N is obtained using eguation (4)
   a. Year 2021

$$N = SL[f(Z_\propto) - Z_\propto \psi(Z_\propto)]$$

$$= (3.046)(0{,}0300)[0{,}1109 - 1{,}62(0{,}0232)]$$

$$= 91{,}38[0{,}1109 - 0{,}037584]$$

$$= 7kg$$

   b. Year 2022

$$r_1 = DL + Z_\alpha S\sqrt{L}$$

$$r_1 = (42{,}600)(0.0304) + 1.62\left(416.7\sqrt{0.0304}\right)$$

$$r_1 = 1{,}412.74kg$$

Equation (1) is used to calculate the value of q_{02} after getting a grade of N.

a. Value $q_{02}$for 2021:

$$q_{02} = \sqrt{\frac{2AD}{h}}$$

$$q_{02} = \sqrt{\frac{2(124{,}000)(41{,}350)}{1{,}524}}$$

$$q_{02} = 2{,}594Kg$$

c. Value q_{02} for 2022:

$$q_{02} = \sqrt{\frac{2AD}{h}}$$

$$q_{02} = \sqrt{\frac{2(124{,}000)(42{,}600)}{1{,}557}}$$

$$q_{02} = 2{,}604Kg$$

5. Count $\alpha$and r_2 with equation (2)

a. Value $q_{02}$for 2021:

$$\alpha = \frac{hq_{01}}{CuD}$$

$$\alpha = \frac{(1{,}524)(2{,}594)}{(2{,}000)(41{,}350)}$$

$$\alpha = 0.0478$$

b. Value q_{02} for 2022:

$$\alpha = \frac{hq_{01}}{CuD}$$

$$\alpha = \frac{(1{,}557)(2{,}604)}{(2{,}000)(42{,}600)}$$

$$\alpha = 0.04758$$

Based on the normal distribution table for αas much as 0.0478 and 0.04758 have a value of$Z_\alpha = 1.62$

a. Year 2021

$$r_2 = DL + Z_\alpha S\sqrt{L}$$

$$r_2 = (41{,}350)(0.0300) + 1.62\left(3{,}046\sqrt{0.0300}\right)$$

$$r_2 = 2{,}095.2kg$$

b. Year 2022

$$r_2 = DL + Z_\alpha S\sqrt{L}$$

$$r_2 = (42{,}600)(0.0304) + 1.62\left(416.7\sqrt{0.0304}\right)$$

$$r_2 = 1{,}412.74kg$$

When compared $r_1$and r_2, it will have the same value, namely 2,095.2 for 2021 and 1,412.74 for 2022. Here's how to get an inventory policy:

$q_0 = q_{02} = 2{,}594$for 2021 and 2,604for 2022

$r_1 = r_2 = 2{,}095$for 2021 and 1,412.74for 2020

Calculating of total costs using equation (14)

a. Total preparation cost in 2021

$$O_T = Ob + Op + Os + Ok$$

$$O_T = \text{IDR } 413{,}500{,}000 + \text{IDR } 1{,}976{,}638 + \text{IDR } 3{,}278{,}886 + \text{IDR } 223{,}169$$

$$O_T = \text{IDR } 418{,}978{,}693$$

b. Total preparation cost in 2022

$$O_T = Ob + Op + Os + Ok$$

$$O_T = \text{IDR } 426{,}000{,}000 + \text{IDR } 2{,}028{,}571 + \text{IDR } 2{,}210{,}473 + \text{IDR } 32{,}719$$

$$O_T = \text{IDR } 430271{,}763$$

Min-Max Method Analysis

Steps to calculate inventory by min-max method:

1. *Safety stock,* calculate *safety stock* using equation (8)

10.12928/bamme.v4i2.11670

a. Year 2021

$$SS = Sd \times \sqrt{LT}$$
$$SS = 3{,}046 \times \sqrt{0.4} = 1{,}926Kg$$

b. Year 2022

$$SS = Sd \times \sqrt{LT}$$
$$SS = 416.7 \times \sqrt{0.4} = 264Kg$$

Based on the calculation above, the lead time data of 12 days or 0.4 m0nths obtained safety stocks of 1,926 kg and 264 kg.

2. Determine the minimum stock with equation (9) and maximum stock with equation (10)

a. Year 2021

$$\text{Min. Stock} = (T \times LT) + SS$$
$$\text{Min. Stock} = (3{,}446 \times 0.4) + 1{,}926 = 3{,}304Kg$$
$$\text{Max. Stock} = 2 \times \big((T \times LT) + SS\big)$$
$$\text{Max. Stock} = 2 \times \big((3{,}446 \times 0.4) + 1{,}926\big) = 6{,}608Kg$$

b. Year 2022

$$\text{Min. Stock} = (T \times LT) + SS$$
$$\text{Min. Stock} = (3{,}550 \times 0.4) + 264 = 1{,}684Kg$$
$$\text{Max. Stock} = 2 \times \big((T \times LT) + SS\big)$$
$$\text{Max. Stock} = 2 \times \big((3{,}550 \times 0.4) + 264\big) = 3{,}368Kg$$

