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Inventory Planning with Method Q and Method P for Probabilistic Demand on Chrysanthemum Seeds at PT Transplants Indonesia

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***Abstract*—** Fluctuating and uncertain demand is a problem faced by manufacturing firms. The problem can be mitigated by the availability of inventory systems. This inventory serves to ensure the availability of appropriate resources in the right quantity and at the right time, so as to minimize the costs incurred. PT. Transplants Indonesia is a company engaged in the business of chrysanthemum flower in Indonesia. PT. Transplants Indonesia is a subsidiary of Okinawa Flower Agricultural Cooperative Association (OKF) in Okinawa, Japan. The purpose of this company establishment is to meet the demand of farmers who are members of the OKF. In the case of backorder, on Q method with probabilistic request the size of the lottery (Q) is always fixed for every time the order is made and the order is made if the amount of inventory system has reached a certain level (r) called the reorder point. In method P with probabilistic order requests made according to a fixed interval of time (T) and the ordering does not exceed the maximum inventory limit (R). Total Inventory cost incurred by the company using the method used by the company amounted to Rp.74.995.360,84. The inventory model using the Q method generates a total inventory cost of Rp.70.253.291,46. Meanwhile, inventory model using P method resulted in total inventory cost of Rp.71.529.327,17. So economically, the selected inventory model is the inventory model with the Q method which has a lower total inventory cost value than using the P method.

***Keywords*—** Inventory system, Probabilistic, Backorder, Method Q, Method P, Reorder point.

I. INTRODUCTION

A. Background

The existence of inventory system in business activity can not be avoided. One of the main causes is that these items can not be obtained instantly, but it takes a grace period to get them. The grace period starts from order time, produce time, delivery time, and processing time until ready for use by the wearer. The time interval between the time of booking is made until the item is ready to be used is called the time of the offensive [1]. The inventory system also acts as a control that controls the level of inventory and determines the level of inventory to be observed, the time for inventory to be provided, and the size of the order to be made. This inventory serves to ensure the availability of appropriate resources, in the right quantity, and at the right time so as to minimize the costs incurred.

PT. Transplants Indonesia (PT.TI) is a company engaged in the business of chrysanthemum flower in Indonesia. PT. Transplants Indonesia is a subsidiary of the Okinawa Flower Agricultural Cooperative Association (OKF) in Okinawa, Japan. The purpose of this company establishment is to meet the demand of farmers who are members of the OKF.

The difficulty of predicting the number of requests requested by OKF in Japan, making PT Transplants Indonesia always do the inventory to remain able to meet the demand if at any time OKF ask for export with a large amount. As a manufacturing company in agriculture, one of the most important managerial functions is to pay attention to the problem of inventory control as it sees a very volatile demand trend. If the company is spending too much on inventory, this will cause excessive storage costs. Also, if the company does not have sufficient inventory, it will result in the expense of raw material shortages.

B. Research Objectives and Benefits

Knowing the total cost of inventory using Q and P methods and proposing inventories of materials that result in a minimum total inventory cost.

Benefits that can be obtained from the application of this research result is to give inputs as a material improvement company in improving the quality of the company especially in terms of controlling the amount of supplies of raw materials (seeds) as well as avoiding the risk of excess or lack of raw materials when needed, Also expected to produce total inventory costs the minimum.

C. Inventory system

In business activities as encountered in manufacturing systems, the inventory is always present in various forms of raw materials as inputs for production process, supplies to assist in the implementation of production process, spare parts to replace components which are damaged, work in process, and finished goods ready to be directly marketed to consumers [1]. As for who presents inventory of goods is as a current assets which includes goods that belong to the company with a purpose to be sold in a period of normal business or inventory of goods still in the work of a production process and raw material inventory that also await its use in in a production process [2]. As for the opinion that the stock of goods in general is a term of the inventory of goods used to indicate the goods that have to be resold or also used to be able to produce goods to be sold [3].

Supply planning research has been carried out using the method Q [4] [10], using the Wagner-Within Algorithm method [11], using the Periodic Order Quantity (POQ) method [12], using the EOQ method [13]. This study aims to calculate the total cost of inventory.

