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Evaluation of E-Commerce Sites using Novel Similarity Measure of Neutrosophic Hypersoft Sets

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Abstract: E-commerce has become a common method of making online purchases. Doorstep delivery, multiple options and variety of products to be bought, discounts and rewards are some of the advantages of online shopping. However, selection of the right shopping website is a challenge for online buyers across all markets. The multiple tangible and intangible factors involved in the e-commerce domain has made it a problem of MCDM. This paper proposes a new MCDM approach to develop a model for the necessary assessment of e-commerce websites. The notion of similarity measures for the single valued neutrosophic hypersoft sets is applied to get the best website on the bases of given criteria. Shopping websites are evaluated at three levels-below average, average and good. The attributes used to evaluate the websites are offers and deals made by the e-commerce sites to present and potential customers, qualitative assessment of the offered products and services, delivery timelines, payment safety and security concerns. Safety of personal data is the attribute which is judged as the most important factor in evaluation of shopping websites.
Keywords: *E-commerce, Similarity measure, Evaluation of shopping website, MCDM.*

1. Introduction

The e-commerce sector has gone under a remarkable evolutionary phase which gives significant impacts on entrepreneurs, bluechip/small-scaled manufacturing industries and ultimately the end-users/consumers. Adoption of internet and e-commerce has increased exponentially over the last few years. In 2022, sales from the e-commerce sector exceeded USD 5.7 trillion. The figure is projected for further increase in coming years. Global online retail sales is projected to exceed USD 7 Trillion by 2025 [1], [2]. Asia has the largest consumer base for the e-commerce market.India has the third largest position in terms of online shoppers base with 150 million in the year 2021. The E-commerce market in India is projected to achieve a growth of 350 billion USD in 2030 as compared to 46.2 billion USD in 2020 [3]. From fashion to groceries, household goods, electronic goods, and bill payments, e-commerce is taking over the traditional retail sector. Number of internet users in India is expected to increase to 320 million by the year 2025 [4]. Despite the robust growth, complete potential is not achieved by the sector. Different challenges like shopping cart abandonment, shifting to other shopping platforms, privacy, security concerns are deterring the growth [5]. Inconsistent, asymmetric and indeterminate information comprise the main limitations of e-commerce. The risks are prevalent not only in B2C but C2C or peer to peer market [6].With information inputs from multiple sources - social media, retail websites, advertisements, it becomes challenging for the consumer to select the best shopping website. Bindia and Daroch [7] outlined the factors affecting online shopping behavior. These include security, lack of trust,privacy policy, website, shopping experience, retailer brand, product information and financial risk. Consumers are skeptical about using online platforms because of cyber frauds, financial risks, hidden costs, long forms [8]. Further, assessment work has been done electric vehicle charge stations in order to enhance the green energy for smart cities [9]. In addition to this, an effective analysis has been done for photovoltaic power plants for the issues of green environment [10].

On the basis of different level survey data defined through a set of questions, various mathematical models have been formulated for obtaining the suitable assessment of the online shopping agencies under the framework of e-commerce services. Such assessments involve several criteria, e.g., "quality of product, cost, shipping services, safety of payments, etc."[11]. Therefore , different researchers have given due considerations on these criteria which are directly connected to access the qualitative aspects of e-commerce online shopping agencies.Since the customer's perceptions and experiences while using the features of e-commerce sectors comprise of precise and imprecise/incomplete both kind of values, therefore any possible judgement must incorporate the content of uncertainty in a considerable amount. For the sake of dealing such scenario, the concept of multi-criteria decision making problem under a certain fuzzified approach would be more useful and considerably better as the decision of buying/not buying is somehow dependent on customer's intuitions, common sense and past-experiences rather than on the crisp, precise and accurate information [12]. This paper presents a Multi Criteria Decision-making (*MCDM*) approach to select the shopping website which has the attributes required by the consumer.

