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Control Inventory of Raw Materials Using Supply Probabilistic with *Q* Method (*Continuous Review Method*) in the Animal Feed Industry Shrimp

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ABSTRACT

The ingredients used to make shrimp feed include soybean meal, shrimp head meal, squid flour, wheat flour, fish head meal, and other components. The demand for companies to produce shrimp feed varies and is unpredictable, leading to a shortage of raw materials and the inability to fulfill orders. To solve this problem, the company places special raw material orders or surprise orders. However, sudden orders result in higher inventory costs than normal company orders. This study aims to determine the optimal raw material order, to minimize inventory costs through a probabilistic model of raw material inventory control with the Q method (continuous review method). Based on the results of the Q method, optimal order quantity (q), reorder points (r), and safety stock (Ss) were obtained. The total inventory cost generated in the Q method was lower than the total inventory cost used by the company, with a total savings of 6.11% per year.

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1. INTRODUCTION

Every company, whether a service company or a manufacturing company, always needs inventory. In the absence of inventory, entrepreneurs will be exposed to the risk that their company will at some time not be able to fulfill the desires of its customers (Puspita & Rahmawati, 2018). Companies often experience difficulties in managing raw materials, such as inventory shortages or excess inventory (Arif et al., 2017). In an effort to overcome the problem of raw materials for the production process in manufacturing, it is very complex and continuous efforts must be made to maintain the quantity and quality of production results so that costs incurred due to problems in procuring raw materials can be reduced (Suwandi et al., 2018)

The fluctuating and unpredictable demand for shrimp animal feed production results in product demand not being met according to orders due to a shortage of raw materials. To overcome shortages of raw materials, companies place special orders or urgent orders for raw materials. Last-minute orders result in higher carrying costs than regular orders. From the problem of shortage of raw material supplies above, the author seeks a solution to this problem by implementing an inventory system that can avoid shortages of raw materials

by determining the optimum order quantity to minimize inventory costs . By implementing raw material inventory control using probabilistic inventory with the Q method (*continuous review method*)

Several previous studies used inventory control methods which became a reference in this research, according to research results (Nirfison, 2017) Controlling compressor material inventory using the Probabilistic EOQ method resulted in total inventory costs being reduced by 8.2% compared to the total inventory costs resulting from company policy. According to research results (Alfi et al., 2022) , rubber raw material inventory by applying a probabilistic model with a fixed order method (Q method) total inventory costs are more efficient at 0.08% of the company's total costs. According to research (Fadilah & Aryanny, 2021), controlling palm oil raw material inventories by applying the *Continuous Review (Q) Lost Sales* method results in inventory cost savings of 4%. From several previous research results, the application of raw material inventory using the Q method can determine optimum raw material ordering and minimize total inventory costs.

2. LITERATURE REVIEW

Forecasting

Forecasting techniques are effective and efficient planning techniques. Forecasting techniques are generally used for capacity planning, budgeting, and purchasing goods and services for business operations. Demand forecasting is a business method for estimating the future value of large asset holdings. Demand forecasting means estimating future behavior by reconstructing past behavioral patterns, or identifying and estimating causal factors that influence behavior (Ackermann & Sellitto, 2022) . The level of raw material requirements for the coming period can be estimated from forecasting consumer demand for the products produced (Hidayat et al., 2020) . This forecasting has a big influence on management decisions to determine the amount of production of goods that must be provided by the company (Rachman, 2018) .

There are two main groups of forecasting methods: quantitative methods and qualitative methods (Suparno, 2018) . Qualitative forecasting is a prediction that does not depend on time. The outcome of a prediction depends on the person who actually makes the prediction whereas quantitative forecasting is based on past quantitative data. The results of the predictions made depend on the method used in the prediction.

Quantitative forecasting can only be used if the following three conditions are met:

- Availability of information regarding historical data
- Historical data information can be quantified into numerical data.
- It can be assumed that some aspects of past patterns will remain in the future.

The forecasting method used in this research is Trend Projection Method with Regression. This method is used to predict the value of the dependent variable in the future based on the value of the independent variable in the past . This method forms the basis of a trend line equation, and future research can be predicted based on the equation.