In this research using the P method and Q method, so that it can compare which method will produce the minimum total cost.

D. Probabilistic Supplies Model Q

As with the simplest probabilistic model, the inventory policy problem to be solved by the probabilistic inventory model Q (Model Q) is related to the determination of the size of the operating stock and its safety stock [1]. As with Q model, the inventory policy problem to be solved by model P is related to determining the amount of operating stock to be provided and the safety reserve. In method P, the time interval between constant ordering and order lot size changes. Statistically probabilistic phenomenon is a predictable phenomenon of population parameters, both expectations, variance, and distribution patterns are likely.

E. Classification ABC

In focusing management's attention on determining the most important types of goods, it can be done with ABC Analysis which is the classification technique of determining the most important type of goods in multi-system inventory system. In the ABC approach, it is often found that about 20% of stored items have about 80% of the total annual money value (demand x price). 80% of the items counted for only 20% of the total value of money. Inventory policy in the ABC classification system is divided into three categories, namely category A, category B, and category C [1].

F. Distribution Testing

Distribution test was done by using Chi-square test to know the demand data of chrysanthemum seedlings normally distributed or not. Because the inventory calculation by using Q probabilistic method required data that is normally distributed.

II. MATH

A. Problem Formulation

Knowing total inventory costs using Q and P methods. Designing a proposed supply of raw materials with minimum total inventory cost.

B. Calculation Data

As for some data used for the calculation of raw material inventory on data processing, including:

1. Demand data and price of chrysanthemum seedlings requested from the company that is during the last 12 periods, from April 2016 until March 2017 along with the price of seeds per pcs.

2. Data the origin area of suppliers and lead time, Lead Time is the time interval between the time of order is made until the goods are ready for use [1]. The origin area Supplier only comes from Okinawa city, Japan for all varieties of chrysanthemum seedlings.

3. Order cost, the cost incurred to order chrysanthemum seeds to the suppliers. Fees that include the cost of messages include:

• Internet cost, which are used for email facilities.

• Administrative costs, which include fees for import permits and coordination fees to the parties involved in the booking process.

• Cost of inspection of raw materials, including costs incurred by the company to check the condition of newly received chrysanthemum seedlings from suppliers.

• Transportation costs, including airport pick-up charge and unloading.

4. Holding cost, the cost to be spent for the process of storage of raw materials. As for the included storage costs include:

• Cost of cold storage to store chrysanthemum seed stock and electricity supply

• Interest on embedded capital, This cost is the cost incurred due to an embedded capital to store raw materials that can actually be invested in other sectors to generate profits.

• Cost of raw material damage, This cost is the cost incurred for broken chrysanthemum seedlings.

5. The cost of shortage of inventory, the cost of deficiency is the cost to be incurred when there is a shortage of inventory at the time required for the production process. So the company must order chrysanthemum seedlings suddenly. And usually the cost incurred for this shortage of inventory will be

greater than the usual booking fee.

C. Data processing

In data processing, raw material priority is made, demand distribution test, and calculation with Method Q backorder model with demand based on probability (probabilistic).

1. Priority Raw Material (Chrysanthemum Flower)

In managing various types of goods need to be sorted according to the level of importance. In the prioritization of raw materials (chrysanthemum seedlings) aims to determine the priority of handling the material inventory for the purposes of control of various types of inventory, so that the company will know the inventory of material that is considered the most important.

Calculation steps ABC method [1], namely:

1. Calculate the amount of absorption of funds for each type of goods per year (Mi), ie by multiplying the amount of usage or demand of each type of goods per year (Di) with the unit price of goods (pi), mathematically can be expressed as in equation 1 as follows:

$$M_i = D_i \; x \; p_i \tag{1}$$

2. Calculate the total amount of funds absorbed for all types of goods with equation 2 as follows:

$$M = \sum M_i \tag{2}$$

3. Calculates the percentage of absorption of funds for each type of goods (Pi) with equation 3 as follows:

$$P_i = \frac{M_i}{M} x \; 100\% \tag{3}$$

4. Sort percentage of fund absorption according to the order of the size of the presentation of fund absorption, starting from the percentage of the largest absorption of funds to the smallest.
5. Calculate the cumulative value of the absorption percentage of funds in the order obtained in step 4.

