Optimization Model for Determining Order Quantity for Growing Item Considering Incremental Discount and Imperfect Quality

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Abstract. This research develops an optimization model of order quantities for growing items by considering incremental discounts and imperfect quality. For growing items, the assumption that inventory weights that always fixed cannot be applied. The supply system has grown so that the weight of the inventory has increased over a certain period. The proposed inventory system has two periods namely growth and consumption period. Suppliers offer incremental discounts for certain purchases. In this research also considered the existence of imperfect quality, where for newborn items purchased at the beginning of each cycle found items with poor quality and death. During the growth period, not all items survive until the end of the period, therefore also considering the probability density function of survival and death of growing items. The proposed inventory system is maximization profit, with total profits being an objective function, and cycle times and order quantities as decision variables. Costs involved include purchased cost by considering by incremental discounts, setup costs, holding costs, and disposal costs. Application and model validation is demonstrated by numerical examples in the poultry industry. The model developed in this study can be used as a suggestion for companies to make purchasing decisions.

1. Introduction
The EOQ model was first formulated by [2] with deterministic demand used to determine the optimal number of orders, with the purpose of minimizing ordering cost and holding cost. In the last few decades the EOQ model has been developed. The traditional EOQ model can be applied to many kinds of products. However, due to the limitations of the model, it cannot be applied to products with certain characteristics, such growing items. In an effort to model the inventory system for items that experience growth during storage time, the assumption that the weight of the inventory remain constant must be relaxed. Such supplies are commonly found in the livestock, poultry, and fisheries industries. The main difference between ameliorating, deteriorating, perishable, and regular items with growing items as inventory items is that the growing items increase the weight over time with certain pattern. In other words the weight of the inventory level of growing items increases over a period of time [6]. And hence the value and size of items also increases over time [4].

Research [6] is the first researcher who includes growing items into inventory theory in the classical EOQ model. The proposed inventory system has two periods, namely growth period and consumption period. In a company with a growing inventory system, the company will buy newborn item and then feed them until they reach their target weight before trading. Therefore, the cost of food is a cost that is very calculated in industries with an inventory system that is experiencing growth [6].
[8]. In purchasing newborn items, suppliers often offer an incremental discount where the provide a reduction in the purchase price if the items purchased by the company are at a specified range of quantity. Research [8] developed the EOQ model by considering the incremental discount factor. The incremental discount offered by suppliers to the company causes the need to calculate the optimal purchase quantity in order to get a large discount in order to increase profit.

Economic Order Quantity (EOQ) involves an unrealistic assumption that all items purchased are of good quality [9]. In fact, not all items purchased are of good quality. Research [3] for the first time developed the EOQ model for products with imperfect quality. Research [7] developed the EOQ model for growing items by considering imperfect quality. In purchasing newborn items, it is often found that items grow with imperfect quality, that is, items with poor quality are found so that the assumption that all items are of good quality must be relaxed. The discovery of a growth item of poor quality results in a probability that the grown item dies during growth. In the real system, item growth is not always well developed. It is possible for a growth item to die during the growth period.

For an inventory system with growing items, [1] developed a model called Economic Growing Quantity, which is a model that considers the probability density function of growing items survival and death. The cost considered in the inventory system includes not only live growth items, but also growth items that experience death, which is counted from the item's life to death. The way to explain the pattern of death can be seen with the probability of items to survive [5]. Thus, in this case there is an additional cost, namely disposal cost [10].

Different from companies in general, companies with a growing inventory system need to pay attention to the growth pattern of goods that continues to increase in order to control inventory. The growth pattern of goods is increasing, indicating an increase in the weight of goods. To be able to meet the demand at the end of the growing period of goods, it is necessary to plan an inventory by determining the number of purchases of newborn items that are just born at the beginning of the growing period. The possibility of growing items dying and not growing properly must be taken into account in determining the number of purchases of newborn items to avoid shortage at the end of the growing period. In this research we will develop an optimization model for determining the quantity of economic orders for growing items by considering incremental discounts and imperfect quality to maximize company profits with decision variables namely order quantity and cycle time.

