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Abstract: In this article, we procure the idea of single-valued pentapartitioned neutrosophic cosine similarity measure (SVPNCSM) and single-valued pentapartitioned neutrosophic weighted cosine similarity measure (SVPNWCSM) under the single-valued pentapartitioned neutrosophic set (SVPNS) environment. Besides, we formulate several interesting results on SVPNCSM and SVPNWCSM of similarities between two SVPNSs. Further, we present a multi-attribute decision-making (MADM) model under SVPNS environment using the SVPNCSM. Finally, we provide a numerical example to show the applicability and effectiveness of our proposed MADM technique.

Keywords: *Neutrosophic Set*; *Similarity Measure*; *SVPNS*; *COVID-19*.

1. Introduction:

In 1965, Late Prof. L.A. Zadeh grounded the concept of fuzzy set theory to deal with the problems having uncertainty. In a fuzzy set, every element has a degree of membership lies between 0 and 1.

In 1986, K. Atanassov presented the idea of intuitionistic fuzzy set by generalizing fuzzy set theory. In an intuitionistic fuzzy set, every element has both degree of membership and non-membership lies between 0 and 1. Many researchers around the globe applied the notion of fuzzy set, intuitionistic fuzzy set and their extensions in the area of theoretical and practical research. Smarandache [40] introduced the idea of neutrosophic set theory by extending the idea of fuzzy set and intuitionistic fuzzy set theory to deal with the events which cannot be easily express by the degree of membership and non-membership. In an neutrosophic set, every element has three independent memberships values namely truth, indeterminacy, and false membership values respectively lies between 0 and 1. The degree of indeterminacy of a mathematical expression plays a vital role in every MADM problem of this real world. Afterwards, Wang et al. [43] extended the idea of neutrosophic set, and grounded the notion of single-valued neutrosophic set (SVNS) in the year 2010, which is more effective in dealing with the situation having incomplete and indeterminate information. Till now, many mathematicians used SVNS and their extensions in several branches of this real world such as medical diagnosis [34, 35], fault diagnosis [46, 47], data mining [30], decision-making problems [5, 11-13, 15, 27-29, 32-33, 36, 48], etc.

In the year 2020, Mallick and Pramanik [25] grounded the notion of SVPNS by splitting the indeterminacy membership function into three independent membership function namely contradiction membership function, ignorance membership function and unknown membership function. Afterwards, the concept of pentapartitioned neutrosophic Q-ideals of pentapartitioned neutrosophic Q-algebra was introduced by Das et al. [10]. In 2021, Das et al. [13] proposed a MADM technique using tangent Similarity Measure under SVPNS environment. Recently, Das et al. [12] established a MADM strategy based on grey relational analysis under the SVPNS environment.

The rest of this article has been designed as follows:

Section 2 is on the preliminaries and relevant definitions. In section 3, we introduce the concept of SVPNCSM and SVPNWCSM of similarities between two SVPNSs. Further, we formulate some theorems and propositions on SVPNCSM and SVPNWCSM under the SVPNS environment. In section 4, we propose a MADM technique using the SVPNWCSM under the SVPNS environment. In section 5, we validate the proposed MADM technique by providing a real world numerical example. Section 6 presents the concluding remarks of our work done in this paper. In this section, we also state some future scope of research in this direction.

Throughout this article, we use the following short terms for the clarity of the presentation.

Short Terms	
Single-Valued Neutrosophic Set	SVNS

Multi-Attribute Decision Making	MADM
Single-Valued Pentapartitioned Neutrosophic Set	SVPNS
Single-Valued Pentapartitioned Neutrosophic Cosine Similarity Measure	SVPNCSM
Single-Valued Pentapartitioned Neutrosophic Weighted Cosine Similarity Measure	SVPNWCSM
Decision Matrix	DM
Positive Ideal Alternative	PIA
Accumulated Measure Function	AMF

2. Preliminaries and Definitions:

In the year 2020, Mallick and Pramanik [25] presented the notion of SVPNS as follows:

Assume that U be a universe of discourse. Then L, a SVPNS over U is defined by:

$$L = \{(\alpha, \Delta_L(\alpha), \Gamma_L(\alpha), \Pi_L(\alpha), \Omega_L(\alpha), \Phi_L(\alpha)): \alpha\in U\}.$$

Here, Δ_L, Γ_L, Π_L, Ω_L and Φ_L are the truth, contradiction, ignorance, unknown, and false membership functions from U to the unit interval [0, 1] respectively i.e., $\Delta_L(\alpha), \Gamma_L(\alpha), \Pi_L(\alpha), \Omega_L(\alpha), \Phi_L(\alpha) \in [0, 1]$, for each $\alpha\in U$. So, $0 \le \Delta_L(\alpha) + \Gamma_L(\alpha) + \Pi_L(\alpha) + \Omega_L(\alpha) + \Phi_L(\alpha) \le 5$, for each $\alpha\in U$.

The absolute SVPNS (1_{PN}) and the null SVPNS (0_{PN}) over a fixed set U are defined as follows:

(*i*) $1_{PN} = \{(\alpha, 1, 1, 0, 0, 0): \alpha\in U\}$,

(*ii*) $0_{PN} = \{(\alpha, 0, 0, 1, 1, 1): \alpha\in U\}$.