2. Testing of Raw Material Demand Distribution (Chrysanthemum Flower)

Distribution testing is necessary. A benevolence test can be used to determine whether a population has a particular theoretical distribution. Distribution testing aims to determine the pattern of product demand because the distribution of demand over the future is probabilistic. And in the application of inventory model Q and inventory model P required normal distributed data. So the normal distribution test is required. The test is performed using Chi-square test of goodness of fit test which is the test of distribution conformity to determine whether the distribution is in accordance with certain hypotheses. This test is based on the good fit between the expected frequencies obtained for observations in the observed samples with the expected frequencies obtained from the hypothesized distributions. Chi-square testing procedure is as follows [4]:

1) Determine the initial hypothesis (Ho) and the final hypothesis (H1).
   a. Hypothesis Ho = raw material demand data is normally distributed
   b. Hypothesis H1 = raw material demand data is not normally distributed

2) Determining the level of significance.
   The level of significance (α) is set at 0.05 or 5%
3) Determining the critical area, The degrees of freedom can be calculated using the following Equation 4:

$$v = k - 1, \tag{4}$$

Statistics count.

4) The calculated statistical measures of the Goodness of Fit Test are as follows:
   a. Group data into multiple classes by first specifying the number of interval classes and interval class widths. The number of interval classes (K) is determined by the following Equation 5:

$$K = 1 + 3.3 \log n, \tag{5}$$

   where n is the amount of data observed. While the class width (L) can be determined using the following Equation 6:

$$L = \frac{R}{K} \tag{6}$$

   The value of R can be determined using Eq. 7 below:

$$R = x \text{ largest} - x \text{ smallest} \tag{7}$$

   Where: x = data
   b. Specifies the observation frequency (Oi) for each interval class.
   c. Calculate the average value using the following equation 8:

$$\mu = \frac{\Sigma X_i}{n} \tag{8}$$

   d. Calculate the standard deviation by using Equation 9 below:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n} (X_i - \mu)^2}{n-1}} \tag{9}$$

   e. Calculates the lower limit of the class and upper limit of the class using Equation 10 and Equation 11 below:

$$Z_1 = \frac{\text{batas atas kelas - } \mu}{\sigma} \quad (10)$$

$$Z_2 = \frac{\text{batas bawah kelas - } \mu}{\sigma} \quad (11)$$

f. Specifies an opportunity value for the upper and lower limits of the normal table.

g. Determine the value of P (Z) using the following Equation 12:
P (Z) = P (Z2) - P (Z1) (12)

h. Determine the expected frequency value (ei) using Eq. 13 below:
$e_i = P(Z) \times \Sigma O_i$ (13)

i. Combines the classes so that the value of $e_i \geq 5$.is obtained.

j. Determine the value of χ^2 using Equation 14 below:

$$\chi^2 hit = \sum_{i=1}^{k} \frac{(O_i - e_i)^2}{e_i} \quad (14)$$

5) Compare χ^2 count with $\chi^2_{(\alpha,\ v)}$ from the table of critical values Chi-square. Acceptance and rejection criteria H0 are:

a. Accept H_0, if χ^2count $\leq \chi^2_{(\alpha, v)}$
b. Reject H_0, if χ^2count $\geq \chi^2_{(\alpha, v)}$

3. Calculation of Seeds Inventory Using Q Method, in this research, inventory planning method used is Q method with probabilistic demand and backorder case.

