NSS

Neutrosophic Sets and Systems, Vol. 68, 2024

University of New Mexico

A Survey on Neutrosophic Principles for Inventory Management Problem

Ankit Dubey[1], Arindam Dey[1], S Broumi[2],Ranjan Kumar[1,*]

[1]VIT-AP University, Inavolu, Beside AP Secretariat, Amaravati AP, India;

[2]Laboratory of Information Processing, Faculty of Science Ben M'Sik, University Hassan II,B.P 7955, Morocco.

[*]Correspondence: ranjank.nit52@gmail.com

Abstract. This paper presents a thorough assessment and classification of different uncertain environments used by researchers to analyze inventory management(IM) systems across various sectors, such as ABC analysis, Last In, First Out (LIFO), and batch tracking. Moreover, it introduces the concepts of the neutrosophic principle and fuzzy principle in inventory management. it also investigates the difficulties associated with the traditional inventory model. The primary focus of the study lies in inventory management under the Neutrosophic principle, specifically addressing uncertain demand and imprecise data. By shedding light on the potential of neutrosophic principle, this manuscript contributes valuable insights into overcoming the challenges posed by fuzzy models and enhancing decision-making in the realm of inventory control system.

Keywords: Supply chain; Trapezoidal fuzzy number(TpFN); Fuzzy economic order quantity (FEOQ); Trapezoidal Neutrosophic number(TpNN); Neutrosophic inventory management(NIM).

1. Introduction

An inventory control system is a mathematical algorithm used to optimize inventory levels for businesses and organizations. It considers factors such as carrying cost, stock out cost, demand, lead time, and ordering costs to determine the most suitable inventory levels. Ronald H. Ballou defines inventory models as quantitative models that determine the appropriate order quantities, timing of orders, and safety stock levels for specific inventory items or sets of items. Notable studies in the field of inventory control models have made significant contributions.In 1996, Song and Zipkin [1] introduced a model incorporating a Markovian representation of the supply system. Feng and Xiao [2], in 2001, focused on enhancing airline seat inventory control through a dynamic model and optimal policy approach. Levi et al. (2007) [3] presented sampling-based policies that provided provable near-optimality for stochastic inventory control models. In 2011, Che-Fu Hsueh [4] conducted research to examine inventory control policies within a manufacturing/remanufacturing system across the entire product life cycle. Lastly, Zhou et al. (2013) [5] proposed a comprehensive inventory control model that integrated multiple products and echelons, along with a joint replenishment strategy. These studies have offered valuable insights into the development and improvement of inventory control policies and systems.

After examining the problem of classical inventory, it has become clear that there are many problems that cannot be solved. That is why in 1965, Zadeh [6] introduced fuzzy logic. Fuzzy set is a mathematical framework for handling uncertainty and vagueness. In 1988, Dubois and Parade [7] proposed a model of IM that handles uncertainty. Section 3 explains how uncertainty is handled in inventory management. Table 1 and Figure 1 provide a summary of the significant contributions to understanding the FIM.

TABLE 1. Represents the impact of uncertainty in Inventory Control Models.

Authors	**Year**	**Application and Environment**	**Contribution**
Paksoy and Pehlivan [8]	2013	Application: Supply Chain Environment: TpFN	A fuzzy linear programming model is proposed for optimizing multi-stage supply chain networks by incorporating triangular and trapezoidal membership functions.
Ranganathan and Thirunavukarasu [9]	2014	Application: ICM for fixed deterioration Environment: TpFN	A fuzzy environment ICM for managing constant deterioration.
Sadeghi et al. [10]}	2016	Application: MIEPQM Environment: TpFN	Two tuned meta-heuristics for optimizing the MIEPQM with trapezoidal fuzzy demand and backordering.

Continued on next page

Table 1 – Continued from previous page

Authors	**Year**	**Application and Environment**	**Contribution**
Singh and Singh [11]	2016	Application: Vendor and Buyers Problem Environment: TpFN	A relationship model between vendors and buyers for deteriorating items, incorporating shortages, fuzzy trapezoidal costs, and inflation.

This manuscript displays different applications and methodologies of fuzzy inventory control in below Figure 1.