The functional form of the Trend Projection with Regression method can be:

a. Constant, with forecasting function (Yt):

Yt = a, where $a = \frac{\sum Y_1}{N}$ …… (1)

where: Yt = added value

N = number of periods

b. Linear, with forecasting function:

Yt = a + bt .... (2)

Where : $a = \frac{Y - bt}{n}$ $b = \frac{n\sum ty - \sum(t)\sum(y)}{n - \sum t^2 - \left(\sum t\right)^2}$

c. Quadratic, with forecasting function:

Yt = a + bt + ct ^{2} …… (3)

Where :

$$a = \frac{\sum Y - b\sum t - c\sum t^2}{n} \qquad c = \frac{\theta - b\alpha}{\partial} \qquad b = \frac{\partial\delta - \theta\alpha}{\partial\beta - \alpha^2}$$

$$\partial = \left(\sum t^2\right)^2 - n\sum t^4$$

$$\delta = \sum t \sum Y - n\sum tY$$

$$\theta = \sum t^2 \sum Y - n\sum t^2 Y$$

$$\alpha = \sum t^2 \sum t^2 - n\sum t^3$$

d. Exponential, with forecasting function:

Yt = ae ^{bt} .... (4)

Where :

$$\ln a = \frac{\sum \ln Y - b\sum t}{n} \qquad \ln a = \frac{n\sum t \ln Y - \sum t \sum \ln Y}{n\sum t^2 - \left(\sum t\right)^2}$$

e. Cyclical, with forecasting function:

$$\hat{Y}_t = a + b\sin\frac{2\tau}{n} + c\cos\frac{2\pi t}{n} \quad \text{..... (5)}$$

Where :

$$\sum Y = na + b\sin\frac{2\pi t}{n} + c\sum \cos\frac{2\pi t}{n}$$

$$\sum Y \sin\frac{2\pi t}{n} = a\sum \sin\frac{2\pi t}{n} + b\sin^2\frac{2\tau}{n} + c\sum \sin\frac{2\pi t}{n}\cos\frac{2\pi t}{n}$$

$$\sum Y \cos\frac{2\pi t}{n} = a\sum \cos\frac{2\pi t}{n} + c\sum \cos^2\frac{2\tau}{n} + b\sum \sin\frac{2\pi t}{n}\cos\frac{2\pi t}{n}$$

Supply

Inventory is one of a company's most important assets because it is very valuable and has an impact on total operating costs. Therefore, inventory planning and control is an activity that requires special attention from company management (Chandra & Sunarni, 2020) . On the one hand, company management wants the costs embedded in inventory to be minimal, but on the other hand, management must also ensure that inventory does not run out and disrupt the ongoing production process. Inventory management has been studied by researchers and industry leaders for more than a century. Economic Order Quantity (EOQ), one of the most well-known inventory models to date, was first introduced by Ford W. Harris in 1913 and has inspired various fixed quantity extensions (Mosca et al., 2019) . Planning and control of raw material inventory is carried out in such a way as to meet raw material needs precisely and at low cost (Pratiwi et al., 2020)

Probabilistic Inventory Model

A probabilistic inventory control model is an inventory model with demand characteristics and order arrivals that are not known with certainty in advance, but the expected value, variance and probability distribution pattern can be predicted and approximated based on the probability distribution (Hidayat et al., 2020) . Probabilistic models are used for predictions and decision making under uncertainty, for example, delivery quantities, production quantities, and inventories change according to various unexpected events, so production inventory control is needed to overcome these irregular fluctuations (Shin et al., 2015) . The uncertainty here is not random, but has a known probability distribution pattern. Statistically, probabilistic events are phenomena in which population parameters such as expected values, variances, and probability distribution patterns can be predicted.

This probabilistic inventory system is used when demand, lead time, or both cannot be known with certainty. What must be taken into account in this model is the possibility of stock outs due to unexpected supplies of raw materials or receipt times that are longer than the expected lead time. So safety stock is needed

to avoid running out of inventory. Operationally, (Almalika, 2021) there are three policies in this inventory, namely:

- Determine the economic order lot size (qo) .
- Determining when to reorder (r)
- Determine the amount of safety reserve (ss)

***Q* Method (*Continuous Review Method*)**

The Q method solves the probabilistic inventory problem by considering that the position of goods available in the warehouse is consistent with the position of goods inventory in a deterministic system by adding safety reserves. In principle, this system almost corresponds to a simple probabilistic inventory model, except for service levels. A simple probabilistic inventory model determines service levels, while the Q method optimizes service levels (Prayudha et al., 2015) .

