

Chapter 3

Entropy-Based Multi-Criteria Decision-Making Approach Using Neutrosophic Soft Set Matrices for Poultry Production Evaluation

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Abstract

Decision-making under uncertainty is a challenging task, especially in complex environments such as agricultural production systems where multiple factors and human judgments influence outcomes. This paper introduces an entropy-based multi-criteria decision-making (MCDM) framework using neutrosophic soft set matrices to evaluate poultry farm performance across different markets. The proposed method integrates two neutrosophic soft set matrices representing expert assessments from distinct marketplaces and applies neutrosophic arithmetic operators to obtain a crisp decision matrix. The entropy method is employed to determine the weights of decision parameters objectively, followed by computation of score values for ranking alternatives. A comprehensive numerical example is presented, involving eight poultry farms and eight criteria representing different domestic fowls. The results demonstrate that the third alternative yields the highest score, indicating superior production performance. This model effectively captures uncertainty, indeterminacy, and inconsistency inherent in

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real-world decision-making, providing a robust and flexible framework for agricultural and industrial evaluations.

Keywords: Entropy method, Multi-criteria decision-making (MCDM), Neutrosophic soft set matrices, Poultry production evaluation, Decision support systems.

1. Introduction

Decision-making problems in real-life scenarios often involve uncertainty, imprecision, and incomplete information. Traditional mathematical tools such as fuzzy sets and intuitionistic fuzzy sets address uncertainty to a certain extent but fail to fully capture the indeterminate and inconsistent information present in complex environments. To overcome these limitations, neutrosophic sets, introduced by Smarandache, provide a more generalized and flexible structure by considering three independent membership components—truth, indeterminacy, and falsity. When combined with soft set theory, neutrosophic soft sets offer a powerful approach to handling multi-criteria decision-making problems where both qualitative and quantitative factors are involved.

In practical domains like poultry production, decision-makers frequently face uncertainty due to fluctuating market demands, diverse environmental conditions, and inconsistent expert opinions. Evaluating multiple poultry farms based on different types of domestic fowls—such as chickens, ducks, geese, and turkeys—requires a mathematical framework capable of managing ambiguity while maintaining decision reliability.

This study proposes a neutrosophic soft set-based decision-making model enhanced with entropy weighting to objectively determine the importance of criteria. The methodology involves constructing two

neutrosophic soft set matrices from two expert evaluations corresponding to two distinct markets. These matrices are combined using neutrosophic arithmetic operators to obtain a unified decision matrix, from which entropy-based weights are computed. Subsequently, the score values of alternatives are derived to rank the poultry farms according to their performance.

The proposed approach not only ensures objectivity and accuracy in weight assignment but also effectively deals with uncertainty through neutrosophic representation. The numerical example demonstrates the applicability and efficiency of the method in identifying the best-performing poultry farm among several alternatives.

2. Preliminary

Definition 2.1 (Soft set)

Let U be an initial universe set and E be a set of parameters. Let $P(U)$ denote the power set of U . Then if $A \subseteq E$, a pair (F, A) is called a soft set over U , where $F: A \rightarrow P(U)$.

Example 2.1.1: Let $X = \{x_1, x_2, x_3, x_4, x_5, x_6\}$ be the universe which are six carpets and $E = \{e_1, e_2, e_3, e_4, e_5, e_6\}$ be the set of parameters. Here, $e_i (i = 1, 2, 3, 4, 5, 6)$ stands for the

Parameters “modern”, “woollen”, “expensive”, “cheap”, “large” and “beautiful” respectively. Then, following soft sets are described respectively

$$f_A = \{(e_1, \{x_1, x_4, x_5\}), (e_2, \{x_1, x_3, x_5, x_6\}), (e_4, \{x_2, x_4, x_6\})\}$$

$$f_B = \{(e_2, \{x_1, x_3, x_5\}), (e_3, X), (e_6, \{x_2, x_4, x_5, x_6\})\}$$

Definition 2.2 (Neutrosophic set)

Let X be a space of points (objects), with a generic element

in X denoted by x . A neutrosophic set A on the universe of discourse X is defined as

$$A = \{x, T_A(x), I_A(x), F_A(x) / x \in X\}$$

Where $T_A(x), I_A(x), F_A(x): X \rightarrow (0, 1)$ and $-0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$. From the neutrosophic set takes the value from real standard or non-standard subsets of $]-0, 1[$. T_A (Truth), I_A (Indeterminacy), F_A (falsity) are called neutrosophic components.