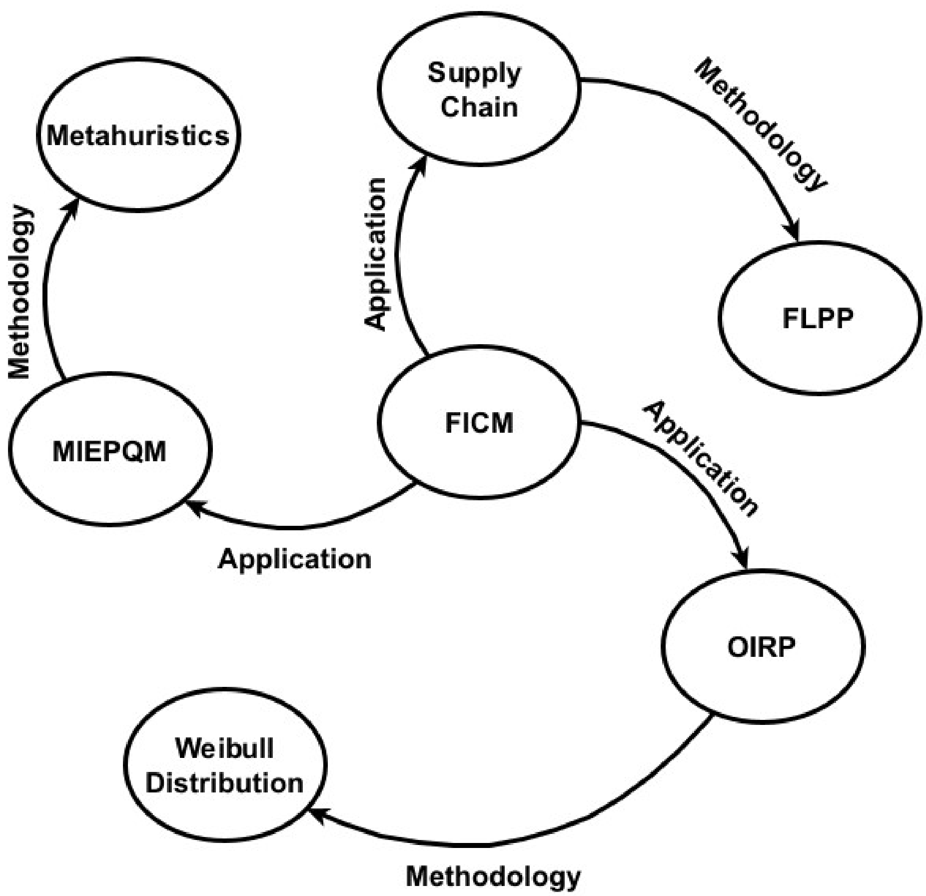

Figure 1. Represent the different applications involved in FIM

In our ongoing investigation, we examined the unique characteristics of fuzzy logic and found that some challenges are important to know. Our goal is to deliver valuable understandings of different methods that are commonly associated with IM. We will focus on important aspects of IM in fuzzy extension scenarios. We aim to assist academics in developing a deep understanding of NIM. Additionally, our manuscript surveys crucial aspects of NIM comprehensively. Moreover, we explore the existence of and challenges of IM that are associated with uncertainty. These challenges include ABC analysis [12], First In, First Out (FIFO) [13], and safety stock [14].

The introduction of this research article lays the groundwork for a comprehensive exploration of fuzzy theory and neutrosophic theory in the context of inventory management. In section 2, we established important definitions related to fuzzy theory, while section 3 shed light on the challenges of the FIM. Moving to section 4, we introduced the key concepts of neutrosophic theory, and specifically in section 4.1, we examined its practical application. In section 5, we delved into IM under the neutrosophic principle, and finally, in section 6, we arrived at the conclusion of our investigation in IM within neutrosophic environments. The forthcoming sections offer a comprehensive analysis of the application and implications of these theories in inventory management, opening new avenues for addressing uncertainties and enhancing decision-making processes in complex supply chain scenarios.

1.1. *List of Abbreviations are as follows:*

FIM stands for "Fuzzy Inventory Management".
ICM stands for "Inventory Control Model".
NTN stands for "Neutrosophic Triangular Number".
PSAOIM stands for "Particle Swarm Algorithm to optimize inventory management".
PIM stands for "Production Inventory Model".
ITFN stands for "Intuitionistic Triangular Fuzzy Number".
MIEPQM stands for "Multi-item Economic Production Quantity Model".
IVTNN stands for "Interval Valued Trapezoidal Neutrosophic Number".

2. **Some Important Definitions Related to Fuzzy Theory**

Definition 2.1. [6] Fuzzy Set: As per the Zedah's definition, The set $\widetilde{f}$ is illustrated as $\widetilde{f} = \left\{\left(\psi, \mu_{\widetilde{f}}(\psi)\right) : \psi \in f, \mu_{\widetilde{f}}(\psi) \in [0,1]\right\}$and generally denoted by the ordered pair $\left(\psi, \mu_{\widetilde{f}}(\psi)\right)$, here $\psi \in f$ be the crisp set and $\mu_{\widetilde{f}}(\psi) \in [0,1]$; such that $0 \leq \mu_{\widetilde{f}}(\psi) \leq 1$, $\widetilde{f}$is termed as the fuzzy set.

