Important Neutrosophic Economic Indicators of the Static Model of Inventory Management without Deficit

Maissam Jdid
Faculty of Informatics Engineering, Al-Sham Private University, Damascus, Syria
Email: m.j.foit@aspu.edu.sy

Abstract:
Inventory models are generally concerned with finding the volume of inventory to be kept to ensure the continuity of work, which achieves the facility with the lowest cost and the greatest profit, and since the ideal volume is affected by the rate of demand for inventory, in previous research [5] we studied the static model without a deficit according to the neutrosophic logic and we came to a relationship that we calculate through which the ideal size of inventory, the result was a neutrosophic value that takes into account all the fluctuations and changes that administrators may encounter during the course of work through the indeterminacy and indeterminate values of the demand rate, in this research we use the neutrosophic concepts of static model of inventory management without deficit and ideal volume which we have in last research, for most important neutrosophic economic indicators that play an important role in the administrative decision-making process about the functioning of production facilities and commercial establishments that have warehouses in which they keep their equipment, goods and manufactured and unmanufactured materials necessary for the production process and provide them with a future vision of the reality of their condition over time.

Keywords: Inventory Management; Static Model of Inventory Management; Indicators of the Static Model without Deficit; Neutrosophic Logic-;Neutrosophic Economic Indicators.

Introduction:

Operations research in its essence is a science and an art, a science of good thinking, and the art of finding the best solutions and reaching them through scientific means, so that nothing is left to chance or luck, and takes decision-making according to scientific methods that use the language of mathematics mainly it uses the computer, without which it would not have been possible to achieve this great development in the process research [2], the field that is interested in the application of scientific methods and scientific research to the complex issues facing decision-makers in all areas of life, through the topics it has presented attached to the methods of solution, such as mathematical programming - network planning - decision analysis - waiting queues --- and others as mentioned in many references that dealt with operations research [1,2,3,4]

Until we reach the subject of our research, which is inventory models, that is one of the most important topics of operations research because it is concerned with finding the ideal size of inventory so that the cost of storage is as low as possible. The storage is intended for goods and materials owned by the establishment for reselling or used in making products for sale ,Raw materials - semi-raw - spare parts ---- and others that ensure the continuity of work and achieve the desired profits, Storage costs are one of the company's capital assets, and in order to preserve the capital and achieve profits, a comprehensive economic study of the facility must be prepared based on modern scientific foundations, such as the use of the neutrosophic logic that has revolutionized all fields of science through the accuracy of the results provided by studies that use concepts The basic principles of this logic, which was clarified by research and studies that dealt with various topics that were published by those interested in this logic.$[5-25]$

Discussion:

In the classical logic, the static stock model without a deficit was studied for one substance, and based on the basic assumptions of this model and the relationship of the ideal size, a set of indicators was

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calculated[1] ,we have discussed the same model with neutrosophic logic [5], Expanding on previous studies, where we will calculate some important neutrosophic economic indicators that help administrators and decision-makers to make ideal decisions through the future vision of the workflow provided by these indicators which differs from what we obtained by studying the same subject according to the classical logic because it takes into account that the rate of demand for inventory is a neutrosophic value we symbolize λ_N, which is an indefinite amount we will take in the form $\lambda_N = [\lambda_1, \lambda_2]$ where λ_1 it is the lowest value of the rate of demand for inventory during the period of the storage cycle and λ_2 is the highest value, and therefore all economic indicators that are related to the rate of demand will also be neutrosophic values that are not specific, taking into account the worst conditions that the facilities can go through to the best, which enables the responsible administrators to make decisions to develop appropriate future plans for the functioning of work in all conditions.

