Neutrosophic Static Model without Deficit and Variable Prices

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Abstract:

Inventory management plays an important role in production and marketing processes, especially in production facilities and commercial institutions that have warehouses in which they store their equipment and goods. Inventory management is considered one of the most important management functions in terms of determining the ideal volume of inventory and calculating its costs, as this affects the facility's efficiency and achieves either large profits or it causes huge losses, so warehouse managers in production facilities or institutions must determine the appropriate and ideal volume of inventory, especially when they are presented with price offers from companies seeking to market their products. These offers are directly related to the volume of the order, and in this case, they must make an ideal decision through which determine the volume of the order by taking into account the following matters:

1. Securing the quantities required for production or sale so that there is no deficit.
2. The storage cost should be as low as possible.
3. Benefit as much as possible from the discounts offered by companies.

In this research, we present a complementary study to what we did in researching the neutrosophic treatment of static inventory models without deficit, through which we arrived at mathematical relationships through which we can calculate the ideal volume of the order at the lowest possible cost. We will use these relationships to determine the ideal volume of the order so that we achieve the greatest benefit from price offers and discounts. Provided by companies.

Keywords: Static inventory models without deficits - Static inventory models without neutrosophic deficits - Variable price (discounts) models without neutrosophic deficits.

Introduction:

Before the emergence of the science of operations research, decision makers relied on experience gained through the profits they obtained for correct decisions and losses for wrong decisions. With the great development witnessed by our contemporary world, we find that experience alone is not sufficient to make decisions on the scale of this development, and a comprehensive study of the reality must be conducted. The work of the system is a study that relies on modern scientific methods, such as operations research methods. Even operations research methods are not sufficient in the face of these changes that the work environment is witnessing because they depend on restricted and specific classical data. Therefore, these methods had to be reformulated using non-specific data, completely specific Neutrosophical data that gives decision makers have a margin of freedom that enables them to face all circumstances, and this is what has been done by researchers and scholars interested in science and scientific development. In the following research, we find many studies presented using the concepts of neutrosophic science [1-15]. In this research, we will present a study using complementary neutrosophic concepts. As we have done previously, we know that most companies provide price offers and these offers are related to the volume of the order in order to market their goods, which are manufactured materials or raw materials used in the manufacturing process. This matter requires warehouse managers in production facilities or institutions that need these goods to determine the appropriate and ideal volume of the stock of each material to secure the demand at one time. We know that if the volume of the stock is very large, this guarantees the provision of the material, but in return, it may cause the organization to suffer losses because the value of the stock is frozen capital, and this large quantity requires a marketing period that depends on the rate of demand. If the quantity of inventory is small, this may lead to a bottleneck in securing materials and to various disturbances such as rising prices and others. In all cases, we find that the rate of demand for inventory is the primary control over the volume of the order. Therefore, in previous research [16], we studied the static model without a deficit using the concepts of neutrosophic science and we reached relationships through which we can calculate the ideal volume of the order and the corresponding cost was a neutrosophic value that takes into account all circumstances. In another research we also calculated a set of neutrosophic indicators for the static inventory model without a deficit [17]. In this research we will present A study based on what was presented in previous research, the purpose of which is to determine the ideal volume for students and to make the most of the price offers provided for the materials that we need to store so that no shortage occurs and the cost of storage is as low as possible.

Discussion:

Inventory models were studied in classical logic, and this study was presented on the basis that the rate of demand for inventory is a fixed value throughout the duration of the storage cycle. Therefore, the rate of demand for inventory is subject to a uniform probability distribution. This issue was addressed by relying on studies presented according to classical logic in the field of operations research, which relies on based on basic concepts in mathematics such as calculus of integration and others [21-32], we presented, in previous research [16-20], static inventory models using the concepts of neutrosophic science. We took in the study the rate of demand for inventory during the duration of the storage cycle. neutrosophic value.

Undetermined values. Completely determined. It is subject to a regular neutrosophic distribution, and we found the extent to which this value affects the ideal volume of the order. Among the research was the neutrosophic treatment of inventory models without a deficit, which is based on the following hypotheses:

Basic hypotheses of the study:

1 – Order volume Q.

2 - The rate of demand for inventory at one time λ_N (unspecified), where $\lambda_N \in \{\lambda_1, \lambda_2\}$ or $\lambda_N \in [\lambda_1, \lambda_2]$ or... so that λ_1 is the minimum rate of demand for inventory and λ_2 is the upper limit of the rate of demand for inventory.

3 – The fixed cost of preparing the order $C_1 = K$.

4 – The cost of purchase, delivery and receipt $C_2 = C.Q$.

5 - The cost of storage for the remaining quantity in the warehouse during one time C_3.

6 - The duration of running out of the stored quantity is $\frac{Q}{\lambda_N}$ (or the duration of the storage cycle).

