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Application of Neutrosophic Fuzzy Set for Efficient Placement of Health Centers for Marburg Virus

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Abstract: The Ebola virus family has been accountable for the epidemic disease called Marburg virus disease, which has high fatality rates of up to 90%. Typically, health facilities deal with the afflicted persons while preventing the spread of infections. Therefore, temporary healthcare facilities are urged to treat the illness to stop the Marburg virus from spreading to other areas. The number of temporary health facilities that must be established in the impacted areas and the areas they serve are taken into consideration in this research. A savings heuristic is used to assign the temporary health centers to the afflicted regions, As for determining the weights of the affected sites, a single-valued neutrosophic fuzzy multi-criteria decision-making process is employed. The suggested neutrosophic fuzzy multi-criteria decision-making integrated saving heuristic approach is employed in conjunction with an efficient model. The results are thought to be advantageous for future multi-facility layout models

Keywords: Marburg Virus; temporary health care centers; saving heuristic approach; neutrosophic fuzzy set .

2010 Mathematics Subject Classification. 26A25; 26A35.

1 Introduction

The Marburg virus is an epidemic disease that has recently spread to the United Republic of Tanzania since March 2023 [1]. The establishment of temporary health centers is the most efficient method, other than the steps performed against the infection. As a result, those who are afflicted need just travel to their local health centers. It assists in lowering patient death rates and halting the spread of diseases. Temporary health facilities are popular because of how simple they are to set up, how simple it is to transport them, and how inexpensive they are. It has been applied in a variety of historical circumstances, such as COVID-19, influenza, dog rabies, polio, etc [2] – [4]. The choice of the necessary quantity of health facilities, alternate locations, and service regions is a challenging administrative issue. A multi-facility layout location-allocation challenge is the nature of this task entails. Many studies add to the collection of knowledge by creating heuristics to address location-allocation issues. To solve the truck routing issues for a single depot, A savings approach was devised by Clark and Wright [5]. They provide a greedy heuristic method for locating a vehicle routing solution. The algorithm looks for a result that is somewhat near to the ideal. The method used by Kuehn and Hamburger is a saving heuristic [6]. The algorithm takes into account all already existing amenities at first. Once the number of facilities with the highest profit growth has been reached, the facilities are subsequently closed one at a time. Hansen et al. described their algorithm for savings heuristics. The algorithm includes a model with several cars as well as facilities and vehicles with capacity [7]. Numerous multi-criterion decision-making approaches have been put out in the literature to rank possibilities. Decision-makers frequently convey their uncertain thoughts using fuzzy multi-criterion decision-making approaches. After Zadeh initially created the fuzzy set theory, Atanassov adds intuitionistic fuzzy sets to the literature [8]. Based on these sets, neutrosophic sets have been evaluated as fuzzy extensions. In single-valued neutrosophic fuzzy sets, three membership functions, with degrees of membership ranging from 0 to 1, are utilized to express certainty: (i) a truth membership function; (ii) an indeterminacy membership function; and (iii) a falsity membership function. Therefore, neutrosophic fuzzy multi-criterion decision-making techniques have been developed to weigh choices in accordance with the criteria [9], [10]. The fuzzy multi-criterion decision-making approach and multi-facility layout are combined in this paper to add

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to the collection of knowledge. A single-valued neutrosophic fuzzy weighted heuristic is suggested for application. During the Marburg virus outbreak, this strategy is employed for the temporary deployment of health centers. The structure of the paper is as follows: In Section II, the recent Marburg virus outbreak is discussed. Section III provides an introduction to single-valued neutrosophic fuzzy sets. Furthermore, the single-valued neutrosophic fuzzy weighted heuristic's stages have been provided. Section IV. we deal with the example solution of the proposed method. The study's conclusion and its future directions are summarized in Section V.

2 Marburg Virus Disease

Marburg virus disease (MVD) is a severe hemorrhagic fever caused by the Marburg virus, a member of the Filoviridae family, which also includes the Ebola virus. MVD was first identified in 1967 during simultaneous outbreaks in Marburg and Frankfurt, Germany, and Belgrade, Serbia, linked to laboratory work with African green monkeys imported from Uganda. The incubation period ranges from 2 to 21 days, with initial symptoms including sudden onset of high fever, severe headache, and muscle pain. This is followed by severe watery diarrhea, abdominal pain, cramping, nausea, and vomiting. In severe cases, patients may experience hemorrhaging, multi-organ dysfunction, and shock, leading to death within 8 to 9 days after symptom onset. The case fatality rate can be as high as 90%.