There are several characteristics that must be considered when using the Q method, namely:

- Demand during the planning period is probabilistic and normally distributed with a mean (D) and standard deviation (σ).
- The order lot size (q^0) is constant for each order, goods arrive at the same time as the lead time (L), and orders are placed when inventory reaches the order point (r).
- The price of an item (ρ) is constant with respect to the number of items ordered and with time.
- Ordering costs (A) are constant for each order, and holding costs (h) are proportional to raw material prices and storage time.
- Inventory shortage costs (π) are proportional to the number of items that cannot be shipped or service time (independent of the number of items out of stock).

The Probabilistic Inventory Model with the *Q method* is formulated as follows:

- **Inventory costs**
  a. Purchase costs (O_b)
  The cost of purchasing goods (*Ob*) is the product of the expected quantity of materials purchased (D) and the price of materials per unit (ρ) mathematically written as follows:
  $Ob = D \,.\, \rho$ …….…….. (6)

  b. Procurement Costs (*Op*)
  The annual procurement cost (O_p) depends on the expected order frequency (*f*) and the cost per order (*A*) can be mathematically expressed as follows:
  $O_p = f \,.\, A$
  The expected frequency of orders per year depends on the need per year (*D*) and the size of the order lot (qo) which can be expressed as follows:
  $f = \frac{D}{q_o}$
  so you can get:
  $O_p = \frac{AD}{q_o}$ ……... (7)

  c. Saving Costs (*Os*)
  Annual holding costs (O_s) depend on the expected amount of inventory stored (*m*) and holding costs per unit per year (*h*), which can be expressed as follows:
  $O_s = hxm$

  The cost of storing per unit per year (*h*) is a function of the price of the material stored and the amount is expressed as a percentage (*I*) and the price of the material (*p*)
  $h = I \,x\, p$

the amount of inventory stored (m) is the amount of materials in the warehouse (*s*) and after the order arrives, the amount of materials will be (s + qo) so that *the steady stock* of inventory in the warehouse will fluctuate between s and (s+qo), so that the existing inventory expectation (*m*) can be expressed:

$m = ½ q_o + s$

So, $O_s = (½ q_o + ss) h$

To be able to calculate the storage costs ($Os_)$ from the equation above, what is not yet known is *s* . *s* prices will vary from one cycle to another. If the demand for materials during the lead-up time (*L*) is *x* with a probability distribution *f(x)*, then the price s is $s = r – x$. The price of *s* can be positive or negative. With *back orders* , it is mathematically possible to have negative inventory. In this case, negative inventory is defined as demand that will be fulfilled by *back order* . The price expectation *s* can be expressed as follows:

$s = r - D_{L.}$

From the substitution results, the saving costs can be expressed as follows:

$$O_s = h \left(\frac{q_o}{2} + r - D_L \right) \text{ ..... (8)}$$

d. Inventory shortage costs

In the *Q model* , inventory shortages are only possible during the lead-up time and this shortage occurs if the amount of demand during the lead-up time (*x*) is greater than the inventory level at the time the order is placed (*r*). to calculate the cost of inventory shortages based on the amount of missing materials. If the cost of shortage per unit of goods is $_\pi$, the annual inventory cost (*Ok*) is:

$O_k = N_T . \pi$

Where :

N_T : Number of material shortages during one year

π : Cost of inventory shortages per unit of material

The price N_T can be found by calculating the expected number of inventory shortages each cycle *(N)* and the expected frequency of cycles for one year *(f)* .

$N_T = fN$

Where :

$$f = \frac{D}{q_o} \text{ and } N = \int_r^\infty (x-r) f(x) dx$$

So the cost of inventory shortages *(Ok)* *which* is calculated based on quantity can be formulated as follows:

$$O_k = \frac{\pi D}{q_o} \int_r^\infty (x-r) f(x) dx \text{ ..... (9)}$$

- **Optimum material inventory quantity**

For determine mark q_0^* and *r** searched iteratively

a. Count mark q_{01}^* beginning with the Willson formula

$$q_{01}^* = \sqrt{\frac{2AD}{h}} \text{ ..... (10)}$$

b. Based on mark q_{01}^* which is obtained can be found the magnitude of the possibility of a shortage of inventory.

