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BEST ENGINEERING COLLEGE SELECTION THROUGH FUZZY MULTI-CRITERIA DECISION MAKING APPROACH: A CASE STUDY

Sonu Rana[1], Pabitra Kumar Dey[2] and DipendraNath Ghosh[3]

[1]*Department of computer science & Engineering, Aryabhatta Institute of Engineering & Management,Durgapur (panagarh-713148),West Bengal, India*

[2]*Department of computer Application, Dr.B.C.Roy Engineering College, Jemua Road, Fuljhore, Durgapur-713206 West Bengal, India*

[3]*Department of computer science & Engineering,Dr.B.C.Roy Engineering College, Jemua Road, Fuljhore, Durgapur-713206,West Bengal, India*

***Abstract*-Best Engineering College selection for a fresh student is very essential to the overall engineering education system. Engineers are the pillars of all over the world and a good engineer can change or develop a country. Best engineering college selection is the process for increasing the quality of engineering education as well as to increase the goodwill of an organization. Opinion of several students are considered to initialize the use of multi-criteria decision making for ranking the colleges with the help of two step methodology containing AHP, TOPSIS and then FUZZY set theory is used to improve two step AHP-TOPSIS methodology for making the decision of best engineering college selection. The result showed that the proposed model yields more realistic way to select the best institute and could solve the shortcomings in existing college selection system.**

***Keywords* - Multi Criteria Decision Making Analysis, Analytic Hierarchy Process, TOPSIS, Fuzzy-AHP.**

I. INTRODUCTION:

Now-a-days most of the parents want their children to become an engineer. So, selection of the Best Engineering College after completion of (10+2) standard examination becomes the first priority. This study is concentrated on the best engineering college selection in a city of West Bengal in India. In this state, the number of Govt. Engineering colleges is not enough. That is why the private engineering colleges under W.B.U.T have been established for those students who can really fulfil their dream to become a good engineer. Accordingly intake of student in engineering courses is growing up rapidly. But sometimes it is seen that few colleges have started their different courses without proper infrastructure and other facilities. At this moment students are confused for making decision of their admission to engineering education. So, students/parents should concentrate on some points like – where they will have good campus interview, good teachers, library facilities, good management, research facility, study facility, which college is disciplined etc. Multi Criteria Decision Making Approach provides the students and their parents' better idea for the selection of best engineering college. Pairwise comparison method like Analytical Hierarchy Process (AHP) developed by Saaty [1, 2] in 1980 is very useful to compare the different criterions and the alternatives for selection of best engineering college. Technique for Order Preference by Similarity to the Ideal Solution (TOPSIS) was first developed by Hwang and Yoon [22], is based on the idea that the chosen alternative should have the shortest distance from the positive ideal solution and on the other side the farthest distance of the negative ideal solution. In this work a combined methodology of AHP and TOPSIS named as Two Step AHP-TOPSIS Methodology is used for defining the different weights of different criteria and calculate the overall ranking of the engineering colleges. A new approach named as Two Step Fuzzy-AHP-TOPSIS methodology have been introduced to handle the vagueness and uncertainty of human judgement to produce the better result of previous Two Step Method.

II. TWO STEP AHP-TOPSIS METHODOLOGY:

In this work two step method consists of AHP and TOPSIS. In first step, AHP is used for calculating the weights of the attributes as well as the overall weights of the colleges in each attribute. In second step these weights are considered and used in TOPSIS process. Then TOPSIS is applied for evaluation of the problem and the results of it show the preference order of the college selection. This methodology levels can be seen in Fig. 1 clearly.