Suppose that $L = \{(\alpha, \Delta_L(\alpha), \Gamma_L(\alpha), \Pi_L(\alpha), \Omega_L(\alpha), \Phi_L(\alpha)): \alpha\in U\}$ and $M = \{(\alpha, \Delta_M(\alpha), \Gamma_M(\alpha), \Pi_M(\alpha), \Omega_M(\alpha), \Phi_M(\alpha)): \alpha\in U\}$ be any two SVPNSs over U. Then,

(*i*) $L \subseteq M$ if and only if $\Delta_L(\alpha) \le \Delta_M(\alpha)$, $\Gamma_L(\alpha) \le \Gamma_M(\alpha)$, $\Pi_L(\alpha) \ge \Pi_M(\alpha)$, $\Omega_L(\alpha) \ge \Omega_M(\alpha)$, $\Phi_L(\alpha) \ge \Phi_M(\alpha)$, for all $\alpha\in U$;

(*ii*) $L^c = \{(\alpha, \Phi_L(\alpha), \Omega_L(\alpha), 1-\Pi_L(\alpha), \Gamma_L(\alpha), \Delta_L(\alpha)): \alpha\in U\}$;

(*iii*) $L \cup M = \{(\alpha, \max\{\Delta_L(\alpha), \Delta_M(\alpha)\}, \max\{\Gamma_L(\alpha), \Gamma_M(\alpha)\}, \min\{\Pi_L(\alpha), \Pi_M(\alpha)\}, \min\{\Omega_L(\alpha), \Omega_M(\alpha)\}, \min\{\Phi_L(\alpha), \Phi_M(\alpha)\}): \alpha\in U\}$;

(*iv*) $L \cap M = \{(\alpha, \min\{\Delta_L(\alpha), \Delta_M(\alpha)\}, \min\{\Gamma_L(\alpha), \Gamma_M(\alpha)\}, \max\{\Pi_L(\alpha), \Pi_M(\alpha)\}, \max\{\Omega_L(\alpha), \Omega_M(\alpha)\}, \max\{\Phi_L(\alpha), \Phi_M(\alpha)\}): \alpha\in U\}$.

Suppose that $L = \{(p, 0.6, 0.1, 0.3, 0.4, 0.5), (q, 0.9, 0.1, 0.2, 0.2, 0.1)\}$ and $M = \{(p, 0.9, 0.2, 0.2, 0.1, 0.4), (q, 1.0, 0.3, 0.1, 0.2, 0.1)\}$ be two SVPNSs over a universe of discourse $U = \{p, q\}$. Then,

(*i*) $L \subseteq M$;

(*ii*) $L^c = \{(p, 0.5, 0.4, 0.7, 0.1, 0.6), (q, 0.1, 0.2, 0.8, 0.1, 0.9)\}$ and $M^c = \{(p, 0.4, 0.1, 0.8, 0.2, 0.9), (q, 0.1, 0.2, 0.9, 0.3, 1.0)\}$;

(*iii*) $L \cup M$ = {(*p*, 0.9, 0.2, 0.2, 0.1, 0.4), (*q*, 1.0, 0.3, 0.1, 0.2, 0.1)};

(*iv*) $L \cap M$ = {(*p*, 0.6, 0.1, 0.3, 0.4, 0.5), (*q*, 0.9, 0.1, 0.2, 0.2, 0.1)}.

3. SVPNCSM and SVPNWCSM under the SVPNS Environment:

In this section, we propose two similarity measures namely single-valued pentapartitioned neutrosophic cosine similarity measure (SVPNCSM) and single-valued pentapartitioned neutrosophic weighted cosine similarity measure (SVPNWCSM) under the SVPNS environment. Further, we formulate several interesting results on them under the SVPNS environment.

Definition 3.1. Let $L = \{(\alpha, \Delta_L(\alpha), \Gamma_L(\alpha), \Pi_L(\alpha), \Omega_L(\alpha), \Phi_L(\alpha)) : \alpha \in U\}$ and $M = \{(\alpha, \Delta_M(\alpha), \Gamma_M(\alpha), \Pi_M(\alpha), \Omega_M(\alpha), \Phi_M(\alpha)) : \alpha \in U\}$ be two SVPNSs over a fixed set U. Then, the SVPNCSM of similarities between L and M is defined as follows:

$$P_{SVPNCSM}(L, M) = 1-\frac{1}{n}\sum_{\alpha\in U} cos\left[\frac{\pi}{10}\left[|\Delta_L(\alpha)-\Delta_M(\alpha)|+|\Gamma_L(\alpha)-\Gamma_M(\alpha)|+|\Pi_L(\alpha)-\Pi_M(\alpha)|+|\Omega_L(\alpha)-\Omega_M(\alpha)| +|\Phi_L(\alpha)-\Phi_M(\alpha)|\right]\right]. \quad (1)$$

Theorem 3.1. If $P_{SVPNCSM}(L, M)$ be the SVPNCSM of similarities between the SVPNSs L and M, then the following holds:

(*i*) $0 \leq P_{SVPNCSM}(L, M) \leq 1$;

(*ii*) $P_{SVPNCSM}(L, M) = P_{SVPNCSM}(M, L)$;

(*iii*) $L = M \Leftrightarrow P_{SVPNCSM}(L, M) = 0$.

Proof. (*i*) We know that, the cosine function is a monotonic decreasing function in the interval [0, π/2]. It is also lies in the interval [0, 1]. Hence, $0 \leq P_{SVPNCSM}(L, M) \leq 1$.

(*ii*) We have, $P_{SVPNCSM}(L, M)$

$$= 1-\frac{1}{n}\sum_{d\in U} cos\left[\frac{\pi}{10}\left[|\Delta_L(d)-\Delta_M(d)| + |\Gamma_L(d)-\Gamma_M(d)| + |\Pi_L(d)-\Pi_M(d)| + |\Omega_L(d)-\Omega_M(d)| + |\Phi_L(d)- \Phi_M(d)|\right]\right]$$

$$= 1-\frac{1}{n}\sum_{d\in U} cos\left[\frac{\pi}{10}\left[|\Delta_M(d)-\Delta_L(d)| + |\Gamma_M(d)-\Gamma_L(d)| + |\Pi_M(d)-\Pi_L(d)| + |\Omega_M(d)-\Omega_L(d)| + |\Phi_M(d)-\Phi_L(d)|\right]\right]$$

$= P_{SVPNCSM}(M, L)$

Therefore, $P_{SVPNCSM}(L, M) = P_{SVPNCSM}(M, L)$.

(*iii*) Suppose that L and M be two SVPNSs over U such that $L = M$.

Now, $L = M$

$\Rightarrow \Delta_L(d)=\Delta_M(d)$, $\Gamma_L(d)= \Gamma_M(d)$, $\Pi_L(d)=\Pi_M(d)$, $\Omega_L(d)=\Omega_M(d)$, and $\Phi_L(d)=\Phi_M(d)$, for all $d\in U$

$\Rightarrow |\Delta_L(d)-\Delta_M(d)|=0$, $|\Gamma_L(d)-\Gamma_M(d)|=0$, $|\Pi_L(d)- \Pi_M(d)|=0$, $|\Omega_L(d)-\Omega_M(d)|=0$ and $|\Phi_L(d)-\Phi_M(d)|=0$, for all $d\in U$

Hence, $P_{SVPNCSM}(L, M) = 1- \frac{1}{n}\sum_{d\in U} cos(0) = 0$.

