

9-30-2020

## An introduction to neutrosophic minimal structure space

M. Karthika

M. Parimala

F. Smarandache

Follow this and additional works at: [https://digitalrepository.unm.edu/nss\\_journal](https://digitalrepository.unm.edu/nss_journal)

---

### Recommended Citation

Karthika, M.; M. Parimala; and F. Smarandache. "An introduction to neutrosophic minimal structure space." *Neutrosophic Sets and Systems* 36, 1 (2020). [https://digitalrepository.unm.edu/nss\\_journal/vol36/iss1/28](https://digitalrepository.unm.edu/nss_journal/vol36/iss1/28)

This Article is brought to you for free and open access by UNM Digital Repository. It has been accepted for inclusion in Neutrosophic Sets and Systems by an authorized editor of UNM Digital Repository. For more information, please contact [amywinter@unm.edu](mailto:amywinter@unm.edu), [lsloane@salud.unm.edu](mailto:lsloane@salud.unm.edu), [sarahrk@unm.edu](mailto:sarahrk@unm.edu).



# An Introduction to Neutrosophic Minimal Structure Spaces

M. Karthika <sup>1</sup>, M. Parimala <sup>1,\*</sup> and F. Smarandache <sup>2</sup>

<sup>1</sup> Department of Mathematics, Bannari Amman Institute of Technology, Sathyamangalam - 638 401, Tamil Nadu, India ; karthikamuthusamy1991@gmail.com, rishwanthpari@gmail.com

<sup>2</sup>Mathematics & Science Department, University of New Mexico, 705 Gurley Ave, Gallup, NM 87301, USA; fsmarandache@gmail.com

\* Correspondence: rishwanthpari@gmail.com

**Abstract.** This paper is an introduction of neutrosophic minimal structure space and addresses properties of neutrosophic minimal structure space. Neutrosophic set has plenty of applications. This motivates us to present the concept of neutrosophic minimal structure space. We defined neutrosophic minimal structure space, closure and interior of a set, subspace. Some properties of neutrosophic minimal structure space are also studied. Finally, Decision making problem solved using score function.

**Keywords:** Neutrosophic minimal structure;  $N_m$ -closure;  $N_m$ -interior;  $N_m$ -connectedness.

## 1. Introduction

Zadeh's [23] Fuzzy set laid the foundation of many theories such as intuitionistic fuzzy set and neutrosophic set, rough sets etc. Later, researchers developed K. T. Atanassov's [4] intuitionistic fuzzy set theory in many fields such as differential equations, topology, computer science and so on. F. Smarandache [20, 21] found that some objects have indeterminacy or neutral other than membership and non-membership. So he coined the notion of neutrosophy. Researchers [12, 15–18] applied the concept of neutrosophy when object has inconsistent, incomplete information. The universal set  $X$  and  $\emptyset$  forms a topology (Munkrer [11]). Popa [14] introduced minimal structures and defined separation axioms using minimal structure. M. Alimohammady, M. Roohi [5] introduced fuzzy minimal structure in lowen sense. S.Bhattacharya (Halder) [6] presented the concept of intuitionistic fuzzy minimal space.

### 1.1. Motivation and Objective

In general topology, the whole set and empty set forms a space with minimal structure. Supra topological space is also a space with neutrosophic minimal structure. These are all the generalization of topological spaces. Our objective is to introduce neutrosophic universal set and neutrosophic null set with neutrosophic minimal structure. It is a generalization of neutrosophic topological space. This paper consisting of basic definitions such as interior, closure, open, closed, subspace with minimal structure and its properties.

### 1.2. Limitations

Neutrosophic topological space, neutrosophic supra topological space are space with neutrosophic minimal structure. The converse is not true that is space with neutrosophic minimal structure is not a neutrosophic supra topological space or neutrosophic topological space.

In section 1, the basic definitions are presented which are useful for our paper and in section 2, the basic definitions of neutrosophic minimal structure space are presented. In further sections some properties of neutrosophic minimal structure space are also investigated. Finally, we introduced an algorithm to solve some applications of neutrosophic minimal structure space. Note that neutrosophic topological space, neutrosophic supra topological space are neutrosophic minimal structure space but converse is not true.