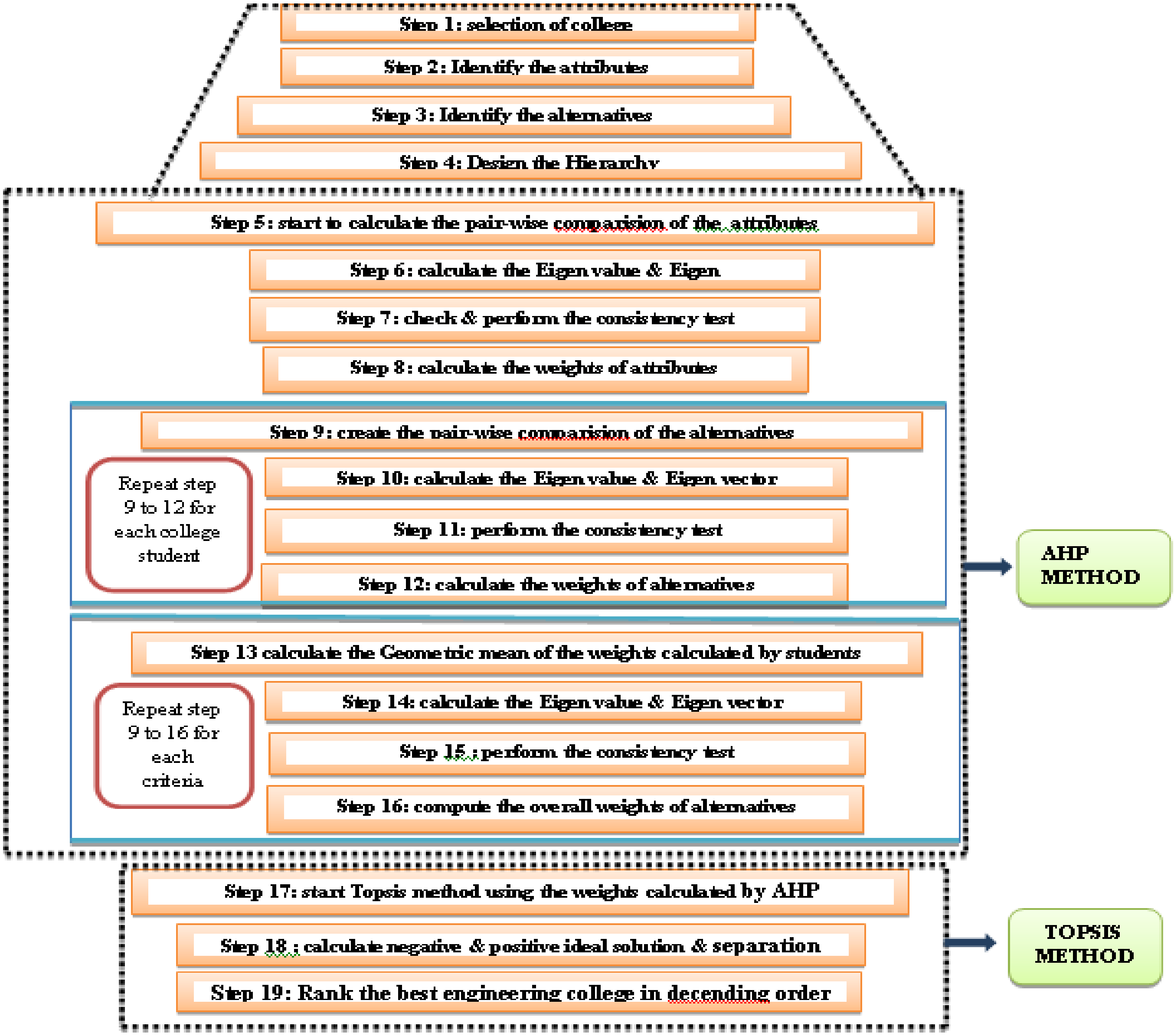

Fig 1: Two – step methodology of AHP & TOPSIS

Here this methodology has been discussed with the help of an illustration.
Three students opinion as expert's opinion are considered and presented in table-1

TABLE 1: STUDENTS' OPINION AS EXPERT OPINION

CRITERIA **vs** ALTERNATIVES	**A1**			**A2**			**A3**			**A4**			**A5**		
	S1	**S2**	**S3**	**S1**	**S1**	**S2**	**S3**	**S2**	**S3**	**S1**	**S2**	**S3**	**S1**	**S2**	**S3**
B1	Vg	G	M	Vg	Vg	Vg	G	G	M	Vg	G	Vg	Vg	Vg	G
B2	Vg	M	G	G	G	G	G	G	M	Vg	Vg	M	G	G	G
B3	E	Vg	E	Vg	Vg	E	Vg	Vg	Vg	E	E	E	Vg	E	Vg
B4	Vg	G	G	Vg	Vg	G	M	Vg	E	Vg	G	Vg	Vg	G	M
B5	M	G	G	M	G	M	G	M	M	G	G	G	G	M	G

CRITERIA **vs** ALTERNATIVES	**A6**			**A7**			**A8**			**A9**		
	S1	**S2**	**S3**	**S1**	**S2**	**S3**	**S1**	**S2**	**S3**	**S1**	**S2**	**S3**
B1	E	G	G	V	G	G	G	G	V	G	M	E
B2	M	V	G	V	G	V	V	Vg	G	M	G	Vg
B3	Vg	E	E	E	V	E	V	E	E	E	V	E
B4	Vg	V	V	V	M	V	G	Vg	G	M	M	M
B5	E	G	G	G	G	M	M	G	M	V	V	Vg

A. Analytic Hierarchy Process(AHP)

It is one of the best and most widely used MCDM approaches. AHP is an approach to decision making that involves structuring multiple choice criteria into a hierarchy, assessing the relative importance of these criteria, comparing alternatives for each criterion and determining an overall ranking of the alternatives [11].

An AHP hierarchy has at least three levels. All the three levels have been mentioned below:

Level- 1 (Goal) – Best Engineering College Selection.