2. System Description

![System Description Diagram](image)

**Figure 1.** System description for growing item

Based on Figure 1, the proposed inventory system in this research model consists of two periods, namely the growth period and the consumption period. In purchasing growing items, the supplier offers an incremental discount, where the supplier gives a reduction in the purchase price if the items the company purchases are at a certain cut-off that has been set. At the time of purchasing a newborn item, it was found that there were items with imperfect quality where the items purchased had poorer
quality. The existence of items with poorer quality can cause the probability of an item experiencing death shortly after purchase and the probability of an item growing can survive until the end of the growth period. During the growth period, the company feeds items that grow until they reach the targeted weight. Growing items do not always grow well. Therefore, in order to better adjust to the real system, where not all growing items can live until the end of the growth period, the model developed also considers the probability density of survival and death for growing items in the inventory system. Growing items that experience death during the growth period must be removed from the inventory system. After reaching the targeted weight, then growing items are slaughtered and then sold. During the consumption period, the amount of inventory will continue to decrease until it reaches zero at the end of the cycle. The company wants to determine the number of newborn items ordered and cycle times for each period. By considering the incremental discount and imperfect quality, the company wants to maximize the profits obtained and to prevent inventory shortages even if there are imperfect items found. The costs considered in this research model are the costs of purchase, setup costs and holding costs during the growth period and consumption period, and disposal costs for items that have died during the growth period.

3. Model Development

![Figure 2. Behaviour of an inventory system for growing item](image)

3.1 Assumptions and Notations

3.1.1 Assumptions
The assumptions used in this paper are as follows:
1. Only one type of item considered
2. Demand is deterministic
3. Items that are grown are immediately slaughtered at the end of the growth cycle.
4. All slaughtered items can be sold
5. There is no excess production and shortages per cycle
6. The product has no reproductive ability during the growth cycle
7. Food costs, storage costs, are not only related to living goods, but also for dead grown items until their death.

3.1.2 Notations
The notations used in this paper are as follows:
3.2 Model Formulation
The behavior of the inventory system proposed in this research is illustrated in Figs. 2. The inventory system consists of two periods, namely growth period and consumption period. The company buys a new growing item with an initial weight of \( w_0 \). Afterwards, the items will be nurtured and fed in the growing period until it reaches a certain weight of \( w_1 \). At the end of the growth period, the items will be slaughtered and sold. The total weight of the item at the end of the growth period is \( Q = Yw_1 \). In purchasing growing items, the supplier offers an incremental discount. Suppliers provide a reduction in the purchase price if the goods purchased by the company are at certain predetermined range of quantity as shown in Equation (1).

\[
P_j = \begin{cases} 
    y_1 & 0 \leq Y < y_2 \\
    y_2 & y_2 \leq Y < y_3 \\
    \vdots \\
    y_m & y_m \leq Y 
\end{cases}
\]

In purchasing growing items, not all items are of good quality which will grow well until they reach certain weights. Items with poor quality can experience death during the growth period. In this research the probability of imperfect items is assumed to follow a uniform random distribution of variables with the probability density function as in Equation (2).

\[
g(x) = \begin{cases} 
    25, & 0 \leq x \leq 0.04 \\
    0, & otherwise 
\end{cases}
\]
The expected items with poor quality can be expressed as $E[x]$ and calculated as in Equation (3). Then the expected good quality items can be calculated by Equation (4).

$$E[x] = \int_0^{0.04} 25x \, dx = 25 \left[ \frac{0.04^2 - 0^2}{2} \right] = 0.02$$  \hspace{1cm} (3)

$$1 - E[x] = 1 - 0.02 = 0.98$$  \hspace{1cm} (4)

During the growth period, the weight of the item is assumed to follow the pattern of polynomial growth (Hadeler, 1974) with the first order $r = 1$ as illustrated in Figs. 2.

$$W = d_0 + \sum_{i=1}^{t} d_i t^i.$$  \hspace{1cm} (5)

Assuming that the growth function for living items and dead items is the same, then

$$G(t) = V(t) = d_0 + d_1 t.$$  \hspace{1cm} (6)

During the growth period uniform distribution is used as the probability density function of survival and death for growing items as used in Seal (1954) which assumes a uniform distribution during the interval $(0, T)$ with the sum of the probability of survival and death per cycle equal to one. Equations (8) and (9) show the survival and mortality probability of the item.

$$s_t(t) \sim Unif(a, b) \rightarrow m_t(t) \sim Unif \left(\frac{a}{b-a-1}, \frac{b}{b-a-1} \right)$$  \hspace{1cm} (7)

$$Sp = \int_0^t s_t(t) \, dt \int_0^t G_t(t) \, dt$$  \hspace{1cm} (8)

$$Mp = \int_0^t m_t(t) \, dt \int_0^t V_t(t) \, dt$$  \hspace{1cm} (9)

