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RESEARCH ARTICLE

Using Fuzzy Ranking Technique to Find the Best Traits and Peak Age Group of Electors in an Election

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Abstract

Objective: To predict the peak-age of age group of voters who turn the table of election results and also to rank the attribute which people look from their candidates. **Methods:** Improved CETD matrix has been used in the sample size of nearly 150 through unsupervised method. **Findings:** This study provides: 1. Ordering or ranking of age groups; 2. Identifying the best attribute for the leaders to possess to win the election. **Novelty:** To get accurate result, the researchers have structured the normalization through max-max (min-min) for improved CETD and rank identification through TOPSIS method. This method enhances the normality of interval measure to lie between [0, 1].

Keywords: ATD; RTD; CETD; Attributes; $\propto$ cut; TOPSIS

1 Introduction

In India, generally, a maximum of only 70% voters appear to cast their votes in elections. Out of the remaining 30% of voters, at least 10% more voters' turnout can bring about a change in results. Rochana Bajpai & Lawrence Sáez[(1)] discussed the social paper, Big Win: The Political Logic of Winning by Large Margins in India. This article has established that winning is not synonymous with large margins and "safe" positions. It identified several factors that led MPs to win by large margins. This paper motivated the researchers to find the main characters/attributes needed by candidate or the leader of the political party. So, the researchers discussed the characters of the leader with the voters in the various ages. They said that erratic unemployment, corruption-free nation, cleanliness etc. The authors of this article merged all these aforementioned into a single attribute i.e., Administrative Skills. The other attributes are participation in people movement; concentrate towards poor and downtrodden, supporter of women empowerment, veteran of social justice and political acumen. The researchers would like to conclude the above-mentioned attributes are best and the age of the people will change the major role in the election result. Therefore, it is suggested to use the fuzzy matrix and subsequently, they compared the result with TOPSIS method in the fuzzy approach.

In recent years, the researchers have seen the constant increase of rate of change in death rate due to various reasons such as pandemic, sudden heart attack, cardiac arrest, cancer, road accidents and much more. This has decreased the percentage of voters' turn around for the election. Most common death toll is in between the age group of 45 and above. This has also made the researchers to think of the age group that predicts the change of Government. In the present paper, more importance is given towards finding the best characterisation of the leaders and the age group who turn the table in changing the Government. The paper is divided into six sections. Section one is introduction of the problem addressed in the study. Section two is of literature review. Section three and four deal with the methodology of CETD and TOPSIS. In section five, the calculation parts with tables and graphs are given. Finally, section six concludes the study.

2 Literature review

Fuzzy set theory was developed by Zadeh's, to develop a new theory which is an intermediate set theory which is not in the form of classical set theory. But as we know that the bivalent logic of 0s and 1 to say whether things are completely false or completely true which is not always certain in real life application which produce a theory named fuzzy set in the year 1965.

In real life problems, we come across uncertainty, vagueness, ambiguity rather than certainly each problem is designed in the nature of fuzzy whose membership ranges from [0,1]. The extension of fuzzy set theory has developed its idea in different areas such as Fuzzy algebra, Fuzzy topology, Fuzzy matrix theory, Fuzzy decision making and much more. In the fuzzy approach, to establish the result for the data provided, the researchers use CETD technique and TOPSIS.

CETD technique is used by Vasantha Kandasamy[2] in 1998 in order to create a new model for passenger enhanced transportation problem and named it as CETD (Combined Effective Time Dependent data) matrix. This technique has been subdivided into RTD (Refined Time Dependent Matrix), ATD (Average Time Dependent Matrix). Later, this technique has been used by Victor Devadoss[3] to predict the peak age of patients of HIV/AIDS who are at more risk to get the diseases. Also, Radhika[4] used this technique to get the factors which are more vulnerable to Breast Cancer. Saraswathi, A[5] used this technique to study the maximum age group of major problems of housemaids by different age interval. Moreover, in the year 2023, Saraswathi[6] used this technique to find the maximum age group of psychological problems of transgender in Tamil Nadu. M. Suresh[7] used this technique to analysis women harassment in villages using CETD Matrix Model. The researchers have changed the small modification in the normalisation and established the improved CETD matrix on the said problem. TOPSIS method is applied in various fields to find the solution for real-world problems. In 2018, Yanjin He and Hosang Jung[8] used TOPSIS technique as a voting TOPSIS approach for determining the priorities of areas damaged in disasters. In the year 2021, Raphael Kwaku Botchway[9] and et.al used this technique in the electoral system. The authors of the present study have used this technique to compare the result with TOPSIS technique, in our problem the weights are assumed as the priorities of the attributes.