Level- 2 (Criteria/Attributes) – Nine major criteria like A1, A2, A3, ... , A9 where

A1: Good Management,
A2: Infrastructure,
A3: Library Facility,
A4: Co-curriculum Activities,
A5: Laboratory Facility,
A6: Extra Curriculum Activities,
A7: Campus interview,
A8: Research Facility,
A9: Faculty & Staff Members

Level- 3 (Alternatives) – Five engineering colleges like B1, B2, B3, B4, B5 where
B1: DIATM,
B2: BCET,
B3: BCREC,
B4: AIEMD,
B5: KIT

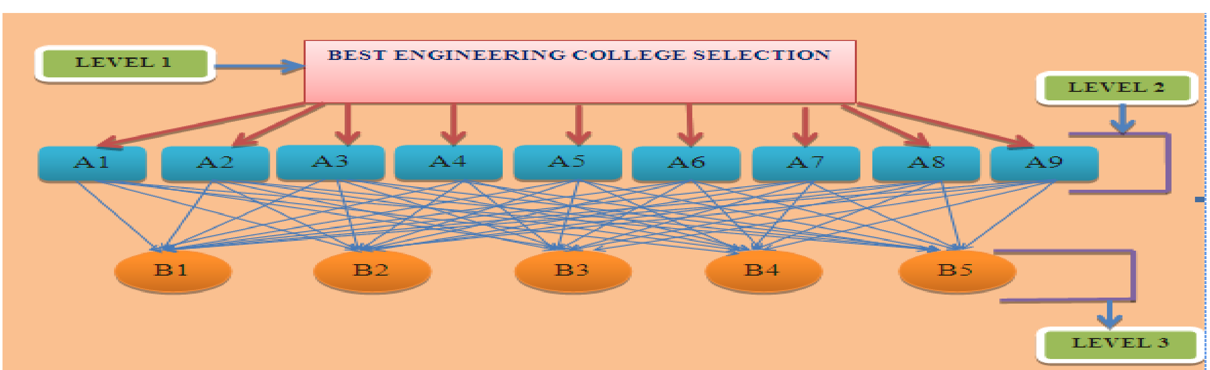

Fig 2: Hierarchy for Best Engineering College Selection

Step 1: Taking the pair wise comparison matrix according Satty's scale mentioned in table-2 of expert-1 for the criteria Good Management are as follows:-

TABLE 2: SAATY'S 9-POINT SCALE OF PAIR-WISE COMPARISON

Scale	Compare factor of i
1	Equally Important
3	Weakly Important
5	Strongly Important
7	Very Strongly Important
9	Extremely Important
2,4,6,8	Intermediate value

TABLE 3: PAIRWISE COMPARISON MATRIX FOR GOOD MANAGEMENT OF EXPERT-1(S1)

EXPERT	B1	B2	B3	B4	B5
B1	**1**	**1**	**0.5**	**1**	**4**
B2	**1**	**1**	**0.5**	**1**	**4**
B3	**2**	**2**	**1**	**2**	**5**
B4	**1**	**1**	**0.5**	**1**	**4**
B5	**0.25**	**0.25**	**0.2**	**0.25**	**1**

Step 2: Calculate the column sum for each column $\sum_i C_{ij}$

Step 3: Standardized each cell by $X_{ij} = \dfrac{C_{ij}}{\sum_i C_{ij}}$

Step 4: Calculate the row sum by $R_i = \sum_j X_{ij}$ and weight by $W_i = \dfrac{R_i}{n}$; n = no. of colleges.

Step 5: Calculate the priority vector by $V_i = A.W_i$ for i = 1,2,..,n.

Step 6: Calculate $\lambda_i = \dfrac{V_i}{W_i}$ and calculate λ_{max} by averaging the λ_i's.

TABLE 4: λ_{max} CALCULATION

EXPERT 1	B1	B2	B3	B4	B5	Weight	Vector	Lamda	Max
B1	**1**	**1**	**0.5**	**1**	**4**	**0.1958**	**0.9845**	**5.0281**	**5.0272**
B2	**1**	**1**	**0.5**	**1**	**4**	**0.1958**	**0.9845**	**5.0281**	
B3	**2**	**2**	**1**	**2**	**5**	**0.3582**	**1.8055**	**5.0405**	
B4	**1**	**1**	**0.5**	**1**	**4**	**0.1958**	**0.9845**	**5.0281**	
B5	**0.25**	**0.25**	**0.2**	**0.25**	**1**	**0.0545**	**0.2731**	**5.011**	
SUM	**5.25**	**5.25**	**2.7**	**5.25**	**18**	**1.0001**	**5.0318**		

Step 7: Calculate Consistency Index (C.I) and Consistency Ratio (C.R).

Here C.I.= $\dfrac{\lambda_{max} - n}{n-1}$ = **0.0068** and C.R. = $\dfrac{C.I}{R.I}$ = **0.0061**< 0.1

TABLE:5 RANDOM INDEX (SATTY, 1980)

Matrix Order	1,2	3	4	5	6	7	8	9	10	11	12	13
R.I.	0	0.52	0.89	1.12	1.26	1.36	1.41	1.46	1.49	1.52	1.54	1.56

This value of C.R is less than the allowable value of 0.10. Therefore, the consistency of the judgment matrix is found to be within an acceptable tolerance. But if the consistency ratio is greater than 0.10 we need to revise the subjective judgment.