Using the previous assumptions, we were able to build a non-linear mathematical model, and the optimal solution for it, i.e., the ideal volume of the order, is given by the following relationship:

$$Q_N^* = \sqrt{\frac{2K\lambda_N}{h}} \qquad (1)$$

The ideal total cost is calculated from the relationship:

$$C(Q_N^*) = \frac{K\lambda_N}{Q_N^*} + C\lambda_N + \frac{hQ_N^*}{2} \qquad (2)$$

In this research, we present a study of static inventory models without shortages after adding a new hypothesis to the basic hypotheses imposed by the reality of the market situation through the offers made by the producing companies. The content of these offers is to provide a discount whose value is determined according to the quantity that is purchased. Here the official must determine the size of the order. So that it suits the system's demand and is sufficient for the duration of the storage cycle without causing a shortage and with the lowest possible storage cost and at the same time benefiting from the companies' offer. According to the above, we present the following formulation of the issue:

Text of the issue:

An insurance company needs a certain material, so if it knows that the rate of demand for this material is λ_N during the storage cycle, and that the cost of purchasing one unit is C monetary units, the cost of storing one unit is h, the cost of preparing the order is K monetary units, and the offer provided by the company the producers of this material are:

$$Price\ \ for\ \ one\ \ item \begin{cases} C_1 & If \quad 0 \leq Q < Q_1 \\ C_2 & If \quad Q_1 \leq Q < Q_2 \\ C_3 & If \quad Q_2 \leq Q < Q_3 \\ C_4 & If \quad Q_3 \leq Q < \infty \end{cases}$$

Where $C_1 > C_2 > C_3 > C_4$

What is required is to determine the ideal volume of the order so that the storage cost is as low as possible.

From the above, the basic hypotheses of this model are written as follows:

Basic assumptions of the model of variable prices without neutrosophic deficit:

1 – Order volume Q.

2 - The rate of demand for inventory at one time λ_N (unspecified), where $\lambda_N \in \{\lambda_1, \lambda_2\}$ or $\lambda_N \in [\lambda_1, \lambda_2]$ or... so that λ_1 is the minimum rate of demand for inventory and λ_2 is the upper limit of the rate of demand for inventory.

3 – The fixed cost of preparing the order $C_1 = K$.

4 – The cost of purchase, delivery and receipt $C_2 = C.Q$.

5 - The cost of storage for the remaining quantity in the warehouse during one time C_3.

6 - The duration of running out of the stored quantity is $\frac{Q}{\lambda_N}$ (or the duration of the storage cycle).

7- One of the companies producing materials to be stored provided four price levels that are inversely proportional to the volume of the order:

$$Price\ \ for\ \ one\ \ item \begin{cases} C_1 & If \quad 0 \leq Q < Q_1 \\ C_2 & If \quad Q_1 \leq Q < Q_2 \\ C_3 & If \quad Q_2 \leq Q < Q_3 \\ C_4 & If \quad Q_3 \leq Q < \infty \end{cases}$$

Neutrosophic treatment of the issue:

We follow the following steps:

1 -We build a mathematical model for this issue within hypotheses 1-6, which in themselves are the basic hypotheses of the static model without neutrosophic deficit that was studied previously, and we arrived at the following:

Find

$$C(Q) = \frac{K\lambda_N}{Q} + C\lambda_N + \frac{hQ}{2} \quad \longrightarrow Min$$

Condition:

$$Q \geq 0$$

It is a nonlinear neutrosophic model whose optimal solution, i.e., the ideal volume of the students, is given by the relationship (1) and the minimum storage cost is calculated from the relationship (2).

To address the issue at hand and choose the optimal volume of the order, taking into account hypothesis No. (7) of the offers presented, we calculate the following storage costs:

$$C_i(Q_N) = \frac{K\lambda_N}{Q_N} + C_i\lambda_N + \frac{hQ_N}{2} \qquad (3)$$

Where $i = 1,2,3,4, \dots$ for all price cases

Since $C_1 > C_2 > C_3 > C_4$the function $C_i(Q)$ satisfies the following inequality:

$$C_1(Q) > C_2(Q) > C_3(Q) > C_4(Q)$$

For $i = 1,2,3,4$.

Each of the previous functions has a minimum limit, which is the optimal solution to the nonlinear model that we arrived at in the first step, corresponding to the inventory volume, which we symbolize as Q_{0N}, calculated from the following relationship:

$$Q_{0N} = \sqrt{\frac{2K\lambda_N}{h}}$$

After calculating Q_{N0}we compare it with the given offers.

We assume that $Q_1 \leq \quad Q_{N0} < Q_2$. Then we calculate the cost corresponding to this volume from the relationship (3). We get $C_2(Q_{0N})$. To determine the ideal volume of the order Q_N^*, we calculate the cost functions for the minimum limits of the quantity ranges specified in the discounts table. Then we choose the smallest of these costs, which is the volume. The corresponding ideal is the volume that secures inventory for the system during the storage cycle period at the lowest possible cost and taking advantage of the offers provided.

We explain the above through the following example:

Example:

A production institution wants to secure its need for a certain material. If it knows that the rate of demand for this material is $[250{,}330]$,units per year, the cost of purchasing one unit in the market is 400 monetary units, the cost of storing one unit per year is 10% of its price, and the cost of preparing the order is equal to 150 units. In cash, the company producing this material offers the following offers:

2% discount if quantity $50 \leq Q \leq 100$.