Selection of online shopping platforms is affected by different criteria. Prior studies have identified several factors which affect consumer choice of a particular purchase platform. E-service quality is an important determinant of e-commerce. Different factors which categorized e-service quality are efficiency, fulfillment.compensation.privacy, in store experience contact, system availability, reliability, trust and quality of communication.[13], [14], [15] .Customer satisfaction results in repeat business and positive online reviews which are instrumental in increasing the brand equity [16] Website quality, content, conditions of product return, payment process, rapid response, transaction security issues are some other factors affecting satisfaction level of e commerce consumers [17]. Anushka et al. [18]. have identified ten factors with the help of a five-point fuzzy scale. The factors include fashion deals,product quality, fast shipping, prompt and regular customer care service, return policy, keeping track of the shipped products, refining search options, detailed product description, safe and secure payment options. The criteria are used to rank eight shopping websites Amazon, Flipkart, Myntra, BigBasket, Jabong, Ebay, Snapdeal and Paytm Mall. Safe payments and quality products are given maximum weightage according to the weight criteria matrix. Fuzzy TOPSIS and PROMETHEE are used to rank the websites based on the selected criteria. Amazon gets the highest rank as the most selected shopping website. Ilias O. Pappas[19] studies the impact of perceived trust, privacy and past experience on evaluation of online shopping sites. Fuzzy set analysis. The paper studies the impact of perceived trust, privacy, and past experience on customer purchase intention. The variables are related through a proposed research model, which is validated through fuzzy logic techniques. Ambiguity and uncertainty are the inherent characteristics of online shopping. Trust is an important factor for increased adoption and success of e-commerce sites. Also various extensions of fuzzy sets in terms of hypersoft sets have been done in the literature with applications in the renewable energy, robotic agrifarming [20], [21], [22], [23], [24]. Different factors have been identified in the prior studies to increase customer trust. These factors are existence, fulfillment, affiliation and company policy. Trust is an important factor for successful online transactions. Presence of trust enables the consumers to share their personal information with others. Presence of trust provides better experience even in the case of negative emotions [25]. Customer needs and security issues have gained attention in lieu of the exponential increase in the number of online customers in the last five years. Affective and cognitive factors such as trust and privacy affect consumer evaluation of online consumer sites [26]. The study highlights the importance of trust, user experience and privacy in defining the behavioral intention of online consumers. Another study by Aydın, Serhat & Kahraman, Cengiz [27] has identified ten criteria for assessing the shopping website. These include ease of use , product quality detail, security, privacy, customer relationship, accurate delivery, billing and safe payment gateways. A holistic approach is required to study the impact of these factors on online buyers' behavior. Researchers like Liang, R., Wang, J., & Zhang, H [28] have used *MCDM* techniques such as SVTN-DEMATEL module to show the relationship between different criteria, highlighting different priority areas.Prior studies on the topic use symmetric analysis tools based on regression like sequential equation modeling (SEM) or multiple regression analysis (MRA). Also, decision-making in neutrosophic topologies have been done along with the most influential sector of Industry 5.0 [29], [30], [31]. However, symmetric tests can be misleading in certain cases. Same technological factors may affect consumers differently. Thus a combination of factors needs to be studied to explain the complex consumer behavior. To address this gap fuzzy networks have been applied to provide a more comprehensive and exhaustive analysis.The paper attempts to propose a method for evaluation and selection of the shopping website that matches the attributes selected by the consumers. Multiple Criteria Decision-making (*MCDM*) approach employing similarity measures of is applied as the main method for data analysis. Fuzzy logic is a qualitative method to analyze complex system behaviors and patterns. It uses multi valued logic to develop effective reasoning and better decision making models [12]. The study uses fuzzy logic analysis to identify the configuration of perceived trust, privacy and user experience in influencing the levels of consumer perception in online buying. The tools are useful in explaining the complex relation among different research variables.Shopping websites are analyzed at three levels- below average, average and good. The attributes used to evaluate the websites are offers and deals offered by the ecommerce sites to their customers, qualitative assessment of the offered products and services, delivery timelines, payment safety and security concerns. Safety of personal data is the attribute which is judged as the most important factor in evaluation of shopping websites.

Novelty and Contribution of the present study

A novel type of similarity measure for single-valued neutrosophic sets has been prosposed for handling the formulated MCDM problem. The proposed notional description of similarity measures for the neutrosophic sets have been utilized in the evaluation of e-commerce sectors and are being integrated in decision-making methodology under a neutrosophic hypersoft setup.

In the present study, the prime focus of the work is to go for the assessment of e-commerce sites by utilizing the similarity measures for neutrosophic hypersoft sets:

- Introducing a new parametrized similarity for neutrosophic hypersoft sets.
- First, the proposed similarity measure has been proved mathematically on certain axioms for validation.
- Further, the proposed similarity measures have been successfully implemented in the evaluation for the e-commerce sites.

The paper's structure is: Section 2 presents fundamental definitions in connection with the proposed measure. Section 3 involves some binary operations and novel similarity measures of *SVNHSS* along with its proof of validation. Section 4 discusses the research methodology of the *MCDM* problem. Section 5 provides details of data analysis using the proposed similarity measure of *SVNHSS* in the E-commerce sector. Section 6 discusses the findings in the form of major conclusions, limitations and future scope.

2. Preliminaries

Definition 1. *[32]"Let X be the universal set and $P(X)$ be the power set of X. Consider $k^1, k^2, \dots, k^n$ for $n \geq 1$ be n well-defined attributes whose corresponding attribute values are respectively the sets $K^1, K^2, \dots, K^n$ with $K^i \cap K^j = \emptyset$, for $i \neq j$ and $i, j \in \{1,2,..,n\}$, then the pair $(\mathfrak{R}, K^1 \times K^2 \times \dots \times K^n)$ is said to be Hypersoft set over the set X, where $\mathfrak{R} : K^1 \times K^2 \times \dots \times K^n \to P(X)$."*