3 Proposed Methodology for Improved CETD matrix

Step 1: Form an initial raw data matrix

$$A_{ij} = (a_{ij}),\ i = 1,2,\ldots m \quad j = 1,2\ldots .n$$

$$A_{ij} = f(A_1, A_2, \ldots\ldots\ldots A_n)$$

where i= Intervals of age group, j= Attributes or factors given by experts.

Step 2: Calculate the following values

$$R_I^+ = \max_j (a_{ij}),\ j = 1,2\ldots n$$

$$R^+ = \max_i (R_I^+),\ i = 1,2\ldots m$$

$$R_J^- = \min_j (a_{ij}),\ j = 1,2\ldots n$$

$$R^- = \min_j (R_J^-), \ \ i = 1, 2 \ldots m$$

Step 3: Calculate $D = R^+ - R^-$

Step 4: We obtain Average Time Dependent Matrix (ATD) using this formula

$$E_{ij} = \frac{(a_{ij})}{D} \quad i = 1, 2, \ldots m, \ j = 1, 2 \ldots . n$$

Step 5: For Normalisation, calculate $F_{ij} = \frac{E_{ij}}{\sum_i E_{ij}}$, where F_{ij} is called ATD matrix.

Step 6: Calculate Mean and Standard Deviation using

Mean $\mu = \frac{\sum_{i=1}^{m} F_{ij}}{N}$,

Standard deviation $\sigma = \sqrt{\frac{\sum_{i=1}^{m} F_{ij}^2}{N} - \mu^2}$,

where $N = number\ of\ observation.$

Step 7: Defuzzification

For different choices of alpha cut within the interval [0,1], we construct Refined Time Depended (RTD) matrix with following relational equation whose entries are {-1,0,1}

$If\ a_{ij} \leq (\mu_j - \alpha * \sigma_j)\ then\ e_{ij} = -1.$

else

$If\ a_{ij} \in (\mu_j - \alpha * \sigma_j, \mu_j + \alpha * \sigma_j,)\ \ then\ e_{ij} = 0.$

else

$If\ a_{ij} \geq (\mu_j + \alpha * \sigma_j)\ \ then\ e_{ij} = 1.$

e_{ij} – Coefficient of RTD matrix which always takes values {-1,0,1}

Step 8: Obtain CETD matrix by combining RTD matrix with addition of matrix. Graphs are plotted with ages and attributes in X-direction and against row sum of matrix in Y-direction.

4 TOPSIS Method

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is a multi-criteria decision-making system. TOPSIS alternately selects short Euclidean distances from the ideal solution and large distances from the negative ideal solution. Alternatives are ranked using a cumulative index calculated based on distance from the best solutions.

Step 1: Compute the normalized decision Matrix

The initial raw matrix C=(c_{ij}) is normalized to M=(m_{ij}) using the following normalization $m_{ij} = \frac{c_{ij}}{\sqrt{\sum_{i=1}^{m} {c_{ij}}^2}}$; i=1,2,…..m, j=1,2,….n where c is the performance value of each cell.

Step 2: Compute the weighted normalized decision matrix

The weighted normalized value A_{ij} is computed in the following manner:

$A_{ij} = w_j * m_{ij}$, i = 1, 2, . . . , m, j = 1, 2, . . . , n, where w_j is the weight of the j[th] criterion, and $\sum_{J=1}^{N} w_J = 1$

Step 3: Compute the ideal best and ideal worst value

The ideal best (A_J^+) and the ideal worst value (A_J^-) are evaluated in the following mannar

$A_J^+ = \{[\max (a_{ij} \mid i = 1, 2, \ldots, m, j \in I)]$,

$A_J^- = \{[\min (a_{ij} \mid i = 1, 2, \ldots, m, j \in I)]$,

where I is related with beneficial criteria and J is related with non-beneficial criteria.