Definition 2.2. [15] Intuitionistic Fuzzy set (IFS): A set $\widetilde{IFS}$, denoted as $\widetilde{IFS} = \{\langle\delta; [\tau(\delta), \gamma(\delta)]\rangle : \delta \in \varphi\}$ can be represented graphically as a membership function where $\tau(\delta), \gamma(\delta) : \varphi \rightarrow [0,1]$the truth membership function is denoted by$\tau(\delta)$ and the false membership function is denoted by $\gamma(\delta)$. The condition for the set $\tau(\delta), \gamma(\delta)$ to satisfy $0 \leq \tau(\delta) + \gamma(\delta) \leq 1$

Definition 2.3. [16] Trapezoidal Fuzzy Number (TpFN): A trapezoidal fuzzy number $\widetilde{TF}$can be illustrated as $(j_{n_1}, j_{n_2}, j_{n_3}, j_{n_4})$shown in Figure.2 with the membership function $\mu_{\widetilde{TF}}$ as follows (ref Figure 2.)

$$\upsilon_{\widetilde{TF}}(\varphi) = \begin{cases} \dfrac{\varphi - j_{n_1}}{j_{n_2} - j_{n_1}}, \; j_{n_1} \leq \varphi \leq j_{n_2}; \\ 1, \; j_{n_2} \leq \varphi \leq j_{n_3}; \\ \dfrac{j_{n_4} - \varphi}{tf_4 - tf_3}, \; j_{n_3} \leq \varphi \leq j_{n_4}; \\ 0, \; Otherwise \end{cases}$$

$$where \quad j_{n_1}, j_{n_2}, j_{n_3}, j_{n_4} \in \mathbb{R}$$

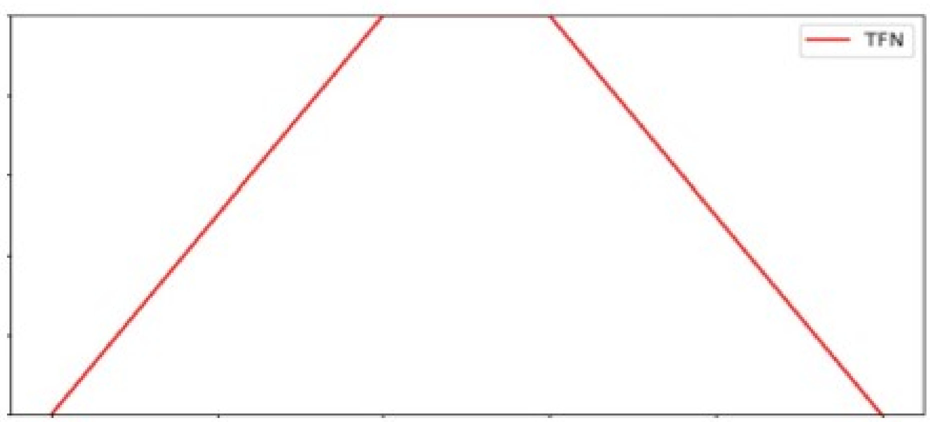

FIGURE 2. Figure 2:Trapezoidal Fuzzy Number

Definition 2.4. [17] Trapezoidal Intuitionistic Fuzzy Number (TpIFN):Let$\widetilde{TpIF}$ $=$ $\left\langle \left([t, u, v, w]\, ; \tau_{\widetilde{TpIF}} \right), \left([u_1, r, s, w_1]; \gamma_{\widetilde{TpIF}} \right) \right\rangle$ has a non-membership $\gamma_{\widetilde{TpIF}}(\varphi)$, and a membership $\tau_{\widetilde{TpIF}}(\varphi)$ functions as follows (ref Figure3):

$$\tau_{\widetilde{TpIF}}(\varphi) = \begin{cases} \dfrac{(\varphi - t)}{(n - q)} \tau_{\widetilde{TpIF}}, \; \text{t} \leq \varphi \leq u; \\ \tau_{\widetilde{TpIF}}, \; \text{u} \leq \varphi \leq v; \\ \dfrac{(w - \varphi)}{(w - v)} \tau_{\widetilde{TpIF}}, \; \text{v} < \varphi \leq w; \\ 0, \; \text{Otherwise.} \end{cases}$$

$$, \gamma_{\widetilde{TpIF}}(\varphi) = \begin{cases} \dfrac{(u-\varphi)+\nu_{\widetilde{ITF}}(\varphi-t_1)}{(u-m_1)}\gamma_{\widetilde{TpIF}}, \ \mathrm{t} \leq \varphi \leq u; \\ \gamma_{\widetilde{TpIF}}, \ \mathrm{n} \leq \varphi \leq v; \\ \dfrac{(\varphi-v)+\nu_{\widetilde{TpIF}}(w_1-\varphi)}{(w_1-o)}\gamma_{\widetilde{TpIF}}, \ \mathrm{v} < \varphi \leq w; \\ 0, \ \text{Otherwise.} \end{cases}$$

Where $0 \leq \tau_{\widetilde{TpIF}}(\delta) \leq 1; 0 \leq \gamma_{\widetilde{TpIF}}(\delta) \leq 1;$ and $\tau_{\widetilde{TpIF}} + \gamma_{\widetilde{TpIF}} \leq 1; t, u, v, w \in \mathbb{R}$.