MVD is transmitted through contact with the bodily fluids of infected individuals or animals. Fruit bats of the Pteropodidae family are considered natural hosts of the virus. Human-to-human transmission occurs via direct contact with blood, secretions, or other bodily fluids, as well as contaminated surfaces and materials. There is no specific antiviral treatment or vaccine for MVD. Management primarily involves supportive care, including rehydration and symptomatic treatment, which can improve survival rates. Preventive measures include strict infection control practices, especially in healthcare settings, and public health interventions to limit the spread during outbreaks. Recent cases have been reported in the Kagera region of Tanzania in March 2023, where contact tracing operations are underway. The virus is believed to be naturally hosted by green monkeys and fruit bats.[11] The primary risk factor for human transmission is direct contact with the blood or bodily fluids of an infected person. The virus cannot presently be neutralized by vaccinations or antiviral medications; however, a number of blood products, immunological therapies, and pharmacological therapies are being developed. Early supportive care that includes rehydration and symptomatic therapy also increases survival.

3 Proposed Method :-

3.1 A.Single-Valued Neutrosophic Fuzzy Sets

Definition 1[12]: Let P be an object space, and let p be the generic element in P. The neutrosophic set M defines three membership functions, including a falsity-membership function (F), an indeterminacy-membership function (I), and a truth-membership function (T). It is described as

$$M = \{\langle p : \tilde{T}_M(p), \tilde{I}_M(p), \tilde{F}_M(p)\rangle, p \in P\} \quad (1)$$

The element $p \in P$'s membership functions to the neutrosophic set M with condition are given as,

$$0 \leq \tilde{T}_M(p) + \tilde{I}_M(p) + \tilde{F}_M(p) \leq 3^+ \quad (2)$$

The functions $\tilde{T}_M(p), \tilde{I}_M(p)$, and $\tilde{F}_M(p)$ are an actual typical subset or an unconventional subset of $]^-0, 1^+[$.

Definition 2: Consider $\tilde{M}_1 = (\tilde{T}_{M_1}, \tilde{I}_{M_1}, \tilde{F}_{M_1})$ and $\tilde{M}_2 = (\tilde{T}_{M_2}, \tilde{I}_{M_2}, \tilde{F}_{M_2})$ are the two single-valued neutrosophic numbers. Then, the functions of two single-valued neutrosophic numbers are stated as follows:

$$\lambda \tilde{M}_1 = (1 - (1 - \tilde{T}_{M_1})^\lambda, (\tilde{I}_{M_1})^\lambda, (\tilde{F}_{M_1})^\lambda) \quad (3)$$

$$\tilde{M}_1^\lambda = (\tilde{T}_{M_1}^\lambda, 1 - (1 - \tilde{I}_{M_1})^\lambda, 1 - (1 - \tilde{F}_{M_1})^\lambda) \quad (4)$$

$$\tilde{M}_1 \oplus \tilde{M}_2 = (\tilde{T}_{M_1} + \tilde{T}_{M_2} - \tilde{T}_{M_1}\tilde{T}_{M_2}, \tilde{I}_{M_1}\tilde{I}_{M_2}, \tilde{F}_{M_1}\tilde{F}_{M_2}) \quad (5)$$

$$\tilde{M}_1 \otimes \tilde{M}_2 = (\tilde{T}_{M_1}\tilde{T}_{M_2}, \tilde{I}_{M_1} + \tilde{I}_{M_2} - \tilde{I}_{M_1}\tilde{I}_{M_2}, \tilde{F}_{M_1} + \tilde{F}_{M_2} - \tilde{F}_{M_1}\tilde{F}_{M_2}) \quad (6)$$

With the condition, $\lambda > 0$.