$$\alpha = \frac{h q_{01}^*}{\pi D}$$ (z_α can searched from table A)

$$\alpha = \int_{r^*}^\infty f(x) dx \quad \text{where , } r_1^* = D_L + z_\alpha S \sqrt{L} \text{ ..... (11)}$$

c. With is known r_1^* which is obtained will can calculated mark q_{02}^* with formula as follows:

$$q_{02}^* = \sqrt{\frac{2D\left[A + \pi \int_{r_1^*}^{\infty} (x - r_1^*) f(x) dx\right]}{h}} \quad \text{……...…….. (12)}$$

Where: $N = \int_{r_1^*}^{\infty} (x - r_1^*) f(x) dx = S_L [f_{(z\alpha)} - z_\alpha \psi_{(z\alpha)}]$

The values of $f_{(z\alpha)}$ and $\psi_{(z\alpha)}$ can be found from table B

d. Calculate again the value of $\alpha = \frac{hq_{02}^*}{\pi D}$ and value r_2^* with using $\alpha = \int_{r_2^*}^{\infty} f(x)dx$ where , $r_2^* = D_L + z_\alpha S\sqrt{L}$ ……...…… (13)

e. Compare mark r_1^* And r_2^* If price r_2^* relatively The same with r_1^* iteration finished and will be obtained $r^* = r_2^*$ and $q_0^* = q_{02}^*$ if not go back to step c with replace mark $r_1^* = r_2^*$ and $q_{01}^* = q_{02}^*$

- **For safety *stock***

  $Ss = z_\alpha S\sqrt{L}$ …… ….. …… (14)

- **Total cost expectations per year**

$$O_T = Dp + \frac{AD}{q_o} + h\left(\frac{1}{2} q_o + r - D_L\right) + \pi \frac{D}{q_o} \int_{r_1^*}^{\infty} (x - r) f(x) dx \quad \text{……...…. (15)}$$

3. RESEARCH METHOD

The research carried out is historical research , a form of research related to the systematic collection and evaluation of data on past events to test hypotheses about the causes of influence and development of events, which can help provide information about current events and predict future events. (Sukardi, 2021) . The research objects studied were the amount of raw material needed for shrimp feed and the amount of demand for shrimp feed as well as inventory costs.

The collection method used in this research is secondary data collection. The data required is as follows:

- Raw Material Order Data for one year
- Data on shrimp feed demand for one year
- Ordering fees and storage fees
- Raw material prices and lead time for ordering raw materials
- Inventory shortage costs
- Percentage/composition of raw materials used

The data that has been collected is processed using a Probabilistic inventory model using the Q method (*Continuous Review Method)* .

The data processing steps carried out in this research are:

1) Distribution Test
   To see the distribution pattern of demand for raw materials, statistical analysis was carried out using the *Chi Square goodness of fit test method* to determine whether the data was normally distributed or not.
2) Forecasting

Carry out forecasting based on product demand data which has been tested for normality of the data with a distribution test to determine the amount of demand one year into the future, with the forecasting method used in this research is Trend Projection Method with Regression. The forecasting results become the basis for determining inventory control.

3) Calculation of the amount of raw materials needed
   Calculate raw material requirements from forecasting results according to the percentage composition of raw materials used by the company.
4) Probabilistic model inventory control using *the Q Method* consists of:
   - Calculation of the optimal order quantity (*Order Quantity*)
   - Determine the reorder point (*Reorder Point*). Calculate when orders will be placed again for the next period.
   - Determining safety stock (*safety stock*) Safety stock is calculated to determine how much inventory there is in case orders arrive late.
   - Calculate the *total inventory costs* for the next year.
5) Calculate the difference between the company's inventory costs and the research results