Conversely, suppose that $P_{SVPNSSM}(W, M) = 0$.

Now, $P_{SVPNSSM}(W, M) = 0$

$\Rightarrow |\Delta_L(d)-\Delta_M(d)|=0, |\Gamma_L(d)-\Gamma_M(d)|=0, |\Pi_L(d)-\Pi_M(d)|=0$, $|\Omega_L(d)- \Omega_M(d)|=0$, $|\Phi_L(d)-\Phi_M(d)|=0$, for all $d\in U$

$\Rightarrow \Delta_L(d)=\Delta_M(d)$, $\Gamma_L(d)=\Gamma_M(d)$, $\Pi_L(d)=\Pi_M(d)$, $\Omega_L(d)=\Omega_M(d)$, and $\Phi_L(d)=\Phi_M(d)$, for all $d\in U$

Hence, $L = M$.

Theorem 3.2. If L, M and C be three SVPNSs over a fixed set U such that $L\subseteq M\subseteq C$, then $P_{SVPNCSM}(L, M) \leq P_{SVPNCSM}(L, C)$ and $P_{SVPNCSM}(M, C) \leq P_{SVPNCSM}(L, C)$.

Proof. Suppose that L, M and C be three SVPNSs over a fixed set U such that $L\subseteq M\subseteq C$. So, $\Delta_L(d) \leq \Delta_M(d)$, $\Gamma_L(d) \leq \Gamma_M(d)$, $\Pi_L(d) \geq \Pi_M(d)$, $\Omega_L(d) \geq \Omega_M(d)$, $\Phi_L(d) \geq \Phi_M(d)$, $\Delta_M(d) \leq \Delta_C(d)$, $\Gamma_M(d) \leq \Gamma_C(d)$, $\Pi_M(d) \geq \Pi_C(d)$, $\Omega_M(d) \geq \Omega_C(d)$, $\Phi_M(d) \geq \Phi_C(d)$, $\Delta_L(d) \leq \Delta_C(d)$, $\Gamma_L(d) \leq \Gamma_C(d)$, $\Pi_L(d) \geq \Pi_C(d)$, $\Omega_L(d) \geq \Omega_C(d)$, $\Phi_L(d) \geq \Phi_C(d)$, for all $d\in U$.

Therefore, $|\Delta_L(d)-\Delta_M(d)|\leq|\Delta_L(d)-\Delta_C(d)|$, $|\Gamma_L(d)-\Gamma_M(d)|\leq|\Gamma_L(d)-\Gamma_C(d)|$, $|\Pi_L(d)-\Pi_M(d)|\leq|\Pi_L(d)-\Pi_C(d)|$, $|\Omega_L(d)-\Omega_M(d)|\leq|\Omega_L(d)-\Omega_C(d)|$, $|\Phi_L(d)-\Phi_M(d)|\leq|\Phi_L(d)-\Phi_C(d)|$, for all $d\in U$.

Therefore, $P_{SVPNCSM}(L, M)$

$$= 1-\frac{1}{n}\sum_{d\in U} cos[\frac{\pi}{10}[|\Delta_L(d)-\Delta_M(d)|+|\Gamma_L(d)-\Gamma_M(d)|+|\Pi_L(d)-\Pi_M(d)|+|\Omega_L(d)-\Omega_M(d)| +|\Phi_L(d)-\Phi_M(d)|]]$$

$$\leq 1-\frac{1}{n}\sum_{d\in U} cos[\frac{\pi}{10}[|\Delta_L(d)-\Delta_C(d)|+|\Gamma_L(d)-\Gamma_C(d)|+|\Pi_L(d)-\Pi_C(d)|+|\Omega_L(d)-\Omega_C(d)| +|\Phi_L(d)-\Phi_C(d)|]]$$

$= P_{SVPNCSM}(L, C)$

Hence, $P_{SVPNCSM}(L, M) \leq P_{SVPNCSM}(L, C)$.

Further, we have $|\Delta_M(d)-\Delta_C(d)|\leq|\Delta_L(d)-\Delta_C(d)|$, $|\Gamma_M(d)-\Gamma_C(d)|\leq|\Gamma_L(d)-\Gamma_C(d)|$, $|\Pi_M(d)-\Pi_C(d)|\leq|\Pi_L(d)-\Pi_C(d)|$, $|\Omega_M(d)-\Omega_C(d)|\leq|\Omega_L(d)-\Omega_C(d)|$, $|\Phi_M(d)-\Phi_C(d)|\leq|\Phi_L(d)-\Phi_C(d)|$, for all $d\in U$.

Therefore, $P_{SVPNCSM}(M, C)$

$$=1-\frac{1}{n}\sum_{d\in U} cos[\frac{\pi}{10}[|\Delta_M(d)-\Delta_C(d)|+|\Gamma_M(d)-\Gamma_C(d)|+|\Pi_M(d)-\Pi_C(d)|+|\Omega_M(d)-\Omega_C(d)|+|\Phi_M(d)-\Phi_C(d)|]]$$

$$\leq 1-\frac{1}{n}\sum_{d\in U} cos[\frac{\pi}{10}[|\Delta_L(d)-\Delta_C(d)|+|\Gamma_L(d)-\Gamma_C(d)|+|\Pi_L(d)-\Pi_C(d)|+|\Omega_L(d)-\Omega_C(d)| +|\Phi_L(d)-\Phi_C(d)|]]$$

$= P_{SVPNCSM}(L, C)$

Hence, $P_{SVPNCSM}(M, C) \leq P_{SVPNCSM}(L, C)$.