1) Calculation Process Data
The calculation process is done by first listing each data required for each raw material, namely:
a. The origin of the supplier
b. Lead time (L)
c. Goods Price (C)
d. Message Fee (A)
e. Charge (IC)
The cost of saving is obtained by multiplying the percentage of the shelf cost to the raw material price, so that the equation 15 is obtained as follows:
IC =% sh save x price (15)

f. Supplies shortage (π)
The cost of inventory shortage is obtained by multiplying the percentage of the shortage of inventory to the price of the raw materials, so as to obtain Equation 16 as follows:
π =% cost of inventory x price. (16)

g. Standard deviation (σ)
h. Annual requirement (λ)
i. Lead time demand (μ_L)
Lead time demand is the demand for raw materials that occur during the ordering period. Lead time demand (μ_L) is obtained using the following Equation 17:

$$\mu_L = \lambda \times L \quad (17)$$

j. Standard deviation demand (σ_L)
Standard deviation demand is the standard deviation of raw material demand during the ordering period. Standard deviation demand (σ_L) is obtained using Eq. 18 as follows:

$$\sigma_L = \sigma \times \sqrt{L}\,. \quad (18)$$

2) Calculation Method Q
After all data collection is included, the process of calculating raw material inventory using Q method can be done by using several iterations until optimal iteration is obtained [5].
a. Iteration 1
Calculation on iteration 1 consists of 3 stages, namely calculating the size of the initial order, the occurrence of shortage of inventory, and the number of deficiencies per cycle.

• Initial booking size
The size of the initial order (Order Quantity) on
iteration 1 is calculated by using the formula to compute a deterministic Q like Eq. 19 below:

$$Q = \sqrt{\frac{2\lambda A}{IC}} \quad (19)$$

• Opportunities for inventory shortages
Opportunities for inventory shortages are calculated using the following Equation 20:

$$H(r) = \Phi\left(\frac{r - \mu_L}{\sigma_L}\right) = \frac{QIC}{\pi\lambda} \quad (20)$$

Thereafter, a value of 1 - H (r), which will result in a Z value to be matched with the Normal Table, then finds the value of ordinate ϕ (f (Z)) obtained by viewing the Normal Distribution Standards Table.
Thus, we get the value of reorder point by using Equation 20.

• The number of deficiencies per cycle
The number of deficiencies per cycle is calculated using the following Equation 21:

$$\eta(r) = (\mu_L - r)\Phi\left(\frac{r - \mu_L}{\sigma_L}\right) + \sigma_L \phi\left(\frac{r - \mu_L}{\sigma_L}\right). \quad (21)$$

After stage 3 is completed, the inventory count is passed to iteration 2 to obtain the optimal Q and r.

b. Iteration 2

• Initial booking size

The initial order size (Order Quantity) in iteration 2 is calculated by using the formula to compute a probabilistic Q like Eq. 22 below:

$$Q = \sqrt{\frac{2\lambda(A + \pi\eta(r))}{IC}} \quad (22)$$

Where the value of $\eta(r)$) is obtained from the value obtained at stage 3 in the previous iteration.

The next calculation stage is the same as iteration 1, where the calculation of each iteration will continue if the value of reorder point (r) obtained on iteration 1 decreases at iteration 2, then the r value obtained in iteration 2 decreases at iteration 3, and so on .

The termination criterion of the iteration calculation will be achieved when the r value obtained is equal to the value of r obtained in the previous iteration. Thus obtained the value of Q and r optimal (Q * and r *).

After that, the calculation of the amount of safety stock (safety stock) using the following Equation 23:

$$Ss = r - \mu_L . \quad (23)$$

4. Total Cost Inventory Calculation Method Q

Having obtained the value of Q *, r *, and Ss then proceed with the calculation of total inventory costs obtained from the sum of the cost of ordering, storage costs, as well as the cost of shortage of inventory.

1) Booking fee

The ordering cost per year (Ordering cost) is obtained using the following Equation 24:

$$Bp = A\frac{\lambda}{Q} . \quad (24)$$

2) Cost save

The cost of saving per year (Holding cost) is obtained using the following Equation 25:

$$\cdot\ Bs = IC\left[\frac{Q}{2} + r - \mu_L\right] \quad (25)$$

3) Cost deficiency

The cost of shortage cost per year is obtained with use Equation 26 below:

$$Bk = \frac{\pi\lambda}{Q}\eta(r) \quad . \quad (26)$$

4) Total inventory cost

Total Inventory Cost is obtained by using the following Equation 27:

$$K = Bp + Bs + Bk . \quad (27)$$

5. Calculation of Seed Inventory Using Method P

In this research, inventory planning method used is P method with probabilistic demand and backorder case.