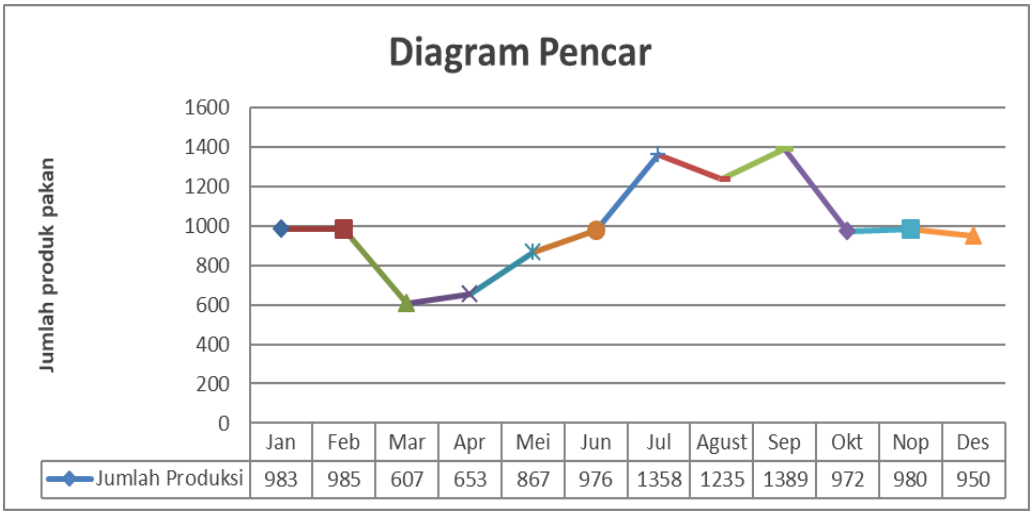
4. RESULTS AND DISCUSSION

- **Production Demand Distribution Testing**

  The normal distribution test was carried out for demand for raw materials to produce shrimp feed for the period January to December using the *Statistical Program for Social Science* (SPSS) program. The normality test for demand for raw materials used the *Kolmogorov – Smirnov data normality test.* From the calculation results, data on demand for raw materials is normally distributed.

- **Forecasting _ _ _**

The forecasting method used in this research is the *time-series method* with a trend projection method with regression. The purpose of forecasting is to predict demand for shrimp feed one year into the future. The data used for forecasting is data on the amount of feed production in the last year. Shrimp feed production data can be seen in the following scatter diagram image.



Picture. 1. Scatter diagram of the amount of shrimp feed production

From the calculation results of the forecasting method used, the smallest SEE and MAPE forecasting errors are then calculated. The results of SEE and MAPE calculations for shrimp feed production volume can be seen in table 1 below.

Table 1. SEE and MAPE calculation results for shrimp feed production volume

Forecasting Methods	*SEE Calculation Results*	*MAPE Calculation Results*
Linear	277.33	21.57
Exponential	234.69	19.44
Quadratic	236.62	20.18
Cyclical	**163.12**	**12.70**

Source: Data processing

From the hypothesis testing, the forecasting method chosen for forecasting demand for shrimp feed products is the cyclical method with the following forecasting function:

$$\mathbf{F}_t = \mathbf{996.25} - 253.128\ \mathbf{sin}\left(\frac{2\pi t}{n}\right) - 36.3998\ \mathbf{cos}\left(\frac{2\pi t}{n}\right)$$

The results of forecasting the amount of shrimp feed production for the next year from January to December can be seen in table 2 below.

Table 2. Forecasting Results of Shrimp Feed Production Amounts

Month	Product quantity (Kg)	Forecasting Results (Kg)
January	983000	838163
February	985000	758835
March	607000	743122
April	653000	795235
May	867000	901209
June	976000	1032650
July	1358000	1154337
August	1235000	1233665
September	1389000	1249378
October	972000	1197265
November	980000	1091291
December	950000	959850

Source: Data processing

- **Calculation of the amount of raw materials needed**

Calculate raw material requirements from forecasting results according to the percentage composition of raw materials used by the company. The percentage of raw materials and the results of calculating the amount of raw materials needed can be seen in table 3 and table 4 below.

Table 3. Percentage of raw materials for shrimp feed

No	Raw material	percentage (%)
1	Soybean Meal (BKK)	12.5 %
2	Shrimp head flour	7.5 %
3	Squid flour	15.0 %
4	Flour	38.0 %
5	Fish flour	25.0 %
6	Drugs	2.0 %
	Total	100%

