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A COMPREHENSIVE APPROACH TO CONTROLLING MOSQUITOS EFFECTIVELY USING TOPSIS METHOD

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The order preference by similarity ideal solution (TOPSIS) technique is debated in this study, and a model for the TOPSIS method is developed. To achieve control, the ideal technique to mosquito monitoring takes use of every step of the mosquito's life span, apply a TOPSIS access to identify the most suitable control activities for Mosquitos. In the following analysis, we use the TOPSIS process to find the most optimal Controlling Mosquitoes best aspects.

1. Introduction

Hwang & Yoon presented TOPSIS, an ordered preferences method by resemblance to an ideal decision, as one among the most renowned traditional MCDM approaches or solving the decision-making problems [1]. MCDM is a key factor for operating decision-making research and computational analysis, as it involves numerous predefined imperative (criteria) and options. The MCDM's goal is to identify the utmost acceptable attribute(s) from a group of possible attributes based on the imperative (criteria) that have been chosen [2]. The MCDM approaches may be used to solve a significant number of issues in Societies, economics, engineering, and governance are all areas of study [3]. The growing complications of the technical and supervision situation necessitates the involvement of a segment of specialists either decision makers (DM) to study all difficulties during decision making process. Lately, various researches have concentrated on MCDM difficulties in order to produce accurate considering the results the analysis of many DMs rather than a single DM [4].

One of them, known as a TOPSIS that was introduced by Hwang & Yoon to address the MCDM issue with multiple choices. Well-chosen option considers the shortest distance from the optimistic ideal solution and the maximum distance from the undesirable ideal solution, according to the main notion of this approach [5]. Moreover, over the last two decades, fuzzy TOPSIS approaches were being widely used in science and technology domains, selecting alternative-fuel buses, for instance [6]. To solve these challenges, the authors augmented the TOPSIS approach using interval data in order to ascertain the parameter range of the decision matrix elements have been treated as intervals [7]. Li D. extended the TOPSIS by considering intuitionistic fuzzy set, and introduced the enhanced TOPSIS algorithm for collective decision with multiple attributes. The concept of a multi-attribute intuitive Fuzzy Group Decision-Making (FGDM) algorithm was first proposed in 2011 [8]. Mahmoud Zadeh et al. combined fuzzy AHP and TOPSIS methodologies to build a strategy for project selection. They applied the improved approach to compute the importance of each criterion, and the TOPSIS is used to rank the projects to be evaluated [9]. Chen et al. An improved TOPSIS has been developed for analyzing qualitative and quantitative data by means of triangular fuzzy numbers [10].

2. Preliminaries

Definition: A FS$\check{T} \subseteq \H{U}$, it is distinguished by a membership function $\mu_{\check{T}}(z)$ representing a mapping $\mu_{\check{T}}(z)$: $\H{U} \rightarrow [0,1]$. The membership value of $\mu_{\check{T}}(z)$ is a function that indicates the degree of truth that z is an element of fuzzy set$\check{T}$.

Definition: A FS $\check{T}$ defined on $\breve{G}$ where $\breve{G}$ be the set of real numbers, is said to be a FN and its membership function $\check{T}: \breve{G} \rightarrow [0,1]$ has satisfied the characteristics below is

(i) It is convex $\mu_{\check{T}}(z)(\acute{\alpha} z_1 + (1-\acute{\alpha})z_2) \geq \min(\mu_{\check{T}}(z_1), \mu_{\check{T}}(z_2), \forall z[z_1, z_2], \acute{\alpha} \in [0,1]$

(ii) It is normal, $Max\ \mu_{\check{T}}(z) = 1$.

(iii) It is piecewise continuous.

Definition: The α-cut of the FS $\check{T} \subseteq \H{U}$ is described as $\check{T}_\sigma = \{z \in \H{U} / \mu_{\check{T}}(z) \geq \sigma\}$, where. $\sigma \in [0,1]$.

2. TOPSIS PROCESS:

Step 1: Establish the decision matrix (DM) as follows

$$\text{DM} = \begin{matrix} & R_1 & R_2 & \dots & R_g \\ A_1 & C_{11} & C_{12} & \dots & C_{1g} \\ A_2 & C_{21} & C_{22} & \dots & C_{2h} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ A_g & C_{g1} & C_{g2} & \dots & C_{gh} \end{matrix}$$

Here, n is the different indexing ($n = 1,2, \dots, h$); n is the possible number of sites and m is the index of criteria ($m = 1,2, \dots, g$). The elements $R_1, R_2, \dots, R_h$ of the decision matrix describe the criteria while $A_1, A_2, \dots, A_g$ describing the alternatives.