Definition 2.5. [18] α-cut: α-cut of $\underline{\tilde{A}} = (a_1^a, a_2^n, a_3^k, a_4^i)$ is $A(\alpha) = [A_L(\alpha), A_R(\alpha)] Where, A_L(\alpha) = a_1^a + (a_2^n - a_1^a)$ & , $A_R(\alpha) = a_4^i - (a_4^i - a_3^k)\alpha$

Definition 2.6. [18] Arithmetical operation in fuzzy Environment : Let $\underline{\tilde{A}} = \left(\tilde{a}_1^a, \tilde{a}_2^n, \tilde{a}_3^k, \tilde{a}_4^i\right)and\underline{\tilde{B}} = \left(\tilde{b}_1^a, \tilde{b}_2^n, \tilde{b}_3^k, \tilde{b}_4^i\right)$ are two Trapezoidal Neutrosophic numbers, then,

$\underline{\tilde{A}} \oplus \underline{\tilde{B}} = \left(\tilde{a}_1^a + \tilde{b}_1^a, \tilde{a}_2^n + \tilde{b}_2^n, \tilde{a}_3^k + \tilde{b}_3^k, \tilde{a}_4^i + \tilde{b}_4^i\right)$.

$\underline{\tilde{A}} \otimes \underline{\tilde{B}} = \left(\tilde{a}_1^a \tilde{b}_1^a, \tilde{a}_2^n \tilde{b}_2^n, \tilde{a}_3^k \tilde{b}_3^k, \tilde{a}_4^i \tilde{b}_4^i\right)$

$\alpha \otimes \underline{\tilde{A}} = \left(\alpha\tilde{a}_1^a, \alpha\tilde{a}_2^n, \alpha\tilde{a}_3^k, \alpha\tilde{a}_4^i\right), \alpha \geq 0$

$\alpha \otimes \underline{\tilde{A}} = \left(\alpha\tilde{a}_4^i, \alpha\tilde{a}_3^k, \alpha\tilde{a}_2^n, \alpha\tilde{a}_1^a\right), \alpha < 0$

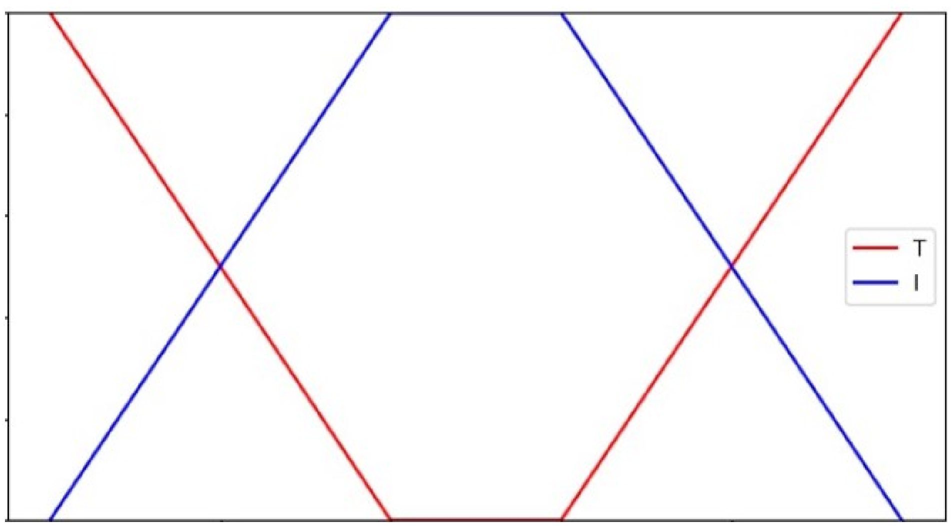

FIGURE 3. Trapezoidal Fuzzy Number

In Section 2, we presented several crucial definitions related to fuzzy theory. As we are aware, fuzzy inventory models involve various parameters, such as demand, holding cost, ordering cost, and others, which are incapable of managing uncertainties. Consequently, it becomes necessary to confront certain challenges. In the forthcoming Section 3, we intend to discuss these challenges in detail.

3. Challenges of the FIM

The FIM is a technique designed to handle the variability and uncertainty in supply and demand. Sometimes, things are not clear or certain. Fuzzy theory is a way to deal with that, but it is not enough. Fuzzy theory alone fails to solve uncertainty, imprecise and vagueness. So, some people came up with new ideas to improve fuzzy theory. These ideas are called extended fuzzy theories i.e., Intuitionistic theory by Atanassov in 1986 [15], Neutrosophic theory [19] by Smarandche in 1990, and Pythagorean theory by Yager in 2013 [20]. The next paragraph will explain more about these ideas.