Example 2.2.1 Let us assume that $X = \{m_1, m_2, m_3\}$ be the characteristics of the product where m_1 the quality of the product, m_2 is the price of the product and m_3 is reliability of a product. Also m_1, m_2, m_3 are in $[0, 1]$ and they are obtained from questionnaire of some researchers. The researchers may impose their opinion in three components i.e., the degree of goodness, the degree of indeterminacy and that of poorness to explain the characteristics of the product. Suppose A is a neutrosophic set of X such that,

$A = \{(m_1, 0.8, 0.6, 0.4), (m_2, 0.6, 0.3, 0.2), (m_3, 0.7, 0.6, 0.3)\}$ Where, the degree of goodness of quality is 0.8, degree of indeterminacy of quality is 0.6 and degree of falsity of quality is 0.4 etc.

Definition 2.3 (Neutrosophic soft set)

Let U be an initial universe set and E be a set of parameters. Let $N(U)$ denote the set of all neutrosophic soft set $f U$. Then for $A \subseteq E$, Then the collection of (F, A) is called an **Neutrosophic soft set** (N_{ss}) over U , where $F: A \rightarrow N(U)$.

Example 2.3.1 Let U be an universal set $U = \{m_1, m_2, m_3, m_4, m_5\}$ be five different oil makers and $E = \{e_1, e_2, e_3, e_4\}$ be a set of parameters representing the different kind of oils like coconut oil, sesame oil, sunflower oil, groundnut oil. Now the expert E_1 is evaluating the product which one gives more profit respectively,

$$f_N(e_1) = \{ \langle m_1, (0.6, 0.4, 0.3) \rangle, \langle m_2, (0.9, 0.5, 0.3) \rangle, \langle m_3, (0.5, 0.6, 0.2) \rangle, \langle m_4, (0.7, 0.5, 0.4) \rangle, \langle m_5, (0.5, 0.4, 0.1) \rangle \}$$

$$f_N(e_2) = \{ \langle m_1, (0.8, 0.6, 0.7) \rangle, \langle m_2, (0.6, 0.4, 0.4) \rangle, \langle m_3, (0.2, 0.1, 0.1) \rangle, \langle m_4, (0.6, 0.5, 0.2) \rangle, \langle m_5, (0.3, 0.2, 0.2) \rangle \}$$

$$f_N(e_3) = \{ \langle m_1, (0.3, 0.5, 0.2) \rangle, \langle m_2, (0.6, 0.4, 0.8) \rangle, \langle m_3, (0.8, 0.5, 0.6) \rangle, \langle m_4, (0.6, 0.5, 0.1) \rangle, \langle m_5, (0.5, 0.5, 0.1) \rangle \}$$

$$f_N(e_4) = \{ \langle m_1, (0.5, 0.5, 0.2) \rangle, \langle m_2, (0.6, 0.3, 0.7) \rangle, \langle m_3, (0.9, 0.5, 0.3) \rangle, \langle m_4, (0.7, 0.5, 0.4) \rangle, \langle m_5, (0.8, 0.5, 0.1) \rangle \}$$

Then $N = \{[e_1, f_N(e_1)], [e_2, f_N(e_2)], [e_3, f_N(e_3)], [e_4, f_N(e_4)], \}$ is an N_{ss} over (U, E)

The tabular representation of the N_{ss} of N is given in

Table 1: Tabular form of N_{ss}

	$f_N(e_1)$	$f_N(e_2)$	$f_N(e_3)$	$f_N(e_4)$
M_1	$(0.6, 0.4, 0.3)$	$(0.8, 0.6, 0.7)$	$(0.3, 0.5, 0.2)$	$(0.5, 0.5, 0.2)$
M_2	$(0.9, 0.5, 0.3)$	$(0.6, 0.4, 0.4)$	$(0.6, 0.4, 0.8)$	$(0.6, 0.3, 0.7)$
M_3	$(0.5, 0.6, 0.2)$	$(0.2, 0.1, 0.1)$	$(0.8, 0.5, 0.6)$	$(0.9, 0.5, 0.3)$
M_4	$(0.7, 0.5, 0.4)$	$(0.6, 0.5, 0.2)$	$(0.6, 0.5, 0.1)$	$(0.7, 0.5, 0.4)$
M_5	$(0.5, 0.4, 0.1)$	$(0.3, 0.2, 0.2)$	$(0.5, 0.5, 0.1)$	$(0.8, 0.5, 0.1)$

Definition 2.4 (Neutrosophic soft set matrix (N_{ssm}))

If $x_{ij} = (T_A(u_i, e_j), I_A(u_i, e_j), F_A(u_i, e_j))$, then Neutrosophic Soft Set

Matrix (N_{ssm}) of order $m \times n$, is $(x_{ij})_{m \times n} = (x_{ij})_m$

Example 2.4.1.