## 2. Preliminaries

In this section, we presented the basic definitions developed by [15, 19–21].

**Definition 2.1.** [20, 21] A neutrosophic set (in short NS)  $U$  on a set  $X \neq \emptyset$  is defined by

$U = \{ \langle a, T_U(a), I_U(a), F_U(a) \rangle : a \in X \}$  where  $T_U : X \rightarrow [0, 1]$ ,  $I_U : X \rightarrow [0, 1]$  and  $F_U : X \rightarrow [0, 1]$  denotes the membership of an object, indeterminacy and non-membership of an object, for each  $a \in X$  to  $U$ , respectively and  $0 \leq T_U(a) + I_U(a) + F_U(a) \leq 3$  for each  $a \in X$ .

**Definition 2.2.** [19] Let  $U = \{ \langle a, T_U(a), I_U(a), F_U(a) \rangle : a \in X \}$  be a neutrosophic set.

- (i) A neutrosophic set  $U$  is an empty set i.e.,  $U = 0_{\sim}$  if 0 is membership of an object and 1 is an indeterminacy and non-membership of an object respectively. i.e.,  $0_{\sim} = \{ x, (0, 1, 1) : x \in X \}$
- (ii) A neutrosophic set  $U$  is a universal set i.e.,  $U = 1_{\sim}$  if 1 is membership of an object and 0 is an indeterminacy and non-membership of an object respectively.  $1_{\sim} = \{ x, (1, 0, 0) : x \in X \}$
- (iii)  $U_1 \cup U_2 = \{ a, \max\{T_{U_1}(a), T_{U_2}(a)\}, \min\{I_{U_1}(a), I_{U_2}(a)\}, \min\{F_{U_1}(a), F_{U_2}(a)\} : a \in X \}$

$$(iv) U_1 \cap U_2 = \{a, \min\{T_{U_1}(a), T_{U_2}(a)\}, \max\{I_{U_1}(a), I_{U_2}(a)\}, \max\{F_{U_1}(a), F_{U_2}(a)\} : a \in X\}$$

$$(v) U_1^C = \{a, F_U(a), 1 - I_U(a), T_U(a) : a \in X\}$$

**Definition 2.3.** [19] A neutrosophic topology (NT) in Salama's sense on a nonempty set  $X$  is a family  $\tau$  of NSs in  $X$  satisfying three axioms:

- (1) Empty set ( $0_\sim$ ) and universal set ( $1_\sim$ ) are members of  $\tau$ .
- (2)  $U_1 \cap U_2 \in \tau$  where  $U_1, U_2 \in \tau$ .
- (3)  $\bigcup_{i=1}^{\infty} U_i \in \tau$  where each  $U_i \in \tau$ .

Each neutrosophic sets in neutrosophic topological spaces are called neutrosophic open sets. Its complements are called neutrosophic closed sets.

**Definition 2.4.** [19] Let NS  $U$  in NTS  $X$ . Then a neutrosophic interior of  $U$  and a neutrosophic closure of  $U$  are defined by

$$n\text{-int}(U) = \max \{F : F \text{ is an Neutrosophic open set in } X \text{ and } F \leq U\} \text{ and}$$

$$n\text{-cl}(U) = \min \{F : F \text{ is an Neutrosophic closed set in } X \text{ and } F \geq U\} \text{ respectively.}$$

**Definition 2.5.** [15] A neutrosophic supra topology (in short, NST) on a nonempty set  $X$  is a family  $\tau$  of NSs in  $X$  satisfying the following axioms:

- (1) Empty set ( $0_\sim$ ) and universal set ( $1_\sim$ ) are members of  $\tau$ .
- (2)  $\bigcup_{i=1}^{\infty} U_i \in \tau$  where each  $U_i \in \tau$ .

### 3. Neutrosophic Minimal Structure Spaces

Neutrosophic minimal structure space is defined and studied its properties in this section.

**Definition 3.1.** Let the neutrosophic minimal structure space over a universal set  $X$  be denoted by  $N_m$ .  $N_m$  is said to be neutrosophic minimal structure space (in short, NMS) over  $X$  if it satisfying following the axiom:

- (1)  $0_\sim, 1_\sim \in N_m$ .