Source: Company Data

Table 4. Calculation Results of the amount of raw materials needed

Month	Product quantity (Kg)	Raw material requirements (kg)				
		BKK	Flour shrimp head	Flour. squid	Flour	Fish flour
January	838163	104770.4	62862.21	125724.4	318501.9	209540.7
February	758835	94854.35	56912.61	113825.2	288357.2	189708.7
March	743122	92890.24	55734.14	111468.3	282386.3	185780.5
April	795235	99404.32	59642.59	119285.2	302189.1	198808.6
May	901209	112651.1	67590.68	135181.4	342459.5	225302.3
June	1032650	129081.2	77448.73	154897.5	392406.9	258162.4
July	1154337	144292.1	86575.29	173150.6	438648.1	288584.3
August	1233665	154208.2	92524.89	185049.8	468792.8	308416.3
September	1249378	156172.3	93703.36	187406.7	474763.7	312344.5
October	1197265	149658.2	89794.91	179589.8	454960.9	299316.4
November	1091291	136411.4	81846.82	163693.6	414690.5	272822.7
December	959850	119981.3	71988.77	143977.5	364743.1	239962.6
Total		1494375	896625	1793250	4542900	2988750
Standard Deviation (σ)		23608.79	14165.27	28330.55	71770.71	47217.58

Source: Data processing

- **Probabilistic model raw material inventory Q method (*continuous review method*)**

After obtaining the required amount of raw materials for feed products in accordance with the percentage of raw materials determined by the company, inventory control is then carried out using the Probabilistic inventory model *Q method* with a Fixed Order system to calculate the optimum order quantity of raw materials and the total cost of raw material inventory for one year. front for each type of shrimp feed raw materials. The results of calculations using a fixed order quantity system (Q method) can be seen in table 5.

Table 5. Results of inventory calculations using the Q method

Type of raw materials	Raw material requirements (kg/year)	Quantity of raw materials ordered (kg/order)	Order period per year	Reorder point (kg)	Safety supplies (kg)	Total cost (Rp)
Soybean Meal	1494375	47660	31	28440	18060	8,273,530,215
Shrimp head flour	896625	31070	29	17070	10836	5,598,231,106
Squid flour	1793250	50100	36	34540	22081	13,170,134,550
Flour	4542900	113120	40	88530	56976	22,842,666,025
Fish flour	2988750	75530	40	58240	37484	20,138,731,228
Total inventory costs						**70.023.293.125**

Source: Data processing

- **Company raw material inventory system**

Currently the company orders raw materials once every three months, so that within a year the company orders four times a year. The company's raw material inventory system can be seen in table 6.

Table 6. Calculation of raw material inventory at the company

Type of raw materials	Number of raw materials ordered (kg/year)	Cost of ordering raw materials (Rp)	Total shortage of raw materials (kg/year)	Cost of shortage of raw materials (Rp)	Total cost of supplies (Rp)
Soybean Meal (BKK)	1357000	760.5043.681	184625	1,218,762,500	8,823,806,181
Shrimp head flour	835000	5,275,471,738	106775	794,643,500	6,070,115,238
Squid flour	1565000	11,640,659,019	238850	2,092,563,500	13,733,222,519
Flour	3870000	19,715,455,625	674420	4,046,757,500	23.762.213.125
Fish flour	2785000	19,011,948,331	395500	3,180,057,500	22,192,005,831
Total inventory costs					**74,581,362,894**

Source: Data processing

- **Total costs of Research Method Inventory with the company's raw material inventory system**

The total inventory costs applied by the company with the results of the research method, namely the probabilistic inventory model with a fixed order quantity system, can be seen in table 7.

Table 7. Total inventory costs resulting from research with companies

Raw material	Total Inventory cost (Rp)		
	Company Method	*Research methods*	*Cost difference*
Soybean Meal (BKK)	8,823,806,181	8,273,530,215	550,275,966
Shrimp head flour	6,070,115,238	5,598,231,106	471,884,132
Squid flour	13,733,222,519	13,170,134,550	563,087,968
Flour	23,762,213,125	22,842,666,025	919,547,100
Fish flour	22,192,005,831	20,138,731,228	2,053,274,603
Total savings			**4,558,069,769**

5. CONCLUSION

From the results of calculating the total inventory cost of raw materials for Shrimp Feed using the Q Method (Continuous Review Method) Probabilistic inventory model, it *was* obtained that it was IDR. 70,023,293,125,- while the results of calculating the total cost of raw material inventory for the company were obtained at Rp. 74,581,362,894,- then, probabilistic inventory control using the Q method results in a total inventory cost that is smaller than the total inventory cost used by the company with a total cost savings of Rp. 4,558,069,769,- or 6.11% of the company's total costs. Thus, the results of calculating the total cost of raw material inventory obtained are the optimal solution.