Definition 3.2. Assume that, $L = \{(d, \Delta_L(d), \Gamma_L(d), \Pi_L(d), \Omega_L(d), \Phi_L(d)) : d\in U\}$ and $W= \{(d, \Delta_W(d), \Gamma_W(d), \Pi_W(d), \Omega_W(d), \Phi_W(d)) : d\in U\}$ be two SVPNSs over a universe of discourse U. Then, the single valued pentapartitioned neutrosophic weighted cosine similarity measure (in short SVPNWCSM) between L and W is defined by:

$$P_{SVPNWCSM}(L, W) = 1-\frac{1}{n}\sum_{d\in U} w_d.cos[\frac{\pi}{10}[|\Delta_L(d)-\Delta_W(d)|+|\Gamma_L(d)-\Gamma_W(d)|+|\Pi_L(d)-\Pi_W(d)|+|\Omega_L(d)-\Omega_W(d)|+|\Phi_L(d)-\Phi_W(d)|]], \quad (2)$$

where, $\sum_{d\in U} w_d = 1$.

Now, we formulate the following results in view of the above theorems:

Proposition 3.1. Let $P_{SVPNWCSM}(L, W)$ be the SVPNWCSM of similarities between the SVPNSs L and W. Then,

(i) $0 \leq P_{SVPNWCSM}(L, W) \leq 1$;

(ii) $P_{SVPNWCSM}(L, W) = P_{SVPNWCSM}(W, L)$;

(iii) $P_{SVPNWCSM}(L, W) = 0$ iff $L = W$.

Proposition 3.2. If L, M and W be three SVPNSs over a universe of discourse U such that $L \subseteq M \subseteq W$, then $P_{SVPNWCSM}(L, M) \leq P_{SVPNWCSM}(L, W)$ and $P_{SVPNWCSM}(M, W) \leq P_{SVPNWCSM}(L, W)$.

4. SVPNCSM Based MADM Strategy under SVPNS Environment:

In this section, an attempt is made to propose a MADM strategy under the SVPNS environment using the SVPNCSM of similarities between two SVPNSs.

Let us consider a MADM problem, where $U = \{U_1, U_2, ..., U_p\}$ and $A = \{A_1, A_2, ..., A_q\}$ denotes the set of all possible alternatives and attributes respectively. Then, a decision maker can give their evaluation information for each alternative U_i (i = 1, 2, ..., p) with respect to the each attribute A_j (j = 1, 2,……, q) by using a SVPNS. By using the decision maker's whole evaluation information, we can form a decision matrix (DM).

The steps of our proposed MADM strategy are discussed below. Figure 1 represents the flow chart of the proposed MADM strategy.

Step-1: Formation of the DM by using SVPNS

In this step, we can build a DM by using the decision maker's evaluation information $P_{U_i} = \{(A_j, \Delta_{ij}(U_i, A_j), \Gamma_{ij}(U_i, A_j), \Pi_{ij}(U_i, A_j), \Omega_{ij}(U_i, A_j), \Phi_{ij}(U_i, A_j)) : A_j \in A\}$ for each alternative U_i (i = 1, 2, ..., p) with respect to the attributes A_j(j = 1, 2, ..., q), where $(\Delta_{ij}(U_i, A_j), \Gamma_{ij}(U_i, A_j), \Pi_{ij}(U_i, A_j), \Omega_{ij}(U_i, A_j), \Phi_{ij}(U_i, A_j)) = (U_i, A_j)$ (say) (i = 1, 2, ..., p, and j = 1, 2, ..., q) indicates the evaluation information of alternatives U_i (i = 1, 2, ..., p) with respect to the attribute A_j (j = 1, 2, ..., q).

The DM can be expressed as follows:

DM	A_1	A_2	…….	……..	A_q
U_1	(U_1, A_1)	(U_1, A_2)	....	…….	(U_1, A_q)
U_2	(U_2, A_1)	(U_2, A_2)	……	……..	(U_2, A_q)
…… …….	………….. …………..	………….. …………..	……… ………	……… ………	………….. …………..
U_p	(U_p, A_1)	(U_p, A_2)	………	………	(U_p, A_q)

Step-2: Determination of the Weights for Each Attribute

In every MADM strategy, the determination of weights for every attributes is an important task. If the information of attributes' weight is completely unknown, then the decision maker can use the compromise function to calculate the weights for each attribute.

The compromise function of β_j for each U_j is defined as follows:

$$\beta_j = \sum_{i=1}^{p} (3 + \Delta_{ij}(U_i, A_j) + \Gamma_{ij}(U_i, A_j) - \Pi_{ij}(U_i, A_j) - \Omega_{ij}(U_i, A_j) - \Phi_{ij}(U_i, A_j))/5. \quad (3)$$

Then, the weight of the *j*-th attribute is defined by $w_j = \frac{\beta_j}{\sum_{j=1}^{q} \beta_j}$ (4)

Here, $\sum_{j=1}^{q} w_j = 1$.

Step-3: Selection of the Positive Ideal Alternative (PIA)

In this step, the decision maker can form the PIA by using the maximum operator for all the attributes.

The positive ideal alternative I is defined as follows:

$$I = (C_1, C_2, \ldots\ldots\ldots, C_q), \quad (5)$$

where C_j = (max $\{\Delta_{ij}(U_i, A_j)$: i=1, 2, 3, ….., $p\}$, max $\{\Gamma_{ij}(U_i, A_j)$: i=1, 2, 3, ….., $p\}$, min $\{\Pi_{ij}(U_i, A_j)$: i=1, 2, 3, ….., $p\}$, min $\{\Omega_{ij}(U_i, A_j)$: i=1, 2, 3, ….., $p\}$, min $\{\Phi_{ij}(U_i, A_j)$: i=1, 2, 3, ….., $p\}$), j = 1, 2, …., q. (6)

Step-4: Determination of the Accumulated Measure Values

In this step, we use an accumulated measure function (AMF) to aggregate the SVPNCSM corresponding to each alternative.

The AMF is defined by $P_{AMF}(U_i) = \sum_{j=1}^{q} w_j \cdot P_{SVPNCSM}((U_i, A_j), C_j)$, (7)

where, $(U_i, A_j) = (\Delta_{ij}(U_i, A_j), \Gamma_{ij}(U_i, A_j), \Pi_{ij}(U_i, A_j), \Omega_{ij}(U_i, A_j), \Phi_{ij}(U_i, A_j))$.

