The static model of inventory management without a deficit with Neutrosophic logic

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Abstract

In this paper, we present an expansion of one of the well-known classical inventory management models, which is the static model of inventory management without a deficit and for a single substance, based on the neutrosophic logic, where we provide through this study a basis for dealing with all data, whether specific or undefined in the field of inventory management, as it provides safe environment to manage inventory without running into deficit , and give us an approximate ideal volume of inventory. Since the ideal size is affected by the rate of demand for inventory, we present in this paper a study of the rate of demand for inventory when it is not precisely defined, and we find that the indeterminate values of the demand rate cannot be ignored, because they actually affect determining the ideal size of inventory and calculating its costs, thus affecting on the efficiency of the facility and achieve great profits for it.

Keywords: Inventory management , the static model of inventory management , the neutrosophic logic ,managing the inventory without a deficit according to the neutrosophic logic.

1.Introduction

A Neutrosophic ; new view of modeling , designed to effectively address the uncertainties inherent in the real world, It came to replace the binary logic that admits right and wrong by introducing a neutral third state that can be interpreted as undetermined or uncertain. It was founded by the American mathematician Florentine Smarandache [2,4,5,6,8] . Where he presented it in 1995 as a generalization of fuzzy logic and an extension of the theory of fuzzy sets [3] presented by Lotfi Zadeh in 1965 [1]. In addition, Ahmed Salama presented the theory of classical neutrosophic sets as a generalization of the theory of classical sets [7,15,16], and he developed, introduced and for mulated new concepts in the fields of mathematics, statistics, computer science and others through neutrosophic [17,25].

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Neutrosophic has grown significantly in recent years, through its application in measurement, sets, graphs, and many scientific and practical fields [10,11,12,13,14,19,20,21,22].

In this paper, we highlight the application of neutrosophical logic to one of the inventory management models, which is the static model without deficit and for a single substance, which will open the way for us to deal with inventory management models whose formulas are expressed in a way that is not precisely defined or uncertain, as if We take ranges of values instead of a single value, as is known in the classic, and in particular we will present the static model without a deficit for a single substance according to the neutrosophic logic ,when the rate of demand for stock is defined in an undefined way, and then we will present an applied example that shows how to deal with this case.

2. Discussion:

Inventory management plays an important role in production and marketing operations, especially in production facilities and commercial establishments that have warehouses where they keep their equipment and goods[9].

Inventory management is one of the most important functions of management, in terms of determining the ideal size of inventory and calculating its costs, as this affects the efficiency of the facility and achieves either great profits or causes it to suffer heavy losses.

It is often the responsibility of warehouse managers in production facilities or enterprises to determine the appropriate and ideal volume of Inventory of each material, to secure the demand in a certain time. We know that if the volume of the Inventory is very large, this guarantees the provision of the material on the one hand, but in return it may cause the institution losses because the value of the Inventory is frozen capital, and this large quantity needs a marketing period that depends on the rate of demand.

But if the inventory quantity is small, this may lead to a stalemate in securing materials and to various disturbances, such as price hikes and others.

Therefore, it was necessary to present a study to help us determine the ideal size of the inventory at the lowest possible cost.

When studying static inventory models in classical logic, the rate of demand for inventory was limited, and we found this rate is subject to a uniform probability distribution. Thus when the rate of demand for inventory is undetermined with the time, we use the neutrosophic uniform probability distribution, which was studied previously [18].

2.1. The main hypotheses of the study:

1. order size Q .
2. The rate of demand for inventory during a given time λ_N (unspecified) where $\lambda_N = \{\lambda_1, \lambda_2\}$ or $\lambda_N = [\lambda_1, \lambda_2]$ or … .

   so that: λ_1 minimum rate of demand for inventory.

   λ_2 Maximum rate of demand for inventory.

3. Fixed cost of order preparation $C_1 = K$.
4. Cost of purchase, delivery and pickup $C_2 = C.Q$.
5. Storage cost for the remaining quantity in the warehouse during a certain time C_3.

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6. inventory run out time is $\frac{Q}{\lambda_N}$ (or the duration of the storage cycle).

- We denote by q_t the quantity remaining in the warehouse at moment t during the period $\left[0, \frac{Q}{\lambda_N}\right]$ (the duration of the storage cycle) , q_t is given as:

$$q_t = Q - \lambda_N t$$

- To calculate C_3 the "storage cost", we divide the period $\left[0, \frac{Q}{\lambda_N}\right]$ into n partial periods, of length Δt.