A family of neutrosophic minimal structure space is denoted by  $(X, N_{mX})$

Note that neutrosophic empty set and neutrosophic universal set can form a topology and it is known as neutrosophic minimal structure space.

Each neutrosophic set in neutrosophic minimal structure space is neutrosophic minimal open set.

The complement of neutrosophic minimal open set is neutrosophic minimal closed set.

**Remark 3.2.** Each neutrosophic set in neutrosophic minimal structure space is neutrosophic minimal open set.

The complement of neutrosophic minimal open set is neutrosophic minimal closed set.

In this paper, we refer definition 2.2 for basic operations.

**Example 3.3.** We know that  $0_{\sim} = \{x, (0, 1, 1)\}$  &  $1_{\sim} = \{x, (1, 0, 0)\}$  are neutrosophic minimal open sets. Lets find out their complements.

$0_{\sim}^C = \{x, (1, 0, 0)\} = 1_{\sim}$  and  $1_{\sim}^C = \{x, (0, 1, 1)\} = 0_{\sim}$ . This clears that  $0_{\sim}$  and  $1_{\sim}$  are both neutrosophic minimal open and closed set.

**Remark 3.4.** From Definition 3.1. the following are obvious

- (1) Neutrosophic supra topological spaces are neutrosophic minimal structure space but converse not true.
- (2) Similarly, Neutrosophic topological spaces are neutrosophic minimal structure space but converse is not true.

The following Example 3.5 proves the above Remark 3.4.

**Example 3.5.** Let  $A = \{< 0.6, 0.4, 0.3 >: a\}$ ,  $B = \{< 0.6, 0.5, 0.1 >: a\}$  are neutrosophic sets over the universal set  $X = \{a\}$ . Then the neutrosophic minimal structure space is  $N_m = \{0, 1, A, B\}$ . But  $N_m$  is not a neutrosophic topological space and not a neutrosophic supra topological space, since arbitrary union and finite intersection doesn't hold in  $N_m$ .

**Definition 3.6.** A is  $N_m$ -closed if and only if  $N_m cl(A) = A$ .

Similarly, A is a  $N_m$ -open if and only if  $N_m int(A) = A$ .

**Definition 3.7.** Let  $N_m$  be any neutrosophic minimal structure space and A be any neutrosophic set. Then

- (1) Every  $A \in N_m$  is open and its complement is closed.
- (2)  $N_m$ -closure of  $A = \min\{F : F \text{ is a neutrosophic minimal closed set and } F \geq A\}$  and its denoted by  $N_m cl(A)$ .
- (3)  $N_m$ -interior of  $A = \max\{F : F \text{ is a neutrosophic minimal open set and } F \leq A\}$  and it is denoted by  $N_m int(A)$ .

In general  $N_m int(A)$  is subset of A and A is a subset of  $N_m cl(A)$ .

**Proposition 3.8.** Suppose A and B are any neutrosophic set of neutrosophic minimal structure space  $N_m$  over X. Then

- i.  $N_m^C = \{0, 1, A_i^C\}$  where  $A_i^C$  is a complement of neutrosophic set  $A_i$ .
- ii.  $X - N_m \text{int}(B) = N_m \text{cl}(X - B)$ .
- iii.  $X - N_m \text{cl}(B) = N_m \text{int}(X - B)$ .
- iv.  $N_m \text{cl}(A^C) = (N_m \text{cl}(A))^C = N_m \text{int}(A)$ .
- v.  $N_m$  closure of an empty set is an empty set and  $N_m$  closure of a universal set is a universal set. Similarly,  $N_m$  interior of an empty set and universal set respectively an empty set and a universal set.
- vi. If  $B$  is a subset of  $A$  then  $N_m \text{cl}(B) \leq N_m \text{cl}(A)$  and  $N_m \text{int}(B) \leq N_m \text{int}(A)$ .
- vii.  $N_m \text{cl}(N_m \text{cl}(A)) = N_m \text{cl}(A)$  and  $N_m \text{int}(N_m \text{int}(A)) = N_m \text{int}(A)$ .
- viii.  $N_m \text{cl}(A \vee B) = N_m \text{cl}(A) \vee N_m \text{cl}(B)$
- ix.  $N_m \text{cl}(A \wedge B) = N_m \text{cl}(A) \wedge N_m \text{cl}(B)$

**Proof.** (i) We know that  $A^C = X - A$ . Then  $N_m \text{cl}(X - A) = N_m \text{cl}(A^C) = (N_m \text{cl}(A))^C = N_m \text{int}(A)$ , from (iv).