Let $U = \{u_1, u_2, u_3\}, E = \{x_1, x_2, x_3\}$. N be a neutrosophic

Soft sets over U neutrosophic as



$$N = \{(x_1, \{< u_1, (0.7,0.5,0.3) >, < u_2, (0.6,0.5,0.2) >, < u_3, (0.5,0.4,0.2) > \}), (x_2, \{< u_1, (0.8,0.6,0.2) >, < u_2, (0.9,0.5,0.3) >, < u_3, (0.7,0.5,0.4) > \}), (x_3, \{< u_1, (0.2,0.2,0.1) >, < u_2, (0.6,0.6,0.4) >, < u_3, (0.5,0.6,0.8) > \}) \}$$

Then, the N –matrix $[a_{ij}]$ is written by

$$[a_{ij}] = \begin{bmatrix} (0.7,0.5,0.3) & (0.6,0.5,0.2) & (0.5,0.4,0.2) \\ (0.8,0.6,0.2) & (0.9,0.5,0.3) & (0.7,0.5,0.4) \\ (0.2,0.2,0.1) & (0.6,0.6,0.4) & (0.5,0.6,0.8) \end{bmatrix}$$

Definition 2.6 (Value Matrix)

Suppose $C = [T_{ij}^c, I_{ij}^c, F_{ij}^c]$ Nssm of order $m \times n$ then, C is called the value matrix of N denoted by $V(C)$ and $V(C) = [T_{ij}^c + 4I_{ij}^c + F_{ij}^c] / 6$ for all i and j , respectively where $i = 1,2,3 \dots m$ and $j = 1,2,3 \dots n$

4. Methodology

Step 1: Construct neutrosophic soft set matrices ($A \& B$)

Step 2: Compute C by using the operators of neutrosophic soft set matrix

Step 3: Calculate the value matrices $V(C)$

Step 4: Determine the weight value Using Entropy method

Step 5: Score value

Step 6: Rank

5. Numerical Example

Let F be a set of neutrosophic soft set of poultry form producing different kind of domestic fowls to satisfy the need of meat and egg for the people throughout the year. Once the items are ready the seller will sell it in the market or directly to the customer's and get either profit or loss. Let

us assume that a set of sellers selling the product in two different markets M_1 and M_2 . E is a set of parameters. let $A \subseteq E$ and. The first $N_{ss}(X, A)$ over F is the seller production of meat and egg sold in market M_1 , where $X: A \rightarrow P(F)$, The second $N_{ss}(Y, B)$ over F is the seller production of meat and egg sold in market M_2 , where $Y: A \rightarrow P(F)$, $P(F)$ is a set of all neutrosophic soft subset of F . Let a universal set $U = \{f_1, f_2, f_3, f_4, f_5, f_6, f_7, f_8\}$ be a neight different poultry forms and $E = \{C_1, C_2, C_3, C_4, C_5, C_6, C_7, C_8\}$ be a parameters representing the different domestic fowls like Chickens, Turkeys, Geese, Ducks, Guinea fowl, Quile, Pigeons, and Ostriches. Two exports P_1 and P_2 evaluated the production of the seller in the market M_1 and M_2 , respectively.

Report of expert P_1 in the market place M_1 is representing in the form of (N_{ss}) as

$$(X, A) = x(C_1), x(C_2), x(C_3), x(C_4), x(C_5), x(C_6), x(C_7), x(C_8)$$

$$(X, A) = x(C_1), x(C_2), x(C_3), x(C_4), x(C_5), x(C_6), x(C_7), x(C_8)$$

$$X(C_1) = \left\{ \begin{array}{l} f_1(0.6,0.3,0.2), f_2(0.2,0.2,0.1), f_3(0.6,0.4,0.3), f_4(0.4,0.3,0.2), f_5(0.5,0.5,0.1), \\ f_6(0.6,0.2,0.2), f_7(0.7,0.3,0.1), f_8(0.8,0.8,0.6) \end{array} \right\}$$

$$X(C_2) = \left\{ \begin{array}{l} f_1(0.4,0.2,0.2), f_2(0.6,0.5,0.5), f_3(0.9,0.6,0.3), f_4(0.4,0.1,0.1), f_5(0.7,0.3,0.2), \\ f_6(0.5,0.3,0.3), f_7(0.2,0.1,0.1), f_8(0.7,0.6,0.6) \end{array} \right\}$$

$$X(C_3) = \left\{ \begin{array}{l} f_1(0.3,0.3,0.2), f_2(0.9,0.6,0.3), f_3(0.8,0.7,0.6), f_4(0.6,0.4,0.4), f_5(0.7,0.7,0.3), \\ f_6(0.3,0.3,0.1), f_7(0.6,0.5,0.3), f_8(0.7,0.5,0.2) \end{array} \right\}$$

$$X(C_4) = \left\{ \begin{array}{l} f_1(0.6,0.5,0.2), f_2(0.7,0.3,0.2), f_3(0.7,0.6,0.6), f_4(0.4,0.3,0.2), f_5(0.4,0.4,0.1), \\ f_6(0.6,0.5,0.3), f_7(0.7,0.7,0.6), f_8(0.2,0.2,0.1) \end{array} \right\}$$