4. Important Definitions, and Introduction Related to Neutrosophic Environment

This section discusses important definitions, preliminaries and applications related to Neutrosophic logic. It also highlights some applications of Neutrosophic Inventory Models (NIM).

Definition 4.1. [21] Trapezoidal Neutrosophic number (TpNNs): Let N be a TpNNs in the set of real numbers with the truth, falsity and indeterminacy membership functions are defined by

$$T_N(\omega)=\left\{\begin{array}{l}\dfrac{(\omega-p)t_N}{q-p}, p\le\omega<q\\ t_N\ ,\text{q}\le\omega\le r\\ \dfrac{(s-\omega)t_N}{s-r}, r<\omega\le s\\ 0\ ,\text{otherwise}\end{array}\right\},\ I_N(\omega)=\left\{\begin{array}{l}\dfrac{q-\omega+(\omega-p)i_N}{q-p}, q>\omega\ge p\\ i_N\ ,\text{q}\le\omega\le r\\ \dfrac{\omega-c+(d-\omega)t_N}{s-r}, r<\omega\le s\\ 0\ ,\text{otherwise}\end{array}\right\}$$

$$\text{, and } F_N(\omega)=\left\{\begin{array}{l}\dfrac{(\omega-p)f_N+p-\omega}{q-p}, p\le\omega<q\\ f_N\ ,\text{q}\le\omega\le r\\ \dfrac{\omega-r+(s-\omega)f_N}{s-r}, r<\omega\le s\\ 0\ ,\text{otherwise}\end{array}\right\}$$

Where $i_N=\left[i^L,i^U\right]\subset[0,1]$,$f_N=\left[f^L,f^U\right]\subset[0,1]$, and $t_N=\left[t^L,t^U\right]\subset[0,1]$ are interval numbers. Then the number N can be denoted by $\left([p,q,r,s];[i^L,i^U],[f^L,f^U],[t^L,t^U]\right)$ and is called IVTNN.

Definition 4.2. [22] : Let $T_{\tilde d},I_{\tilde d},F_{\tilde d}\in[0,1]$, then a SVTpN number$\tilde d=\left\langle\left[\tilde d^a,\tilde d^s,\tilde d^h,\tilde d^o\right],(T_{\tilde d},I_{\tilde d},F_{\tilde d})\right\rangle$ is a special Ns on the real number set R, whose truth-MF $\psi_{\tilde d}(x)$, falsity-MF $\zeta_{\tilde d}(x)$, and indeterminacy-MF $\xi_{\tilde d}(x)$ are given as follows:

$$\psi_{\tilde{d}}(x)=\begin{cases}\dfrac{T_{\tilde{d}}(x-\tilde{d}^a)}{(\tilde{d}^s-\tilde{d}^a)}, \tilde{d}^a\leq x\leq \tilde{d}^s\\ T_{\tilde{d}}, \tilde{d}^s\leq x\leq \tilde{d}^h\\ \dfrac{T_{\tilde{d}}(\tilde{d}^o-x)}{(\tilde{d}^o-\tilde{d}^h)}, \tilde{d}^h\leq x\leq \tilde{d}^o\\ 0, otherwise\end{cases}, \xi_{\tilde{d}}(x)=\begin{cases}\dfrac{(\tilde{d}^s-x+I_{\tilde{d}}(x-\tilde{d}^a))}{(\tilde{d}^s-\tilde{d}^a)}, \tilde{d}^a\leq x\leq \tilde{d}^s\\ I_{\tilde{d}}, \tilde{d}^s\leq x\leq \tilde{d}^h\\ \dfrac{(x-\tilde{d}^h+I_{\tilde{d}}(\tilde{d}^o-x))}{(\tilde{d}^o-\tilde{d}^h)}, \tilde{d}^h\leq x\leq \tilde{d}^o\\ 1, otherwise\end{cases} \text{,and}$$

$$\zeta_{\tilde{d}}(x)=\begin{cases}\dfrac{(\tilde{d}^s-x+F_{\tilde{d}}(x-\tilde{d}^a))}{(\tilde{d}^s-\tilde{d}^a)}, \tilde{d}^a\leq x\leq \tilde{d}^s\\ F_{\tilde{d}}, \tilde{d}^s\leq x\leq \tilde{d}^h\\ \dfrac{(x-\tilde{d}^h+F_{\tilde{d}}(\tilde{d}^o-x))}{(\tilde{d}^o-\tilde{d}^h)}, \tilde{d}^h\leq x\leq \tilde{d}^o\\ 1, otherwise\end{cases}$$

4.1. *The Application of the Neutrosophic Principle in Inventory management*

Neutrosophic principles exhibit a broad spectrum of applications spanning across diverse sectors and domains. Presented in Table 2 is a comprehensive overview of the notable progressions in Neutrosophic principle, highlighting their multifarious implementations in various fields.

Table 2. Comprehensive overview in inventory management under neutrosophic environment.