Similarly for (ii).

(vi) Let  $B \leq A$ . We know that  $B \leq N_m \text{cl}(B)$  and  $A \leq N_m \text{cl}(B)$ . So  $B \leq N_m \text{cl}(B) \leq A \leq N_m \text{cl}(A)$ . Therefore  $N_m \text{cl}(B) \leq N_m \text{cl}(A)$ .

Proof of (vii) is straight forward.

(viii) We know that  $A \leq A \vee B$  and  $B \leq A \vee B$ .  $N_m \text{cl}(A) \leq N_m \text{cl}(A \vee B)$  and  $N_m \text{cl}(B) \leq N_m \text{cl}(A \vee B)$  this implies  $N_m \text{cl}(A) \vee N_m \text{cl}(B) \leq N_m \text{cl}(A \vee B)$ .  $\rightarrow (*)$

Also  $A \leq N_m \text{cl}(A)$  and  $B \leq N_m \text{cl}(B) \Rightarrow A \vee B \leq N_m \text{cl}(A) \vee N_m \text{cl}(B)$ .  $N_m \text{cl}(A \vee B) \leq N_m \text{cl}(N_m \text{cl}(A) \vee N_m \text{cl}(B)) = N_m \text{cl}(A) \vee N_m \text{cl}(B) \rightarrow (**)$ .

From (\*) and (\*\*), we have  $N_m \text{cl}(A \vee B) = N_m \text{cl}(A) \vee N_m \text{cl}(B)$ .

**Example 3.9.** Consider Example 3.5, the complement of  $N_m$  is  $\{0, 1, A^C, B^C\}$  where  $A^C = \{ \langle 1 - 0.6, 1 - 0.4, 1 - 0.3 \rangle / a : a \in X \} = \{ \langle 0.4, 0.6, 0.7 \rangle / a : a \in X \}$  and  $B^C = \{ \langle 1 - 0.6, 1 - 0.5, 1 - 0.1 \rangle / a : a \in X \} = \{ \langle 0.4, 0.5, 0.9 \rangle / a : a \in X \}$ .

**Definintion 3.10.** A function  $f : (X, N_{mX}) \rightarrow (Y, N_{mY})$  is called neutrosophic minimal continuous function if and only if  $f^{-1}(V) \in N_{mX}$  whenever  $V \in N_{mY}$ .

**Definintion 3.11.** Boundary of a neutrosophic set  $A$  (in short  $Bd(A)$ ) of neutrosophic minimal structure  $(X, N_{mX})$  is the intersection of  $N_m \text{closure}$  of the set  $A$  and  $N_m \text{closure}$  of  $X - A$ . i.e.,  $Bd(A) = N_m \text{cl}(A) \cap N_m \text{cl}(X - A)$

**Theorem 3.12.** If  $(X, N_{mX})$  and  $(Y, N_{mY})$  are neutrosophic minimal structure space. Then

---

*M. Karthika, M. Parimala, F. Smarandache, An introduction to neutrosophic minimal structure space*

- (1) Identity map from  $(X, N_{mX})$  to  $(Y, N_{mY})$  is a neutrosophic minimal continuous function.
- (2) Any constant function which maps from  $(X, N_{mX})$  to  $(Y, N_{mY})$  is a neutrosophic minimal continuous function.