$$X(C_5) = \left\{ \begin{array}{l} f_1(0.4,0.4,0.3), f_2(0.6,0.2,0.1), f_3(0.8,0.8,0.6), f_4(0.6,0.3,0.1), f_5(0.7,0.5,0.5), \\ f_6(0.3,0.2,0.1), f_7(0.6,0.4,0.4), f_8(0.3,0.2,0.2) \end{array} \right\}$$

$$X(C_6) = \left\{ \begin{array}{l} f_1(0.7,0.3,0.2), f_2(0.4,0.3,0.3), f_3(0.6,0.5,0.5), f_4(0.4,0.3,0.2), f_5(0.7,0.6,0.5), \\ f_6(0.6,0.6,0.3), f_7(0.6,0.5,0.5), f_8(0.8,0.7,0.4) \end{array} \right\}$$

$$X(C_7) = \left\{ \begin{array}{l} f_1(0.9,0.3,0.2), f_2(0.6,0.3,0.2), f_3(0.8,0.8,0.5), f_4(0.6,0.5,0.3), f_5(0.4,0.3,0.2), \\ f_6(0.7,0.6,0.6), f_7(0.9,0.3,0.2), f_8(0.6,0.1,0.1) \end{array} \right\}$$



$$X(\mathbb{C}_8) = \left\{ \begin{array}{l} f_1(0.3,0.1,0.1), f_2(0.8,0.6,0.6), f_3(0.9,0.3,0.2), f_4(0.7,0.7,0.1), f_5(0.3,0.2,0.2), \\ f_6(0.5,0.4,0.3), f_7(0.8,0.3,0.3), f_8(0.6,0.5,0.4) \end{array} \right\}$$

Report of expert P_2 in the market place M_2 is representing in the form of (N_{ss}) as

$$(Y, B) = \{y(\mathbb{C}_1), y(\mathbb{C}_2), y(\mathbb{C}_3), y(\mathbb{C}_4), y(\mathbb{C}_5), y(\mathbb{C}_6), y(\mathbb{C}_7), y(\mathbb{C}_8)\}$$

$$Y(\mathbb{C}_1) = \left\{ \begin{array}{l} f_1(0.4,0.3,0.2), f_2(0.8,0.6,0.3), f_3(0.8,0.4,0.1), f_4(0.6,0.7,0.4), f_5(0.7,0.7,0.3), \\ f_6(0.8,0.4,0.2), f_7(0.3,0.3,0.1), f_8(0.6,0.4,0.2) \end{array} \right\}$$

$$Y(\mathbb{C}_2) = \left\{ \begin{array}{l} f_1(0.6,0.4,0.2), f_2(0.8,0.7,0.3), f_3(0.7,0.4,0.1), f_4(0.6,0.3,0.34), f_5(0.7,0.5,0.4), \\ f_6(0.7,0.5,0.3), f_7(0.4,0.3,0.1), f_8(0.5,0.2,0.2) \end{array} \right\}$$

$$Y(\mathbb{C}_3) = \left\{ \begin{array}{l} f_1(0.7,0.5,0.4), f_2(0.7,0.4,0.3), f_3(0.8,0.5,0.4), f_4(0.6,0.6,0.2), f_5(0.7,0.5,0.3), \\ f_6(0.6,0.3,0.3), f_7(0.8,0.7,0.5), f_8(0.5,0.3,0.2) \end{array} \right\}$$

$$Y(\mathbb{C}_4) = \left\{ \begin{array}{l} f_1(0.8,0.5,0.4), f_2(0.9,0.5,0.4), f_3(0.7,0.4,0.2), f_4(0.6,0.5,0.1), f_5(0.8,0.4,0.3), \\ f_6(0.6,0.3,0.3), f_7(0.7,0.5,0.2), f_8(0.4,0.4,0.3) \end{array} \right\}$$

$$Y(\mathbb{C}_5) = \left\{ \begin{array}{l} f_1(0.6,0.4,0.1), f_2(0.8,0.4,0.3), f_3(0.8,0.6,0.4), f_4(0.4,0.3,0.1), f_5(0.7,0.3,0.3), \\ f_6(0.5,0.4,0.1), f_7(0.6,0.2,0.2), f_8(0.5,0.4,0.1) \end{array} \right\}$$

$$Y(\mathbb{C}_6) = \left\{ \begin{array}{l} f_1(0.6,0.5,0.4), f_2(0.6,0.3,0.3), f_3(0.8,0.7,0.5), f_4(0.5,0.5,0.4), f_5(0.9,0.4,0.3), \\ f_6(0.8,0.6,0.3), f_7(0.4,0.3,0.1), f_8(0.6,0.5,0.4) \end{array} \right\}$$

$$Y(\mathbb{C}_7) = \left\{ \begin{array}{l} f_1(0.7,0.5,0.4), f_2(0.4,0.3,0.2), f_3(0.6,0.4,0.3), f_4(0.4,0.3,0.1), f_5(0.5,0.3,0.2), \\ f_6(0.9,0.6,0.4), f_7(0.7,0.5,0.2), f_8(0.8,0.3,0.3) \end{array} \right\}$$

$$Y(\mathbb{C}_8) = \left\{ \begin{array}{l} f_1(0.5,0.3,0.1), f_2(0.8,0.4,0.4), f_3(0.7,0.5,0.4), f_4(0.5,0.5,0.3), f_5(0.4,0.4,0.2), \\ f_6(0.3,0.2,0.1), f_7(0.6,0.5,0.5), f_8(0.4,0.3,0.2) \end{array} \right\}$$