The growing items with imperfect quality has two possibilities

1. Good quality, where items with good quality can grow well until the end of the growth period

$$Gq = Y(1 - E[x]) \left( \int_0^t G_t(t) \, dt \right)$$  \hspace{1cm} (10)

2. Poor quality, items with poor quality there are two possibilities where the item will die or the item can survive at the end of the growth period

- The probability live

$$Pq_L = Y(E[x]) \left( \int_0^t s_t(t) \, dt \int_0^t G_t(t) \, dt \right)$$  \hspace{1cm} (11)

- The probability dead

$$Pq_D = Y(E[x]) \left( \int_0^t m_t(t) \, dt \int_0^t V_t(t) \, dt \right)$$  \hspace{1cm} (12)

The growing item will be slaughtered when in the end of growing period. The total weight at the end of the growth period must be equal to the demand to avoid shortage. Then the duration of growth is expressed as follows:

$$D = W_t$$

$$D = Y(1 - E[x]) \left( \int_0^t G_t(t) \, dt \right) + YE[x] + \int_0^t s_t(t) \, dt \int_0^t G_t(t) \, dt + \int_0^t m_t(t) \, dt \int_0^t V_t(t) \, dt$$

$$D = Y \left( d_0t + \frac{d_1 t^2}{2} \right) \left[ \left( 1 - E[x] \right) + E[x] \left( \frac{1}{b - a} + \frac{b - a - 1}{b - a} \right) \right]$$

$$t = \frac{2d_0 + \sqrt{-2d_0^2 + 4d_1 - \frac{8D}{Y}}}{2d_1}$$  \hspace{1cm} (13)
The cycle time is defined based on the amount of demand and weight at the end of the growth period as follow
\[ T = \frac{y w_1}{D} \]  
(14)

The existence of incremental discounts and imperfect quality in the purchase of growing items makes it necessary to modify the calculation of the optimal order quantity in order to get discounts and all demand can be fulfilled even though items with imperfect quality are found, so that the profits of the company increase. The objective function in this research is profit maximization with order quantity and optimal cycle times as decision variables.

**Total Revenue**
Total revenue is obtained from total sales for growing items that live until the end of the growth period
\[ \text{Total Revenue} = s Y \lambda (1 - E[x]) \left( \int_0^t G_t (dt) dt \right) + s y E[x] \left( \int_0^t s_t (dt) dt \int_0^t G_t (dt) dt \right) \]

\[ TR = s Y \lambda \left[ \frac{d_0 t + \frac{d_1 t^2}{2}}{2} \right] \left[ (1 - E[x]) + E[x] \left( \frac{1}{b-a} \right) \right] \]  
(15)

**Purchasing Cost (with incremental discount)**
The supplier offers an incremental discount for the purchase of items at a specified predetermined cut-off agreed \( j \leq Y < Y_{j+1} \), where the purchase price gets smaller if the number of purchases increases \( p_1 > p_2 > \ldots > p_j > p_{j+1} \). So the purchasing cost is expressed as follows
\[ PC = p_1 (y_2 - y_1) w_0 + p_1 (y_2 - y_1) w_0 + \ldots + p_{j-1} (y_j - y_{j-1}) w_0 + p_j (Y - y_j) w_0 \]  
(16)

The sum of Equation (18) is defined as \( R_j \)
\[ R_j = \begin{cases} p_1 (y_2 - y_1) w_0 + p_2 (y_3 - y_2) w_0 + \ldots + p_{j-1} (y_j - y_{j-1}) w_0 + p_j (Y - y_j) w_0 & j \geq 2 \\ 0 & j = 1 \end{cases} \]  
(17)

Equation (16) can be rewritten as
\[ PC = R_j + p_j (y - y_j) \]  
(18)

**Feeding cost**
Feeding cost is obtained from the cost of feeding multiplied by the weight of growing items that live until the end of the growth period (Rp / kg / week)
\[ F = f Y (1 - E[x]) \left( \int_0^t G_t (dt) dt \right) + f Y E[x] \left( \int_0^t s_t (dt) dt \int_0^t G_t (dt) dt \right) + \int_0^t m_t (dt) dt \int_0^t V_t (dt) dt + \int_0^t m_t (dt) dt \int_0^t V_t (dt) dt \]
\[ F = f Y \left[ 1 - E[x] \right] \left( \frac{d_0 t + \frac{d_1 t^2}{2}}{2} \right) + E[x] \left[ \frac{1}{b-a} \right] \left( d_0 t + \frac{d_1 t^2}{2} \right) + \left( \frac{b-a-1}{b-a} \right) \left( d_0 t + \frac{d_1 t^2}{2} \right) \]  
(19)

**Holding Cost**
Holding costs are costs incurred while storing the growing items, consisting of holding costs for the growth period and the consumption period.