**Proof.** The proof is obvious.

**Theorem 3.13.** Let the map  $f$  from neutrosophic minimal structure space  $(X, N_{mX})$  to neutrosophic minimal structure space  $(Y, N_{mY})$ . Then the following are equivalent,

- (1) The map  $f$  is a neutrosophic minimal continuous function.
- (2)  $f^{-1}(V)$  is a neutrosophic minimal closed set for each neutrosophic minimal closed set  $V \in N_{mY}$ .
- (3)  $N_{mcl}(f^{-1}(V)) \leq f^{-1}(N_{mcl}(V))$ , for each  $V \in N_{mY}$ .
- (4)  $N_{mcl}(f(A)) \geq f(N_{mcl}(A))$ , for each  $A \in N_{mX}$ .
- (5)  $N_{mint}(f^{-1}(V)) \geq f^{-1}(N_{mint}(V))$ , for each  $V \in N_{mY}$ .

**Proof.** (1)  $\Rightarrow$  (2): Let  $A$  be a  $N_m$ -closed in  $Y$ . Then  $f^{-1}(A)^C = f^{-1}(A^C) \in N_{mX}$ .

(2)  $\Rightarrow$  (3):  $N_{mcl}(f^{-1}(A)) = \wedge\{D : f^{-1}(A) \leq D, D^C \in N_{mX}\} \leq \wedge\{f^{-1}(D) : A \leq D, D^C \in N_{mY}\} = f^{-1}(\{D : A \leq D^C \in N_{mY}\}) = f^{-1}(N_{mcl}(A))$ .

(3)  $\Rightarrow$  (4): Since  $A \leq f^{-1}(f(A))$ , then  $N_{mcl}(A) \leq N_{mcl}f^{-1}(f(A)) \leq f^{-1}(N_{mcl}(f(A)))$ . Therefore  $f(N_{mcl}(A)) \leq N_{mcl}(f(A))$ .

(4)  $\Rightarrow$  (5):  $f(N_{mint}(f^{-1}(A)))^C = f(N_{mcl}(f^{-1}(A))^C) = f(N_{mcl}(f(A)^C)) \leq N_{mcl}(f(f^{-1}(A^C))) \leq N_{mcl}(A^C) = (N_{mint}(A))^C$ . This implies that  $N_{mint}(f^{-1}(B))^C \leq f^{-1}(N_{mint}(A))^C = (f^{-1}(N_{mint}(A)))^C$ .

Taking complement on both sides,  $f^{-1}(N_{mint}(A)) \leq N_{mint}(f^{-1}(B))$ .

**Definition 3.14.** Let  $(X, N_{mX})$  be neutrosophic minimal structure space.

- i. Arbitrary union of neutrosophic minimal open sets in  $(X, N_{mX})$  is neutrosophic minimal open. (Union Property)
- ii. Finite intersection of neutrosophic minimal open sets in  $(X, N_{mX})$  is neutrosophic minimal open. (intersection Property)

#### 4. Neutrosophic Minimal Subspace

In this section, we introduced the neutrosophic minimal subspace and investigate some properties of subspace.

**Definition 4.1.** Let  $A$  be a neutrosophic set in neutrosophic minimal structure space  $(X, N_{mX})$ . Then  $Y$  is said to be neutrosophic minimal subspace if  $(Y, N_{mY}) = \{A \cap U : U \in N_{mY}\}$ .

**Lemma 4.2.** If neutrosophic set  $b$  in the basis  $B$  for neutrosophic minimal structure space  $X$ . Then the collection  $B_Y = \{b \cap Y : Y \subset X\}$  is a basis for neutrosophic minimal subspace on  $Y$ .

**Proof.** Given a neutrosophic set  $A$  in  $X$  and  $C$  is a neutrosophic set in both  $A$  and subset  $Y$  of  $X$ . Consider a basis element  $b$  of  $B$  such that  $C$  in  $b$  and in  $Y$ . Then  $C \in B \cap Y \subset U \cap Y$ . Hence  $B_Y$  is a basis for the neutrosophic minimal subspace on the set  $Y$ .

**Lemma 4.3.** Let  $(Y, N_{mY})$  be a subspace of  $(X, N_{mX})$ . If  $A$  is a neutrosophic set in  $Y$  and  $Y \subset X$ . Then  $A$  is in  $(X, N_{mX})$ .