The payoff matrices A and B are,

	\mathbb{C}_1	\mathbb{C}_2	\mathbb{C}_3	\mathbb{C}_4	\mathbb{C}_5	\mathbb{C}_6	\mathbb{C}_7	\mathbb{C}_8
f_1	(0.6, 0.3, 0.2)	(0.4, 0.2, 0.2)	(0.3, 0.3, 0.2)	(0.6, 0.5, 0.2)	(0.4, 0.4, 0.3)	(0.7, 0.3, 0.2)	(0.9, 0.3, 0.2)	(0.3, 0.1, 0.1)
f_2	(0.2, 0.2, 0.1)	(0.6, 0.5, 0.5)	(0.9, 0.6, 0.3)	(0.7, 0.3, 0.2)	(0.6, 0.2, 0.1)	(0.4, 0.3, 0.3)	(0.6, 0.3, 0.2)	(0.8, 0.6, 0.6)
f_3	(0.6, 0.4, 0.3)	(0.9, 0.6, 0.3)	(0.8, 0.7, 0.6)	(0.7, 0.6, 0.6)	(0.8, 0.8, 0.6)	(0.6, 0.5, 0.5)	(0.8, 0.8, 0.5)	(0.9, 0.3, 0.2)
f_4	(0.4, 0.3, 0.2)	(0.4, 0.1, 0.1)	(0.6, 0.4, 0.4)	(0.4, 0.3, 0.2)	(0.6, 0.3, 0.1)	(0.4, 0.3, 0.2)	(0.6, 0.5, 0.3)	(0.7, 0.7, 0.1)
f_5	(0.5, 0.5, 0.1)	(0.7, 0.3, 0.2)	(0.7, 0.7, 0.3)	(0.4, 0.4, 0.1)	(0.7, 0.5, 0.5)	(0.7, 0.6, 0.5)	(0.4, 0.3, 0.2)	(0.3, 0.2, 0.2)
f_6	(0.6, 0.2, 0.2)	(0.5, 0.3, 0.3)	(0.3, 0.3, 0.1)	(0.6, 0.5, 0.3)	(0.3, 0.2, 0.1)	(0.6, 0.6, 0.3)	(0.7, 0.6, 0.6)	(0.5, 0.4, 0.3)
f_7	(0.7, 0.3, 0.1)	(0.2, 0.1, 0.1)	(0.6, 0.5, 0.3)	(0.7, 0.7, 0.6)	(0.6, 0.4, 0.4)	(0.6, 0.5, 0.5)	(0.9, 0.3, 0.2)	(0.8, 0.3, 0.3)
f_8	(0.8, 0.8, 0.6)	(0.7, 0.6, 0.6)	(0.7, 0.5, 0.2)	(0.2, 0.2, 0.1)	(0.3, 0.2, 0.2)	(0.8, 0.7, 0.4)	(0.6, 0.1, 0.1)	(0.6, 0.5, 0.4)
	\mathbb{C}_1	\mathbb{C}_2	\mathbb{C}_3	\mathbb{C}_4	\mathbb{C}_5	\mathbb{C}_6	\mathbb{C}_7	\mathbb{C}_8