Definition 3: Consider $\tilde{M}_1 = (\tilde{T}_{M_1}, \tilde{I}_{M_1}, \tilde{F}_{M_1})$ and $\tilde{M}_2 = (\tilde{T}_{M_2}, \tilde{I}_{M_2}, \tilde{F}_{M_2})$ are the two single-valued neutrosophic numbers. Then, the functions of two single-valued neutrosophic numbers are stated as follows:

$$\lambda \tilde{M}_1 = (1-(1-\tilde{T}_{M_1})^{\lambda}, (\tilde{I}_{M_1})^{\lambda}, (\tilde{F}_{M_1})^{\lambda}) \quad (3)$$

$$\tilde{M}_1^{\lambda} = (\tilde{T}_{M_1}^{\lambda}, 1-(1-\tilde{I}_{M_1})^{\lambda}, 1-(1-\tilde{F}_{M_1})^{\lambda}) \quad (4)$$

$$\tilde{M}_1 \oplus \tilde{M}_2 = (\tilde{T}_{M_1} + \tilde{T}_{M_2} - \tilde{T}_{M_1}\tilde{T}_{M_2}, \tilde{I}_{M_1}\tilde{I}_{M_2}, \tilde{F}_{M_1}\tilde{F}_{M_2}) \quad (5)$$

$$\tilde{M}_1 \otimes \tilde{M}_2 = (\tilde{T}_{M_1}\tilde{T}_{M_2}, \tilde{I}_{M_1} + \tilde{I}_{M_2} - \tilde{I}_{M_1}\tilde{I}_{M_2}, \tilde{F}_{M_1} + \tilde{F}_{M_2} - \tilde{F}_{M_1}\tilde{F}_{M_2}) \quad (6)$$

With the condition, $\lambda > 0$.

The application of a scoring function is a practical method for comparing two single-valued neutrosophic numbers. Then 0_n might be considered as,

$$0_n = \{\langle p, (0,1,1)\rangle : p \in P\}\} \quad (7)$$

Definition 4: Consider $\tilde{M} = (\tilde{T}_M, \tilde{I}_M, \tilde{F}_M)$ is a single-valued neutrosophic fuzzy number. Afterward, the scoring function $s(\tilde{M})$ of $\tilde{M}$ is expressed as,

$$s(\tilde{M}) = \frac{2 + \tilde{T}_M - \tilde{I}_M - \tilde{F}_M}{3} \quad (8)$$

Definition 5: Consider $\tilde{M}_1 = (\tilde{T}_{M_1}, \tilde{I}_{M_1}, \tilde{F}_{M_1})$ and $\tilde{M}_2 = (\tilde{T}_{M_2}, \tilde{I}_{M_2}, \tilde{F}_{M_2})$ are the two single-valued neutrosophic numbers. Then, the ranking method is defined as follows:

$$\text{if } s(\tilde{A}_1) \succ s(\tilde{A}_2), \text{ then } \tilde{A}_1 \succ \tilde{A}_2 \quad (9)$$

$$\text{If } s(\tilde{A}_1) = s(\tilde{A}_2), \text{ then } \tilde{A}_1 = \tilde{A}_2 \quad (10)$$

Definition 6: A set of n single-valued neutrosophic fuzzy numbers is considered as $\{\tilde{M}_1, \tilde{M}_2, \ldots, \tilde{M}_n\}$, where $\tilde{M}_j = (\tilde{T}_{M_j}, \tilde{I}_{M_j}, \tilde{F}_{M_j})$. The weighted average operator for the single-valued neutrosophic fuzzy numbers is expressed as,

$$\sum_{j=1}^{n} \lambda_j \tilde{M}_j = \left(1 - \prod_{j=1}^{n}(1-\tilde{T}_{M_j})^{\lambda_j}, \prod_{j=1}^{n}(\tilde{I}_{M_j})^{\lambda_j}, \prod_{j=1}^{n}(\tilde{F}_{M_j})^{\lambda_j}\right) \quad (11)$$

With the conditions that λ_j is the weight of $\tilde{M}_j$ ($j = 1,2,\ldots,n$), $\lambda_j \in [0,1]$ and $\sum_{j=1}^{n} \lambda_j = 1$.

4 Characteristics and Mathematical Properties of Neutrosophic Fuzzy Sets

The characteristics and mathematical properties of the neutrosophic fuzzy set are clearly defined and explained. In the context of this research on temporary health centers during a Marburg virus outbreak, union, intersection, and complement operations within neutrosophic sets play a crucial role in determining the weights of affected sites. Here's how these operations are applied:

A neutrosophic set M in an object space P is defined by three membership functions: truth membership function $T_M(p)$, indeterminacy membership function $I_M(p)$, and falsity membership function $F_M(p)$ [**?**]. These functions indicate the degree of truth, indeterminacy, and falsity for an element p within the set, providing a more comprehensive framework for dealing with uncertainty and imprecision.