Step 2: The Normalized Decision Matrix (NDM) is established in the following way

$$NDM = L_{nm} = \frac{C_{nm}}{\sqrt{\sum_{n=1}^{h} C_{nm}^2}}$$

Step 3: Weighted Normalized Decision Matrix Determining (WNDM).

A weighted decision matrix was obtained by multiplying every element of each column of Normalized Decision Matrix (NDM).

$$V = V_{nm} = W_m \times L_{nm}$$

Step 4: The positive ideal solution (PIS) as well as the negative ideal solution (NIS) are determined.

The positive ideal solution (I^+) and the negative ideal solution (I^-) are defined for the weighted decision matrix as follows.

$PIS = I^+ = \{V_1^+, V_2^+, \dots, V_g^+\}$, $Where: V_m^+ = \{(\text{maxi}(V_{nm})\ if\ m\epsilon J);\ (\text{mini}(V_{nm})\ if\ m\epsilon J')\}$

$NIS = I^- = \{V_1^-, V_2^-, \dots, V_h^-\}$, $Where: V_m^- = \{(\text{mini}(V_{nm})\ if\ m\epsilon J);\ (\text{maxi}(V_{nm})\ if\ m\epsilon J')\}$

Here J' corresponds to quasi attributes while J corresponds to positive attributes.

Step 5: Distance between two point's positive ideal solution (PIS) and negative ideal solution (NIS) of every alternatives.

$$S_i^+ = \sqrt{\sum_{m=1}^{g} (V_m^+ - V_{nm})^2}\ ; n = 1,2, \dots, h$$

$$S_i^- = \sqrt{\sum_{m=1}^{g} (V_m^- - V_{nm})^2} \; ; n = 1,2, \dots, h$$

Here,n = Alternative index, m = Criteria index.

Step 6: Comparative Closeness to the FBV.

The Fuzzy Best solution's comparative closeness is calculated as

$$R_i = \frac{S_i^-}{(S_i^+ + S_i^-)} \; , 0 \le R_i \le 1$$

Step 7: Preferred Ordered Ranking.

The values of R_i are used to rank the alternatives; the greater the relative closeness, the greater the rank, and hence the greater the alternative's performance. To compare the better performances of other alternatives, rank them in decreasing order.

3. TOPSIS Technique Decision Hierarchy of MADM

It's a compensating aggregate technique that analyses a group of attributes by defining weights of each criterion, normalization scores, and the distance is computed among all attributes and the ideal alternative that has the maximum score in each criterion. In fig.1. It shows multi attributes decision making (MADM) problems solving method.

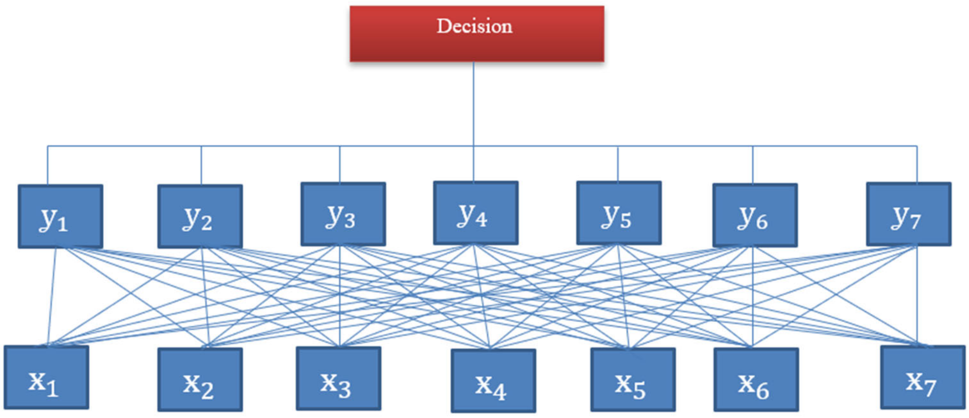

Figure 1. Decision hierarchy of MADM

4. Proposed problem of TOPSIS Method:

Different approaches to eradicate mosquitoes and their habitat are included in an integrated management mosquitoes control approach. Seven critical access given as follows x= {Control Mosquitoes at the Larval Stage (x_1), Control Adult Mosquitoes (x_2), Abolish Mosquito Sources (x_3), Use Structural Barriers (x_4), Monitoring mosquito populations (x_5), Mosquito traps(x_6), Proposals to eradicate mosquitoes(x_7)}. To identify the most suitable control activities for Mosquitos Effectively Requires.