Definition 2. *[32]"Let $X = \{x_1, x_2, \dots, x_n\}$ be the universal set and $P(X)$ be the power set of X. Consider $K_1, K_2, \dots, K_m$ for $m \geq 1$ be m well-defined attributes whose corresponding attribute values are respectively the sets $K_1^a, K_2^b, \dots, K_m^z$ with the relation $K_1^a \times K_2^b \times \dots \times K_m^z = \Gamma$, where a, b, c, …, z = 1,2,..,n. Then the pair $(\mathfrak{R}, \Gamma)$ is said to be Neutrosophic Hypersoft set (NHSS) over X, where, $\mathfrak{R} : K_1^a \times K_2^b \times \dots \times K_m^z \to P(X)$ and $\mathfrak{R}(K_1^a \times K_2^b \times \dots \times K_m^z) = \{\langle x, T_{\mathfrak{R}(\xi)}(x), I_{\mathfrak{R}(\xi)}(x), F_{\mathfrak{R}(\xi)}(x)\rangle, x \in X, \xi \in \Gamma\}$; where T is the degree of truthness, I is the degree of indeterminacy and F is the degree of falsity such that T, I, F : $V \to (0^-, 1^+)$ and satisfies the constraint $0^- \leq T_{\mathfrak{R}(\xi)}(x) + I_{\mathfrak{R}(\xi)}(x) + F_{\mathfrak{R}(\xi)}(x)) \leq 3^+$.*

While dealing with applications of science and engineering, it becomes very difficult to handle situations under a neutrosophic environment. In order to deal with such situations notion of Single-Valued Neutrosophic HyperSoft sets ($SVNHSS$) is very useful and applicable."

Definition 3. *[33]"Let $X = \{x_1, x_2, \dots, x_n\}$be the universal set and $P(X)$be the power set of X. Consider $K_1, K_2, \dots, K_m$ for $m \geq 1$ be m well-defined attributes whose corresponding attribute values are respectively the sets $K_1^a, K_2^b, \dots, K_m^z$ with the relation $K_1^a \times K_2^b \times \dots \times K_m^z = \Gamma$, where a, b, c, …, z = 1,2,..,n. Then the pair $(\mathfrak{R}, \Gamma)$ is said to be a Single-Valued Neutrosophic Hypersoft set ($SVNHSS$)over X, where, $\mathfrak{R} : K_1^a \times K_2^b \times \dots \times K_m^z \to P(X)$ and $\mathfrak{R}(K_1^a \times K_2^b \times \dots \times K_m^z) = \{\langle x, T_{\mathfrak{R}(\xi)}(x), I_{\mathfrak{R}(\xi)}(x), F_{\mathfrak{R}(\xi)}(x)\rangle, x \in X, \xi \in \Gamma\}$; where T is the degree of truthness, I is the degree of indeterminacy and F is the degree of falsity such that T, I, F : $V \to [0, 1]$ and satisfies the constraint $0 \leq T_{\mathfrak{R}(\xi)}(x) + I_{\mathfrak{R}(\xi)}(x) + F_{\mathfrak{R}(\xi)}(x)) \leq 3$."*

Definition 4.*[30]"Consider A and B be two single-valued neutrosophic sets, then the axiomatic definition of similarity measure are as follows:*

i. $0 \leq \mathbb{S}(A, B) \leq 1$;

ii. $\mathbb{S}(A, A) = 1$.

iii. $\mathbb{S}(A, B) = \mathbb{S}(B, A) \ \forall \ B \in SVNS(X)$.

iv. *If* $A \subseteq B \subseteq C, \forall \ C \in SVNS(X)$, $\mathbb{S}(A, C) \leq \mathbb{S}(A, B)$ *and* $\mathbb{S}(A, C) \leq \mathbb{S}(B, C)$."

3. Binary Operations and Similarity Measure of Neutrosophic Hypersoft Sets

Some binary algebraic operations on $SVNHSSs$ have been presented where $SVNHSS(X)$ represents a collection of SVNHSSs over X. For $A, B \in SVNHSS(X)$, we present the operations as below:

• "**Union of** A **and** B":$A \cup B = \{x, \ T_{A\cup B}(\mathfrak{R}(\Gamma)), \ I_{A\cup B}(\mathfrak{R}(\Gamma)), \ F_{A\cup B}(\mathfrak{R}(\Gamma)) | \ x \in X \ \}$

where,

$$T_{A\cup B}(\mathfrak{R}(\Gamma))(x) = max\{T_A(\mathfrak{R}(\Gamma))(x), \quad T_B(\mathfrak{R}(\Gamma))(x)\} \ , I_{A\cup B}(\mathfrak{R}(\Gamma))(x) = min\{I_A(\mathfrak{R}(\Gamma))(x), \quad I_B(\mathfrak{R}(\Gamma))(x)\}$$

and $F_{A\cup B}(\mathfrak{R}(\Gamma))(x) = min\{F_A(\mathfrak{R}(\Gamma))(x), \ F_B(\mathfrak{R}(\Gamma))(x)\} \forall \ x \ \in X$.