4.1 Characteristics:

Three Membership Degrees: 1) Truth Membership (T): Represents the degree of truth. 2) Indeterminacy Membership (I): Represents the degree of indeterminacy or uncertainty. 3) Falsity Membership (F): Represents the degree of falsity.
2. Ranges of Membership Degrees: The values of T, I, and F are real numbers within the interval [0, 1].
3. Flexibility: NFS can handle incomplete and inconsistent information better than traditional fuzzy sets.

4.2 Mathematical Properties::

Definition 7: Let P be an object space, and p be a generic element in P. A neutrosophic set M is defined as:

$$M = \{\langle p, T_M(p), I_M(p), F_M(p)\rangle : p \in P\}$$

where $T_M(p)$, $I_M(p)$, and $F_M(p)$ are the truth, indeterminacy, and falsity membership functions, respectively.
Sum Condition: For any element $p \in P$:

$$0 \leq T_M(p) + I_M(p) + F_M(p) \leq 3$$

Operations:
a)Scalar Multiplication:

$$\lambda M = (\lambda T_M(p), \lambda I_M(p), \lambda F_M(p))$$

where λ is a scalar.
b)Addition:

$$M_1 \oplus M_2 = (T_{M_1}(p) + T_{M_2}(p) - T_{M_1}(p)T_{M_2}(p), I_{M_1}(p)I_{M_2}(p), F_{M_1}(p)F_{M_2}(p))$$

c)Multiplication:

$$M_1 \otimes M_2 = (T_{M_1}(p)T_{M_2}(p), I_{M_1}(p) + I_{M_2}(p) - I_{M_1}(p)I_{M_2}(p), F_{M_1}(p) + F_{M_2}(p) - F_{M_1}(p)F_{M_2}(p))$$

Score Function: The score function $s(M)$ of a neutrosophic fuzzy set M is used to compare elements:

$$S(M) = \frac{3}{2} + T_M - I_M - F_M$$

Weighted Average: For a set of single-valued neutrosophic fuzzy numbers $\{M_j\}$ with weights $\{\lambda_j\}$:

$$\sum_{j=1}^{n} \lambda_j M_j = \left(1 - \prod_{j=1}^{n}(1 - T_{M_j})^{\lambda_j}, \prod_{j=1}^{n}(I_{M_j})^{\lambda_j}, \prod_{j=1}^{n}(F_{M_j})^{\lambda_j}\right)$$

where λ_j is the weight of M_j and $\sum_{j=1}^{n} \lambda_j = 1$.

Neutrosophic fuzzy sets provide a powerful and flexible tool for modeling and analyzing systems with inherent uncertainty and vagueness, making them highly suitable for complex decision-making processes.

5 Multi-Facility Layout Using a Single-Valued Neutrosophic Fuzzy Weighted Heuristic:

Heuristics are particularly useful when dealing with large-scale, real-world problems where traditional optimization methods would require excessive time and resources. These approaches offer good enough solutions within a reasonable timeframe, making them valuable in fields like logistics, scheduling, and network design. Heuristics are designed to be efficient and can handle the uncertainty and variability inherent in many practical problems. They are adaptable and can be tailored to specific problem contexts, often incorporating domain-specific knowledge to improve performance [**?**]. While heuristics do not guarantee the optimal solution, they are effective in finding high-quality solutions that are close to optimal, thus balancing the trade-off between solution quality and computational effort. The proposed method for multi-facility layout using single-valued neutrosophic fuzzy information is presented in this section. The algorithm's initial step involves utilizing the single-valued neutrosophic fuzzy multi criteria decision-making approach to weight the affected people's places. The weights that were determined are added to the matrix of transportation costs in the second section[15]. With the least amount of expense, the medical centers are distributed to potential places using a saving heuristic technique. Maximal savings in each cycle are used to establish the best assignment number and assignment pairings. The single-valued neutrosophic fuzzy multi criteria decision-making approach's phases for calculating affected people's location weights are detailed in the first section as follows:

5.1 Problem Definition and Criteria Identification:

Phase 1.1:
Establish the issue and determine a plan of action based on the circumstances.