Step 8: Repeat Step-1 to Step- 7 for Expert-2 and Expert-3 and check the consistency criteria for each case.

Step 9: Calculate the Geometric mean of each cell of Student -1, Student -2 and Student -3 and repeat Step -1 to Step -7 for calculating the overall weight for each college for the criteria of Good Management.

TABLE 6: OVERALL WEIGHT OF EACH COLLEGE FOR GOOD MANAGEMENT (A1).

COLLEGES	A1
B1	0.1656
B2	0.1643
B3	0.3126
B4	0.2016
B5	0.1556

Step 10: Repeat Step-1 to Step-9 for each criterion and calculate the weights for each college according each criterion and calculate the weight of each criterion by step- 1 to step- 7.

TABLE 7: OVERALL WEIGHT OF EACH COLLEGE.

WEIGHT	0.1698	0.0843	0.0423	0.1698	0.0843	0.0251	0.2973	0.0423	0.0843
COLLEGES	A1	A2	A3	A4	A5	A6	A7	A8	A9
B1	0.1656	0.2016	0.1766	0.1906	0.2293	0.1923	0.1901	0.1859	0.185
B2	0.1643	0.1785	0.1766	0.1644	0.1786	0.1222	0.2124	0.2136	0.1655
B3	0.3126	0.2853	0.2907	0.3039	0.2858	0.2737	0.3041	0.2955	0.2988
B4	0.2016	0.2016	0.2266	0.1906	0.1673	0.2192	0.151	0.1891	0.1081
B5	0.1556	0.1324	0.1291	0.1501	0.1386	0.1923	0.1419	0.1154	0.2422

B. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

TOPSIS, known as one of the most classical MCDM methods, was first developed by Hwang and Yoon [22], is based on the idea that the chosen alternative should have the shortest distance from the Positive Ideal Solution (PIS) and on the other side the farthest distance of the Negative Ideal Solution (NIS). The Positive Ideal Solution maximizes the benefit criteria and minimizes the cost criteria, whereas the Negative Ideal Solution maximizes the cost criteria and minimizes the benefit criteria [24, 25]. In the process of TOPSIS, the performance ratings and the weights of the criteria are given as exact values. Abo-sinna and Amer [17] extend TOPSIS approach to solve multi-objective nonlinear programming problems. Jahanshahloo et al. [19] extends the concept of TOPSIS to develop a methodology for solving multi-criteria decision-making problems with interval data. The steps of TOPSIS model are as follows:

- Calculate the normalized decision matrix.
- Calculate the weighted normalized decision matrix.
- Determine the Positive Ideal Solution and Negative Ideal Solution.
- Calculate the separation measures for each alternative from the positive and negative ideal solution.
- Calculate the relative closeness to the ideal solution for each alternative.
- Rank the preference order.

Using these steps, the defined problem can be explained as mathematically like:

Step 1: Construct normalized decision matrix. Normalize scores or data as follows:

$$r_{ij} = \frac{x_{ij}}{\sqrt{(\sum_i x_{ij}^2)}}, \quad \text{for } i = 1, \dots, m;\ j = 1, \dots, n$$

Step 2: Construct the weighted normalized decision matrix by multiply each column of the normalized decision matrix by its associated weight. An element of the new matrix is: $v_{ij} = w_j . r_{ij}$

TABLE 8: WEIGHTED NORMALIZED DECISION MATRIX CALCULATION

WEIGHT	**0.1698**	**0.0843**	**0.0423**	**0.1698**	**0.0843**	**0.0251**	**0.2973**	**0.0423**	**0.0843**
COLLEGE	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**
B1	**0.06036**	**0.03690**	**0.01611**	**0.06986**	**0.04184**	**0.01054**	**0.12141**	**0.01689**	**0.03315**
B2	**0.05989**	**0.03267**	**0.01611**	**0.06026**	**0.03259**	**0.00666**	**0.13566**	**0.01941**	**0.02966**
B3	**0.11394**	**0.05222**	**0.02652**	**0.11140**	**0.05216**	**0.01492**	**0.19423**	**0.02685**	**0.05355**
B4	**0.07348**	**0.03690**	**0.02067**	**0.06986**	**0.03053**	**0.01195**	**0.09644**	**0.01718**	**0.01937**
B5	**0.05671**	**0.02423**	**0.01178**	**0.05502**	**0.02529**	**0.01048**	**0.09063**	**0.01048**	**0.04340**

Step 3: Determine the ideal and negative ideal solutions.