From the previous study of the static stock model without a deficit and for one substance according to the neutrosophic logic [5]we found the ideal volume of the order given by the following relationship:

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

where λ_N is the rate of demand for inventory in one time, K is the fixed cost of preparing the order, h is the cost of storage per unit in the warehouse during the unit of time:

We also found that the interval between one order and another is given by the following relationship:

$$T_N^* = \frac{Q_N^*}{\lambda_N}$$

Substituting Q_N^* by its equal, we get the relationship:

$$T_N^* = \frac{Q_N^*}{\lambda_N} = \sqrt{\frac{2k}{\lambda_N h}}$$

In this research to calculate the most important indicators, we make use of the basic assumptions of the static model without deficits mentioned in the reference [1]and the relationship (∗) we get:

1. The number of orders needed during one time:

$$n_N^* = \frac{\lambda_N}{Q_N^*}$$

2.Reorder Quantity:

In this form, the deficit is not allowed, so the quantity that is available in the warehouse must be known, and then the order must be repeated, and we will symbolize it with the code Q_N^1 so that the deficit does not occur, we can calculate it after knowing the time required to receive the order, which we will denote by the code d, then we get:

$$\frac{d}{T_N^*} = \frac{Q_N^1}{Q_N^*} \Rightarrow Q_N^1 = \frac{d}{T_N^*} Q_N^* = \frac{d}{\frac{Q_N^*}{\lambda_N}} Q_N^* \Rightarrow Q_1^* = d\lambda_N$$

3. Total Stock Accumulation in Warehouse During Storage Cycle Duration:

Calculated from the relationship:

$$Y_N^* = \int_0^{T_N^*} (Q_N^* - \lambda_N t)\, dt$$

$$Y_N^* = \int_0^{T_N^*} (Q_N^* - \lambda_N t)\, dt = \left[Q_N^* - \lambda_N \frac{t^2}{2}\right]_0^{T_N^*} = \frac{Q_N^*}{2\lambda_N}$$

$$Y_N^* = \frac{Q_N^*}{2\lambda_N}$$

4. Average Volume of Stock in the Warehouse During Unit of Time in the Period $[0, T_N^*]$:

Calculated from the relationship:

$$\bar{Y}_N = \frac{Y_N^*}{T_N^*} = \frac{Q_N^*}{2}$$

5. Smallest Storage Cost:

Calculated from the relationship:

$$NC(Q_N^*) = \frac{k\lambda_N}{Q_N^*} + C\lambda_N + h\frac{Q_N^*}{2}$$

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6. Total Storage Cost During Storage Cycle Duration:

Calculated from the relationship:

$$TNC(Q_N^*) = C(Q_N^*)T_N^*$$

Substituting T_N^* by its equivalent, we get the relationship:

$$TNC(Q_N^*) = k + CQ_N^* + \frac{h}{\lambda_N}\frac{{Q_N^*}^2}{2}$$

7. Total Sales During the Unit of Time:

If the selling price of one unit of the stored material equals P and we symbolize the total sales during one time by V_N, then it is calculated from the relationship:

$$V_N = P\lambda_N$$

8. Total Sales During the Storage Cycle Period:

We symbolize the total sales during the storage cycle period with W_N, then W_N is calculated from the relationship:

$$W_N = P\lambda_N T_N^* \Rightarrow W_N = P\lambda_N \frac{Q_N^*}{\lambda_N}$$

$$W_N = PQ_N^*$$

9. Average Profit During the Unit of Time:

We denote the average profit during one with the symbol B_N and calculate it from the relationship:

$$B_N = V_N - NC(Q_N^*)$$

10. Average Profit During the Storage Cycle Period:

We get the average profit over the storage cycle period B'_N from the relationship:

$$B'_N = W_N - TNC(Q_N^*)$$

11. We Get the Average Profit Per Year from the Relationship:

$$B_N^1 = 12 * B_N$$

We declare the above with the following example:

Practical Example According to Neutrosophic Logic:

A merchant wishes to invest his existing capital in storing and selling iron used in construction. Before starting the work, he conducted a study of the market movement in the area in which he wanted to invest, and obtained the following information:

1. The monthly demand rate for iron ranges between 250 and 300 tons, meaning there is no exact value for the demand rate. Therefore, the demand rate is a neutrosophic value and equals $\lambda = [250,300]$ ton.
2. The cost of preparing Q ton order is $k = 200\$$.
3. The cost of storing one ton of iron during the unit of time (month) is $h = 10\$$.
4. The cost of purchasing, delivering, receiving and arranging an order of size Q equals $C = 6000\$$.
5. The period of receiving the order is $d = 5\ day$
6. The selling price of one ton is $P = 7000\$$.