Step 4: Compute Euclidean distance from ideal Best and Worst

The Euclidean distance of each age from the ideal best value (A_J^+) and the ideal worst value A_j^- are given as $T_i^+ = \sqrt{\sum_{i=1}^{n} (a_{ij} - A_j^+)^2}$, i=1,2,….m, j=1,2,…..n $T_i^- = \sqrt{\sum_{i=1}^{n} (a_{ij} - A_j^-)^2}$, i=1,2,….m, j=1,2,…..n.

Step 5: Compute the relative closeness to the ideal best value

The relative closeness of the i[th] alternative with respect to A_J^+ is defined as $\rho_i = \frac{T_i^-}{T_i^- + T_i^+}\ \ where\ 0 \leq \rho_i \leq 1;\ \ i = 1, 2, \ldots . m.$

Step 6: Rank the ages

The set of ages now can be ranked by the descending order of the value of ρ_{ij}.

5 Description of the problems

The researchers have taken a survey of nearly 150 people in and around Chennai region from different age groups, i.e., from the age of 18 (who are eligible to cast their first vote) and moves on to age up to 75. The researchers could analyse the different age groups sounding for different attributes (characterisation of leaders). They have enlisted nearly 20 attributes but for the sake of best performance the best among the attributes is chosen for the present survey.

Estimation of best attributes for the leader using 6x4 matrix and estimate the maximum age group of voters using 4x6 matrix.

Table 1.

Attributes	Remarks
A1	Administrative skill
A2	Participation in people movement
A3	concentrate towards poor and downtrodden
A4	Supporter of women empowerment
A5	Veteran of social justice
A6	Political acumen

5.1 CETD Calculation for the best attributes for the leader

Table 2. Initial Raw data matrix of order 6x4

Attributes	18-24	25-34	35-44	45-64
A1	27	28	34	15
A2	13	14	28	11
A3	26	29	29	14
A4	22	21	25	7
A5	15	17	18	9
A6	14	19	14	5

Table 3. ATD Matrix for the best attributes for the leader of 6x4 matrix

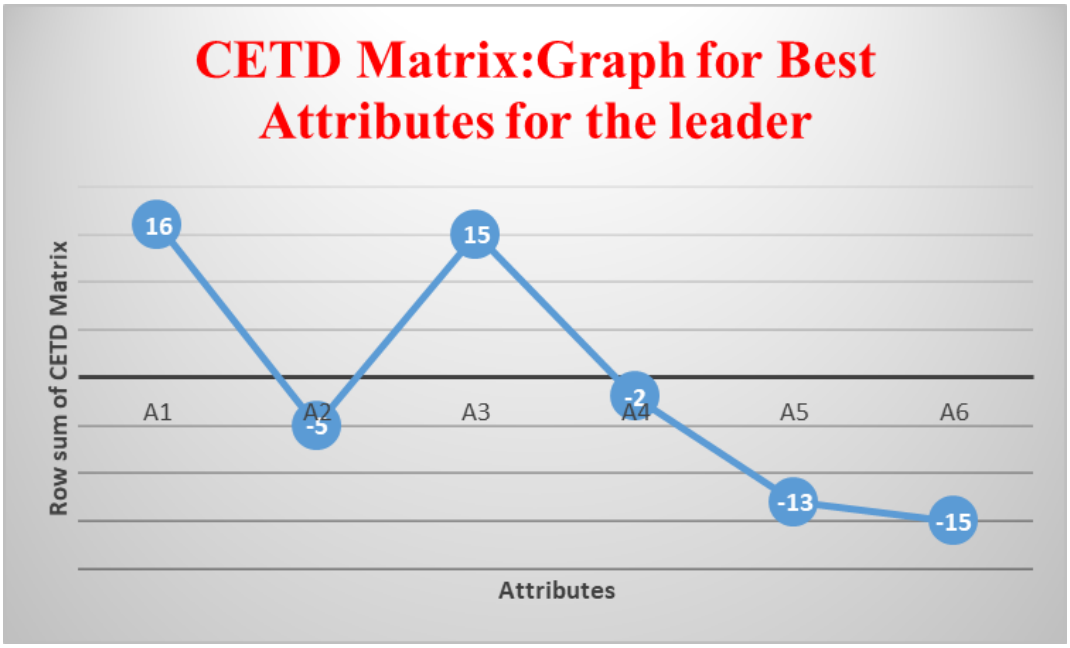
Attributes	18-24	25-34	35-44	45-64
A1	0.931034	0.965517	1.172414	0.517241
A2	0.448276	0.482759	0.965517	0.37931
A3	0.896552	1	1	0.482759
A4	0.758621	0.724138	0.862069	0.241379
A5	0.517241	0.586207	0.62069	0.310345
A6	0.482759	0.655172	0.482759	0.172414
Total	4.034483	4.413793	5.103448	2.103448