Phase 1.2:
Decide the criteria and criteria weights by the plan of action. Let $X = \{x_1, x_2, \ldots, x_n\}$ be the set of criteria and $y = \{y_1, y_2, \ldots, y_n\}$ be the set of weight vector criteria set with $y_j \in [0,1]$, $\sum_{j=1}^{n} y_j = 1$.

5.2 Fuzzy Pairwise Comparison and Neutrosophic Aggregation:

Phase 1.3:
Make decisions using predetermined criteria and locations to construct a single-valued neutrosophic fuzzy pairwise comparison matrix. Consider

$$\tilde{M}^z_{(x,y)} = \left(T^z_{\tilde{M}_{(i,j)}}, I^z_{\tilde{M}_{(i,j)}}, F^z_{\tilde{M}_{(i,j)}} \right)$$

is the choice made by the z^{th} decision, which is described as a single-valued neutrosophic fuzzy number for the alternative location L_i with regard to the criterion x_j.
Phase 1.4:
Use

$$\tilde{D}_{(i,j)} = \left(T^z_{\tilde{D}_{(i,j)}}, I^z_{\tilde{D}_{(i,j)}}, F^z_{\tilde{D}_{(i,j)}} \right) = \text{SVNWA}\left(\tilde{D}^1_{(i,j)}, \tilde{D}^2_{(i,j)}, \ldots, \tilde{D}^q_{(i,j)} \right)$$

for $i = 1, 2, \ldots, m$ to aggregate all fuzzy decision matrices, and the weights of decision makers are set by the decision-making process. Let $\mathbf{D}[\tilde{D}_{(i,j)}]$ be the whole neutrosophic fuzzy single-valued decision matrix. Normalize the decision-making data to remove the influence of various choice values (benefit and cost types).
Phase 1.5:
Use the SVNWA operator to evaluate the weights of the affected places using the computation of $\tilde{D}$ in the context of single-valued neutrosophic fuzzy (SVNF) multi-criteria decision-making. This involves aggregating pairwise comparisons. Each element $\tilde{D}_{ij}$ in $\tilde{D}$ represents a SVNF number describing the comparison between alternatives i and j. It is computed using a Single-Valued Neutrosophic Weighted Averaging (SVNWA) approach:

$$\tilde{D}_{ij} = \text{SVNWA}(\tilde{D}_{i1}, \tilde{D}_{i2}, \ldots, \tilde{D}_{in}) \quad \text{for} \quad i = 1, 2, \ldots, m$$

Here, $\tilde{D}_{ij}$ are SVNF numbers obtained from the decision makers' assessments or criteria. The SVNWA operator aggregates these SVNF numbers into a single SVNF $\tilde{D}_{ij}$, which encapsulates the collective decision or comparison between alternatives i and j. This process ensures that uncertainties and indeterminacies in decision-making are captured through the neutrosophic framework, providing a comprehensive basis for making informed decisions in complex scenarios.

Use the score function to determine the weight scores $s(\tilde{D}_i)$ of potential locations.//

5.3 Weighted Average Calculation:

Phase 1.6:
Calculate the weighted average operator for SVNF sets to obtain the comprehensive score for each alternative:

$$W_i = \left(1 - \prod_{j=1}^{n} (1 - T_{\tilde{M}_j})^{\lambda_j}, \prod_{j=1}^{n} (I_{\tilde{M}_j})^{\lambda_j}, \prod_{j=1}^{n} (F_{\tilde{M}_j})^{\lambda_j} \right)$$

Here, W_i represents the SVNF weighted score for alternative l_i.

5.4 Ranking and Selection:

Phase 1.7: Rank the alternatives according to their SVNF scores W_i. The alternative with the highest score is generally considered the preferred choice, as it aligns best with the decision-maker's objectives and criteria weights.

5.5 Application Example:

In the context of managing a disease outbreak like the Marburg virus, these phases could be applied to determine the optimal locations for temporary healthcare centers based on factors such as accessibility, population density, and logistical feasibility. The SVNF MCDM approach ensures that decisions are robust against uncertainties and varying degrees of information, providing a structured framework for complex decision-making scenarios. A heuristic technique is used to study the assignments of Multi-Facility Location Problem (MFLP) using the weights of affected people's places. The following are the steps of the heuristic saving algorithm:
Phase 2.1: With the affected people's site weights, distance (or travel time), and demand information provided, create the first matrix.