Step-5: Ranking of the Alternatives

Finally, we prepare the ranking order of alternatives based on the descending order of accumulated measure values. The alternative associated with the lowest accumulated measure value is the best suitable alternatives.

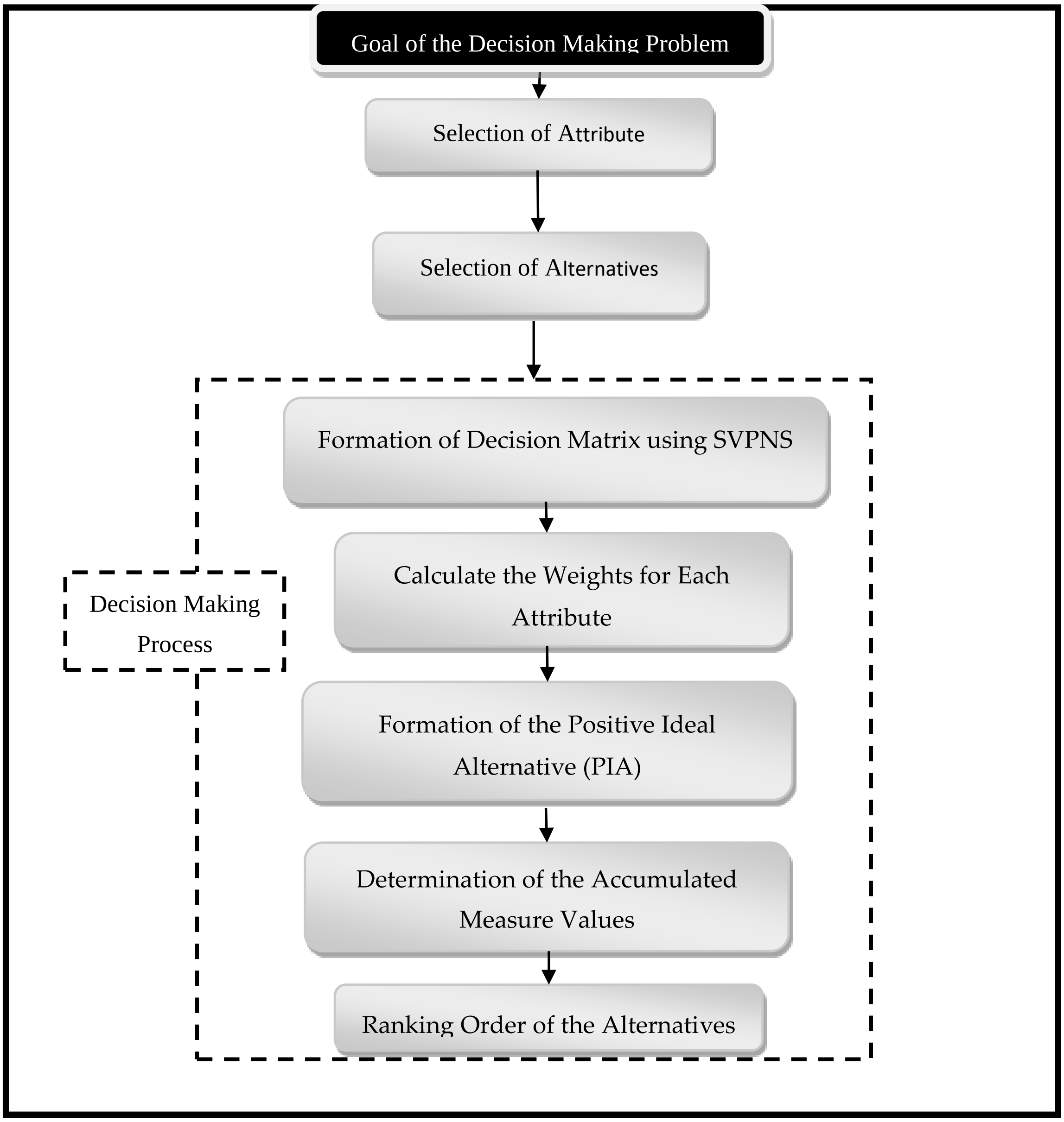

Figure-1: Proposed MADM-Strategy

5. Application of the Proposed MADM Strategy:

In this section, we present a numerical example to show the applicability of our proposed MADM strategy.

Example 5.1. "**Identification of the Most Significant Risk Factor of COVID-19 in the Economy**".

Presently, the world is under the threat of a deadly virus named Corona Virus. The COVID-19 makes an unbelievable provocation with very serious social and economic outcomes [17]. As per the World Health Organization (WHO), Corona Virus disease is a pandemic [44]. On 31st December 2019, it was reported to the World Health Organization that a number of pneumonia cases due to an unknown cause had happened in Wuhan city of China [45]. In January 2020 a new virus was spotted which was later named as the 2019 Novel Corona Virus responsible for the outbreak. In February 2020, WHO named the Virus as Corona Virus Disease 2019 as it had appeared in 2019 [26]. This virus influences immediately to a person's lungs and has symptoms similar to influenza and pneumonia [37]. Although it is not known correctly the process to transmit of COVID-19 from man to man, the method of transmission is same as other respiratory diseases [1, 36]. Environmental factors have a vital role in the movement of the virus [7]. Many researchers observed and established many techniques to cope up with medical and decision-making obstacles. Till 11th July 2021, the total number of confirmed case are 187,280,697 which have been reported worldwide, with 4,043,032 died and 171,255,731 recovered [8, 44]. The COVID-19 pandemic poses an immense threat to people's health and livelihood more specifically the employment [18]. A large number of countries have imposed lockdown and as a result, companies cannot afford to run smoothly. According to UNESCO, more than 188 countries have halted schools, colleges, and universities, responsible to affect the educations of nearly 90% of the world's students. The lockdown has caused the renewal of the environment, with the factories being closed and reduction in transportation vehicles use. COVID-19 improved the air quality in various parts of the world due to the imposing of lockdown [17].