3% discount if quantity $100 \leq Q \leq 200$.

5% discount if quantity is $200 \leq Q$.

Required: Find the optimal quantity Q_N^*,that makes the total costs of storage as small as possible.

The solution:

Data:

$\lambda \in [250{,}350] \quad ,K = 150 \ \ ,C = 400$

h is the storage cost and is 10% of the price of one unit of stock in the market. Therefore:

$$h = \frac{10}{100}.400 = 40$$

1- We determine price levels by discounts:

a. When $Q \leq 50$ then $C_1 = C = 400$ there is no discount.

b. When $50 \leq Q \leq 100$ the discount is 2% and the purchase price is equal to:

$$C_2 = 400\left(1 - \frac{2}{100}\right) = 392$$

c. When $100 \leq Q \leq 200$ the discount is 3% and the purchase price equals to:

$$C_3 = 400\left(1 - \frac{3}{100}\right) = 388$$

d. When $Q \geq 200$ the discount is 5% and the purchase price is equal to:

$$C_4 = 400\left(1 - \frac{5}{100}\right) = 380$$

2- We calculate the initial quantity of inventory:

We study the issue based on hypotheses 1-6, and here we are faced with a storage model without a neutrosophic deficit. We calculate the ideal volume of the order through the following relationship:

$$Q_{0N} = \sqrt{\frac{2K\lambda_N}{h}} = \sqrt{\frac{2.[250,350].150}{20}} \in [61,72]$$

This means that in order for the company to provide a safe work environment without shortages and with the lowest storage cost, the volume of the order must be greater than Q_{0N}. To calculate the cost, we compare the initial quantity with the offers presented by the producing company. We find that $Q_{0N} \in [50,100]$, meaning that this quantity deserves a 2% discount. The purchase price per unit is $C_2 = 392$, and then the total storage cost is calculated from the relationship:

$$C_2(Q_{0N}) = \frac{K\lambda_N}{Q_{0N}} + \frac{hQ_{0N}}{2} + C_2\lambda_N$$

$$C_2([61,72]) = \frac{150.[250,350]}{[61,72]} + \frac{40.[61,72]}{2} + 392.[250,350] \in [99834,139369]$$

To benefit more from the offers presented.

3- We calculate costs for the minimum offer areas:

For the range $100 \leq Q \leq 200$we find:

$$C_3(100) = \frac{150.[250,350]}{100} + \frac{40.100}{2} + 392.[250,350] \in [100375,139725]$$

$$C_4(200) = \frac{150.[250,350]}{200} + \frac{40.200}{2} + 380.[250,350] \in [99187.5,137262.5]$$

After obtaining the costs corresponding to the offers, we find that:
As for the cost $C_1 = C = 400$, it is offset by the order volume $Q \leq 50$, and for this volume there is no discount. In addition, this volume is less than the minimum required, meaning that it does not suit the company because the company works on the basis of not having a deficit, and this order quantity will cause a deficit to be paid. The company will face fines, which will be reflected in the total cost, so we rule out this solution.

4- We choose the lowest cost from the remaining costs:

That is, we take:

$$Min\{C_2(Q), C_3(Q), C_3(Q)\}$$

We find:

$$Min\{[99834,139369],[100375,139725],[99187.5,137262.5]\}$$
$$= [99187.5,137262.5] \quad (*)$$

It corresponds to an order size $Q = 200$. This volume is appropriate for the company's workflow.
In order to achieve the maximum benefit from the offers presented, we calculate the costs corresponding to the largest volume that the company can adopt if the storage cost is appropriate, which corresponds to an order volume equal to the rate of demand for inventory, that is:
We calculate storage costs if the order volume equals the inventory demand rate. That is, when $Q \in [250,350]$, we find that the price of one unit will be $C_4 = 380$, and the total storage costs are equal to:

$$C([250,350]) = \frac{150[250,350]}{[250,350]} + \frac{40.[250,350]}{2} + [250,350].380 \in [100150,140150]$$

We compare this cost with the cost we obtained through the comparison (*). We find that the cost is greater and there is no interest for the company in requesting this size of the order because it can ensure a safe work flow and benefit from the offers provided at a lower cost when the order volume is $Q = 200$.

From the above, we note that the minimum value of storage costs is:

$$[99187.5,137262.5]$$

And corresponds to the ideal volume of the order, which is equal to $Q^* = 200$.

Conclusion and Results:

The storage model with variable prices is considered one of the important models in inventory models because we encounter it frequently in practical life and it requires careful study from us so that we do not fall into the temptation of the offers presented. Through the offers we may be able to obtain lower prices for large quantities, but these quantities may become a burden on the company. During the costs that must be paid for the storage process, on the other hand, we find that using the neutrosophic value of the demand rate for inventory gave a careful study of the model, as we obtained the neutrosophic storage cost from which we can determine the lowest cost and the largest cost if the ideal volume of the order is adopted $Q^* = 200$.

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