Phase 2.2: By combining weighted distance (or trip time) with demand, create the transportation cost table. To determine the overall cost, add up the columns. (Costs are negative while benefits are positive.)

Phase 2.3: Put (assign) every affected people to a potential location with the lowest overall cost.

Phase 2.4: By moving affected people to other candidates for sites, you may calculate the relocation savings.

Phase 2.5: Determine the column totals, then place the following facility in the column with the highest overall maximum savings. Affected people´s associated with a certain location have savings.

Phase 2.6: Make changes to the savings matrix. If savings exist, proceed to Phase 2.5. In every other case, stop the algorithm.
The process's total cost should be kept to a minimum. The temporary medical centers should be established according to the number of allocated places.
Weights represent the relative importance of different criteria, ensuring that significant factors have a greater influence on outcomes. They help balance multiple criteria, aggregate complex data, enhance decision accuracy, and reflect expert judgment. In scenarios such as allocating temporary health centers during an epidemic, weights prioritize critical criteria, leading to more accurate and contextually relevant decisions. Properly assigned weights ensure that important considerations are adequately emphasized, thereby improving the effectiveness and reliability of the decision-making process.

6 An Example for the Proposed Method :-

For the purpose of demonstrating the aforesaid strategy, we concentrate on determining the best possible number of medical centers and affected people assignments for Marburg virus temporary health care centers. **Phase 1.1:** To speed up the treatment of those who are afflicted and prevent the spread of the disease, the concept of temporary healthcare centers has been proposed. Two potential locations for three areas are chosen by experts as a case study. Three health-related decision-makers are looking at the distribution of healthcare facilities among the affected populations as well as the regional assignments.

x_1: Accessibility
x_2: Environmental factors
x_3: Center capacity

The decision-making process yields the criterion weights as follows:
$y_1 = 0.33$
$y_2 = 0.30$
$y_3 = 0.37$
Phase 1.3 & Phase 1.4: The SVNWA operator is used to aggregate single-valued neutrosophic fuzzy pairwise comparison matrices that are created during decision-making. The collective fuzzy decision matrix is assessed as follows

$$\tilde{D} = \begin{bmatrix} (0.79,0.91,0.87) & (0.73,0.92,0.74) & (0.84,0.86,0.83) \\ (0.86,0.77,0.63) & (0.63,0.84,0.80) & (0.68,0.75,0.78) \\ (0.84,0.95,0.87) & (0.94,0.69,0.93) & (0.62,0.83,0.75) \end{bmatrix}$$

Table 1: Three affected people locations weights

Affected People Location	$\tilde{D}_i$	$S(\tilde{D}_i)$	Normalized (= W_j)
R1	(0.547, 0.609, 0.415)	0.507	0.200
R2	(0.509, 0.435, 0.473)	0.534	0.211
R3	(0.586, 0.625, 0.593)	0.456	0.180

Phase 1.5: Here, each element of the matrix $\tilde{D}$ is represented as a single-valued neutrosophic fuzzy number, which reflects the aggregated pairwise comparisons.

Phase 1.6: To calculate the weighted average operator for SVNF sets and obtain the comprehensive score for each alternative l_i, use the following formula:

$$W_i = \frac{\left(1 - \prod_{j=1}^{n}\left(1 - T_{\widetilde{M}_j}\right)^{\lambda_j}\right)}{\prod_{j=1}^{n}\left(I_{\widetilde{M}_j}\right)^{\lambda_j} \cdot \prod_{j=1}^{n}\left(F_{\widetilde{M}_j}\right)^{\lambda_j}}$$

W_i represents the SVNF weighted score for alternative l_i.
λ_j represents the weights, which are necessary in decision-making with neutrosophic sets. These weights indicate the relative importance of different criteria, ensuring that significant factors have a greater influence on outcomes.
$T_{\widetilde{M}_j}$, $I_{\widetilde{M}_j}$, and $F_{\widetilde{M}_j}$ represent the truth, indeterminacy, and falsity memberships of the neutrosophic set for criterion j.

Weights help balance multiple criteria, aggregate complex data, enhance decision accuracy, and reflect expert judgment. In scenarios like allocating temporary health centers during an epidemic, weights prioritize critical criteria, leading to more accurate and contextually relevant decisions. Properly assigned weights ensure that important considerations are adequately emphasized, improving the effectiveness and reliability of the decision-making process.
Phase 1.7: Rank the alternatives based on their SVNF scores Wi. The alternative with the highest score may be selected as the preferred choice, considering the decision-maker's objectives and criteria weights.