1) Data calculation process

The calculation process is done by first listing each data required for each raw material, namely:

a. The origin of the supplier
b. Lead time *(L)*
c. Goods Price *(p)*
d. Message Fee *(A)*
e. Charge (*h*)

The cost of saving is obtained by multiplying the percentage of the shelf cost to the raw material price, so that Equation 28 is obtained as follows:

h = % h x price. (28)

f. Supplies shortage (Cu)

The cost of inventory shortage is obtained by multiplying the percentage of the shortage of inventory to the price of the raw materials, so as to obtain Equation 29 as follows:

Cu = % Cu x price. (29)

g. Needs per year (D)
h. Lead time demand (DL)
i. Lead time demand is the demand for raw materials that occur during the ordering period. Lead time demand (DL) is obtained using the following Equation 30:

$$D_L = \lambda \ x \ L \quad (30)$$

j. Standard deviation demand *(σ_L)*

Standard deviation demand is the standard deviation of raw material demand during the ordering period. Standard deviation demand *(σ_L)* is obtained using Equation 31 as follows:

$$\sigma_L = \sigma x \sqrt{L} . \quad (31)$$

2) Calculation Method P

After all data collection is included, the process of calculating raw material inventory using P method can be done. The inventory calculation using the P method can be done by the following steps [1]:

a. Calculating the booking period (T)

Calculating the booking period can be obtained by using equation 32 as follows:

$$T = \sqrt{\frac{2\,x\,A}{h\,x\,D}} \tag{32}$$

b. Calculate the maximum inventory (R)
Calculating the maximum inventory can be obtained using equation 33 as follows:

$$\alpha = \frac{Th}{Cu} \tag{33}$$

After α is known, from normal distribution table will get value from Zα. If the requirement is normally distributed, then the value of R includes the need for (T + L) period and is expressed by equation 34 as follows:

$$R = D(T + L) + Z_{\alpha}\sqrt{T + L} \tag{34}$$

c. Calculating the expected shortage of inventory (N)
Calculating the expected shortage of inventory can be obtained by using equation 35 as follows:

$$N = \sigma\sqrt{T + L} - [f(z_{\alpha}) - z_{\alpha}\Psi(z_{\alpha})] \tag{35}$$

d. Calculating Safety Stock (Ss)
Calculating safety stock can be obtained by using equation 36 as follows:

$$Ss = R - D_L + N \tag{36}$$

e. Calculating total cost (Ot)
Calculating the total cost can be calculated by equation 37 as follows:

$$O_t = \left(\frac{A}{T}\right) + \left(R - D_L - \frac{TD}{2}\right)h + \left(\frac{CuN}{T}\right) \tag{37}$$

To determine the value of T * and R * can be searched by means of iteration. As in the Q model the search for solutions T * and R * will also use the Hadley-Within method in the following way:
Repeat the probabilistic step of calculating the shortfall by changing T as in equation 38 as follows:

$$T = T + \Delta T \tag{38}$$

With the following provisions:

- If the new total cost calculation is greater than the total initial onkos, the iteration of the T addition is stopped. Then try with a reduction iteration as in equation 39 as follows:

$$T = T - \Delta T \tag{39}$$

Until a value of T * = T is found that gives a minimum total cost

- If the new total cost is less than the initial total cost, iteration of the addition of T continues and only stops if the new total cost is greater than the total cost calculated previously. The price of T which gives the smallest total cost is the optimal time interval T *.

6. Calculation of Total Cost of Inventory Method P
The total inventory cost calculation is derived from the sum of procurement cost (Op), storage cost (Os), and inventory shortage (Ok) cost.