Holding cost growth period
\[ H = h_t + h_d \]
\[ H = h Y (1 - E[x]) \left( \int_0^t G_t (dt) dt \right) + E[x] \left( \int_0^t s_t (dt) dt \int_0^t G_t (dt) dt \right) + \int_0^t m_t (dt) dt \int_0^t V_t (dt) dt \]
\[ H = h Y \left( 1 - E[x] \right) \left( d_0 t + \frac{d_1 t^2}{2} \right) + E[x] \left( \frac{1}{b-a} \right) \left( d_0 t + \frac{d_1 t^2}{2} \right) + \left( \frac{b-a-1}{b-a} \right) \left( d_0 t + \frac{d_1 t^2}{2} \right) \]  

(20)

Holding cost consumption period

\[ H = h \left[ \frac{Y^2 w^2}{2D} \right] \]  

(21)

Setup cost

Setup costs consist of the setup cost for the growth period, i.e. the costs incurred for the purchase setup costs and during maintenance of the growing items. While the setup costs for the consumption period are used for the slaughtering process and other relevant costs.

Setup cost of growth period

\[ K = k_t + k_d \]

\[ K = k Y \left( 1 - E[x] \right) \left( \int_0^t G_t \, dt \right) + E[x] \left( \int_0^t s_t \, dt \right) \left( \int_0^t G_t \, dt \right) + \int_0^t m_t \, dt \left( \int_0^t V_t \, dt \right) \]

\[ K = k Y \left( 1 - E[x] \right) \left( d_0 t + \frac{d_1 t^2}{2} \right) + E[x] \left( \frac{1}{b-a} \right) \left( d_0 t + \frac{d_1 t^2}{2} \right) + \left( \frac{b-a-1}{b-a} \right) \left( d_0 t + \frac{d_1 t^2}{2} \right) \]  

(22)

Setup cost of consumption period

\[ K = K \]  

(23)

Disposal Cost

Disposal cost is used to dispose of dead items during the growth period

\[ M = m Y E[x] \left( \int_0^t m_t \, dt \right) \left( \int_0^t V_t \, dt \right) \]

\[ M = m Y E[x] \left( E[x] \left( \frac{b-a-1}{b-a} \right) \left( d_0 t + \frac{d_1 t^2}{2} \right) \right) \]  

(24)

Total Profit

\[ TP = TR - PC - F - H - K - M \]

\[ TP = s Y \lambda \left( \int_0^t G_t \, dt \right) \left( 1 - E[x] \right) + E[x] \left( \int_0^t s_t \, dt \right) - R_j + p_j \omega_0 (Y - y_j) - K - \]

\[ k Y \left( 1 - E[x] \right) \left( \int_0^t G_t \, dt \right) + E[x] \left( \int_0^t s_t \, dt \right) \left( \int_0^t G_t \, dt \right) + \int_0^t m_t \, dt \left( \int_0^t V_t \, dt \right) - \]

\[ h \left[ \frac{Y^2 w^2}{2D} \right] - \left( k Y \left( 1 - E[x] \right) \left( \int_0^t G_t \, dt \right) \right) + \lambda h E[x] \left( \int_0^t s_t \, dt \right) \left( \int_0^t G_t \, dt \right) + \int_0^t m_t \, dt \left( \int_0^t V_t \, dt \right) \]

\[ f Y E[x] \left( \int_0^t s_t \, dt \right) \left( \int_0^t G_t \, dt \right) + \int_0^t m_t \, dt \left( \int_0^t V_t \, dt \right) \]

\[ m Y E[x] \left( \int_0^t m_t \, dt \right) \left( \int_0^t V_t \, dt \right) \]

(25)