If t_i is a point of partial period i , then the remaining quantity of inventory corresponding to that partial period is equal to:

$$q_i = Q - \lambda_N t_i$$

Thus the storage cost in the partial period is:

$$C_i = h .q_i . \Delta t = h(Q - \lambda_N t_i)\, \Delta t$$

Therefore, the total storage cost during the period $\left[0, \frac{Q}{\lambda_N}\right]$ is the sum of the partial costs,

ie: $$C_3 = \sum_i^n C_i$$

When $\Delta t \to 0$, the number of partial periods is $n \to \infty$, then:

$$C_3 = \lim_{n\to\infty} h(Q - \lambda_N t_i)\Delta t$$
$$= \int_0^{\frac{Q}{\lambda_N}} h(Q - \lambda t)dt = \frac{hQ^2}{2\lambda_N}$$

That is, the cost of storage during $\left[0, \frac{Q}{\lambda_N}\right]$ is:

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$$C_3 = \frac{hQ^2}{2\lambda_N}$$

The total cost is:

$$TC(Q) = C_1 + C_2 + C_3$$
$$= K + CQ + \frac{hQ^2}{2\lambda_N}$$

To get the cost of storage at a given time, we divide the total cost $TC(Q)$ by the length of the period $\frac{Q}{\lambda_N}$,

denoted by the symbol C(Q):

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

To determine the maximum values of the function C(Q), with the condition $Q > 0$, we find:

$$\frac{dC(Q)}{dQ} = \frac{-K\lambda_N}{Q^2} + \frac{h}{2}$$

$$\frac{dC(Q)}{dQ} = 0 \Rightarrow Q = \sqrt{\frac{2K\lambda_N}{h}}$$

To specify the type of this maximum value:

$$\frac{d2C(Q)}{dQ^2} = \frac{2\lambda_N K}{Q^2} > 0$$

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So the function C(Q) achieves a minimum value when $Q = \sqrt{\frac{2K\lambda_N}{h}}$, The ideal size for the demand is:

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

3. Application example:

Assuming we have a production facility, which stores spare pieces for its production lines, and that the rate of demand for these pieces in the warehouse is not absolutely specified, but ranges between [2.4] pieces per month, According to the conditions of the facility such as working pressure, operating pressure, weather conditions, etc., and that the cost of Preparing a single demand of Q Pieces is $100, and the cost of storing one piece for a month is $20.

Let us calculate the ideal size of the demand , which makes the cost of storage as small as possible, taking into account that the rate of demand for Pieces is an indeterminate case and ranges between $\lambda_N = [2, 4]$.

And :

K = $100 (the cost of preparing the demand).

h = $20 (the cost of storing one piece for a month).

We find, based on (**):

$$Q_N^* = \sqrt{\frac{2K\lambda_N}{h}} = \sqrt{\frac{2(100)[2,4]}{20}} = \sqrt{[20,40]} = [4.5,6.3]$$

That is, the ideal size of the demand ranges from 4 to 6 spare Pieces per month, so that we remain in the safety of Inventory management and avoid reaching the stage of deficit.

- Calculating the duration of the storage cycle in hours, knowing that the number of working days per month is 23 days and the number of working hours per day is only 8 hours. We find:

$$T_N^* = \frac{Q_N^*}{\lambda_N} = \frac{[4.5,6.3]}{[2,4]} = [1.1,3.2]$$

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The time period is in hours:

$$[1.1, 3.2] \times 23 \times 8 = [202.4 , 588.8]$$

That is, between 8 to 24 days.

4. Conclusion and results:

We conclude that dealing with inventory management models, under the neutrosophic logic, provides us with a more general and comprehensive study than the well-known classical study, so that it does not neglect any data just because it is not explicitly specified, especially in our dealing with the static model without a deficit , we found that the unspecified value of demand for inventory has affected the ideal size of the inventory , and it was given approximatly, so that it gives the minimum ideal size of the inventory that protects from reaching the stage of deficit and loss, and gives the maximum ideal size of the inventory so that it makes the inventory available in the best quantity without cause loss for the facility.

Thus, we find that the indeterminacy actually affects the results, and these unspecified values cannot be ignored and removed from the study framework , in order to obtain the most accurate results as possible, and thus obtain the ideal volume of inventory that meets the needs of the facility , during the period of the storage cycle at the lowest cost.

We find that working within the classical logic is no longer sufficient at the present time, as the development of science has put a large number of new problems that need more general and accurate results than the results we got it using classical logic and fuzzy logic, and here comes the role of neutrosophic logic, which provides us with more comprehensiveness to Interpret the study data and get the most accurate results possible.

In the near future, we look forward to studying the rest of the inventory management models according to the neutrosophic logic , such as inventory models with a deficit , dynamic models, and others..

REFERENCES

[1] L. A. ZADEH. Fuzzy Sets. Inform. Control 8 (1965).

[2] F. Smarandache. Introduction to Neutrosophic statistics, Sitech & Education Publishing, 2014.

[3] Atanassov .k, Intuitionistic fuzzy sets. In V. Sgurev, ed., ITKRS Session, Sofia, June 1983, Central Sci. and Techn. Library, Bulg. Academy of Sciences, 1984.