**Proof.** Given that neutrosophic set  $A$  in  $(Y, N_{mY})$ .  $A = Y \cap B$  for some neutrosophic set  $B \in X$ . Since  $Y$  and  $B$  in  $X$ . Then  $A$  is in  $X$ .

**Proposition 4.4.** Suppose  $(Y, N_{mY})$  is a neutrosophic minimal subspace of  $(X, \tau_X)$ .

- (1) If the neutrosophic minimal structure space  $(X, N_{mX})$  has the union property, then the subspace  $(Y, N_{mY})$  also has union property.
- (2) If the neutrosophic minimal structure space  $(X, N_{mX})$  has the intersection property, then the subspace  $(Y, N_{mY})$  also has union property.

**Proof.** Suppose the family of open set  $\{V_i : i \in Y\}$  in neutrosophic minimal subspace  $(Y, N_{mY})$  then there exist a family of open sets  $\{U_j : j \in X\}$  in neutrosophic minimal structure space  $(X, N_{mX})$  such that  $V_i = U_j \cap A, \forall i \in Y$  where  $A \in N_{mY}$ .  $\bigcup_{(i \in Y)} V_i = \bigcup_{(j \in X)} (U_j \cap A) = \bigcup_{(i \in Y)} U_j \cap A$ . Since  $(X, N_{mX})$  has union property then  $(Y, N_{mY})$  also has union property. The proof of (ii) is similarly to (i).

**Definition 4.5.** Suppose  $(B, N_{mB})$  and  $(C, N_{mC})$  are neutrosophic minimal subspaces of neutrosophic minimal structure spaces  $(Y, N_{mY})$  and  $(Z, N_{mZ})$  respectively. Also, suppose that  $f$  is a mapping from  $(Y, N_{mY})$  to  $(Z, N_{mZ})$  is a mapping. We say that  $f$  is a mapping from  $(B, N_{mB})$  into  $(C, N_{mC})$  if the image of  $B$  under  $f$  is a subset of  $C$ .

**Definition 4.6.** Suppose  $(A, N_{mA})$  and  $(B, N_{mB})$  are neutrosophic minimal subspaces of neutrosophic minimal structure spaces  $(Y, N_{mY})$  and  $(Z, N_{mZ})$  respectively. The mapping  $f$  from  $(A, N_{mA})$  into  $(B, N_{mB})$  is called a

- (1) comparative neutrosophic minimal continuous, if  $f^1(W) \wedge A \in N_{mA}$  for every neutrosophic minimal structure set  $W$  in  $B$ ,
- (2) comparative neutrosophic minimal open, if  $f(V) \in N_{mB}$  for every fuzzy set  $V \in N_{mA}$ .



X/E	$c_1$	$c_2$	$c_3$	....	$c_n$
$a_1$	$d_{11}$	$d_{12}$	$d_{13}$	....	$d_{1n}$
$a_2$	$d_{21}$	$d_{22}$	$d_{23}$	....	$d_{2n}$
.	.	.	.	.	.
$a_m$	$d_{m1}$	$d_{m2}$	$d_{m3}$	....	$d_{mn}$

TABLE 1. Attributes and Alternative

### 5. Applications

The application of neutrosophic minimal structure space is based on the minimal element and maximal element. In neutrosophic minimal structure space,  $0_{\sim}$  is the minimal element and  $1_{\sim}$  is the maximal element. The application of neutrosophic minimal structure space used in consumer theory where the customer has only two objective. In consumer theory, the customer has either minimize purchase cost and maximize the quantity or maximize the durability.

The following steps are proposed to take better decision.

Step 1.

Input m Attributes and n alternatives (See TABLE 1).

Step 2. Construct the neutrosophic minimal structure from the data.  $\tau_k = \{0_{\sim}, 1_{\sim}, U_k\}$  where  $U_k = \{d_{1k}, d_{2k} \dots d_{mk}\}$

Step 3. compute the neutrosophic score function (in short, NF) using the following simple formula,  $NF(U_k) = \frac{1}{3m} [\sum_{i=1}^m [2 + T_i - I_i - F_i]]$

Step 4. Arrange the score function  $U_k$  which we calculated in step 3 in ascending order. Choose the largest score value  $U_k$  for better decision.