From the data we find:

The ideal size of the order we substitute in the following relationship:

$$Q_N^* = \sqrt{\frac{2k\lambda_N}{h}} = \sqrt{\frac{2 * 200 * [250,300]}{10}} = [100,109.5]\ \ ton$$

Let's calculate the basic indicators that give this investor a future vision of the business situation over time:

1. The ideal time interval between one order and another, we substitute in the relationship:

$$T_N^* = \sqrt{\frac{2K}{\lambda_N h}}$$

$$T_N^* = \sqrt{\frac{2k}{\lambda_N h}} = \sqrt{\frac{2 * 200}{[250,300] * 10}} = [0.4,0.4] = 0.4\,month$$

And it equals: $T_N^* = 0.4 * 30 = 12\ \ day$

2. The number of orders needed during a month; we substitute in the relationship:

$$n_N^* = \frac{\lambda_N}{Q_N^*}$$

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$$n_N^* = \frac{[250,300]}{[100,109.5]} = [2.5,2.7] \ order$$

3.The quantity that is available in the warehouse, and then the order must be repeated, we substitute in the relationship:

$$Q_1^* = d\lambda_N = 5 * [250,300] = [1250,1500] \ \ ton$$

4. The total accumulation of inventory in the warehouse during the period of the storage cycle, we substitute in the relationship:

$$Y_N^* = \frac{Q_N^*}{2\lambda_N} = \frac{[100,109.5]}{2 * [250,300]} = [0.2,0.2] = 0.2 \ ton$$

5. The average volume of stock held in the warehouse during one time in the period we substitute in the relationship:

$$\bar{Y}_N = \frac{Q_N^*}{2} = \frac{[100,109.5]}{2} = [50,54.8] \ \ ton$$

6. The smallest storage cost we substitute in the relationship:

$$NC(Q_N^*) = \frac{k\lambda_N}{Q_N^*} + C\lambda_N + h\frac{Q_N^*}{2}$$

$$NC(Q_N^*) = \frac{10 * [250,300]}{[100,109.5]} + 6000 * [250,300] + 10 * \frac{[100,109.5]}{2} \Rightarrow$$

$$NC(Q_N^*) = [1500525,1800575] \ \$$$

7. The total cost of storage during the storage cycle period, we substitute in the relationship:

$$TNC(Q_N^*) = C(Q_N^*)T_N^*$$

$$TNC(Q_N^*) = [1500525,1800575] * 0.4 = [600210,720230] \ \ \$$$

8. The total value of sales during a month, we substitute in the relationship:

$$V_N = P\lambda_N$$

$$V_N = 7000 * [250,300] = [1750000,2100000] \ \$$$

9. Total sales during the storage cycle period, we compensate with the relationship:

$$W_N = PQ_N^*$$

$$W_N = 7000 * [100,109.5] = [700000,766500] \ \ \$$$

10. Average profit during the unit of time (month) we substitute in the relationship:

$$B_N = V_N - NC(Q_N^*)$$

$$B_N = [1750000,2100000] = [249475,299425] \ \ \$$$

11. The average profit during the storage cycle period, we substitute in the relationship:

$$B_N' = W_N - TNC(Q_N^*)$$

$$B_N' = [700000,766500] - [600210,720230] = [46270,99790] \ \ \$$$

12. Average profit per year we substitute in the relationship:

$$B_N^1 = 12 * B_N$$

$$B_N^1 = 12 * [249475,299425] = [2993700,3593100] \ \ \$$$

In order to be able to clarify the difference made by the concepts of neutrosophic logic and neutrosophic values when they are used in any field of science, we will re-solve this example according to classical logic based on the study mentioned in reference [1] and compare the results:

Practical Example According to Classical Logic:

A merchant wishes to invest his existing capital in storing and selling iron used in construction. Before starting the work, he conducted a study of the market movement in the area in which he wanted to invest, and obtained the following information:

1. The monthly demand rate for iron is 250 tons, $\lambda = 250$ ton.
2. The cost of preparing Q ton order is $k = 200\$$.
3. The cost of storing one ton of iron during the unit of time (month) is $h = 10\$$.
4. The cost of purchasing, delivering, receiving and arranging an order of size Q equals $C = 6000\$$
5. The period of receiving the order is $d = 5 \ day$.
6. The selling price of one ton is $P = 7000\$$