[4] Smarandache, F, Neutrosophy and Neutrosophic Logic, First International Conference on Neutrosophy , Neutrosophic Logic, Set, Probability, and Statistics University of New Mexico, Gallup, NM 87301, USA,2002.

Doi : https://doi.org/10.54216/IJNS.160104
Received: July 21, 2021 Accepted: November 03, 2021

[5] Smarandache, F. A Unifying Field in Logics: Neutrosophic Logic. Neutrosophy, Neutrosophic Set, Neutrosophic Probability. American Research Press, Rehoboth, NM, 1999.

[6] Smarandache, F, Neutrosophic set a generalization of the intuitionistic fuzzy sets. Inter. J. Pure Appl. Math., 24, 287 – 297, 2005.

[7] Salama, A. A, Smarandache, F, and Kroumov, V, Neutrosophic crisp Sets & Neutrosophic crisp Topological Spaces. Sets and Systems, 2(1), 25-30, 2014.

[8] Smarandache, F. & Pramanik, S. (Eds). (2016). New trends in neutrosophic theory and applications. Brussels: Pons Editions.

[9] Alali. Ibrahim Muhammad, Operations Research. Tishreen University Publications, 2004. (Arabic version).

[10] Alhabib.R, The Neutrosophic Time Series, the Study of Its Linear Model, and test Significance of Its Coefficients. Albaath University Journal, Vol.42, 2020. (Arabic version).

[11] Alhabib.R, Ranna.M, Farah.H and Salama, A. A, Neutrosophic Exponential Distribution. Albaath University Journal, Vol.40, 2018. (Arabic version).

[12] Alhabib.R, Ranna.M, Farah.H and Salama, A. A, studying the random variables according to Neutrosophic logic. Albaath- University Journal, Vol (39), 2017. (Arabic version).

[13] Alhabib.R, Ranna.M, Farah.H and Salama, A. A, Neutrosophic decision-making & neutrosophic decision tree. Albaath- University Journal, Vol (40), 2018. (Arabic version).

[14] Alhabib.R, Ranna.M, Farah.H and Salama, A. A, Studying the Hypergeometric probability distribution according to neutrosophic logic. Albaath- University Journal, Vol (40), 2018.(Arabic version).

[15] A. A. Salama, F. Smarandache Neutrosophic Crisp Set Theory, Educational. Education Publishing 1313 Chesapeake, Avenue, Columbus, Ohio 43212, (2015).

[16] A. A. Salama and F. Smarandache. "Neutrosophic crisp probability theory & decision making process." Critical Review: A Publication of Society for Mathematics of Uncertainty, vol. 12, p. 34-48, 2016.

[17] R. Alhabib, M. Ranna, H. Farah and A. A Salama, ''Foundation of Neutrosophic Crisp Probability Theory'', Neutrosophic Operational Research, Volume III , Edited by Florentin Smarandache, Mohamed Abdel-Basset and Dr. Victor Chang (Editors), pp.49-60, 2017.

[18] R. Alhabib, M. Ranna, H. Farah and A. A Salama.(2018). Some neutrosophic probability distributions. Neutrosophic Sets and Systems, 22, 30-38, 2018.

[19] Aslam, M., Khan, N. and Khan, M.A. (2018). Monitoring the Variability in the Process Using the Neutrosophic Statistical Interval Method, Symmetry, 10 (11), 562.

[20] Aslam, M., Khan, N. and AL-Marshadi, A. H. (2019). Design of Variable Sampling Plan for Pareto Distribution Using Neutrosophic Statistical Interval Method, Symmetry, 11 (1), 80.

[21] Aslam, M. (2019). Control Chart for Variance using Repetitive Sampling under Neutrosophic Statistical Interval System, IEEE Access, 7 (1), 25253-25262.

[22] Victor Christianto , Robert N. Boyd , Florentin Smarandache, Three possible applications of Neutrosophic Logic in Fundamental and Applied Sciences, International Journal of Neutrosophic Science, Volume 1 , Issue 2, PP: 90-95 , 2020.

[23] Madeleine Al- Tahan, Some Results on Single Valued Neutrosophic (Weak) Polygroups, International Journal of Neutrosophic Science, Volume 2 , Issue 1, PP: 38-46 , 2020.

[24] P. Singh and Y.-P. Huang. A New Hybrid Time Series Forecasting Model Based on the Neutrosophic Set and Quantum Optimization. Computers in Industry (Elsevier), 111, 121–139, 2019.

[25] R. Alhabib, A. A Salama, "Using Moving Averages To Pave The Neutrosophic Time Series'', International Journal of Neutrosophic Science (IJNS), Volume III, Issue 1, PP: 14-20, 2020.

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