Ideal solution:

A* = {v_1^*, …,v_n^*},where v_j^*={ $\max_i(v_{ij})$ if j ∈J ; $\min_i(v_{ij})$ if j ∈J' }= {0.113948, 0.052226, 0.026526, 0.111400, 0.052160, 0.014925, 0.194231, 0.026859, 0.053551}

Negative ideal solution:

A' = {v_1', …,v_n' },where v_j' = { $\min_i(v_{ij})$ if j ∈J ; $\max_i(v_{ij})$ if j ∈J' } = {0.056719, 0.024236, 0.011780, 0.055021, 0.025295, 0.006663, 0.090632, 0.010489, 0.019373}

Step 4: Calculate the separation measures for each alternative.

The separation from the positive ideal alternative is:

$$S_i^* = [\sum_j (v_j^* - v_{ij})^2]^{\frac{1}{2}} \quad ; \quad i = 1, \dots, m$$

The separation from the negative ideal alternative is:

$$S'_i = [\sum_j (v_j^{'} - v_{ij})^2]^{\frac{1}{2}} \quad ; \quad i = 1, \dots, m$$

Step 5: Calculate the relative closeness to the ideal solution C_i^* and the corresponding rank of the colleges

$$C_i^* = \frac{S_i^{'}}{S_i^* + S_i^{'}} \quad ; \quad 0 < C_i^* < 1$$

TABLE :9 OVERALL PERFORMANCE OF EACH COLLEGE WITH THEIR RANK.

COLLEGES	RESULT	RANK
B1	0.293491	3
B2	0.322671	2
B3	1.000000	1
B4	0.194557	4
B5	0.148947	5

III. CONCEPT OF FUZZY SET THEORY AND FUZZY AHP:

Zadeh (1965) came out with the fuzzy set theory [23] to deal with vagueness and uncertainty in decision making in order to enhance precision. Thus the vague data may be represented using fuzzy numbers, which can be further subjected to mathematical operation in fuzzy domain. Thus fuzzy numbers can be represented by its membership grade ranging between 0 and 1. A triangular fuzzy number (TFN) $\tilde{M}$ is shown in Fig. 3.

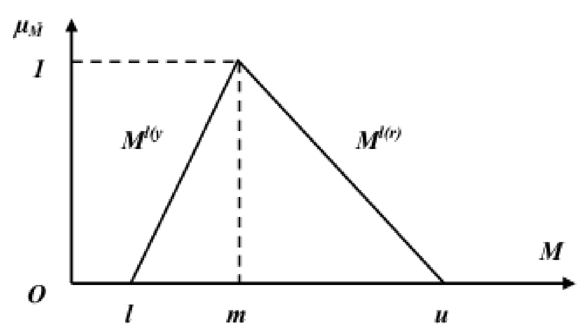

Fig 3: Triangular fuzzy number

A TFN is denoted simply as (l, m, u), represents the smallest possible value, the most promising value and the largest possible value respectively. The TFN having linear representation on left and right side can be defined in terms of its membership function as:

$$\mu(X|\tilde{M}) = \begin{cases} (X-l)|(m-l), & l \leq X \leq m \\ (u-X)|(u-m), & m \leq X \leq u \\ 0 & ,Otherwise \end{cases}$$

Saaty's AHP has some shortcomings as follows [2]: (1) The AHP method is mainly used in nearly crisp decision applications, (2) The AHP method creates and deals with a very unbalanced scale of judgment, (3) The AHP method does not take into account the uncertainty associated with the mapping of one's judgment to a number, (4) Ranking of the AHP method is rather imprecise, (5) The subjective judgment, selection and preference of decision-makers have great influence on the AHP results. (6) A decision maker's requirements on evaluating alternatives always contain ambiguity and multiplicity of meaning. Furthermore, it is also recognized that human assessment on qualitative attributes is always subjective and thus imprecise. Therefore, conventional AHP seems inadequate to capture decision maker's requirements explicitly [10]. In order to model this kind of uncertainty in human preference, fuzzy sets could be incorporated with the pairwise comparison as an extension of AHP. A variant of AHP, called Fuzzy AHP, comes into implementation in order to overcome the compensatory approach and the inability of the AHP in handling linguistic variables. The fuzzy AHP approach allows a more accurate description of the decision making process.

In this study, we prefer Chang [8] extent analysis method because the steps of this approach are easier than the other fuzzy-AHP approaches. The steps of Chang (1996) extent analysis approach are as follows: Let X = {x1, x2, … , xn}be an object set, and U = {u1, u2, … , um}be a goal set. According to the method of Chang [8] extent analysis, each object is taken and extent analysis for each goal, gi, is performed, respectively. Therefore, m extent analysis values for each object can be obtained, with the following signs $\tilde{M}_{g_i}^1, \tilde{M}_{g_i}^2, \ldots, \tilde{M}_{g_i}^m, \ i = 1,2,\ldots,n$ where $\tilde{M}_{g_i}^j \ j = 1,2,\ldots,m$ *are* all triangular fuzzy numbers [10].