1. Procurement cost (Op)
The procurement cost per year can be expressed in equation 40 as follows:

$$O_p = A\,x\,f \tag{40}$$

Where f = frequency of orders per year
If every time the order is made by time interval T, then the frequency of ordering per year as in equation 41 as follows:

$$f = \frac{1}{T} \tag{41}$$

So the procurement cost per year can be expressed in equation 42 as follows:

$$O_p = \frac{A}{T} \tag{42}$$

2. Storage cost (Os)
The storage cost can be obtained by using equation 43 as follows:

$$O_s = \left(R - D_L - \frac{TD}{2}\right)h \tag{43}$$

3. Inventory shortage costs (Ok)
The cost of inventory shortage can be obtained using equation 44 as follows:

$$O_k = \frac{CuN}{T} \tag{44}$$

4. Total inventory cost (Ot)
Total inventory cost can be obtained by using equation 45 as follows:

$$O_t = O_p + O_s + O_k \tag{45}$$

The following describes the notations used in inventory calculations, namely:
Mi = Junlah the absorption of funds of each variety
Di = Number of requests
pi = unit price of goods
Q = order quantity size,

λ = raw material requirements for the planning period,
A = the cost of each time a message,
π = inventory shortage costs,
$\eta(r)$ = number of deficiencies per cycle,
IC = cost per unit save,
$H(x)$ = probability of occurrence of shortage of inventory,
ϕ = the function of the opportunity distribution of raw material needs,
μ_L = average raw material requirement during lead time,
σ_L = standard deviation during lead time, and
r = reorder point.

III. RESEARCH RESULT

A. Data Collection

TABLE I DATA REQUEST AND PRICE

Chrysanthemum Flower Type Ogiku				
No	**Chrysanthemum Seed Varieties**	**amount**	**Price**	**Unit**
1	Aki	693000	Rp 570,00	Pcs
2	Hibiki	778000	Rp 570,00	Pcs
3	Kougen	316000	Rp 570,00	Pcs
4	Makoto	2238000	Rp 570,00	Pcs
5	Hana	536000	Rp 570,00	Pcs
Chrysanthemum Type Kogiku				
No	**Chrysanthemum Seed Varieties**	**amount**	**Price**	**Unit**
1	Kinka	1412000	Rp 480,00	Pcs
2	Kirameki	924000	Rp 480,00	Pcs
3	Tsubasa	979000	Rp 480,00	Pcs
4	Izumi	299000	Rp 480,00	Pcs
5	Otome	251000	Rp 480,00	Pcs
6	Nana	1372000	Rp 480,00	Pcs
Type Spray Chrysanthemum Flower				
No	**Chrysanthemum Seed Varieties**	**amount**	**Price**	**Unit**
1	Maiki	155000	Rp 480,00	Pcs
2	Malaikat	446000	Rp 480,00	pcs
3	Sheltie	149000	Rp 480,00	pcs
4	Urizun	123000	Rp 480,00	pcs
5	Cherry Urizun	0	Rp 480,00	pcs
6	Mao	235000	Rp 480,00	pcs

Source: Production Section of PT Transplants Indonesia (processed)

B. Determination of Raw Material Priority

After calculating the priority of chrysanthemum seedlings based on the above method, the result of chrysanthemum seedlings included in category A are 7 varieties namely Makoto, Kinka, Nana, Tsubasa, Kirameki, Hibiki, and Aki. Chrysanthemum seedlings belonging to Category B are 4 varieties of Hana, Angel, Kougen, and Izumi. Chrysanthemum seedlings belonging to category C are 5 varieties of Otome, Mao, Maiki, Sheltie, and Urizun.

C. Distribution Testing

All data on the demand of chrysanthemum seedlings in the period of April 2016 until March 2017 are normally distributed, so that all such demand data can be used to perform inventory calculations by Q method

TABLE II RESULT OF DISTRIBUTION TESTING

No	Seed Varieties	Comparison X^2*count* *with* $X^2(\alpha,v)$	Distribution
1	*Makoto*	1,365 ≤ 3,841	Normal
2	*Kinka*	3,690 ≤ 3,841	Normal
3	*Nana*	3,450 ≤ 3,841	Normal
4	*Tsubasa*	1,078 ≤ 3,841	Normal
5	*Kirameki*	0,677 ≤ 3,841	Normal
6	*Hibiki*	0,896 ≤ 3,841	Normal
7	*Aki*	0,676 ≤ 3,841	Normal
8	*Hana*	1,612 ≤ 3,841	Normal
9	*Malaikat*	1,723 ≤ 3,841	Normal
10	*Kougen*	2,220 ≤ 3,841	Normal
11	*Izumi*	1,360 ≤ 3,841	Normal
12	*Otome*	2,360 ≤ 3,841	Normal
13	*Mao*	1,347 ≤ 3,841	Normal
14	*Maiki*	2,125 ≤ 3,841	Normal
15	*Sheltie*	1,952 ≤ 3,841	Normal
16	*Urizun*	2,992 ≤ 3,841	Normal