Phase 2.1: Table II provides the information regarding the Information on demand and travel time.

Table 2: Primary Matrix: Information on Demand and Travel Time

Region	Location L1	Location L2	Demand (Affected People)
R1	47.49	25.00	1500
R2	9.22	37.91	1000
R3	20.00	13.00	750

Weights:
Location L1: $W_{L1} = 0.211$
Location L2: $W_{L2} = 0.180$

Phase 2.2: Table III has a cost-of-transportation table. No benefit-type statistics are available.

Table 3: Matrix for Transportation Cost

Affected people location	L1	L2
Region		
R1	70,500	35,000
R2	8,000	46,000
R3	32,000	11,250
Medical Center Cost ($)	7,000	6,500
Total Cost ($)	117,500	98,750

The statement indicates that a temporary medical health center, located at candidate location ”L2”, has been chosen based on minimizing the total cost of operations, which amounts to $98,750. This decision considers factors such as transportation costs, operational efficiency, and resource utilization. By assigning affected people location ”L2” to all regions, the center aims to strategically manage and serve the affected populations efficiently, despite varying distances and demand distributions across regions R1, R2, and R3. This approach ensures equitable access to medical care while optimizing cost-effectiveness, potentially minimizing logistical challenges and improving overall response effectiveness during health emergencies such as the Marburg virus outbreak.

Phase 2.3: A temporary medical health center with a minimum total cost of $98,750 is assigned to candidate location ”L2”. Affected people location ”L2” has been assigned to all regions.

Phase 2.4: By reassigning affected people to other potential sites, Table IV assesses the relocation savings (benefit). Candidate location ”L1”, which has a save of $49,250, had a temporary health care center assigned to it. The candidate site ”L2” has been assigned to R1 and R3. R2 is best assigned to L2 because there is no saving in any other possible locations for it. Table V updates the savings matrix. The potential locations have no savings. As a result, there is no need for a new health care center, and the algorithm ends.

Table 4: Savings Matrix

Affected people location	**L1**	**L2**
Region		
R1	35,500	R1
R2	-	R2
R3	20,750	R3
Medical Center Cost ($)	7,000	6,500
Total Saving ($)	49,250	-

Phase 2.5: Candidate location ”L1”, which has a save of $49,250, had a temporary health care center assigned to it. The candidate site ”L2” has been assigned to R1 and R3. R2 is best assigned to L2 because there is no saving in any other possible locations for it. Table V updates the savings matrix. The potential locations have no savings. As a result, there is no need for a new health care center, and the algorithm ends.

Table 5: Savings Matrix

Affected people location	**L1**	**L2**
Region		
R1	R_1^*	R1
R2	-	R_2^*
R3	R_3^*	R3
Medical Center Cost ($)	7,000	6,500
Total Saving ($)	-	-

Table VI lists the final assignments and associated expenses. The suggested model’s findings indicate that two temporary health care centers should be located in L1 and L2, respectively. Residents of R1 and R3 are served by the temporary health care centers in L1. Only the inhabitants of R2 are served by the temporary center at L2.

Creating a table for the cost-of-transportation involves listing the transportation costs between affected people locations and potential medical center locations. Here’s a tabulated example:
Table VI. Cost-of-Transportation
In this table:
Each row represents an affected people location (R1, R2, R3).
Each column represents a potential medical center location (L1, L2). The values in the table denote the transportation costs (in dollars) from each affected people location to each medical center location.

Table 6: Savings Matrix

Affected People Location	Medical Center Location L1 ($)	Medical Center Location L2 ($)
Region R1	70,500	35,000
Region R2	8,000	46,000
Region R3	32,000	11,250

This table is essential for evaluating the total transportation costs associated with assigning affected people from their respective regions to different medical center locations based on cost minimization strategies. The SVNF-MCDM approach evaluates potential sites for health care centers to combat the Marburg virus by considering multiple criteria and uncertainties. The method uses fuzzy judgments to weight candidate sites, and the savings heuristic determines the optimal number and locations of centers. Two centers are proposed, costing $67,750.