Authors	**Year**	**Environment**	**Application**	**Contribution**
Mullai and Surya [23]	2018	TpNN	Economic Order Quantity (EOQ)	To presents the development of an IM with a price break, utilizing an EOQ approach.
Sarma et al. [24]	2019	TpNN	Disaster Management	Cost minimization in disaster management under uncertainty using TpNN necessitates redistribution.

Continued on next page

Table 2 – Continued from previous page

Authors	Year	Environment	Application	Contribution
Martin et al. [25]	2020	TpNN	Production Management	To presents a revised PIM that explores the transition towards a smart production process.
Bhavani et al. [26]	2022	TpNN	PSAOIM	To introduces a restructured inventory system with a neutrosophic cost pattern, incorporating novel demand considerations such as deterioration and discounts on defective items. The proposed system employs a PSOOIM.
Sugapriya et al. [27]	2022	TpNN	Power Demand Patterns	A two-warehouse system is proposed for managing TpNN disparate and expeditious deteriorate items with power demand.

This article features Figure 3, which illustrates the vital components and processes of Neutrosophic Principle in a visually engaging manner. This graphical representation facilitates readers' understanding of the concepts discussed and offers a practical view of how Neutrosophic Principle operates. Furthermore, Figure 3 seamlessly integrates Table 2 for easy reference.

The main objective of this table 2 is to show that fuzzy isn't the only way to handle uncertainty. There are other methods, like Neutrosophic principles, that can give better and more precise solution. These methods are becoming more popular in many areas and applications. However, due to limitations, it is impractical to extensively discuss all these mentioned applications within this paper. So, we'll focus on how the Neutrosophic theory affects inventory management.

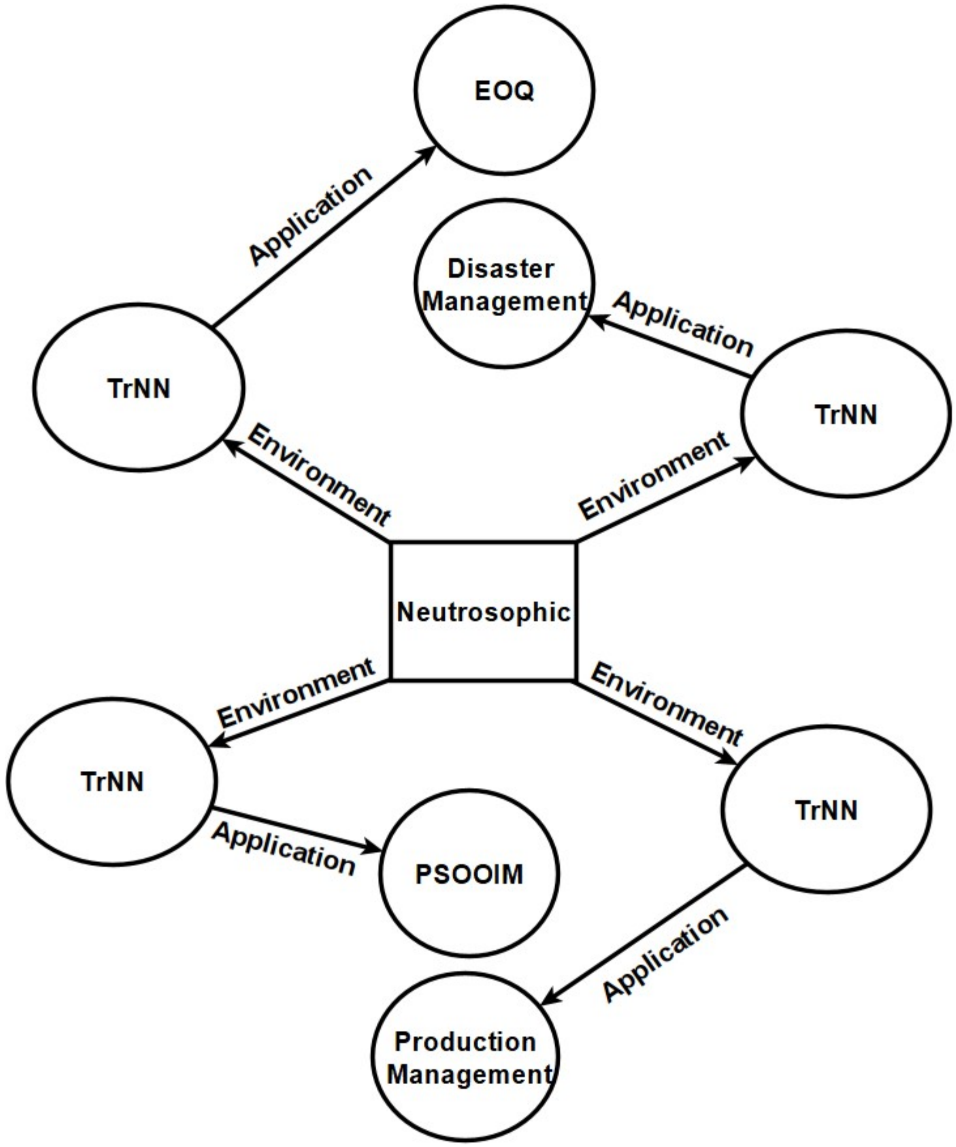

Figure 4. This illustrates the various applications and environments associated with Neutrosophic Principle.