Let's calculate the basic indicators that give this investor a future vision of the business situation over time:

From the data we find:

The ideal size of the order is substituted in the following relationship:

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$$Q^* = \sqrt{\frac{2k\lambda}{h}} = 100 \quad ton$$

Therefore, the main indicators are:

1. The ideal time interval between one order and another, we substitute in the relationship:

$$T^* = \sqrt{\frac{2k}{\lambda h}} = 0.4 \ month$$

$$T^* = 0.4 * 30 = 12 \ day$$

2. The number of orders needed during a month; we substitute in the relationship:

$$n_N^* = \frac{\lambda}{Q^*} = 2.5 \ order$$

3.The quantity that is available in the warehouse, and then the order must be repeated, we substitute in the relationship:

$$Q_1^* = d\lambda = 1250 \ ton$$

4. The total accumulation of inventory in the warehouse during the period of the storage cycle, we substitute in the relationship:

$$Y^* = \frac{Q^*}{2\lambda} = 0.2 \ \ ton$$

5. The average volume of stock held in the warehouse during one time in the period we substitute in the relationship:

$$\bar{Y}_N = \frac{Q^*}{2} = 50 \ \ ton$$

6. The smallest storage cost we substitute in the relationship:

$$C(Q^*) = \frac{k\lambda}{Q^*} + C\lambda + h\frac{Q^*}{2} = 1500525 \ \ \$$$

7. The total cost of storage during the storage cycle period, we substitute in the relationship:

$$TC(Q^*) = C(Q^*)T^* = 600210 \ \ \$$$

8. The total value of sales during a month, we substitute in the relationship:

$$V = P\lambda = 1750000 \quad \$$$

9. Total sales during the storage cycle period, we substitute in the relationship:

$$W = PQ^* = 700000 \quad \$$$

10. Average profit during the unit of time (month) we substitute in the relationship:

$$B = V - C(Q^*) = 249475 \quad \$$$

11. The average profit during the storage cycle period, we substitute in the relationship:

$$B' = W - TC(Q^*) = 99790 \quad \$$$

12. Average profit per year we substitute in the relationship:

$$B^1 = 12 * B = 2993700 \quad \$$$

Conclusion and Results:

We summarize our findings in this research through the following table:

Neutrosophic Logic	**Classical Logic**	**Economic Indicators**
$Q_N^* = [100,109.5]$ **ton**	$Q^* = 100\ ton$	Order volume
$T_N^* = 12 \ day$	$T^* = 12 \ day$	Intervals between one order and another
$n_N^* = [2.5,2.7] \ order$	$n_N^* = 2.5 \ order$	Orders number
$Q_N^1 = [1250,1500] \ \ ton$	$Q_1^* = 1250 \ ton$	Quantity to be re-ordered
$\bar{Y}_N = 0.2 \ ton$	$Y^* = 0.2 \ \ ton$	total inventory backlog

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$NC(Q_N^*) = [1500525,1800575]$ \$	$C(Q^*) = 1500525$ \$	Smallest storage cost during the unit of time
$TNC(Q_N^*) = [600210,720230]$ \$	$TC(Q^*) = 600210$ \$	Total storage cost during the storage cycle
$V_N = [1750000,2100000]$ \$	$V = 1750000$ \$	Total sales value during the unit of time
$W_N = [700000,766500]$ \$	$W = 700000$ \$	Total sales value during the storage cycle
$B_N = [249475,299425]$ \$	$B = 249475$ \$	Average profit over the unit of time
$B'_N = [46270,99790]$ \$	$B' = 99790$ \$	Average profit over the storage cycle period
$B_N^1 = [2993700,3593100]$ \$	$B^1 = 2993700$ \$	Average profit per year

Results Comparison Table

From the previous table, we notice that dealing with neutrosophic values gives more accurate results and has a margin of freedom, which provides a safe working environment for the investor because studying according to the neutrosophic logic, gave values for economic indicators that took into account the worst and best conditions and thus the investor is aware and ready to face everything that may arise on the work environment.

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