The most important mosquito control strategy the following criteria y = {Removing unused plastic pools, old tires, or buckets, (y_1),Clearing clogged gutters (y_2),Filling or draining puddles (y_3),Changing water in bird baths and swampy areas (y_4),Cover all gaps in walls (y_5),Used indoors and outdoors around your home (y_6),Use natural pyrethrums (y_7)}.

5. Calculation by TOPSIS:

The TOPSIS approach will be demonstrated using a mosquito management approach to eradicate mosquitoes and their habitats. The set of Seven critical tactics alternatives given as follows x = {Control Mosquitoes at the Larval Stage (x_1), Control Adult Mosquitoes (x_2), Abolish Mosquito Sources (x_3), Use Structural Barriers (x_4), Monitoring mosquito populations (x_5), Mosquito traps (x_6), Proposals to eradicate mosquitoes (x_7)}. and the set of evaluation following criteria y = {Removing unused plastic pools, old tires, or buckets, (y_1), Clearing clogged gutters (y_2), Filling or draining puddles (y_3), Changing water in bird baths and swampy areas (y_4),Cover all gaps in walls (y_5),Used indoors and outdoors around your home (y_6),Use natural pyrethrums (y_7)}.

Using linguistic variables = {No Influence (NI), Very Low Influence (VLI), Low Influence (LI), Medium Influence (MI), High Influence (HI), Very High Influence (VHI)}.For linguistic variables convert to the fuzzy number = {NI-(0), VLI-(0.2), LI-(0.3), MI-(0.5), HI-(0.8), VHI-(1)}

Step 1: Construction of a Decision Matrix (DM).

Table 1. Decision Matrix $DM = [x_{ij}]_{m\times n}$

x\y	y_1	y_2	y_3	y_4	y_5	y_6	y_7
x_1	0.5	0.8	0.5	1	0.5	0.5	0.8
x_2	1	0.8	0.5	0.5	0.8	1	0.5
x_3	0.8	0.8	1	0.8	1	1	0.8
x_4	0.3	0.5	0.3	0.8	0.3	0.3	0.8
x_5	0.3	0.3	0.5	0.3	0.5	0.3	0.5
x_6	0.8	0.3	0.5	0.5	0.3	0.8	0.3
x_7	0.5	0.8	0.5	0.3	0.3	0.5	0.5

Step 2: Normalization.

$$NDM = L_{nm} = \frac{C_{nm}}{\sqrt{\sum_{n=1}^{h} C_{nm}^2}}$$

Table 2. Normalization Decision Matrix.

x\y	y_1	y_2	y_3	y_4	y_5	y_6	y_7
x_1	0.2906	0.46	0.327	0.581	0.322	0.274	0.48
x_2	0.5812	0.46	0.327	0.291	0.515	0.549	0.3
x_3	0.465	0.46	0.654	0.465	0.644	0.549	0.48
x_4	0.1744	0.29	0.196	0.465	0.193	0.165	0.48
x_5	0.1744	0.17	0.327	0.174	0.322	0.165	0.3
x_6	0.465	0.17	0.327	0.291	0.193	0.439	0.18
x_7	0.2906	0.46	0.327	0.174	0.193	0.274	0.3

Step 3: Weight Matrix Calculation.

Table 3. Weight Matrix Calculation.

Criteria	y_1	y_2	y_3	y_4	y_5	y_6	y_7
Weight	0.3	0.5	0.9	0.6	0.4	0.8	0.7

Step 4: Weighted Normalization Decision Matrix (WNDM) $V = V_{lm} = W_m \times L_{lm}$.

Table 4. Weighted Normalization Decision Matrix.

x\y	y_1	y_2	y_3	y_4	y_5	y_6	y_7
x_1	0.087186	0.231326	0.294174	0.348743	0.128831	0.219529	0.33708
x_2	0.174371	0.231326	0.294174	0.174371	0.20613	0.439057	0.210675
x_3	0.139497	0.231326	0.588348	0.278994	0.257663	0.439057	0.33708
x_4	0.052311	0.144579	0.176505	0.278994	0.077299	0.131717	0.33708
x_5	0.052311	0.086747	0.294174	0.104623	0.128831	0.131717	0.210675
x_6	0.139497	0.086747	0.294174	0.174371	0.077299	0.351246	0.126405
x_7	0.087186	0.231326	0.294174	0.104623	0.077299	0.219529	0.210675

Step 5: The finding of PIS (I^+) and NIS (I^-).

$$PIS = I^+ = \{V_1^+, V_2^+, \ldots, V_p^+\},\ \ Where: V_m^+ = \{(\text{maxi}(V_{lm})\ if\ m\epsilon J);\ (\text{mini}(V_{lm})\ if\ m\epsilon J')\}$$

$$NIS = I^- = \{V_1^-, V_2^-, \ldots, V_q^-\},\ \ Where: V_m^- = \{(\text{mini}(V_{lm})\ if\ m\epsilon J);\ (\text{maxi}(V_{lm})\ if\ m\epsilon J')\}$$

Table 5. The calculation of PIS (I^+).