• "**Intersection of** A **and** B":$A \cap B = \{x, \ T_{A\cap B}(\mathfrak{R}(\Gamma)), \ I_{A\cap B}(\mathfrak{R}(\Gamma)), \ F_{A\cap B}(\mathfrak{R}(\Gamma)) | \ x \in X \ \}$

where,

$$T_{A\cap B}(\mathfrak{R}(\Gamma))(x) = min\{T_A(\mathfrak{R}(\Gamma))(x), \quad T_B(\mathfrak{R}(\Gamma))(x)\} \ , I_{A\cap B}(\mathfrak{R}(\Gamma))(x) = max\{I_A(\mathfrak{R}(\Gamma))(x), \quad I_B(\mathfrak{R}(\Gamma))(x)\}$$

and $F_{A\cap B}(\mathfrak{R}(\Gamma))(x) = max\{F_A(\mathfrak{R}(\Gamma))(x), \ F_B(\mathfrak{R}(\Gamma))(x)\} \forall \ x \ \in X$.

•**Containment:**$A \subseteq B$ if and only if

$$T_A(\mathfrak{R}(\Gamma))(x) \leq T_B(\mathfrak{R}(\Gamma))(x), \ \ I_A(\mathfrak{R}(\Gamma))(x) \geq I_B(\mathfrak{R}(\Gamma))(x), \ \ F_A(\mathfrak{R}(\Gamma))(x) \geq F_B(\mathfrak{R}(\Gamma))(x) \forall \ x \in X.$$

• "**Complement:**

$$T_{\bar{A}}(\mathfrak{R}(\Gamma))(x) = 1 - \ T_A(\mathfrak{R}(\Gamma))(x), \ I_{\bar{A}}(\mathfrak{R}(\Gamma))(x) = 1 - \ I_A(\mathfrak{R}(\Gamma))(x), \ F_{\bar{A}}(\mathfrak{R}(\Gamma))(x) = 1 - F_A(\mathfrak{R}(\Gamma))(x)".$$

Further, we propose a new similarity measure for two $SVNHSSA$ and B,

$$\mathbb{S}(A, B) = \frac{1}{nm} \sum_{i=1}^{n} \sum_{j=1}^{m} \frac{1 - \frac{1}{2}\left[\left(\min\left\{\left|T_{A(\xi_j^s)}(x^i) - T_{B(\xi_j^s)}(x^i)\right|, \left|I_{A(\xi_j^s)}(x^i) - I_{B(\xi_j^s)}(x^i)\right|\right\} + \left|F_{A(\xi_j^s)}(x^i) - F_{B(\xi_j^s)}(x^i)\right|\right)\right]}{1 + \frac{1}{2}\left[\left(\max\left\{\left|T_{A(\xi_j^s)}(x^i) - T_{B(\xi_j^s)}(x^i)\right|, \left|I_{A(\xi_j^s)}(x^i) - I_{B(\xi_j^s)}(x^i)\right|\right\} + \left|F_{A(\xi_j^s)}(x^i) - F_{B(\xi_j^s)}(x^i)\right|\right)\right]} \tag{1}$$

where, $j = 1,2, \dots, m; i = 1,2, \dots, n; s = a, b, \dots, z; z = 1,2, \dots, n$ and $\xi_j^s \in \ K_1^a \times K_2^b \times \dots \times \ K_m^z$.

Theorem 1.*The above-proposed similarity measure* $\mathbb{S}(A, B)$ *given in* (1) *is a valid similarity measure of* $SVNHSSs$.

Proof: Refer Section 2, we establish the axioms provided for checking the validity.

The axioms *(i)* and *(ii)* immidiately follows from the definition of the proposed measure.

(iii) Here, we assume that $A = B$.

Then, $T_{A(\xi_j^s)}(x^i) = T_{B(\xi_j^s)}(x^i)$, $I_{A(\xi_j^s)}(x^i) = I_{B(\xi_j^s)}(x^i)$, $F_{A(\xi_j^s)}(x^i) = F_{B(\xi_j^s)}(x^i)$.

$$\Rightarrow \quad \mathbb{S}(A,B) = 1.$$

Conversely, let $\mathbb{S}(A,B) = 1$.

$$\Rightarrow \frac{1-\frac{1}{2}\left[\left(\min\left\{\left|T_{A(\xi_j^s)}(x^i) - T_{B(\xi_j^s)}(x^i)\right|, \left|I_{A(\xi_j^s)}(x^i) - I_{B(\xi_j^s)}(x^i)\right|\right\} + \left|F_{A(\xi_j^s)}(x^i) - F_{B(\xi_j^s)}(x^i)\right|\right)\right]}{1+\frac{1}{2}\left[\left(\max\left\{\left|T_{A(\xi_j^s)}(x^i) - T_{B(\xi_j^s)}(x^i)\right|, \left|I_{A(\xi_j^s)}(x^i) - I_{B(\xi_j^s)}(x^i)\right|\right\} + \left|F_{A(\xi_j^s)}(x^i) - F_{B(\xi_j^s)}(x^i)\right|\right)\right]} = 1,$$