The steps of the Chang's extent analysis can be summarized as follows:

Step -1: The value of fuzzy synthetic extent with respect to the ith object is defined as:

$$S_i = \sum_{j=1}^{m} \tilde{M}_{g_i}^j \otimes \left[\sum_{i=1}^{n} \sum_{j=1}^{m} \tilde{M}_{g_i}^j \right]^{-1}$$

,where $\otimes$ denotes the extended multiplication of two fuzzy numbers. In order to obtain $\sum_{j=1}^{m} \tilde{M}_{g_i}^j$ we perform the addition of m extent analysis values for a particular matrix such that,

$$\sum_{j=1}^{m} \tilde{M}_{g_i}^j = \left(\sum_{j=1}^{m} l_j, \ \sum_{j=1}^{m} m_j, \ \sum_{j=1}^{m} u_j \right)$$

and to obtain $\left[\sum_{i=1}^{n} \sum_{j=1}^{m} \tilde{M}_{g_i}^j \right]^{-1}$ we perform the fuzzy addition operation of $\tilde{M}_{g_i}^j$ (j=1,2, …, m) values such that,

$$\sum_{i=1}^{n} \sum_{j=1}^{m} \tilde{M}_{g_i}^j = \left(\sum_{i=1}^{n} l_i, \ \sum_{i=1}^{n} m_i, \ \sum_{i=1}^{n} u_i \right)$$

Then the inverse of the vector computed as,

$$\left[\sum_{i=1}^{n} \sum_{j=1}^{m} \tilde{M}_{g_i}^j \right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i}, \ \frac{1}{\sum_{i=1}^{n} m_i}, \ \frac{1}{\sum_{i=1}^{n} l_i} \right)$$

Finally, to obtain the Si, we perform the following multiplication:

$$S_i = \sum_{j=1}^{m} \tilde{M}_{g_i}^j \otimes \left[\sum_{i=1}^{n} \sum_{j=1}^{m} \tilde{M}_{g_i}^j \right]^{-1} =$$

$$\left(\sum_{j=1}^{m} l_j \otimes \sum_{i=1}^{n} l_i, \ \sum_{j=1}^{m} m_j \otimes \sum_{i=1}^{n} m_i, \ \sum_{j=1}^{m} u_j \otimes \sum_{i=1}^{n} u_i \right)$$

Step -2: The degree of possibility of $\tilde{M}_2 \geq \tilde{M}_1$ is defined as

$$V\left(\tilde{M}_2 \geq \tilde{M}_1\right) = \sup\left[\min\left(\tilde{M}_1(x), \tilde{M}_2(y)\right)\right]$$

This can be equivalently expressed as,

$$V\left(\tilde{M}_2 \geq \tilde{M}_1\right) = hgt(\tilde{M}_1 \cap \tilde{M}_2) = \tilde{M}_2(d)$$

$$= \begin{cases} 1, & if \ m_2 \geq m_1 \\ 0, & if \ l_1 \geq u_2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}, & otherwise \end{cases}$$

Fig.4 illustrates $V\left(\tilde{M}_2 \geq \tilde{M}_1\right)$ for the case d for the case M1<L1<U2<M2, where d is the abscissa value corresponding to the highest crossover point D between $\tilde{M}_1$ and $\tilde{M}_2$. To compare $\tilde{M}_1$ and $\tilde{M}_2$, we need both of the values $V\left(\tilde{M}_2 \geq \tilde{M}_1\right)$ and $V\left(\tilde{M}_1 \geq \tilde{M}_2\right)$

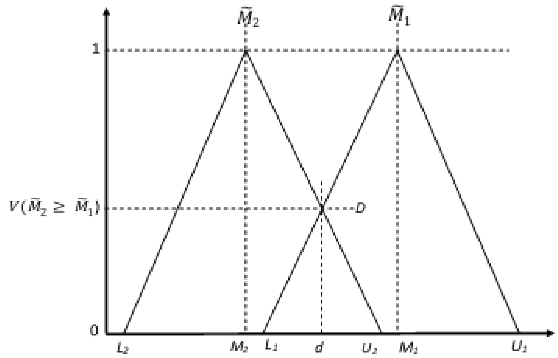

Fig. 4: Degree of Possibility

Step – 3: The degree of possibility for a convex fuzzy number to be greater than k convex fuzzy numbers M_i (i=1,2,…k) is defined as

$$V(\tilde{M} \geq \tilde{M}_1, \tilde{M}_2, \cdots, \tilde{M}_k) = \min(V(\tilde{M} \geq \tilde{M}_i)),$$
$$i = 1,2,\cdots,k$$

Step–4:Finally,

$$W = (\min V(s_1 \geq s_k), \min V(s_2 \geq s_k), \cdots, \min V(s_n \geq s_k))^T$$

, is the weight vector.