Table 4. Average Time Dependent Matrix for order 6x4 (Normalised)

Attributes	18-24	25-34	35-44	45-64
A1	0.230769	0.21875	0.22973	0.245902
A2	0.111111	0.109375	0.189189	0.180328
A3	0.222222	0.226563	0.195946	0.229508
A4	0.188034	0.164063	0.168919	0.114754
A5	0.128205	0.132813	0.121622	0.147541
A6	0.119658	0.148438	0.094595	0.081967
MEAN	0.166667	0.166667	0.166667	0.166667
SD	0.053717	0.047048	0.05014	0.064263

CETD Matrix for the best attributes for the leader:

$$\begin{matrix} & & & & \textit{Row Sum Matrix} \\ \begin{bmatrix} 4 & 4 & 4 & 4 \\ -4 & -4 & 2 & 1 \\ 4 & 4 & 3 & 4 \\ 2 & 0 & 0 & -4 \\ -3 & -3 & -4 & -3 \\ -4 & -3 & -4 & -4 \end{bmatrix} & & & & \begin{bmatrix} 16 \\ -5 \\ 15 \\ -2 \\ -13 \\ -15 \end{bmatrix} \end{matrix}$$



Graph 1: **Portraying of best attributes for the leader CETD Matrix**

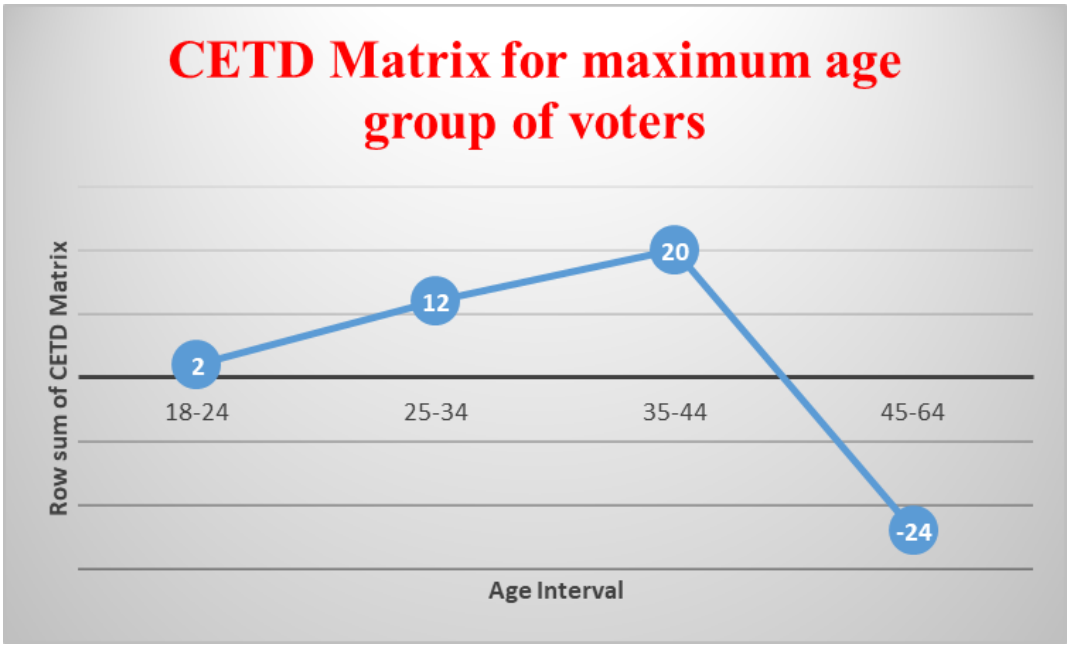
5.2 CETD calculation for the maximum age group of voters