5. The Inventory Management under the Neutrosophic Principle

Supply Chain is a complex decision-making problem with conflicting objectives in various supply chain operations and their corresponding sub-criteria. Haq et al. (2021) [28] aims to develop a model that incorporates key components of real-world supply chain planning. Haq et al. (2021) [28] propose a supply chain model that involves multiple suppliers, plants, warehouses, and distributors. This approach addresses the challenges of a complex multi-site composite supply chain problem under uncertainty by utilizing a fuzzy multi-objective model. Haq et al. (2021) primary objective is to optimize transportation cost and delivery time concurrently. To handle the ambiguity inherent in the supply chain, Haq et al. (2021) [28] employ neutrosophical set theory, using falsity, indeterminacy, and truth membership functions. Additionally, a neutrosophical compromise programming approach is employed to obtain the desired solution. To showcase the effectiveness of authors models, Haq et al. (2021) [28] present an industrial design problem. The reported findings are compared against other well-known approaches.

Suresh et al. (2021) [29] explores the application of the Euclidean Distance measure in frame centroid-based ranking for NTFN and NTpFN. The effectiveness of the model is demonstrated through an illustrative example of a multi-criteria decision-making (MCDM) problem in the Neutrosophic fuzzy environment. The proposed ranking approach offers a solution to various decision-making and optimization problems characterized by uncertainty.

Mondal et al. (2021) [30] looked at a system for managing inventory of seasonal products. These products have changing demand rates and partial backordering in a viable market. The Weibull distribution shows the seasonality and versatility of these products. Weibull distribution deterioration rates, fully permissible payment delays, and partial backordering are considered in this paper. The proposed EOQ model is optimized using the neutrosophic set which quatifies imprecise information in real-life senarios. The study suggests reducing expenses on early promotions to lessen demand fluctuations at the start of the cycle. It also shows that the best time to deplete inventory depends on the demand during shortages within a neutrosophic environment.

Lakshmi et al. (2022) [31] The purpose of this manuscript is to present a TpN approach for dealing with the logarithmic demand model involving shortage of deteriorating items. The vendor determines the order placement for customers based on stock availability. The logarithmic demand model is applied to multiple products and takes into account the shortage of items initially. Additionally, a practical example is provided to demonstrate the extraction of optimal values and the attainment of valuable and effective results.

Conclusion

This manuscript provides a comprehensive assessment and classification of uncertain situations used in IM systems across diverse areas. By recognizing the limitations of traditional inventory models, the study presents the concepts of the neutrosophic and fuzzy principle as alternative approaches in inventory management. This manuscript focused on how the Neutrosophic principle can help manage inventory, especially when dealing with uncertain demand and imprecise data. Our research highlights the potential of the neutrosophic theory to improve decision-making in inventory management by overcoming the limitations of fuzzy models. This study contributes valuable insights and paves the way for future research in this field.

References

[1] Jing-Sheng Song and Paul H Zipkin. Inventory control with information about supply conditions. *Management Science*, 42(10):1409–1419, 1996.

[2] Youyi Feng and Baichun Xiao. A dynamic airline seat inventory control model and its optimal policy. *Operations Research*, 49(6):938–949, 2001.

[3] Retsef Levi, Robin O Roundy, and David B Shmoys. Provably near-optimal sampling-based policies for stochastic inventory control models. *Mathematics of Operations Research*, 32(4):821–839, 2007.

[4] Che-Fu Hsueh. An inventory control model with consideration of remanufacturing and product life cycle. *International Journal of Production Economics*, 133(2):645–652, 2011.

[5] Wei-Qi Zhou, Long Chen, and Hui-Ming Ge. A multi-product multi-echelon inventory control model with joint replenishment strategy. *Applied Mathematical Modelling*, 37(4):2039–2050, 2013.

[6] LA Zadeh. Fuzzy sets, information and control, vol. 8, pp. 338–353, 1965, 1965.

[7] Didier Dubois and Henri Prade. Fuzzy logic in expert systems: the role of uncertainty management. *Fuzzy Sets and Systems*, 28:3–17, 1988.

[8] Turan Paksoy and Nimet Yapici Pehlivan. A fuzzy linear programming model for the optimization of multi-stage supply chain networks with triangular and trapezoidal membership functions. *Journal of the Franklin Institute*, 349(1):93–109, 2012.