Coronavirus has quickly influenced our everyday life, organizations, upset the world exchange and developments. Recognizable proof of the sickness at a beginning phase is essential to control the spread of the infection since it quickly spreads from one individual to another. The greater part of the nations has hindered their assembling of the items [17]. The different businesses and areas are influenced by the reason for this sickness; these incorporate the drugs business, sun based force area, the travel industry, Information and gadgets industry. This infection makes critical thump on impacts on the day by day life of residents, just as about the worldwide economy. So in this paper, we have focused on the bad impacts of COVID-19 on economy to survive in this COVID-19 phase. Some factors of economy are effected by COVID-19 [24], these are (i) Slowing of the manufacturing of essential goods (U_1), (ii) Disrupt the supply chain of products (U_2), (iii) Losses in national and international business (U_3) (iv) Poor cash flow in the market (U_4) and (v) Significant slowing down in the revenue growth (U_5). All these factors are selected from Literature review (A_1), Expert survey (A_2) and Media survey (A_3). Although, all these factors are effected by COVID-19 pandemic phase but all factors are not equally effected. So the main objective of the present investigation is to identify the most significant effected economical factor affected by COVID-19 pandemic phase. For identify the most significant indicators we use a novel similarity measure namely SVPNCSM under SVPNS environment. All the factors U_1, U_2, U_3, U_4, and U_5 are consider as alternatives and A_1, A_2 and A_3 are consider as attribute. Figure-2 depicts the decision hierarchy of the current problem. Recently Majumder et al. [24] used decision making techniques for select the most significant for speeding the COVID-19. Majumder [23] also used PNN (Polynomial Neural Network) model for predicting confirmed and death cases daily. Assessing the unemployment problem was studied by Nguyen [31] using decision making technique. Aydin and Seker [4] proposed a MADM model to choose the suitable location for isolation in a hospital. Alkan and Kahraman [3] developed a model to evaluate the significant strategies of government against in COVID-19 period with the help of TOPSIS method under the q-rung orthopair fuzzy environment. Ahmad et al. [2] proposed a technique to identifying affected cases globally using the fuzzy cloud based COVID-19.

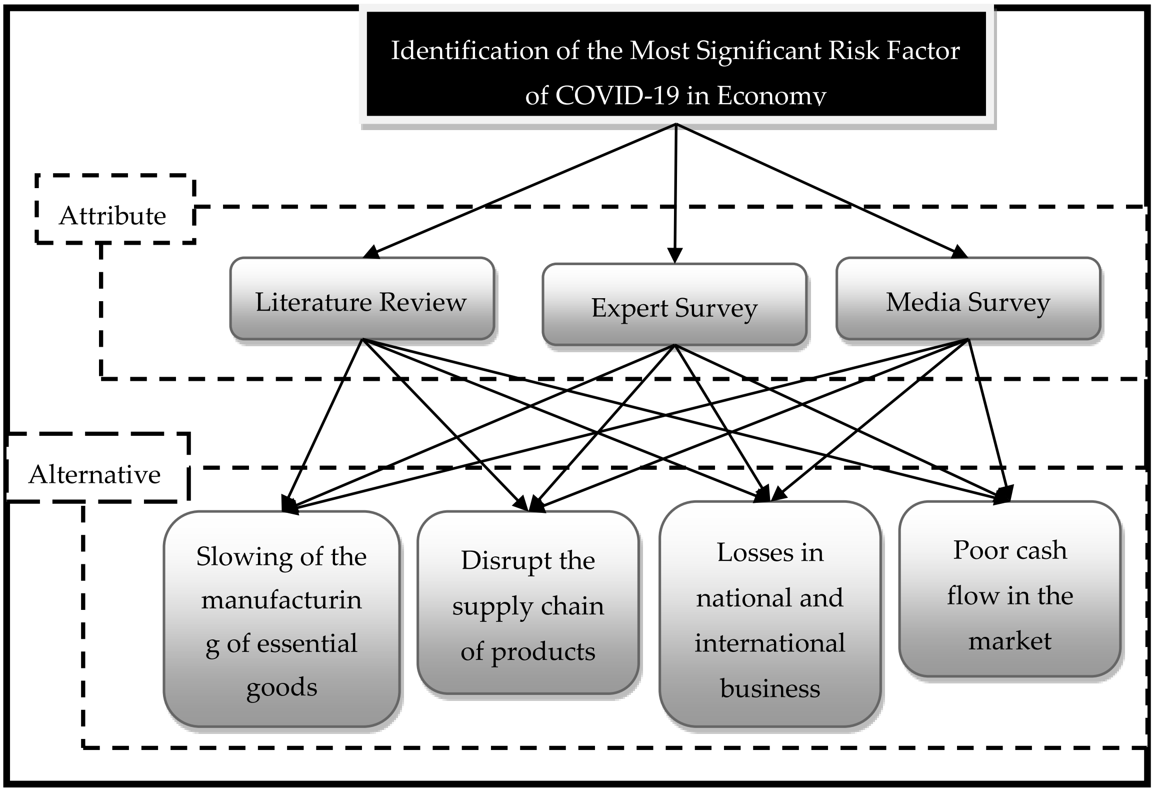

Figure- 2: Decision Hierarchy of the Current Problem.

The proposed MADM strategy is presented as follows:

By using the evaluation information for all alternatives given by the decision makers, we prepare the decision matrix as follows:

Table-1:

	A_1	A_2	A_3
U_1	(0.9,0.1,0.1,0.2,0.1)	(1.0,0.2,0.0,0.0,0.1)	(1.0,0.0,0.1,0.2,0.2)
U_2	(0.8,0.2,0.1,0.0,0.0)	(0.9,0.0,0.1,0.0,0.1)	(0.8,0.1,0.0,0.1,0.1)
U_3	(1.0,0.2,0.2,0.1,0.1)	(0.8,0.2,0.2,0.1,0.1)	(0.9,0.3,0.2,0.1,0.0)
U_4	(0.9,0.1,0.1,0.0,0.2)	(0.9,0.1,0.1,0.1,0.1)	(1.0,0.0,0.1,0.2,0.1)
U_5	(1.0,0.2,0.2,0.1,0.0)	(0.9,0.1,0.2,0.0,0.1)	(1.0,0.2,0.2,0.2,0.0)

Now, by using eq. (3) & eq. (4), we get the weights w_1 = 0.3362989, w_2 = 0.3345196, and w_3 = 0.3291815.