By using Equation (6) and (7), the total profit (TP) can be re-written as
\[ TP = sY \lambda \left( d_0 t + \frac{d_1 t^2}{2} \right) \left[ (1 - E[x]) + \frac{E[x]}{b-a} \right] - R_j + p_j w_0(Y - y_j) - K - h \left[ \frac{Y^2 w_1^2}{2D} \right] - Y \left( 1 - E[x] \right) \left( d_0 t + \frac{d_1 t^2}{2} \right) \left( h + f + k \right) - Y \left( E[x] \left( \frac{1}{b-a} \right) \left( d_0 t + \frac{d_1 t^2}{2} \right) \right) \left( h + f + k + m \right) \] 

Total profit per unit time is calculated by dividing total profit by the cycle time to result Equation (14) in the equation:

\[ TPU = \frac{sD\lambda}{w_1} \left( d_0 t + \frac{d_1 t^2}{2} \right) \left[ (1 - E[x]) + \frac{E[x]}{b-a} \right] - D \left[ \frac{R_j}{w_1} + \frac{p_j w_0}{w_1} - \frac{p_j w_0 y_j}{w_1} \right] - \frac{KD}{w_1} - h \left[ \frac{Y w_1}{w_1} \right] - \frac{D}{w_1} \left( 1 - E[x] \right) \left( d_0 t + \frac{d_1 t^2}{2} \right) \left( h + f + k \right) - \frac{D}{w_1} \left( E[x] \left( \frac{1}{b-a} \right) \left( d_0 t + \frac{d_1 t^2}{2} \right) \right) \left( h + f + k \right) - \frac{D}{w_1} \left( E[x] \left( \frac{b-a-1}{b-a} \right) \left( d_0 t + \frac{d_1 t^2}{2} \right) \right) \left( h + f + k + m \right) \]  

Equation (28) can be simplified as follows:

\[ TPU = \frac{sD\lambda}{w_1} \left( d_0 t + \frac{d_1 t^2}{2} \right) \left[ (1 - E[x]) + \frac{E[x]}{b-a} \right] - \frac{D}{w_1} \left[ R_j + p_j w_0 y_j + K \right] - \frac{Dp_j w_0}{w_1} - h \left[ \frac{Y w_1}{w_1} \right] - \frac{D}{w_1} \left( 1 - E[x] \right) \left( d_0 t + \frac{d_1 t^2}{2} \right) \left( h + f + k \right) - \frac{D}{w_1} \left( E[x] \left( \frac{1}{b-a} \right) \left( d_0 t + \frac{d_1 t^2}{2} \right) \right) \left( h + f + k \right) - \frac{D}{w_1} \left( E[x] \left( \frac{b-a-1}{b-a} \right) \left( d_0 t + \frac{d_1 t^2}{2} \right) \right) \left( h + f + k + m \right) \]  

The optimal order quantity for the proposed inventory system taking into account incremental discounts and imperfect quality is obtained with the first derivative of the objective function equal to zero:

\[ \frac{\partial TPU}{\partial Y} = - \frac{D}{Y w_1} \left[ R_j + p_j w_0 y_j + K \right] - h \left[ \frac{Y w_1}{w_1} \right] = 0 \]

\[ \frac{\partial TPU}{\partial Y} = \frac{D}{Y^2 w_1} \left[ R_j + p_j w_0 y_j + K \right] - \frac{h w_1}{2} = 0 \]

\[ Y^* = \sqrt{\frac{2(R_j + p_j w_0 y_j + K)}{h w_1^2}} \]  

The optimal cycle time is calculated by substituting equation (30) to Eq. (14)

\[ T^* = \sqrt{\frac{2(R_j + p_j w_0 y_j + K)}{h D}} \]  

4. Numerical Result

4.1 Computational Algorithm

1. Calculate PC for each price break or price level offered using Equation (17)
2. Calculate \( Y_j \) for each purchase cost per unit using the Equation (30)
3. Determine whether the \( Y_j \) obtained is feasible or not. \( Y_j \) is said to be feasible if \( Y_j \) is within the specified interval \( y_j \leq Y < y_{j+1} \) If the value of \( Y \) is not feasible then the value of \( Y \) is ignored
4. Calculate the $T$ value for every $Y_j$ that is feasible using the Equation (31)
5. Calculate the $t$ value for every $Y$ that is feasible using the Equation (13)
6. Calculate TCU using Equation (29) for all feasible $Y_j$. The $Y_j$ value that produces the highest TPU is the optimal result
7. End.