Lets consider the following example. Let the set of variety of cars be  $X = \{C_1, C_2, C_3\}$  and the parameter set  $E = \{a = \text{cost of the car}, b = \text{safety}, c = \text{maintenance}\}$ . A customer will assign minimum value of  $0_{\sim}$  to bad features, maximum  $1_{\sim}$  to the best feature of the product. Membership, indeterminacy and non-membership values taken from customer’s review rating. Membership referred to cost of the car is worth to the model, safe and low maintenance cost. Non-membership referred to cost of the car is not worth to the model, not safe due to break failure or some other reason and high maintenance cost. Indeterminacy referred to neutrality of cost of the car, safe if drive safe and maintenance is neutral. Let us assume TABLE 2. values are taken from customer review rating for the models  $C_1, C_2$  and  $C_3$  with parameters a, b and c.

Step 2. The neutrosophic minimal structure

$$\tau_1 = \{0_{\sim}, 1_{\sim}, U_1\} \text{ where } U_1 = \{(0.6, 0.2, 0.4), (0.7, 0.3, 0.4), (0.6, 0.3, 0.4)\}$$

$$\text{Similarly, } \tau_2 = \{0_{\sim}, 1_{\sim}, U_2\} \text{ where } U_2 = \{(0.6, 0.3, 0.4), (0.6, 0.3, 0.4), (0.5, 0.2, 0.4)\}$$

X/E	$C_1$	$C_2$	$C_3$
a	(0.6,0.2,0.4)	(0.6,0.3,0.4)	(0.7,0.3,0.4)
b	(0.7,0.3,0.4)	(0.6,0.3,0.4)	(0.8,0.2,0.2)
c	(0.6,0.3,0.4)	(0.5,0.2,0.4)	(0.6,0.2,0.3)

TABLE 2. Input matrix

$\tau_3 = \{0\sim, 1\sim, U_3\}$  where  $U_3 = \{(0.7, 0.3, 0.4), (0.8, 0.2, 0.2), (0.6, 0.2, 0.3)\}$

Step 3. Neutrosophic score functions are

$$NS(U_1) = 0.6556$$

$$NS(U_2) = 0.6333$$

$$NS(U_3) = 0.7222$$

Step 4. The neutrosophic score functions are arranged in ascending order as follows  $U_2 \leq U_1 \leq U_3$ . Based on score function,  $U_3$  is the largest score function.  $U_3$  related to the model  $C_3$ . Hence Model  $C_3$  is best to buy.

**Comparison Analysis:** The existing and proposed notion of neutrosophic minimal structure space is compared in the below table.

Spaces	Uncertainty	Truth value of parameter	Uncertainty of parameter	False value of parameter.
Minimal structure space	-	-	-	-
Fuzzy minimal structure space	Present	Present	-	-
Intuitionistic Minimal structure space	Present	Present	Present	-
Neutrosophic minimal structure space	Present	Present	Present	present

TABLE 3. Comparison Table

## 6. Conclusions

In this paper, Neutrosophic minimal structure space is introduced and some of its properties investigated along with this. Neutrosophic minimal continuous and subspace are also investigated with few properties. Finally, application of neutrosophic minimal structure space is discussed. Future work of this paper is to investigate and study various open sets and separation axioms in neutrosophic minimal structure space. Also the application part discussed in this work leads to analyze in weak structure.