$$\Rightarrow 1-\frac{1}{2}\left[\left(\min\left\{\left|T_{A(\xi_j^s)}(x^i) - T_{B(\xi_j^s)}(x^i)\right|, \left|I_{A(\xi_j^s)}(x^i) - I_{B(\xi_j^s)}(x^i)\right|\right\} + \left|F_{A(\xi_j^s)}(x^i) - F_{B(\xi_j^s)}(x^i)\right|\right)\right] = 1 +$$
$$\frac{1}{2}\left[\left(\max\left\{\left|T_{A(\xi_j^s)}(x^i) - T_{B(\xi_j^s)}(x^i)\right|, \left|I_{A(\xi_j^s)}(x^i) - I_{B(\xi_j^s)}(x^i)\right|\right\} + \left|F_{A(\xi_j^s)}(x^i) - F_{B(\xi_j^s)}(x^i)\right|\right)\right],$$

$$\Rightarrow \frac{1}{2}\left[\left(\min\left\{\left|T_{A(\xi_j^s)}(x^i) - T_{B(\xi_j^s)}(x^i)\right|, \left|I_{A(\xi_j^s)}(x^i) - I_{B(\xi_j^s)}(x^i)\right|\right\} + \left|F_{A(\xi_j^s)}(x^i) - F_{B(\xi_j^s)}(x^i)\right|\right)\right] +$$
$$\frac{1}{2}\left[\left(\max\left\{\left|T_{A(\xi_j^s)}(x^i) - T_{B(\xi_j^s)}(x^i)\right|, \left|I_{A(\xi_j^s)}(x^i) - I_{B(\xi_j^s)}(x^i)\right|\right\} + \left|F_{A(\xi_j^s)}(x^i) - F_{B(\xi_j^s)}(x^i)\right|\right)\right]=0,$$

$$\Rightarrow \left|T_{A(\xi_j^s)}(x^i) - T_{B(\xi_j^s)}(x^i)\right| = 0, \left|I_{A(\xi_j^s)}(x^i) - I_{B(\xi_j^s)}(x^i)\right| = 0, \text{ and } \left|F_{A(\xi_j^s)}(x^i) - F_{B(\xi_j^s)}(x^i)\right| = 0,$$

$$\Rightarrow \quad A = B.$$

(iv) Let $A \subseteq B \subseteq C$,

$$\Rightarrow \left|T_{A(\xi_j^s)}(x^i) - T_{B(\xi_j^s)}(x^i)\right| \le \left|T_{A(\xi_j^s)}(x^i) - T_{C(\xi_j^s)}(x^i)\right|, \ \left|I_{A(\xi_j^s)}(x^i) - I_{B(\xi_j^s)}(x^i)\right| \le \left|I_{A(\xi_j^s)}(x^i) - I_{C(\xi_j^s)}(x^i)\right|$$

and $\left|F_{A(\xi_j^s)}(x^i) - F_{B(\xi_j^s)}(x^i)\right| \le \left|F_{A(\xi_j^s)}(x^i) - F_{C(\xi_j^s)}(x^i)\right|$,

$$\Rightarrow \min\left\{\left|T_{A(\xi_j^s)}(x^i) - T_{B(\xi_j^s)}(x^i)\right|, \left|I_{A(\xi_j^s)}(x^i) - I_{B(\xi_j^s)}(x^i)\right|\right\} + \left|F_{A(\xi_j^s)}(x^i) - F_{B(\xi_j^s)}(x^i)\right|$$
$$\le \min\left\{\left|T_{A(\xi_j^s)}(x^i) - T_{C(\xi_j^s)}(x^i)\right|, \left|I_{A(\xi_j^s)}(x^i) - I_{C(\xi_j^s)}(x^i)\right|\right\} + \left|F_{A(\xi_j^s)}(x^i) - F_{C(\xi_j^s)}(x^i)\right|$$

and $\max\left\{\left|T_{A(\xi_j^s)}(x^i) - T_{B(\xi_j^s)}(x^i)\right|, \left|I_{A(\xi_j^s)}(x^i) - I_{B(\xi_j^s)}(x^i)\right|\right\} + \left|F_{A(\xi_j^s)}(x^i) - F_{B(\xi_j^s)}(x^i)\right| \le \max\left\{\left|T_{A(\xi_j^s)}(x^i) -\right.\right.$