PIS	y_1	y_2	y_3	y_4	y_5	y_6	y_7
I^+	0.1744	0.23	0.588	0.349	0.258	0.439	0.34

Table 6. The calculation of NIS (I^-).

NIS	y_1	y_2	y_3	y_4	y_5	y_6	y_7
I^-	0.0523	0.09	0.177	0.105	0.077	0.132	0.13

Then determine the separation measures for each alternative of $S_i^+$and S_i^-.

$$S_i^+ = \sqrt{\sum_{m=1}^{p} (V_m^+ - V_{lm})^2}\ ; l = 1,2, \ldots, q$$

$$S_i^- = \sqrt{\sum_{m=1}^{p} (V_m^- - V_{lm})^2}\ ; l = 1,2, \ldots, q$$

Table 7. Determine the separation measures for each alternative of S_i^+.

PIS	x_1	x_2	x_3	x_4	x_5	x_6	x_7

S_i^+	0.703233	0.58044	0.268577	0.530783	0.633006	0.389835	0.453993

Table 8: Determine the criteria of segregation for each alternative of S_i^-.

NIS	x_1	x_2	x_3	x_4	x_5	x_6	x_7
S_i^-	0.123383	0.26584	0.614719	0.373497	0.188333	0.530639	0.448544

Step 6: The distance between you and the best alternative. The best alternative's relative closeness is calculated as

$$R_i = \frac{S_i^-}{(S_i^+ + S_i^-)}, 0 \le R_i \le 1$$

Table 9. Closeness to the Ideal Solution of R_i.

Factor	x_1	x_2	x_3	x_4	x_5	x_6	x_7
R_i	0.149263	0.314128	0.695938	0.413032	0.2293	0.576485	0.496981

Step 7: Computation of Rank.

Table 10. Rankings

Factor	R_i	Rank
x_1	0.149263	7
x_2	0.314128	5
x_3	0.695938	1
x_4	0.413032	4
x_5	0.2293	6
x_6	0.576485	2
x_7	0.496981	3

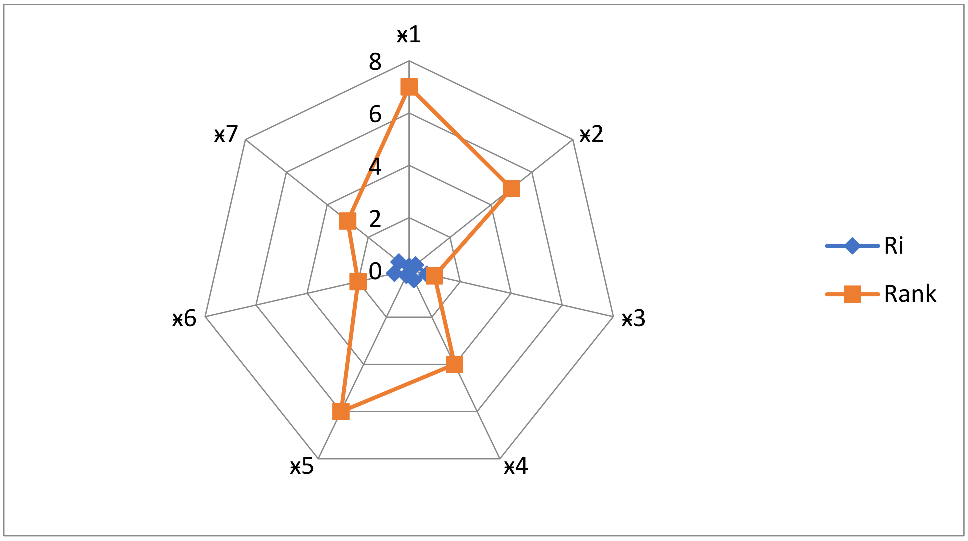

Figure 2. Closeness coefficient.

6. Conclusion

According to the closeness confident values, the following rank has been given to the factors $x_3 > x_6 > x_7 > x_4 > x_2 > x_5 > x_1$. Hence, the first four are more appropriate Factors for eradicating the mosquitos to the given parameters. To identify the most suitable activities for the Mosquitos control, The TOPSIS approach is discussed in this study, and a visual representation for the TOPSIS technique has been constructed. Finally, we use the TOPSIS approach to select the most suitable Factors for mosquito eradication.

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