[9] V Ranganathan and P Thirunavukarasu. An inventory control model for constant deterioration in fuzzy environment. *International Journal of Fuzzy Mathematics and Systems*, 4(1):17–26, 2014.

[10] Javad Sadeghi, Seyed Taghi Akhavan Niaki, Mohammad Reza Malekian, and Saeid Sadeghi. Optimising multi-item economic production quantity model with trapezoidal fuzzy demand and backordering: two tuned meta-heuristics. *European Journal of Industrial Engineering*, 10(2):170–195, 2016.

[11] Chaman Singh. Vendor-buyers relationship model for deteriorating items with shortages, fuzzy trapezoidal costs and inflation. *Yugoslav Journal of Operations Research*, 23(1), 2016.

[12] Liao X.; Zhao W.; Yang N. Liu, J. A classification approach based on the outranking model for multiple criteria abc analysis. *Omega*, 61:19–34, 2016.

[13] J. Manurung. Application of fifo algorithm (first in first out) to simulation queue. *Infokum*, 7(2):44–47, 2019.

[14] M. Albrecht. Optimization of safety stocks in models with an order service level objective or constraint. *European Journal of Operational Research*, 263(3):900–909, 2017.

[15] K Atanassov. Intuitionistic fuzzy sets. *Fuzzy Sets and Systems*, 20(1):87–96, 1986.

[16] JQ Wang; Z Zhang. Multi-criteria decision-making method with incomplete certain information based on intuitionistic fuzzy number. *Control and Decision*, 24(2):226–230, 2009.

[17] J Wang. Multi-criteria decision-making approach with incomplete certain information based on ternary ahp. *Journal of Systems Engineering and Electronics*, 17(1):109–114, 2006.

[18] Neelanjana Rajput, AP Singh, and RK Pandey. Optimize the cost of a fuzzy inventory model with shortage using signed distance method. *International Journal of Research in Advent Technology*, 7(5):204–208, 2019.

[19] Florentin Smarandache. A unifying field in logics. neutrosophy: Neutrosophic probability, set and logic, 1999.

[20] Ronald R Yager. Pythagorean membership grades in multicriteria decision making. *IEEE Transactions on fuzzy systems*, 22(4):958–965, 2013.

[21] Surapati Pramanik and Rama Mallick. Vikor based magdm strategy with trapezoidal neutrosophic numbers. *Neutrosophic Sets and Systems*, 22:118–129, 2018.

[22] Said Broumi, Assia Bakali, Mohamed Talea, Florentin Smarandache, and Luige Vladareanu. Computation of shortest path problem in a network with sv-trapezoidal neutrosophic numbers. In *2016 International Conference on Advanced Mechatronic Systems (ICAMechS)*, pages 417–422. IEEE, 2016.

[23] M Mullai and R Surya. Neutrosophic eoq model with price break. *Neutrosophic sets and systems*, 19:24–29, 2018.

[24] Deepshikha Sarma, Amrit Das, Uttam Kumar Bera, and Ibrahim M Hezam. Redistribution for cost minimization in disaster management under uncertainty with trapezoidal neutrosophic number. *Computers in Industry*, 109:226–238, 2019.

[25] Nivetha Martin, M Kasi Mayan, and Florentin Smarandache. *Neutrosophic optimization of industry 4.0 production inventory model*, volume 38. Infinite Study, 2020.

[26] G Durga Bhavani, Fasika Bete Georgise, GS Mahapatra, and B Maneckshaw. Neutrosophic cost pattern of inventory system with novel demand incorporating deterioration and discount on defective items using particle swarm algorithm. *Computational Intelligence and Neuroscience*, 2022, 2022.

[27] C Sugapriya, V Lakshmi, D Nagarajan, and S Broumi. Two-warehouse system for trapezoidal bipolar neutrosophic disparate expeditious worsen items with power demand pattern. *Neutrosophic Sets and Systems*, 48:86–99, 2022.

[28] Ahteshamul Haq, Srikant Gupta, and Aquil Ahmed. A multi-criteria fuzzy neutrosophic decision-making model for solving the supply chain network problem. *Neutrosophic Sets and Systems*, 46:50–66, 2021.

[29] M Suresh, K Arun Prakash, and S Vengataasalam. Multi-criteria decision making based on ranking of neutrosophic trapezoidal fuzzy numbers. *Granular Computing*, 6:943–952, 2021.

[30] Bappa Mondal, Arindam Garai, Arindum Mukhopadhyay, and Sanat Kumar Majumder. Inventory policies for seasonal items with logistic-growth demand rate under fully permissible delay in payment: a neutrosophic optimization approach. *Soft Computing*, 25:3725–3750, 2021.

[31] V Lakshmi, C Sugapriya, D Nagarajan, and S Broumi. Tropezoidal neutrosophic deal with logarithmic demand with shortage of deteriorating items. *Neutrosophic Sets and Systems*, 48:318–327, 2022.

Received: Mar 5, 2024. Accepted: May 30, 2024