3. Reorder Rate (Q), using equation (11)

a. Year 2021

$$Q = 2 \times T \times LT$$
$$Q = 2 \times 3{,}446 \times 0.4 = 2{,}757Kg$$

b. Year 2022

$$Q = 2 \times T \times LT$$
$$Q = 2 \times 3{,}550 \times 0.4 = 2{,}840Kg$$

4. Calculating *reorder points* using equations (12)

a. Year 2021$\text{ROP} = (T \times LT) + SS$

$$\text{ROP} = (3{,}446 \times 0.4) + 1{,}926 = 3{,}304Kg$$

b. Year 2022

$$\text{ROP} = (T \times LT) + SS$$
$$\text{ROP} = (3{,}550 \times 0.4) + 264 = 1{,}684Kg$$

5. Frequency of Orders in a year, using equation (13)

a. Year 2021

$$F = \frac{D}{Q} = \frac{41{,}350}{2{,}757} = 15 \text{ kali/tahun}$$

b. Year 2022

$$F = \frac{D}{Q} = \frac{42{,}600}{2{,}840} = 15 \text{ kali/tahun}$$

6. Calculate *total inventory cost* using equation (15)

a. Year 2021

$$TIC = \left(\frac{D}{Q} \times S\right) + \left(\frac{Q}{2} \times H\right) A$$
$$TIC = \left(\frac{41{,}350}{2{,}757} \times \text{IDR } 124{,}000(12)\right) + \left(\frac{2{,}757}{2} \times \text{IDR } 1{,}524\right)$$
$$TIC = \text{IDR } 22{,}317{,}301 + \text{IDR } 2{,}100{,}834$$
$$TIC = \text{IDR } 24{,}418{,}135 \times \text{ order frequency/year}$$
$$TIC = \text{IDR } 24{,}418{,}135 \times 15$$
$$TIC = \text{IDR } 366{,}272{,}031$$

b. Year 2022

$$TIC = \left(\frac{D}{Q} \times S\right) + \left(\frac{Q}{2} \times H\right)$$

$$TIC = \left(\frac{42{,}600}{2{,}840} \times \text{IDR } 124{,}000(12)\right) + \left(\frac{2{,}343}{2} \times \text{IDR } 1{,}557\right)$$

$$TIC = \text{IDR } 22{,}320{,}000 + \text{IDR } 2{,}210{,}940$$

$$TIC = \text{IDR } 2{,}530{,}940 \times \text{order frequency/year}$$

$$TIC = \text{IDR } 24{,}530{,}940 \times 15$$

$$TIC = \text{IDR } 36{,}964{,}100$$

Based on the data calculation, Table 1 are the results of comparison of total soybean inventory costs with companies, continuous review system method, and min-max method.

Table 1. Results of comparison of total soybean inventory costs with companies, continuous review system method, and min-max method

Method Used	Total Inventory Costs	
	2021	2022
Company Policy	IDR 429,321,708/year 2021	IDR 445,381,200/year 2022
Continuous Review System Method	IDR 418,978,693/year 2021	IDR 430,271.763/year 2022
Min-Max Method	IDR 366,272,031/year 2021	IDR 367,964,100/year 2022

The min-max method in inventory management is an approach that regulates stock by setting two important points: (1) Min: the minimum amount of stock that must always be available to ensure uninterrupted operations. (2) Max: the maximum amount of stock that must not be exceeded so that storage costs and the risk of excess stock can be minimized. When a company implements the Min-Max method, potential operational changes that can be implemented include: (1) Purchasing and procurement control: The company will only order stock when inventory is close to the minimum level. This reduces the frequency of unnecessary procurement, so that total order costs a storage costs can be controlled. (2) Storage cost efficiency: By maintaining stock at an optimal level the company can reduce storage costs such as warehouse spaces costs. (3) Reducing stock-out: Determining the minimum level ensures that the company always has stock to meet demand. Overall, implementing the min-max method can help companies reduce total inventory costs by maintaining balance between stock requirements and operational efficiency.

Conclusion

As inventory increases and orders become more frequent, the costs associated with inventory storage increase. After research and discussion, the min-max method will be used as a substitute for the continuous review system method to establish inventory management policies. Using the min-max approach, the safety stock results were 1,926 kg/year 2021 and 264 kg/year 2022 and reorder points of 2,757 kg/year 2021 and 2,840 kg/year 2022. Since orders are not made regularly, this strategy reduces the number of soybeans orders and reduces the cost of ordering. When the reorder limit is reached, the company will place the order.

Comparison of the total inventory cost value using the continuous review system and the total inventory cost value using the min-max methodology carried out based on the calculation above, can then be analyzed based on the total inventory cost using the continuous review system method

10.12928/bamme.v4i2.11670

of IDR 418,978,693 in 2021 and IDR 430,271.763 in 2022. Meanwhile, the total value of inventory costs using the Min-Max method is Rp 366,272,031 in 2021 and Rp 367,964,100 in 2022. The cost is then compared to the company's resources. Based on table 4.9, it can be seen that the total cost with the company method is IDR 429,321,708 in 2021 and IDR 445,381,200 in 2022 and the total inventory cost with the min-max method is IDR 366,272,031 in 2021 and IDR 367,964,100 in 2022. The inventory management system with the min-max method saves IDR 63,049,677 in 2021 and IDR 77,417,100 in 2022. Therefore, it can be said that the min-max method was chosen because it has the lowest total overall cost.

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