Source: Data processing

D. Calculation Result Method Q

Calculation Q method is secondary data from previous research result [10]

The inventory model or inventory plan using Q method obtains optimal order size (Q *), optimal re-ordering point (r *), and safety stock (Ss) by doing calculation iteration for all varieties of chrysanthemum seedlings in PT Transplants Indonesia as following:

TABLE III RESULT OF CALCULATION OF METHODS Q

No	Seed Varieties	*Q**	*r**	*Ss*

1	Makoto	123387	135105	73790
2	Kinka	98812	87544	48859
3	Nana	93325	71213	33624
4	Tsubasa	78537	47186	20364
5	Kirameki	75490	43568	18253
6	Hibiki	63583	39355	18040
7	Aki	146862	26181	7195
8	Hana	52760	28001	13316
9	Malaikat	52002	21410	9190
10	Kougen	39991	15800	7142
11	Izumi	42293	14116	5924
12	Otome	38548	11588	4711
13	Mao	37283	11154	4715
14	Maiki	30951	8293	4046
15	Sheltie	29736	7151	3069
16	Urizun	27054	5739	2370

Source: Data processing [10]

The calculation of the order cost, the cost of storage, cost of deficiency, and total cost of inventory Q method as follows:

TABLE IV ORDER COST, INVENTORY COST, DEBT COST AND TOTAL COST OF SUPPLIES

Order Fee	Storage costs	Shortage Costs	Inventory Cost
Rp 2.266.127,75	Rp 7.722.594,51	Rp 1.081.751,13	Rp 11.070.473,39
Rp 1.785.336,72	Rp 4.716.744,88	Rp 587.143,44	Rp 7.089.225,04
Rp 1.836.759,34	Rp 3.853.758,35	Rp 462.186,15	Rp 6.152.703,84
Rp 1.557.410,27	Rp 2.862.376,85	Rp 325.416,83	Rp 4.745.203,95
Rp 1.529.240,93	Rp 2.687.907,05	Rp 278.804,14	Rp 4.495.952,11
Rp 1.528.739,34	Rp 2.840.376,74	Rp 314.529,73	Rp 4.683.645,80
Rp 589.548,03	Rp 4.595.667,96	Rp 290.665,85	Rp 5.475.881,84
Rp 1.269.262,41	Rp 2.262.697,86	Rp 6.235.247,20	Rp 9.767.207,47
Rp 1.071.542,54	Rp 1.689.190,63	Rp 176.297,46	Rp 2.937.030,63
Rp 987.245,71	Rp 1.546.825,90	Rp 170.098,70	Rp 2.704.170,31
Rp 883.287,22	Rp 1.299.375,18	Rp 145.533,51	Rp 2.328.195,91
Rp 813.510,37	Rp 1.151.291,77	Rp 121.797,10	Rp 2.086.599,24
Rp 787.499,89	Rp 1.121.129,44	Rp 117.441,71	Rp 2.026.071,04
Rp 625.686,22	Rp 937.024,76	Rp 126.298,80	Rp 1.689.009,78
Rp 626.028,36	Rp 860.976,84	Rp 96.011,75	Rp 1.583.016,95
Rp 568.029,49	Rp 763.032,13	Rp 87.842,50	Rp 1.418.904,12

Source : Data processing [10]

E. Calculation Result Method P

The inventory model uses the P method to obtain the optimal ordering period (T *), the optimal maximum inventory limit (R *), and safety stock (Ss) for all chrysanthemum seed varieties in PT Transplants Indonesia as follows:

TABLE V RESULTS OF INVENTORY METHODS OF P

Procurement Costs	Storage costs	Shortage Costs	Inventory Cost
Rp 2.822.930,12	Rp 3.689.132,44	Rp 6.041.052,22	Rp 12.553.114,78
Rp 2.057.645,84	Rp 2.329.917,99	Rp 1.904.200,34	Rp 6.291.764,16
Rp 2.421.388,04	Rp 2.412.792,26	Rp 2.451.497,41	Rp 7.285.677,72
Rp 1.985.646,48	Rp 2.067.654,37	Rp 1.602.638,00	Rp 5.655.938,84
Rp 1.664.520,94	Rp 2.249.350,74	Rp 1.491.423,15	Rp 5.405.294,83
Rp 1.664.408,35	Rp 2.139.638,79	Rp 1.750.297,81	Rp 5.554.344,96
Rp 1.796.765,85	Rp 1.942.970,79	Rp 1.186.311,02	Rp 4.926.047,66
Rp 1.381.505,07	Rp 1.630.181,60	Rp 1.419.246,84	Rp 4.430.933,50
Rp 1.156.433,62	Rp 1.372.269,86	Rp 910.519,85	Rp 3.439.223,32
Rp 1.060.751,44	Rp 1.197.155,33	Rp 885.529,72	Rp 3.143.436,49
Rp 1.024.511,19	Rp 1.002.583,69	Rp 684.245,72	Rp 2.711.340,59
Rp 932.276,31	Rp 915.707,55	Rp 571.945,81	Rp 2.419.929,67
Rp 899.897,61	Rp 865.764,20	Rp 571.984,68	Rp 2.337.646,49
Rp 765.254,65	Rp 579.997,06	Rp 592.860,79	Rp 1.938.112,50
Rp 706.196,63	Rp 653.258,57	Rp 452.259,37	Rp 1.811.714,57
Rp 579.151,97	Rp 650.882,90	Rp 394.772,21	Rp 1.624.807,08

Source : Data processing

IV. Discussion

When compared to Total Inventory Costs incurred by a company with the previous method, the inventory system using Q and P methods has a lower total inventory cost. Total inventory cost incurred by the company amounted to Rp.74,995,360.84, total inventory cost using Q method amounted to Rp.70.253.291,46, and total inventory cost using P method amounting to Rp.71.529.327,17.

In comparison result there are 13 varieties of chrysanthemum seedlings that better use inventory model with method of Q, while better use inventory model by using method of P only amounted to 3 varieties only. Thus, the proposed inventory control method of PT Transplants Indonesia is the inventory model with the Q method. In Q method, the fixed quantity is the order quantity, whereas in P, the fixed period is the time interval between the orders (order period) . So on the P method, if the demand is relatively higher then it will cause the size of the order to be large as well. While in Q method, the length of the order cycle is uncertain from one order to the next order, it depends on the level of demand that occurs in the cycle. If the level of demand is high, then the reorder point will be more quickly achieved and the ordering cycle will become shorter.

For probabilistic requests (based on probability), the P method must have safeguards against supply outages for the grace period plus advanced booking cycles, but Q methods require safety only during the grace period when additional bookings can be placed at any time and can be received as soon as possible. So there is a great need for safety stock in the P method rather than in Q method.

V. CONCLUSION

The inventory model using Q method by obtaining optimal order size (Q *) and optimal reorder point (r *) for all varieties of chrysanthemum seedlings at PT Transplants Indonesia resulted in total inventory cost of Rp.70.253.291,46. The inventory model using the P method by obtaining the optimal optimization period (T *) and the optimal maximum inventory (R *) for all varieties of chrysanthemum seedlings at PT Transplants Indonesia resulted in total inventory cost of Rp.71.529.327,17. This means that using the Q method can produce cost savings of 6.32% of the total inventory costs incurred by the company, and by the P method it can generate savings of 4.62% of the total cost of inventory spent by the company.

In addition to the total inventory cost minimization, Q method is suitable for high raw material requirement and high fluctuation also, because in this condition the stock position is required continuously and accurately. This method allows the inventory system to react quickly in the event of fluctuations in the use of raw materials. So the inventory system using Q method is highly recommended in PT Transplants Indonesia.

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