Table 7: Transportation Cost Data

Affected people location	L1	L2	Cost ($)
Region			
R1	R_1^*		35,000
R2	-	R_2^*	8,000
R3	R_3^*		11,250
Medical Center Cost ($)	7,000	6,500	13,500
Total Cost ($)	-	-	67,750

7 Conclusion :-

Health care centers are the most effective strategy against the Marburg virus to reduce the fatal rate. Temporary health care centers should be taken into consideration in addition to the current health facilities for improving patient care and avoiding the further spreading of the virus. In this work, a technique has been proposed for identifying the locations of these centers and designating the regions that they serve. Multifacility layouts are the foundation of the suggested strategy. A single-valued neutrosophic fuzzy multi-criteria decision-making approach is used to assess the weights of potential sites. The number of centers, the regions in which they should be situated, and the regions they should serve are decided using the savings heuristic. In the example provided, two potential sites that may service three areas are considered. The candidate sites are weighted based on the criteria and the fuzzy judgments of the decision makers. As a consequence of the cost-saving heuristic, it is agreed to build two centers at two potential locations for a total of $67,750. It is advised to use various fuzzy extensions, such as spherical fuzzy sets, hesitant fuzzy sets, intuitionistic fuzzy sets, etc., with the multi-criteria decision-making approach in future studies. It is possible to compare the outcomes of various assignment algorithms and consider new assessment criteria. Real-world examples can be used to expand the topic.

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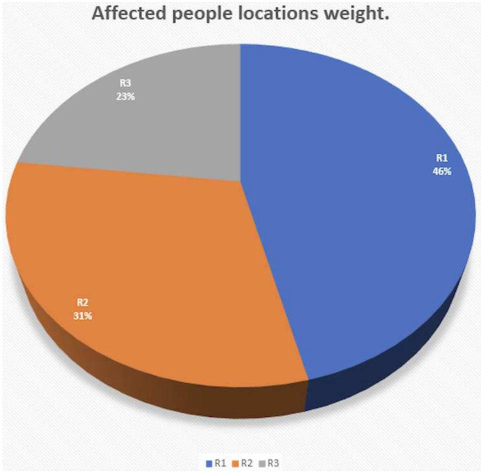

Fig. 1: Three affected people locations weights details

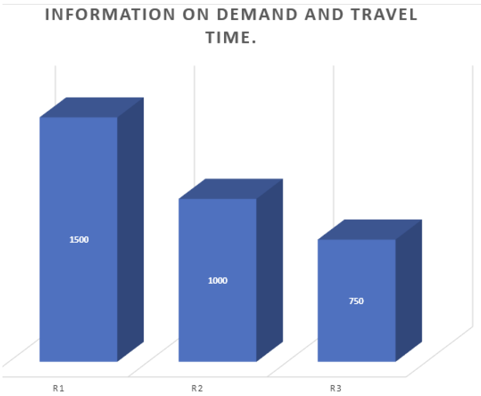

Fig. 2: Information on demand and travel time.

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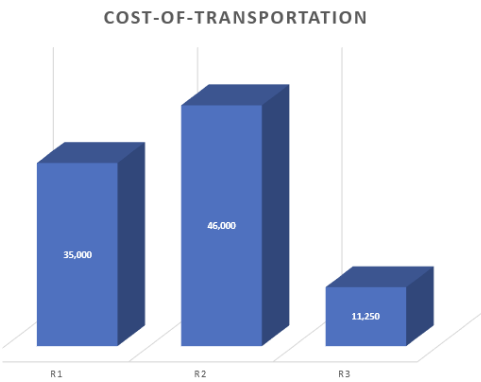

Fig. 3: cost-of-transportation

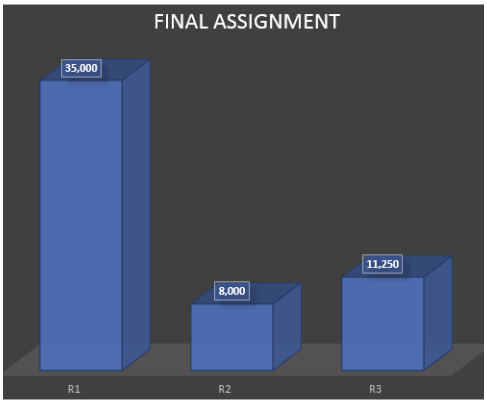

Fig. 4: Final Assignment

Declarations

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