REFERENCE

Ackermann, A. E. F., & Sellitto, M. A. (2022). Demand forecasting methods: a review of the literature. *Innovar , 32* (85). https://doi.org/10.15446/innovar.v32n85.100979

Alfi, R., Harif, M., & Pharmayeni, P. (2022). Application of Tire Raw Material Inventory Control with Probabilistic Models and Fixed Order Quantity Systems. *INVENTORY: Industrial Vocational E-Journal On Agroindustry , 3* (1), 33. https://doi.org/10.52759/inventory.v3i1.71

Almalika, R. (2021). *Raw Material Inventory Control as an Important Factor in the Smooth Production Process* . https://ilmu.lpkn.id/2021/02/13/pengendalian-persediaan-bahan-baku-as-politik-cepat-dalam-kelancaran-produk-produk/

Arif, M., Supriyadi, S., & Cahyadi (Serang Raya University), D. (2017). Analysis of FX Coal Inventory Planning Using the Material Requirement Planning Method. *Journal of Industrial Management and*

Logistics , *1* (2), 148. https://doi.org/10.30988/jmil.v1i2.25

Chandra, SL, & Sunarni, T. (2020). Application of the Probabilistic Inventory Model Q Considering Lost Sales at Pharmacy X. *Scientific Journal of Industrial Engineering* , *8* (2), 90–100. https://doi.org/10.24912/jitiuntar.v8i2.7313

Fadilah, MF, & Aryanny, E. (2021). Control of Palm Oil Raw Material Inventory Using Continuous (Q) and Periodic (P) Methods Review at Pt. Xyz. *Juminten* , *2* (4), 97–108. https://doi.org/10.33005/juminten.v2i4.309

Hidayat, U., Suhara, A., Fariza, AN, & Wathoni, AZ (2020). Raw Material Inventory Planning Using Probabilistic Methods (Pt Sintas Kurama Perdana). *Conference on Innovation and Application of Science and Technology (CIASTECH)* , *Ciastech* , 793–802.

Mosca, A., Vidyarthi, N., & Satir, A. (2019). Integrated transportation – inventory models: A review. *Operations Research Perspectives* , *6* (January). https://doi.org/10.1016/j.orp.2019.100101

Nirfison. (2017). Inventory Planning for Compressor Materials Using Probabilistic Economic Order Quantity for Air Conditioner Products. *Operation Excellence* , *9* (3), 282–289.

Pratiwi, AI, Fariza, AN, & Yusup, RA (2020). Evaluation of Raw Material Inventory Using the Continuous Review System and Periodic Review System Approach. *Options* , *13* (2), 120. https://doi.org/10.31315/opsi.v13i2.4137

Prayudha, H., Kusmaningrum, & Amila, K. (2015). Size of the Optimal Order Quantity of Wedge and Taper Components on a Lathe Using the Q Model (Continuous Review Method). *National Institute of Technology Online Journal* , *3* (4), 330–341.

Puspita, A., & Rahmawati, Y. (2018). Control Method of Palm Oil's Raw Materials Supplies to Guarantee the Quality of the Product. *International Journal of Transportation and Infrastructure* , *ISSN 2597 - 4769* , 65–69.

Rachman, R. (2018). Application of Moving Average and Exponential Smoothing Methods in Garment Industry Production Forecasting. *Journal of Informatics* , *5* (2), 211–220. https://doi.org/10.31311/ji.v5i2.3309

Shin, J. S., Kim, S., & Lee, J. M. (2015). Production and inventory control of auto parts based on predicted probabilistic distribution of inventory. *Digital Communications and Networks* , *1* (4), 292–301. https://doi.org/10.1016/j.dcan.2015.10.002

Sukardi. (2021). *Educational Research Methodology: Competencies and Practices* (R. Damayanti (ed.); Revised). Literary Earth.

Suparno. (2018). Production planning uses the aggregate method for turning processed wood, umbrella model, measuring 4.5 cm x 81 cm to minimize production costs. *Management Systems & Industrial Engineering* , *1* (2), 74–83.

Suwandi, A., Zagloel, TY, & Hidayatno, A. (2018). Conceptual model of failure risk control on raw materials inventory system. *IOP Conference Series: Materials Science and Engineering* , *453* (1). https://doi.org/10.1088/1757-899X/453/1/012007