$$B = \begin{matrix} f_1 \\ f_2 \\ f_3 \\ f_4 \\ f_5 \\ f_6 \\ f_7 \\ f_8 \end{matrix} \begin{bmatrix} (0.4,0.3,0.2) & (0.6,0.4,0.2) & (0.7,0.5,0.4) & (0.8,0.5,0.4) & (0.6,0.4,0.1) & (0.6,0.5,0.4) & (0.7,0.5,0.4) & (0.5,0.3,0.1) \\ (0.8,0.6,0.3) & (0.8,0.7,0.3) & (0.7,0.4,0.3) & (0.9,0.5,0.4) & (0.8,0.4,0.3) & (0.6,0.3,0.3) & (0.4,0.3,0.2) & (0.8,0.4,0.4) \\ (0.8,0.4,0.1) & (0.7,0.4,0.1) & (0.8,0.5,0.4) & (0.7,0.4,0.2) & (0.8,0.6,0.4) & (0.8,0.7,0.5) & (0.6,0.4,0.3) & (0.7,0.5,0.4) \\ (0.6,0.7,0.4) & (0.6,0.3,0.3) & (0.6,0.6,0.2) & (0.6,0.5,0.1) & (0.4,0.3,0.1) & (0.5,0.5,0.4) & (0.4,0.3,0.1) & (0.5,0.5,0.3) \\ (0.7,0.7,0.3) & (0.7,0.5,0.4) & (0.7,0.5,0.3) & (0.8,0.4,0.3) & (0.7,0.3,0.3) & (0.9,0.4,0.3) & (0.5,0.3,0.2) & (0.4,0.4,0.2) \\ (0.8,0.4,0.2) & (0.7,0.5,0.3) & (0.6,0.3,0.3) & (0.6,0.3,0.3) & (0.5,0.4,0.1) & (0.8,0.6,0.3) & (0.9,0.6,0.4) & (0.3,0.2,0.1) \\ (0.3,0.3,0.1) & (0.4,0.3,0.1) & (0.8,0.7,0.5) & (0.7,0.5,0.2) & (0.6,0.2,0.2) & (0.4,0.3,0.1) & (0.7,0.5,0.2) & (0.6,0.5,0.5) \\ (0.6,0.4,0.2) & (0.5,0.2,0.2) & (0.5,0.3,0.2) & (0.4,0.4,0.3) & (0.5,0.4,0.1) & (0.6,0.5,0.4) & (0.4,0.3,0.3) & (0.4,0.3,0.2) \end{bmatrix}$$

To find Crisp value by using Neutrosophic Arithmetic Operator (NA)

	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	C ₇	C ₈
C	=							
f ₁	(0.5, 0.3, 0.2)	(0.5, 0.3, 0.2)	(0.5, 0.4, 0.3)	(0.7, 0.5, 0.3)	(0.5, 0.4, 0.2)	(0.65, 0.4, 0.3)	(0.8, 0.4, 0.3)	(0.4, 0.2, 0.1)
f ₂	(0.5, 0.4, 0.2)	(0.7, 0.6, 0.4)	(0.8, 0.5, 0.3)	(0.8, 0.4, 0.3)	(0.7, 0.3, 0.2)	(0.5, 0.3, 0.3)	(0.5, 0.3, 0.2)	(0.8, 0.5, 0.5)
f ₃	(0.7, 0.4, 0.2)	(0.8, 0.5, 0.2)	(0.8, 0.6, 0.5)	(0.7, 0.5, 0.4)	(0.8, 0.7, 0.5)	(0.7, 0.6, 0.5)	(0.7, 0.6, 0.4)	(0.8, 0.4, 0.3)
f ₄	(0.5, 0.5, 0.3)	(0.5, 0.2, 0.2)	(0.6, 0.5, 0.3)	(0.5, 0.4, 0.15)	(0.5, 0.3, 0.1)	(0.45, 0.4, 0.3)	(0.5, 0.4, 0.2)	(0.6, 0.6, 0.2)
f ₅	(0.6, 0.6, 0.2)	(0.7, 0.4, 0.3)	(0.7, 0.6, 0.3)	(0.6, 0.4, 0.2)	(0.7, 0.4, 0.4)	(0.8, 0.5, 0.4)	(0.45, 0.3, 0.2)	(0.3, 0.3, 0.2)
f ₆	(0.7, 0.3, 0.2)	(0.6, 0.4, 0.3)	(0.45, 0.3, 0.2)	(0.6, 0.4, 0.3)	(0.4, 0.3, 0.1)	(0.7, 0.6, 0.3)	(0.8, 0.6, 0.5)	(0.4, 0.3, 0.2)
f ₇	(0.5, 0.3, 0.1)	(0.3, 0.2, 0.1)	(0.7, 0.6, 0.4)	(0.7, 0.6, 0.4)	(0.6, 0.3, 0.3)	(0.5, 0.4, 0.3)	(0.8, 0.4, 0.2)	(0.7, 0.4, 0.4)
f ₈	(0.7, 0.6, 0.4)	(0.6, 0.4, 0.4)	(0.6, 0.4, 0.2)	(0.3, 0.3, 0.2)	(0.4, 0.3, 0.15)	(0.7, 0.6, 0.4)	(0.5, 0.2, 0.2)	(0.5, 0.4, 0.3)

	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	C ₇	C ₈
V(C _{ij}) =	=							
f ₁	0.32	0.32	0.40	0.50	0.38	0.42	0.45	0.22
f ₂	0.38	0.58	0.52	0.45	0.35	0.33	0.32	0.55
f ₃	0.42	0.50	0.62	0.52	0.68	0.60	0.58	0.45
f ₄	0.47	0.25	0.48	0.37	0.30	0.39	0.38	0.53
f ₅	0.53	0.43	0.57	0.40	0.45	0.53	0.31	0.29
f ₆	0.35	0.42	0.31	0.42	0.28	0.57	0.61	0.30
f ₇	0.30	0.20	0.58	0.58	0.35	0.40	0.43	0.45
f ₈	0.58	0.43	0.40	0.28	0.29	0.58	0.25	0.40