The positive ideal alternative I have been formed using eq. (5) & eq. (6), which was shown in Table-2.

Table-2:

	A_1	A_2	A_3
I	(1.0,0.2,0.1,0.0,0.0)	(1.0,0.2,0.0,0.0,0.1)	(1.0,0.3,0.0,0.1,0.0)

Now, by using eq. (7), we calculate the accumulated measure values of each alternative U_1, U_2, U_3, U_4, and U_5 as follows:

$P_{AMF}(U_1)$ = 0.0496014196;

$P_{AMF}(U_2)$ = 0.0040071176;

$P_{AMF}(U_3)$ = 0.0070106764;

$P_{AMF}(U_4)$ = 0.011291815;

$P_{AMF}(U_5)$ = 0.0059822066.

Here, the order of the accumulated measure values is $P_{AMF}(U_1) > P_{AMF}(U_4) > P_{AMF}(U_3) > P_{AMF}(U_5) > P_{AMF}(U_2)$. Therefore, the alternative U_2 i.e., "**disrupt the supply chain of products**" is the most significant risk factor of COVID-19 in the economy.

6. Conclusions:

In the article, we have established a MADM strategy based on SVPNCSM of similarities between two SVPNSs under the SVPNS environment. Further, we have validated our proposed MADM strategy by solving an illustrative real world numerical example to demonstrate the effectiveness and usefulness of the proposed MADM strategy.

Further, it is hoped that, the proposed MADM strategy can also be used to deal with other decision-making problems such as tender selection [11], weaver selection [15], logistic center location selection [32, 33], medical diagnosis [34, 35], fault diagnosis [46, 47], etc.

Conflict of Interest: The authors declare that they have no conflict of interest.

References:

1. Acter, T., Uddin, N., Das, J., Akhter, A., Choudhury, T.R., & Kim, S. (2020). Evolution of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) as coronavirus disease 2019 (COVID-19) pandemic: A global health emergency. *Science of the Total Environment*, 138996.
2. Ahmad, S., Mehfuz, S., Beg, J., Khan, N.A., & Khan, A.H. (2021). Fuzzy Cloud Based COVID-19 Diagnosis Assistant for identifying affected cases globally using MCDM. *Materials Today: Proceedings*.
3. Alkan, N., & Kahraman, C. (2021). Evaluation of government strategies against COVID-19 pandemic using q-rung orthopair fuzzy TOPSIS method. *Applied Soft Computing*, 107653.
4. Aydin, N., & Seker, S. (2021). Determining the location of isolation hospitals for COVID-19 via Delphi-based MCDM method. *International Journal of Intelligent Systems*, 36(6), 3011-3034.
5. Biswas, P., Pramanik, S., & Giri, B.C. (2014). Entropy based grey relational analysis method for multi-attribute decision making under single valued neutrosophic assessments. *Neutrosophic Sets and Systems*, 2, 102-110.
6. Campbell D, Bannock. 'Unlike Anything Seen in Peacetime': NHS Prepares for Surge in Covid-19 Cases;2020.https://www.theguardian.com/world/2020/mar/13/-unlike-anything-seen-in-peacetime-nhs-prepares-for-surge-in-covid-19-coronavirus-cases.
7. Cássaro, F.A., & Pires, L.F. (2020). Can we predict the occurrence of COVID-19 cases? Considerations using a simple model of growth. *Science of the Total Environment*, 138834.
8. Chakraborty, I., & Maity, P. (2020). COVID-19 outbreak: Migration, effects on society, global environment and prevention. *Science of the Total Environment*, 138882.
9. Das, S. (2021). Neutrosophic Supra Simply Open Set and Neutrosophic Supra Simply Compact Space. *Neutrosophic Sets and Systems*, 43, 105-113.
10. Das, S., Das, R., Granados, C., & Mukherjee, A. (2021). Pentapartitioned Neutrosophic *Q*-Ideals of *Q*-Algebra. *Neutrosophic Sets and Systems*, 41, 52-63.

11. Das, S., Das, R., & Tripathy, B.C. (2020). Multi-criteria group decision making model using single-valued neutrosophic set. *LogForum*, 16(3), 421-429.
12. Das, S., Shil, B., & Pramanik, S. SVPNS-MADM strategy based on GRA in SVPNS Environment. *Neutrosophic Sets and Systems*, In Press.
13. Das, S., Shil, B., & Tripathy, B.C. (2021). Tangent Similarity Measure Based MADM-Strategy under SVPNS-Environment. *Neutrosophic Sets and Systems*, 43, 93-104.
14. Das, R., Smarandache, F., & Tripathy, B.C. (2020). Neutrosophic Fuzzy Matrices and Some Algebraic Operations. *Neutrosophic Sets and Systems*, 32, 401-409.
15. Dey, P.P., Pramanik, S., & Giri, B.C. (2015). An extended grey relational analysis based interval neutrosophic multi attribute decision making for weaver selection. *Journal of New Theory*, 9, 82-93.
16. European Council, Council of the European Union. Report on the comprehensive economic policy response to the COVID-19 pandemic, https://www.consilium.europa.eu/en/press/press-releases/2020/04/09/report-on-the-comprehensive-economic-policy-response-to-the-covid-19-pandemic/(2020, accessed 25 May 2020).
17. Ferguson, N., Laydon, D., Nedjati-Gilani, G., Imai, N., Ainslie, K., Baguelin, M., & Dighe, A. (2020). Report 9: Impact of non-pharmaceutical interventions (NPIs) to reduce COVID19 mortality and healthcare demand.
18. Haleem, A., Javaid, M., & Vaishya, R. (2020). Effects of COVID-19 pandemic in daily life. *Current medicine research and practice*, 10(2), 78.
19. Jin, Y.H., Cai, L., Cheng, Z.S., Cheng, H., Deng, T., Fan, Y.P., & Wang, X.H. (2020). A rapid advice guideline for the diagnosis and treatment of 2019 novel coronavirus (2019-nCoV) infected pneumonia (standard version). *Military Medical Research*, *7*(1), 1-23.
20. Mahapatra, R., Samanta, S., & Pal, M. (2021). Generalized neutrosophic planar graphs and its application. *Journal of Applied Mathematics and Computing*, 65, 693-712.
21. Mahapatra, R., Samanta, S., Pal, M., Lee, J.G., Khalid, S.K., Naseem, U., & Bhadoria, R.S. (2021). Colouring of COVID-19 Affected Region Based on Fuzzy Directed Graphs. *Computers, Materials & Continua*, 68(1), 1219-1233.
22. Mahapatra, R., Samanta, S., Pal, M., & Xin, Q. (2020). Link Prediction in Social Networks by Neutrosophic Graph. *International Journal of Computational Intelligence Systems*, 13(1), 1699-1713.
23. Majumder, P. (2021). Daily confirmed cases and deaths prediction of novel coronavirus in Asian continent Polynomial Neural Network. In *Biomedical Engineering Tools for Management for Patients with COVID-19* (pp. 163-172). Academic Press.
24. Majumder, P., Biswas, P., & Majumder, S. (2020). Application of New TOPSIS Approach to Identify the Most Significant Risk Factor and Continuous Monitoring of Death of COVID-19. *Electronic Journal of General Medicine*, 17(6).