$\left.\left.T_{C(\xi_j^s)}(x^i)\right|, \left|I_{A(\xi_j^s)}(x^i) - I_{C(\xi_j^s)}(x^i)\right|\right\} + \left|F_{A(\xi_j^s)}(x^i) - F_{C(\xi_j^s)}(x^i)\right|$,

$$\Rightarrow 1-\frac{1}{2}[\min\left\{\left|T_{A(\xi_j^s)}(x^i)-T_{B(\xi_j^s)}(x^i)\right|,\left|I_{A(\xi_j^s)}(x^i)-I_{B(\xi_j^s)}(x^i)\right|\right\}+\left|F_{A(\xi_j^s)}(x^i)-F_{B(\xi_j^s)}(x^i)\right|]$$
$$\geq 1-\frac{1}{2}[\min\left\{\left|T_{A(\xi_j^s)}(x^i)-T_{C(\xi_j^s)}(x^i)\right|,\left|I_{A(\xi_j^s)}(x^i)-I_{C(\xi_j^s)}(x^i)\right|\right\}+\left|F_{A(\xi_j^s)}(x^i)-F_{C(\xi_j^s)}(x^i)\right|]$$

and $1+\frac{1}{2}[\max\left\{\left|T_{A(\xi_j^s)}(x^i)-T_{B(\xi_j^s)}(x^i)\right|,\left|I_{A(\xi_j^s)}(x^i)-I_{B(\xi_j^s)}(x^i)\right|\right\}+\left|F_{A(\xi_j^s)}(x^i)-F_{B(\xi_j^s)}(x^i)\right|]\leq 1+\frac{1}{2}[\max\left\{\left|T_{A(\xi_j^s)}(x^i)-T_{C(\xi_j^s)}(x^i)\right|,\left|I_{A(\xi_j^s)}(x^i)-I_{C(\xi_j^s)}(x^i)\right|\right\}+\left|F_{A(\xi_j^s)}(x^i)-F_{C(\xi_j^s)}(x^i)\right|]$

$\Rightarrow \mathbb{S}(A,C)\leq\mathbb{S}(A,B)$. On the similar lines, we can prove $\mathbb{S}(A,C)\leq\mathbb{S}(B,C)$.

Remark: Also, a tangent similar measure between the two $SVNHSSA$ and $B$is given by,

$$\mathbb{T}(A,B)=\frac{1}{nm}\sum_{i=1}^{n}\sum_{j=1}^{m}\left[1-tan\frac{\pi}{12}\left(\left|T_{A(\xi_j^s)}(x^i)-T_{B(\xi_j^s)}(x^i)\right|+\left|I_{A(\xi_j^s)}(x^i)-I_{B(\xi_j^s)}(x^i)\right|+\left|F_{A(\xi_j^s)}(x^i)-F_{B(\xi_j^s)}(x^i)\right|\right)\right]$$

where, $j=1,2,\dots,m; i=1,2,\dots,n; s=a,b,\dots,z; z=1,2,\dots,n$ and $\xi_j^s\in K_1^a\times K_2^b\times\ldots\times K_m^z$. The validity of this trigonometric similarity measure can be done as above.

4. Implementation of the Proposed Similarity Measure in the MCDM Problem

The procedural phase wise computation involved in the proposed methodology has been elaborated through Figure 1. Let us assume that there are m alternatives $\{Y_1,Y_2,\dots,Y_m\}$ and n attributes $K^1,K^2,\dots,K^n$ and "whose corresponding attribute values are respectively the sets $K_1^a,K_2^b,\dots,K_m^z$ with the relation $K_1^a\times K_2^b\times\ldots\times K_m^z=\Gamma$, where *a, b, c, …, z = 1,2,..,n.*"The set of all possible $SVNHSSs$ are given by $(\mathfrak{R},\Gamma)$, where $\Gamma=K_1^a\times K_2^b\times\ldots\times K_m^z$. The objective of a decision-maker is to select the most appropriate choice among the available alternatives from the set of available ones satisfying the given attribute values. The decisions in the form of an information from all the decision-makers are tabulated in a matrix format, say, $H=[h_{ij}]_{m\times n}$ called single-valued neutrosophic hypersoft matrix where $h_{ij}=(T_{\mathfrak{R}(\xi)}(x)_{ij},\ I_{\mathfrak{R}(\xi)}(x)_{ij},\ F_{\mathfrak{R}(\xi)}(x)_{ij})$. The procedure of the proposed methodology has been presented in Figure 1 below:

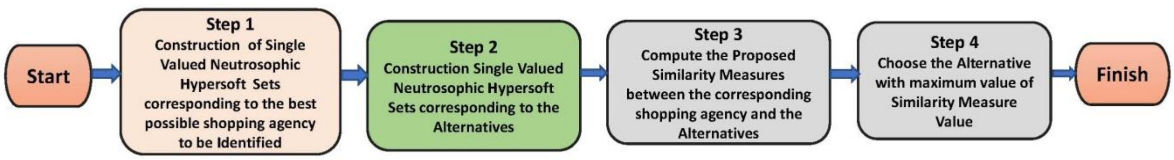

Figure 1: Methodology of MCDM

Step 1: Construction of a decision matrix on the basis of prescribed information in the form of SVNHSS.