## References

- [1] Abdel-Basset, M.; Gamal, A.; Son, L.H.; Smarandache, F. A Bipolar Neutrosophic Multi Criteria Decision Making Framework for Professional Selection. Appl. Sci.(2020), 10, 1202.
- [2] Abdel-Basset, M.; Mohamed, R.; Zaied, A. E. N. H.; Gamal, A.; & Smarandache, F. Solving the supply chain problem using the best-worst method based on a novel Plithogenic model. In Optimization Theory Based on Neutrosophic and Plithogenic Sets,(2020), (pp. 1-19). Academic Press.
- [3] Abdel-Basst, M.; Mohamed, R.; & Elhoseny, M. A novel framework to evaluate innovation value proposition for smart product-service systems. Environmental Technology & Innovation, (2020), DOI: 10.1016/j.eti.2020.101036
- [4] Atanassov, K.T. Intuitionistic fuzzy sets. Fuzzy sets and systems, (1986), 20, 87-96.
- [5] Alimohammady, M.; Roohi, M. Fixed point in minimal spaces. Nonlinear Anal.Model. Control, (2005),10,305-314.
- [6] Battacharya. S(Halder). Some results on IF generalized minimal closed set. Int. Journal of Math. Analysis, (2010), 4(32), 1577 - 1589.
- [7] Banu priya, V.; Chandrasekar, S. Neutrosophic  $\alpha$  gs Continuity and Neutrosophic  $\alpha$ gs Irresolute Maps. Neutrosophic Sets and Systems, (2019), 28, 162-170. DOI: 10.5281/zenodo.3382531
- [8] Coker, D. An introduction to fuzzy topological spaces. Fuzzy sets and systems (1997), 88, 81-89.
- [9] Dhavaseelan, R.; Narmada Devi, R.; Jafari, S and Qays Hatem Imran. Neutrosophic alpha-m-continuity. Neutrosophic Sets and Systems, (2019), 27, 171-179. DOI: 10.5281/zenodo.3275578
- [10] Dhavaseelan, R.; Parimala, M.; Jafari, S.; Smarandache, F. On neutrosophic semi-supra open set and neutrosophic semi-supra continuous functions. Neutrosophic Sets and Systems, (2017), 16 ,39-43.
- [11] James Munkres, Topology. pearson, (2000).
- [12] Karthika, M.; Parimala, M.; Jafari, S.; Smarandache, F.; Mohammad Alshumrani.; Cenap Ozel and Udhayakumar. R. Neutrosophic complex  $\alpha\psi$  connectedness in neutrosophic complex topological spaces. Neutrosophic sets and systems, (2019), 29, 158-164.
- [13] Kuratowski. K, Topology Vol. II. Academic Press: New York, (1966).
- [14] Popa, V.; Noiri, T. On M-continuous functions. Anal. Univ. Dunarea de Jos Galati, Ser. Mat. Fiz. Mec. Teor. Fasc. II, (2000), 18 (23), 31-41.
- [15] Parimala, M.; Karthika, M.; Dhavaseelan, R.; Jafari, S. On neutrosophic supra pre-continuous functions in neutrosophic topological spaces. New Trends in Neutrosophic Theory and Applications, (2017), 2, 371-383.
- [16] Parimala, M.; Karthika, M.; Jafari, S.; Smarandache, F.; Udhayakumar, R. Decision-Making via Neutrosophic Support Soft Topological Spaces. Symmetry, (2018), 10(6), 217, 1-10.
- [17] Parimala, M.; Karthika,M.; Jafari, S.; Smarandache, F.; El-Atik,A.A. Neutrosophic  $\alpha\psi$ -connectedness. Journal of Intelligent & Fuzzy Systems, (2020), 38, 853 - 857.

- [18] Parimala, M.; Karthika, M.; Jafari, S.; Smarandache, F. and Udhayakumar, R. Neutrosophic nano ideal topological structures. *Neutrosophic sets and systems*, (2019), 24, 70-77.
- [19] Salama, A.A.; Alblowi, S.A. Neutrosophic Set and Neutrosophic Topological Spaces. *IOSR J. Math.* (2012), 3, 31-35.
- [20] Smarandache, F. Neutrosophy and Neutrosophic Logic. First International Conference on Neutrosophy, Neutrosophic Logic Set, Probability and Statistics, University of New Mexico, Gallup, NM, USA, (2002).
- [21] Smarandache, F. A Unifying Field in Logics: Neutrosophic Logic. Neutrosophy, Neutrosophic Set, Neutrosophic Probability, American Research Press: Rehoboth, NM, USA, (1999).
- [22] Smarandache, F.; Mumtaz Ali. Neutrosophic Triplet Group (revisited). *Neutrosophic Sets and Systems*, 26,(2019), 1-11.
- [23] Zadeh, L.A. Fuzzy Sets. *Information and Control*, (1965), 18, 338-353.

**Received: Jul 29, 2020 / Accepted: Sep 30, 2020**