25. Mallick, R., & Pramanik, S. (2020). Pentapartitioned neutrosophic set and its properties. *Neutrosophic Sets and Systems*, 36, 184-192.
26. Ministry of Health, Covid 19 (2020), https://covid19.saglik.gov.tr/.
27. Mondal, K., & Pramanik, S. (2015). Neutrosophic tangent similarity measure and its application to multiple attribute decision making. *Neutrosophic sets and systems*, 9, 80-87.
28. Mondal, K., Pramanik, S., & Giri, B.C. (2018). Interval neutrosophic tangent similarity measure based MAMD strategy and its application to MAMD problems.*Neutrosophic sets and systems*, 19, 47-53.
29. Mondal, K., Pramanik, S., & Giri, B.C. (2018). Single valued neutrosophic hyperbolic sine similarity measure based MADM strategy. *Neutrosophic Sets and Systems*, 20, 3-11.
30. Mondal, K., Pramanik, S., & Smarandache, F. (2016). Role of neutrosophic logic in data mining. *New Trends in Neutrosophic Theory and Application*. Pons Editions, Brussels, 15-23.
31. Nguyen, P.H., Tsai, J.F., Nguyen, H.P., Nguyen, V.T., & Dao, T.K. (2020). Assessing the Unemployment Problem Using A Grey MCDM Model under COVID-19 Impacts: A Case Analysis from Vietnam. *The Journal of Asian Finance, Economics, and Business*, *7*(12), 53-62.
32. Pramanik, S., Dalapati, S., & Roy, T.K. (2016). Logistics center location selection approach based on neutrosophic multicriteria decision making. *New Trends in Neutrosophic Theory and Application*. Pons Editions, Brussels, 161-174.
33. Pramanik, S., Dalapati, S., & Roy, T.K. (2018). Neutrosophic multi-attribute group decision making strategy for logistic center location selection. *Neutrosophic Operational Research*, Vol. III. Pons Asbl, Brussels, 13-32.
34. Pramanik, S., & Mondal, K. (2015). Cosine similarity measure of rough neutrosophic sets and its application in medical diagnosis. *Global Journal of Advanced Research*, 2(1), 212-220.
35. Pramanik, S., & Mondal, K. (2015). Cotangent similarity measure of rough neutrosophic sets and its application to medical diagnosis. *Journal of New Theory*, 4, 464-471.
36. Raza Hashmi, M., Riaz, M., & Smarandache, F. m-polar Neutrosophic Generalized Weighted and m-polar Neutrosophic Generalized Einstein Weighted Aggregation Operators to Diagnose Coronavirus (COVID-19). *Journal of Intelligent & Fuzzy Systems*, (Preprint), 1-21.
37. Read, J.M., Bridgen, J.R., Cummings, D.A., Ho, A., & Jewell, C.P. (2020). Novel coronavirus 2019-nCoV: early estimation of epidemiological parameters and epidemic predictions. *MedRxiv*.
38. Saadat, S., Rawtani, D., & Hussain, C.M. (2020). Environmental perspective of COVID-19. *Science of The Total Environment*, 138870.
39. Saglietto, A., D'Ascenzo, F., Zoccai, G.B., & De Ferrari, G.M. (2020). COVID-19 in Europe: the Italian lesson. *Lancet*, 395(10230), 1110-1.
40. Smarandache, F. (1998). A unifying field in logics, neutrosophy: neutrosophic probability, set and logic. Rehoboth, *American Research Press*.

41. Tobías, A., Carnerero, C., Reche, C., Massagué, J., Via, M., Minguillón, M.C., & Querol, X. (2020). Changes in air quality during the lockdown in Barcelona (Spain) one month into the SARS-CoV-2 epidemic. *Science of the Total Environment*, 138540.
42. Tripathy, B.C., & Das, S. (2021). Pairwise Neutrosophic *b*-Continuous Function in Neutrosophic Bitopological Spaces. *Neutrosophic Sets and Systems*, 43, 82-92.
43. Wang, H., Smarandache, F., Zhang, Y.Q., & Sunderraman, R. (2010). Single valued neutrosophic sets. *Multispace and Multistructure*, 4, 410-413.
44. World Health Organization. WHO Director-General's opening remarks at the media briefing on COVID-19- 11TH March 2020.
45. Worldometer, Coronavirus, https://www.worldometers.info/coronavirus/country/
46. Ye, J. (2016). Fault diagnoses of steam turbine using the exponential similarity measure of neutrosophic numbers. *Journal of Intelligent & Fuzzy Systems*, 30(4), 1927-1934.
47. Ye, J. (2017). Single-valued neutrosophic similarity measures based on cotangent function and their application in the fault diagnosis of steam turbine. *Soft Computing*, 21(3), 817-825.
48. Ye, J., & Zhang, Q.S. (2014). Single valued neutrosophic similarity measures for multiple attribute decision making. *Neutrosophic Sets and Systems*, 2, 48-54.

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