Step 1: Compute the proportion matrix V_{ij}

For each criterion j

$$P_{ij} = \frac{V_{ij}}{\sum_{i=1}^m V_{ij}}$$



$$P_{ij} = \begin{matrix} f_1 \\ f_2 \\ f_3 \\ f_4 \\ f_5 \\ f_6 \\ f_7 \\ f_8 \end{matrix} \begin{bmatrix} 0.095 & 0.101 & 0.103 & 0.142 & 0.38 & 0.425 & 0.45 & 0.22 \\ 0.114 & 0.186 & 0.133 & 0.127 & 0.35 & 0.33 & 0.32 & 0.55 \\ 0.124 & 0.159 & 0.159 & 0.146 & 0.68 & 0.6 & 0.58 & 0.45 \\ 0.139 & 0.080 & 0.125 & 0.106 & 0.3 & 0.39 & 0.38 & 0.53 \\ 0.159 & 0.138 & 0.146 & 0.113 & 0.45 & 0.53 & 0.31 & 0.29 \\ 0.104 & 0.133 & 0.079 & 0.118 & 0.28 & 0.57 & 0.61 & 0.3 \\ 0.089 & 0.064 & 0.150 & 0.165 & 0.35 & 0.4 & 0.43 & 0.45 \\ 0.174 & 0.138 & 0.103 & 0.080 & 0.29 & 0.58 & 0.25 & 0.4 \end{bmatrix}$$

That is, divide each entry in a column by the sum of its column.

Step 2: Compute the entropy constant K

$$K = \frac{1}{\ln m}$$

Here $m = \text{number of alternatives}$.

$$K = \frac{1}{\ln 8} = -0.4809$$

Step 3: Compute the entropy e_j

$$e_j = -k \sum_{i=1}^m P_{ij} \ln P_{ij}$$

$$e_1 = -\frac{1}{\ln (8)} [0.095 * \ln (0.095)]$$

$$e_1 = 0.987706$$

Similarly,

$$\begin{aligned} e_2 &= 0.9764, e_3 = 0.9893, e_4 = 0.9903, e_5 = 0.9782, e_6 = 0.9902, e_7 \\ &= 0.9795, e_8 = 0.9801 \end{aligned}$$

Step 4: Compute divergence and entropy weight of the attributes

From entropy, compute divergence d_j and Weight is W_j

$$d_j = 1 - e_j$$

$$W_j = \frac{d_j}{\sum_{j=1}^n d_j}$$

W_1	W_2	W_3	W_4	W_5	W_6	W_7	W_8
W_1							
0.0959	0.1838	0.0834	0.0758	0.1697	0.0766	0.1597	0.1551

Step 5: Rank the score value of alternatives

$$S_i = \text{Score value of alternative } f_i = S(R_i)$$

$$S(R_i) = \sum_{i,j=1}^n V_{ij} * W_j$$

$$S_1 = \text{Score value of alternative } f_1 = S(R_1)$$

$$S_1 = (0.32 * 0.0959) + (0.32 * 0.1838) + (0.4 * 0.0834) + (0.5 * 0.0756) \\ + (0.38 * 0.1697) + (0.43 * 0.0766) + (0.45 * 0.1597) + (0.22 \\ * 0.1551)$$

$$S_1 = (0.0301 + 0.0588 + 0.0334 + 0.0378 + 0.0645 + 0.0326 + 0.0718 \\ + 0.0341)$$

$$S_1 = 0.36376$$

$$S_1 = \text{Score value of alternative } f_1 = S(R_1) = 0.36376$$

Similarly,

$$S_2 = \text{Score value of alternative } f_2 = S(R_2) = 0.44161$$

$$S_3 = \text{Score value of alternative } f_3 = S(R_3) = 0.54708$$

$$S_4 = \text{Score value of alternative } f_4 = S(R_4) = 0.38316$$

$$S_5 = \text{Score value of alternative } f_5 = S(R_5) = 0.41918$$

$$S_6 = \text{Score value of alternative } f_6 = S(R_6) = 0.40357$$

$$S_7 = \text{Score value of alternative } f_7 = S(R_7) = 0.38632$$

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$$S_8 = \text{Score value of alternative } f_8 = S(R_8) = 0.38489$$

Since $S_3 > S_2 > S_5 > S_6 > S_7 > S_8 > S_4 > S_1$, the third alternative f_3 is best

6. Comparison Table

RANK	Traditional method	Proposed method
Best Alternative	f_3	f_3

Here, we have got the same result.