4.2 Numerical Example
To implement the proposed model, a numerical example is given to the poultry industry, where companies buy newborn chickens then be fed / nurtured until they reach the targeted weight to be slaughtered and sold. The model parameters are shown in Table 1.

| Table 1. Model parameters |
|---------------------------|
| **Variable**               | **Units** | **Quantity** |
| Demand                    | Kg        | 100,000      |
| Initial weight of newborn item | Kg     | 0.045        |
| The weight of the growing item when slaughtered | Kg  | 3.5          |
| Seup cost growing period  | Rp/kg/week | 951.81      |
| Seup cost consumption period | Rp/kg/week | 10,000,000 |
| Holding cost              | Rp/kg/week | 663.46      |
| Disposal cost             | Rp/kg/week | 991.81      |
| Feeding cost              | Rp/kg/week | 4,407       |
| $d_0$                     |           | 357.067      |
| $d_1$                     |           | 124.671      |
| $a$                       |           | 9.9          |
| $b$                       |           | 11           |

| Table 2. Purchase cost structure under incremental quantity discount |
|---------------------------------------------------------------|
| **Quantity Purchased (unit)** | **Price per Weight Unit (RP/kg)** |
| 0 – 100,000              | 25,000                        |
| 100,001 – 300,000        | 24,000                        |
| 300,001 – 500,000        | 23,000                        |
| 500,001+                 | 22,000                        |

Step 1
Calculate $PC$ for each price break or price level offered using Equation (17)

$PC_1 = 0$
$PC_2 = 24,000 (10,001 – 0) 0.045 = 11,251,125$
$PC_3 = 11,251,125 + 24,000 (30,001 – 10,001) 0.045 = 32,851,125$
$PC_4 = 32,851,125 + 23,000 (50,001 – 30,001) 0.045 = 53,551,125$

Step 2
Calculate $Y_j$ for each purchase cost per unit using the Equation (30)

$Y_1 = \sqrt{\frac{2(0 + (25,000\times0.045\times0 + 10,000,000)100,000}{663.46\times3.5^2}} = 15,687$
Step 3
Determine whether the $y_j$ obtained is feasible or not. $y_j$ is said to be feasible if $y_j$ is within the specified interval $y_j \leq Y < y_{j+1}$. If the value of $y_j$ is not feasible then the value of $Y$ is ignored.

1. $0 < y_1 = 15,687 < 10,001$
2. $10,001 \leq y_2 = 28,085 < 30,001$
3. $30,001 \leq y_3 = 42,645 < 50,001$
4. $50,001 < y_4 = 52,745$

Step 4
Calculate the $T$ value for every $Y$ that is feasible using Equation (31).

**Table 3.** Cycle time for consumption period

| Cycle Time for Consumption Period $(T)$ | Week |
|----------------------------------------|------|
| $T_2$                                  | 0.98 |
| $T_3$                                  | 1.49 |
| $T_4$                                  | 1.85 |

Step 5
Calculate the $t$ value for every $Y$ that is feasible using the Equation (13).

**Table 4.** Cycle time for growing period

| Cycle Time for Growing Period $(T_g)$ | Week |
|--------------------------------------|------|
| $t_2$                                | 4.8915 |
| $t_3$                                | 4.8919 |
| $t_4$                                | 4.8920 |

Step 6
Calculate TCU using Equation (29) for all $y_j$. The $y_j$ value that produces the highest TPU is the optimal result.

**Table 4.** Summary of the result from the numerical example

| Price(Rp) | $Y_2$     | $Y_3$     | $Y_4$     |
|-----------|-----------|-----------|-----------|
| TRU       | 579,445,455,540 | 579,445,455,540 | 579,445,455,540 |
| PCU       | 31,314,989  | 30,777,458 | 30,479,643 |
| FCU       | 407,677,561,371 | 407,682,276,024 | 407,684,017,314 |
| SCgU      | 88,048,917,560 | 88,049,935,816 | 88,050,311,895 |
| SCcU      | 10,173,337  | 6,699,830  | 5,416,928  |
5. Conclusion
In this paper, we developed an EOQ model for growing items, where the weight of the item increases with time over a certain period. The model considered the incremental discount offered by the supplier. In addition, the model also considered imperfect quality for purchasing newborn items, where items of poor quality are often found that result in death at the beginning of purchase or cannot survive until the end of growth. The probability that an item will die during the growth period is also an important thing to consider to determine the quantity of the order to avoid shortage at the end of the growth period. With the model developed in this research, it can be used as a reference for companies to determine the number of optimal orders quantity to increase the profits of the company. For further research, the inclusion of suppliers and other related parties will give a better solution in the supply chain of growing items by considering several aspects such as sustainability.

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