Step 2: Further, we eliminate the heterogeneity present in the attributes & transform it in its homogenous form for the attribute. Next, the decision matrix $H=[h_{ij}]_{m\times n}$ has been changed to a revised decision matrix $H'=[h'_{ij}]_{m\times n}$ such that h'_{ij} is given by

$$h'_{ij} = \left(T_{\mathfrak{R}(\xi)}(x)_{ij}, I_{\mathfrak{R}(\xi)}(x)_{ij}, F_{\mathfrak{R}(\xi)}(x)_{ij}\right) = \begin{cases} \mathrm{h_{ij}} \; ; & \text{for benefit criteria} \\ \mathrm{h_{ij}}^{c} \; ; & \text{for cost criteria.} \end{cases}$$

Step 3: We evaluate the score from the proposed measure for the $Y_i's$ respectively with the sub-attributes on one to one basis.

Step 4: Finally, the necessary ranking of alternatives may be worked out on the basis of the score values obtained from the similarity measure.

5. Use of Proposed Similarity Measures in E-commerce sector.

On the basis of the methodology discussed above, we move on for the assessment of the best possible e-shopping agencies based on the similarity measure for $SVNHSSs$. Let there are four e-shopping agencies $\{Y_1, Y_2, Y_3, Y_4\}$. Suppose there are three stages of selectionfor assessing the shoping agencies as $below \;\; average(x^1)$, $average(x^2)$ and $good(x^3)$. The universal set $X = \{x^1, x^2, x^3\}$. Let $K = \{K^1 = captivating \;\; offers \;\; or \;\; deals, \;\; K^2 = qualitative \;\; assessment \;\; of \;\; items, \;\; K^3 = on \;\; time \;\; delivery, \;\; K^4 = paying \;\; safety \;\&\; security \;\; \}$ be a group of criterions which are categorized with sub-attributes:

$$K^1 = \text{“}captivating \;\; offers \;\; or \;\; deals = \{trendy, \quad elegant\}\text{”}$$

$$K^2 = \text{“}qualitative \;\; assessment \;\; of \;\; items = \{test \;\; automation, defect \;\; rate, mean \;\; time \;\; to \;\; green\}\text{”}$$

$$K^3 = \text{“}on \;\; time \;\; delivery\text{”}$$

$$K^4 = \text{“}paying \;\; safety \;\&\; security = \{online \;\; payment, \quad pay \;\; on \;\; delivery \;\; option, \; assurance \;\; of \;\; safety \;\; of \;\; personal \;\; data \;\; of \;\; customers \;\}\text{”}$$

Now, let us define a relation $\mathfrak{R} : K_1^a \times K_2^b \times \ldots \times \;\; K_m^z \to P(X)$ defined as,

$\mathfrak{R} \;\; (K_1^a \times K_2^b \times \ldots \times \;\; K_m^z) = \{\xi = elegant, \zeta = test \;\; automation, \varrho = on \;\; time \;\; delivery, \varsigma = assurance \;\; of \;\; safety \;\; of \;\; personal \;\; data \;\; of \;\; customers\}$ is the most prominent choice of the sub-attributes for the assessment of online shopping agencies.

Step1: Let $(\mathfrak{R}, \Gamma)$ be a $SVNHSS(X)$ for best possible online shopping agency prepared with the help of experts in the field of e-commerce sector as given in Table 1.

Table 1. $SVNHSS(\mathfrak{R}, \Gamma)$ for best possible online shopping agency

$(\mathfrak{R}, \Gamma)$	K^1	K^2	K^3	K^4
x^1	$\xi(0.4,0.2,0.3)$	$\zeta(0.3,0.4,0.3)$	$\varrho(0.7,0.1,0.2)$	$\varsigma(0.4,0.2,0.3)$
x^2	$\xi(0.5,0.1,0.3)$	$\zeta(0.1,0.8,0.1)$	$\varrho(0.4,0.3,0.2)$	$\varsigma(0.5,0.2,0.3)$
x^3	$\xi(0.3,0.5,0.1)$	$\zeta(0.1,0.2,0.7)$	$\varrho(0.1,0.6,0.2)$	$\varsigma(0.5,0.4,0.1)$

The $SVNHSSs$ for the patients/subjects under observation are tabulated in Table 2-Table 5.

Table 2. $SVNHSS(\mathfrak{R}, \Gamma)$ for the shopping agency Y_1

$(\mathfrak{R}, \Gamma)$	K^1	K^2	K^3	K^4
x^1	$\xi(0.5,0.2,0.3)$	$\zeta(0.8,0.1,0.0)$	$\varrho(0.2,0.7,0.1)$	$\varsigma(0.9,0.1,0.0)$
x^2	$\xi(0.3,0.1,0.5)$	$\zeta(0.2,0.8,0.0)$	$\varrho(0.5,0.2,0.2)$	$\varsigma(0.6,0.1,0.2)$
x^3	$\xi(0.4,0.5,0.1)$	$\zeta(0.7,0.2,0.0)$	$\varrho(0.3,0.6,0.1)$	$\varsigma(0.4,0.5,0.1)$