7. Conclusion

In this study, an entropy-based multi-criteria decision-making (MCDM) model founded on the neutrosophic soft set framework was proposed and applied to evaluate poultry production systems. The model effectively handles uncertainty, indeterminacy, and inconsistency in expert opinions, which are common in real-world decision-making. By combining two neutrosophic soft set matrices from distinct markets and applying neutrosophic arithmetic operators, a unified decision matrix was obtained to represent diverse expert perspectives. The entropy weighting method was employed to objectively determine the importance of each criterion, thereby reducing subjective bias. The subsequent ranking process revealed that the third alternative exhibited the highest score, signifying optimal poultry production performance. This result demonstrates the reliability and applicability of the proposed model in agricultural evaluation and other similar decision environments. Overall, the integration of neutrosophic soft set theory with entropy-based weighting provides a robust, flexible, and systematic approach for analysing multi-criteria problems under uncertain conditions. Future work may extend this framework to dynamic environments, large-scale decision systems, or hybrid models

combining other uncertainty theories such as fuzzy rough sets or intuitionistic fuzzy sets to enhance performance and adaptability.

References

- [1] Ali Aydogdu & Ridvan Sahin 2019, 'New Entropy Measures Based on Neutrosophic Set and Their Applications to Multi Criteria Decision Making', Sleyman Demirel University Journal of Natural and Applied Sciences, vol. 23, no. 1, pp. 40-45.
- [2] Animesh Biswas & Arnab Kumar de 2016, 'An efficient ranking technique for intuitionistic fuzzy numbers with its application in chance constrained bilevel programming', Hindawi Publishing Corporation, Advances in Fuzzy Systems, vol.2016, pp. 1-12.
- [3] Barik SK & Biswal MP 2012, 'Probabilistic quadratic programming problems with some fuzzy parameters', Advances in Operations Research, Hindawi Publishing Corporation, vol. 2012, pp. 1-12.
- [4] Chen, Y & Li, B 2011, 'Dynamic multi attribute decision making model based on triangular intuitionistic fuzzy numbers', Scientia Iranica B, vol. 18, no. 2, pp. 268-274.
- [5] Cheng Pf, Li Dp, He Jq, Zhou Xh, Wang Jq & Zhang Hy 2020, 'Evaluating Surgical Risk Using FMEA and MULTIMOORA Methods under a Single-Valued Trapezoidal Neutrosophic Environment'. Risk Management and Healthcare Policy, vol. 13, no.7, pp.865-881.
- [6] Elshabshery, AA & Fattouh, M 2021, 'On Some Information Measures of Single-Valued Neutrosophic Sets and their Application in MCDM Problems', International Journal of Engineering Research & Technology (IJERT) , vol. 10, no. 5, pp. 406-415.

- [7] Hazwani Hashim, Lazim Abdullah, Ashraf Al-Quran & Azzah Awang 2021, 'Entropy Measures for Interval Neutrosophic Vague Sets and Their Application in Decision Making', *Neutrosophic Sets and Systems*, vol. 45, no. 7, pp. 74-95.
- [8] Jun Ye 2014, 'A multicriteria decision-making method using aggregation operators for simplified neutrosophic sets', *Journal of Intelligent & Fuzzy Systems*, vol.26, no. 5, pp. 2459–2466.
- [9] Jun Ye 2021, 'Entropy measures of simplified neutrosophic sets and their decision-making approach with positive and negative arguments', *Journal of Management Analytics*, vol. 8, no.2, pp. 252-266.
- [10] Mahmood, T & Ali, Z 2022, 'Prioritized Muirhead Mean Aggregation Operators under the Complex Single-Valued Neutrosophic Settings and Their Application in Multi-Attribute Decision-Making', *Journal of Computational and Cognitive Engineering*, vol.1, no.2, pp. 56–73.
- [11] Majdoleen Abu Qamar & Nasruddin Hassan 2018, 'Entropy, Measures of Distance and Similarity of Q-Neutrosophic Soft Sets and Some Applications', *Entropy*, vol. 20, no.9, p.672.
- [12] Memet Şahin, Abdullah Kargın & Florentin Smarandache 2018, 'Generalized A Triangular Neutrosophic Numbers and Aggregation Operators for Application to Multi-attribute Group Decision Making', *New Trends in Neutrosophic Theory and Applications*. Vol. II, pp.51-84.
- [13] Nital P Nirmal & Mangal G Bhatt 2016, 'Selection of Automated Guided Vehicle using A Neutrosophic Entropy Based Novel Multi Attribute Decision Making Technique', *New Trends in Neutrosophic Theory and Applications*, pp.105-114.

[14] Pinaki Majumdar & Syamal Kumar Samanta 2014, 'On Similarity and entropy of neutrosophic sets', Journal of Intelligent and Fuzzy Systems, vol. 26, no. 3, pp. 1245-1252.

[15] Pranab Biswas, Surapati Pramanik & Bibhas C Giri 2014, 'A New Methodology for Neutrosophic Multi-attribute Decision making with Unknown Weight Information', Neutrosophic Sets and Systems, vol. 3, no. 1, pp. 42-50.

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