IV. TWO STEP METHODOLOGY OF FUZZY-AHP-TOPSIS:

In this paper also use two step methods consist of FUZZY-AHP and FUZZY-TOPSIS method. In first step FUZZY-AHP is used for calculating the normalized weights of the attributes and alternatives as well calculated average weights by using normalized weights of alternatives through each student opinions. In second step these average weights are considered for overall and used in TOPSIS process. Then TOPSIS is applied for the evaluation problem and the results of it show the preference order of the college selection in engineering organization. This methodology levels can be seen in Fig. 5 clearly

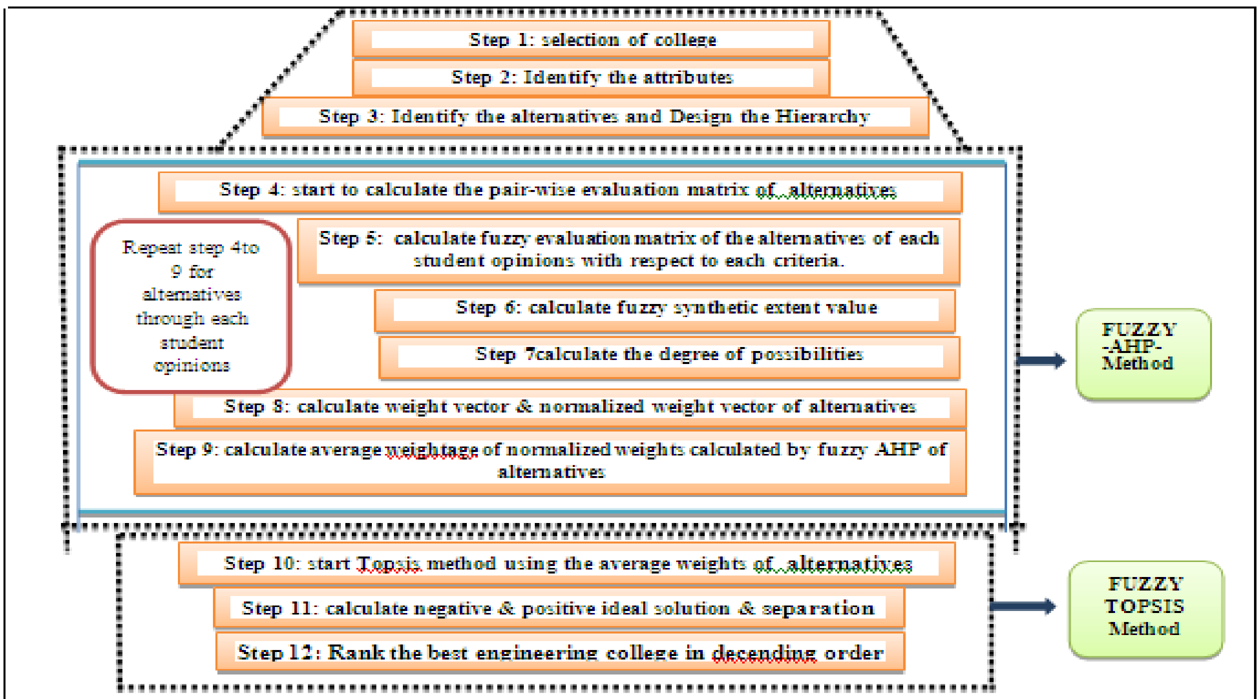

Fig 5: Two step methodology of FUUZY-AHP and FUZZY-TOPSIS

A. Procedure of FUZZY-AHP

Using the procedure stated above the computational output is as follows:

TABLE 10: WEIGHTAGE OF EACH COLLEGE AGAINST A1.

Student1	B1	B2	B3	B4	B5
B1	1,1,1	0.5,1,1.5	0.25,0.5,0.75	0.5,1,1.5	3,4,5
B2	0.66,1,2	1,1,1	0.25,0.5,0.75	0.5,1,1.5	3,4,5
B3	1.33,2,4	1.33,2,4	1,1,1	1,2,3	4,5,6
B4	0.66,1,2	0.66,1,2	0.33,0.5,1	1,1,1	3,4,5
B5	0.2,0.25,0.33	0.2,0.25,0.33	0.16,0.2,0.25	0.2,0.25,0.33	1,1,1

Fuzzy Synthetic Extent Value:

S_{b1}=(5.25,7.5,9.75) $\otimes$ (0.019,0.027,0.046)
= (0.099,0.202,0.448)

S_{b2}=(5.41,7.5,10.25) $\otimes$ (0.019,0.027,0.046)
= (0.102,0.202,0.471)

S_{b3}=(8.66,12,18) $\otimes$ (0.019,0.027, 0.046)
= (0.164,0.324,0.828)

S_{b4}=(5.65,7.5,11) $\otimes$ (0.019,0.027,0.046)
= (0.107,0.202,0.506)

S_{b5}=(1.76,1.95,2.24) $\otimes$ (0.019,0.027,0.046)
= (0.033,0.052,0.103)

Degree of Possibilities are:

$V_{b1}\geq V_{b2}=1, V_{b1}\geq V_{b3}=0.699, V_{b1}\geq V_{b4}=1, V_{b1}\geq V_{b5}=1$
$V_{b2}\geq V_{b1}=1, V_{b2}\geq V_{b3}=0.715, V_{b2}\geq V_{b4}=1, V_{b2}\geq V_{b5}=1$
$V_{b3}\geq V_{b1}=1, V_{b3}\geq V_{b2}=1, V_{b3}\geq V_{b4}=1, V_{b3}\geq V_{b5}=1$
$V_{b4}\geq V_{b1}=1, V_{b4}\geq V_{b2}=1, V_{b4}\geq V_{b3}=0.737, V_{b4}\geq V_{b5}=1$
$V_{b5}\geq V_{b1}=0.025, V_{b5}\geq V_{b2}=0.006, V_{b5}\geq V_{b3}=0, V_{b5}\geq V_{b4}=0$

The normalized weight vector is: $W_1=(0.324,0.332,0.464,0.342,0)^T$

Similarly, calculate the weightage of each college with respect to A1 by other students S2 and S3 are

$W_2=(0.209,0.0009,0.317,0.234,0.237)^T$,
$W_3=(0,0.197,0.387,0.204,0.211)^T$

TABLE 11: FORMULATE AVERAGE WEIGHTAGE AGAINST A1

Weight	0.1698			
Colleges	**S1**	**S2**	**S3**	**Average**
B1	0.324	0.209	0.000	0.177
B2	0.333	0.0009	0.197	0.176
B3	0.464	0.317	0.387	0.389
B4	0.342	0.234	0.204	0.260
B5	0.000	0.237	0.211	0.149

TABLE 12: CALCULATE AVERAGE WEIGHTAGE FOR EACH CRITERIA USING SAME PROCEDURE

Weight	0.1698	0.0843	0.0423	0.1698	0.0843	0.0251	0.2973	0.0423	0.0843
Colleges	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**
B1	0.177	0.204	0.118	0.172	0.247	0.151	0.169	0.184	0.173
B2	0.176	0.171	0.157	0.160	0.156	0.118	0.224	0.226	0.149
B3	0.389	0.330	0.391	0.340	0.330	0.314	0.336	0.351	0.353
B4	0.260	0.211	0.293	0.194	0.130	0.253	0.158	0.200	0.014
B5	0.149	0.080	0.038	0.130	0.134	0.161	0.109	0.035	0.306

B. *College Rank Calculation using FUZZY-AHP-TOPSIS*

The procedure of Fuzzy-AHP-TOPSIS has been defined in the Fig. 5. Accordingly the final result and rank of each college by using Fuzzy-AHP-TOPSIS has come out as:

TABLE 13: **COLLEGE RANK** CALCULATION

Colleges	Result	Rank
B1	**0.517**	**2**
B2	**0.266**	**3**
B3	**1.000**	**1**
B4	**0.219**	**4**
B5	**0.147**	**5**

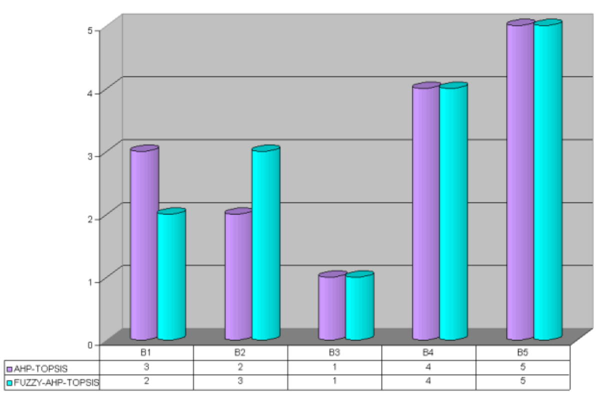

Fig. 6: Non-Fuzzy vs Fuzzy

V. CONCLUSION:

In this paper, using AHP and TOPSIS we observed from table 9 that B3 (BCREC) is best engineering college followed by B2 (BCET), B1 (DIATM), B4 (AIEMD) and B5 (KIT) is not that good as compared to other colleges of Durgapur in West Bengal. Also from table 13 by using Fuzzy- AHP-TOPSIS we found that the college B3 (BCREC) is best compared to other colleges and B5 is not up to the mark.

Simultaneously, it is also proved by using Fuzzy-AHP that the important criterion for the selection of a best engineering college is A7 (Campus Interview). So, the selection of best engineering college for a student specially depends upon the criteria A7 i.e; % of students recruited by different reputed companies from that college.

This paper also concludes that Fuzzy-AHP-TOPSIS approach is more realistic than AHP-TOPSIS.

Thus this project yields a good idea for selecting the best engineering college in West Bengal for the fresh students depending on several criterions rather depending on a particular criterion. This concept can be extended for the selection of best engineering colleges all over India.

The proposed model provides a great opportunity to the students or decision makers for selection of best engineering college in India/World. Finally this article introduces a multi criteria decision making approach that integrates Fuzzy, AHP and TOPSIS to support Best Engineering College Selection decisions.

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