Table 5. Average Time Dependent Matrix for the maximum age group of voters of order 4x6 matrix

Age	A1	A2	A3	A4	A5	A6
18-24	0.259615	0.19697	0.265306	0.293333	0.254237	0.269231
25-34	0.269231	0.212121	0.295918	0.28	0.288136	0.365385
35-44	0.326923	0.424242	0.295918	0.333333	0.305085	0.269231
45-64	0.144231	0.166667	0.142857	0.093333	0.152542	0.096154
Mean	0.25	0.25	0.25	0.25	0.25	0.25
SD	0.076521	0.117688	0.072872	0.106875	0.068324	0.112134

CETD Matrix for maximum age group of voters:

$$\begin{matrix} & & & & & & \textit{Row Sum Matrix} \\ \begin{bmatrix} 1 & -2 & 1 & 1 & 0 & 1 \\ 2 & -2 & 3 & 2 & 3 & 4 \\ 4 & 4 & 3 & 4 & 4 & 1 \\ -4 & -4 & -4 & -4 & -4 & -4 \end{bmatrix} & & & & & & \begin{bmatrix} 2 \\ 12 \\ 20 \\ -24 \end{bmatrix} \end{matrix}$$



Graph 2: **Portraying of maximum age group for CETD Matrix**

5.3 TOPSIS Calculation for the maximum ages of voters

Table 6. Initial raw data matrix

Weight	0.3	0.2	0.2	0.1	0.1	0.1
AGE	A1	A2	A3	A4	A5	A6
18-24	27	13	26	22	15	14
25-34	28	14	29	21	17	19
35-44	34	28	29	25	18	14
45-64	15	11	14	7	9	5

Table 7. Normalized decision matrix

Weight	0.3	0.2	0.2	0.1	0.1	0.1
AGE	A1	A2	A3	A4	A5	A6
18-24	0.501897	0.364789	0.514473	0.550172	0.494804	0.501924
25-34	0.520486	0.392849	0.573836	0.525164	0.560778	0.681183
35-44	0.632018	0.785699	0.573836	0.625195	0.593765	0.501924
45-64	0.278832	0.308667	0.277024	0.175055	0.296883	0.179259

Table 8. The weighted normalized decision matrix

Weight	0.3	0.2	0.2	0.1	0.1	0.1
AGE	A1	A2	A3	A4	A5	A6
18-24	0.150569	0.072958	0.102895	0.055017	0.04948	0.050192
25-34	0.156146	0.07857	0.114767	0.052516	0.056078	0.068118
35-44	0.189605	0.15714	0.114767	0.06252	0.059377	0.050192
45-64	0.083649	0.061733	0.055405	0.017505	0.029688	0.017926

Table 9. Relative closeness to the ideal best value

AGE	T_i^+	T_i^-	ρ_i	Rank
18-24	0.096057	0.059773	0.38358	3
25-34	0.086045	0.078312	0.476475	2
35-44	0.017926	0.103725	0.852645	1
45-64	0.171114	0.050644	0.228376	4

6 Conclusion

From the graph, the researchers could give the following observations:

1. The age group study the paper, the age group between the intervals 35 and 44 attains the peak age and this result is matched with TOPSIS method.
2. The age group between 25 to 34 is closely the criteria 'nearby to peak'.
3. The researchers conclude the age group between 25 and 44 which possibly act as the catalyst in election result.
4. The researchers' results go with the statistical survey of ECI by collecting very meagre data comparative to data collected by ECI.
5. By the transformation of matrix of the data set, the researchers could find the ranking of attributes which predict the best ranking as: (a) Education is mainframe attribute a leader should possess, (b) To work for poor and downtrodden people who are economically weaker, and all the rest of attributes follow upon in order.
6. Thus, the researchers could go with the suggestion people with peak age and the peak characterization can be adopted for to get the best outcome for political parties.

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