Table 3. $SVNHSS(\mathfrak{R}, \Gamma)$ for the shopping agency Y_2

$(\mathfrak{R},\Gamma)$	K^1	K^2	K^3	K^4
x^1	$\xi(0.2,0.6,0.2)$	$\zeta(0.2,0.5,0.3)$	$\varrho(0.6,0.1,0.2)$	$\varsigma(0.7,0.2,0.1)$
x^2	$\xi(0.3,0.4,0.3)$	$\zeta(0.2,0.6,0.2)$	$\varrho(0.4,0.3,0.2)$	$\varsigma(0.5,0.2,0.3)$
x^3	$\xi(0.8,0.1,0.1)$	$\zeta(0.1,0.2,0.7)$	$\varrho(0.1,0.6,0.2)$	$\varsigma(0.8,0.1,0.1)$

Table 4. $SVNHSS(\mathfrak{R},\Gamma)$ for the shopping agency Y_3

$(\mathfrak{R},\Gamma)$	K^1	K^2	K^3	K^4
x^1	$\xi(0.3,0.4,0.3)$	$\zeta(0.2,0.6,0.1)$	$\varrho(0.3,0.6,0.0)$	$\varsigma(0.4,0.2,0.3)$
x^2	$\xi(0.5,0.1,0.3)$	$\zeta(0.1,0.8,0.1)$	$\varrho(0.4,0.3,0.2)$	$\varsigma(0.5,0.2,0.3)$
x^3	$\xi(0.5,0.5,0.0)$	$\zeta(0.2,0.0,0.8)$	$\varrho(0.4,0.5,0.1)$	$\varsigma(0.4,0.4,0.1)$

Table 5. $SVNHSS(\mathfrak{R},\Gamma)$ for the shopping agency Y_4

$(\mathfrak{R},\Gamma)$	K^1	K^2	K^3	K^4
x^1	$\xi(0.9,0.0,0.1)$	$\zeta(0.2,0.6,0.1)$	$\varrho(0.6,0.1,0.2)$	$\varsigma(0.5,0.2,0.2)$
x^2	$\xi(0.3,0.5,0.2)$	$\zeta(0.4,0.0,0.6)$	$\varrho(0.2,0.3,0.5)$	$\varsigma(0.7,0.2,0.1)$
x^3	$\xi(0.4,0.3,0.3)$	$\zeta(0.4,0.2,0.4)$	$\varrho(0.3,0.6,0.1)$	$\varsigma(0.0,0.1,0.9)$

Step 2: There is no requirement of excercising the normalization process as the given attributes are benefit type.

Step 3: Next, the proposed similarity measure has been utilized for computing the values of the similarity for various shopping agencies. In view of the proposed similarity measure (1), it is calculated that $\mathbb{S}(\mathfrak{R},Y_1) = 0.3457$ for theshopping agency Y_1, $\mathbb{I}_\gamma(\mathfrak{R},Y_2) = 0.6243$ for theshopping agency Y_2, $\mathbb{I}_\gamma(\mathfrak{R},Y_3) = 0.4892$ for theshopping agency Y_3 and $\mathbb{I}_\gamma(\mathfrak{R},Y_4) = 0.8657$ for theshopping agency Y_4.

Step 4: The maximum similarity measure is 0.8657 which is in reference with the shopping agency Y_1. Therefore, among all the four shopping agencies, Y_1 is the best possible shopping agency on the basis of the given criterions.

The following Table 6 breifly makes the indication in terms of benefits of utilizing the proposed notion and its analogous methodology in contrast with the available ones:

Table 6: Characteristic Comparitive Observations

Authors	**Information Measures**	**Truthiness**	**Indeterminacy**	**Falsity**	**Sub-Attributes**
Ohlan et al. [34]	"*Fuzzy Sets*"	Yes	No	No	No
Kadian et al. [35]	"*Intuitionistic Fuzzy Sets*"	Yes	No	Yes	No
Montes et al.[36]	"*Picture Fuzzy Sets*"	Yes	No	Yes	No
Proposed	"*Single-valued Neutrosophic Hypersoft Sets*"	Yes	Yes	Yes	Yes

6. Conclusion & Scope for Future Work

Evaluation method for selecting the best shopping website based on the needs of the customers is highly required in e-commerce sector. The characteristics defining a website quality can be both tangible and intangible. Making the evaluation process a multi-criteria decision making (MCDM) problem. The paper has employed fuzzy logic method of similarity measures of $SVNHSSs$ to assist the consumer in selection of the shopping website which is bets suited to their needs.The paper has added to the existing research on the topic by employing innovative data analysis method like fuzzy set analysis, which can be a better alternative to conventional methods based on variance [18]. The method can be used by the e –commerce vendors and consumers to evaluate the shopping platforms in the light of required attributes. E-comerce service providers can identify the main impact factors useful for framing customer centric strategies. However,selection of limited attributes is the major limitation in the present study. Including more attributes representing diverse areas and concerns of e-commerce can be undertaken in the future studies.

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