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A study on student absenteeism problem in colleges in the framework of fuzzy AHP

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ABSTRACT:

The aim of the study is applying a fuzzy decision model to rank alternatives that curb student absenteeism in engineering colleges by taking subjective judgments of decision makers into consideration. Here Fuzzy Analytic Hierarchy Process (FAHP) approach is used. This method is applied because the concepts like fuzziness, uncertainty and vagueness were obtained in the Experts' opinions. FAHP method is used in determining the weights of the criteria and then rankings of the alternatives for consistent and inconsistent matrices were obtained by extending the matrices to Fuzzy matrices. The study gives the alternative "*Infrastructure*" , as the one with highest priority and the alternative "*Involvement of parents*" as the next top priority in curbing student absenteeism. The alternatives are compared with those obtained by SVM (Stochastic Vector Method).

Key Words: Fuzzy AHP, SVM, Priority vectors

I INTRODUCTION

Determination and evaluation of the criteria for selection of alternatives that curb student absenteeism in engineering colleges can be affected by the expert opinions and the conditions of the decision making platform. Thus, deterministic scale or crisp values can produce misleading consequences sometimes. For example, some pessimistic people may not give any point more than four, or some optimistic people may easily give 5 even if it does not deserve it. These situations generate fuzziness within the decision making process, so fuzzy AHP method can handle these deviations concerning this fuzziness. Therefore, for the selection of alternatives that curb student absenteeism in engineering colleges, if a multi-criteria decision making method with linguistic evaluations is selected, this method can be fuzzy AHP or similar methods concerning fuzzy conditions. Analytical Hierarchy Process (AHP) is one of the best ways for deciding among the complex criteria structure in different levels. Fuzzy AHP is an extension of classical AHP method when the fuzziness of the decision makers is considered.

Many mathematical models have been developed over a period of time and successfully implemented to real life decision problems in Government, Defence, Industry and many other areas. The AHP is also a method for ranking decision alternatives and selecting the best one among them when the decision maker has multiple criteria to evaluate alternatives. It has been shown in the literature that these solutions perform poorly with respect to other error criteria like least square error (LSE) even for moderately inconsistent matrices (CR > 0.1). This may be due to the fact that the methods that rely on the eigen vector approach require solving the crisp linear equations and near approximate solutions are often ignored. The uncertainty in the preference judgments essentially gives rise to uncertainty in the ranking of alternatives and hence leading to difficulty in determining consistency of preferences. Hence there is a necessity of Fuzzy AHP in such problems. Section II gives literature survey of the related and referred papers. Section III describes the methods FAHP, Geometric Mean Method (GMM) and stochastic Vector methods by giving the algorithms. Section IV gives the results of FAHP and SVM. The results and their analysis is discussed in Section V The conclusions and Scope for further research is given in Section VI.

II LITERATURE

Many methods for generating weights have been proposed in Multi Criteria decision Analysis. Saaty[9] proposed AHP method as a decision-making aid to solve unstructured problems in economics, social and management sciences. Saaty and Vargas [11] investigated the effect of uncertainty in judgment on the stability of the rank order of alternatives. The study also points out that some matrices which are reasonably consistent according to Saaty and Vargas [10] are inconsistent in fuzzy approach and there is a need to re-examine whether

the upper bound 0.1 for the CR includes inconsistent matrices as well and concluded that an AHP matrix can be considered reasonably consistent if its CR is not more than 0.1. Ami Arbel and Vargas [2] formulated the problem of finding a priority vector from an interval reciprocal matrix as a Euclidean center problem. Ying-Ming Wang et al [13] developed a method of consistency test to check whether an interval comparison matrix is consistent or not. Van Laarhoven and Pedrycz [12] proposed studies that applied fuzzy logic principle to AHP in which triangular fuzzy numbers (TFN's) are used to model the pair-wise comparisons. Buckley [5]described Fuzzy Hierarchical Analysis by determining fuzzy priorities of comparison ratios with trapezoidal membership functions. Chang [6] introduced an approach for handling Fuzzy-AHP using triangular fuzzy numbers (TFN's) for pair-wise comparisons . Wei Cuiping et al [14] suggested to check whether the Fuzzy comparison matrix is consistent or not by means of the kernals of fuzzy numbers. Kousalya et al [7]have found the rankings of the alternatives for student absenteeism problem using crisp solutions. Anagnostopoulos. et al., [1] used the Fuzzy Analytical Hierarchy Process for selecting waste water facilities. Arbel and Vargas [3] gave *Preference* simulation and preference programming: method to find robustness issues in priority deviation. Xu and Zhai[15**]**,used Fuzzy logarithmic least squares ranking method in analytic hierarchy process. Xu[16] described Fuzzy least squares priority method in the analytic hierarchy process problems. Kousalya P et al., [8] proposed Stochastic Vector method by comparing the performance of Averaging Methods and Stochastic Vector Methods in Analytical Hierarchy Process problems".

III METHODOLOGY

The Fuzzy AHP method is explained in detail in this section by giving the algorithm. In the next two sub sections, two other methods namely Geometric mean method and Stochastic Vector Method are discussed. In the FAHP method the opinions from the experts are collected as fuzzy numbers where as in SVM they are collected as crisp numbers.

3.1 Fuzzy AHP method

Algorithm of FAHP method:

Let $X=\{x_1,x_2,x_3,\ldots, x_m\}$ be an object set and $G=\{g_1,g_2,g_3,\ldots,g_n\}$ be a goal set. According to this method, each object is taken and extent analysis for each goal performed respectively. Therefore, m extent analysis values for each object can be obtained, with the following signs.

$M^1_{gi}, M^2_{gi},\ldots, M^m_{gi}$. i= 1, 2, 3…, n Where M^j_{gi}, (j=1, 2, 3,…m) all are Triangular Fuzzy Numbers (TFNs).

Step 1: The value of fuzzy synthetic extent with respect to the i^{th} object is defined as

$$S_i = \sum_{j=1}^{m} M_{gi}^{j} \otimes \left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j} \right]^{-1} \text{---------- (1)}$$

To obtain $\sum_{j=1}^{m} M_{gi}^{j}$, perform the fuzzy addition operation of m extent values for a particular matrix such that

$$\sum_{j=1}^{m} M_{gi}^{j} = \left(\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j \right) \text{------ (2)}$$

and to obtain $\left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j} \right]^{-1}$, perform fuzzy addition operation of M_{gi}^{j},(j=1,2,3,…m) values such that

$$\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j} = \left(\sum_{i=1}^{n} l_i, \sum_{i=1}^{n} m_i, \sum_{i=1}^{n} u_i \right) \text{--------(3)}$$

and then compute the inverse of the above vector , such that

$$\left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j} \right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i} \right) \text{---- (4)}$$

Step 2: As $\tilde{M}_1 = (l_1, m_1, u_1)$ and $\tilde{M}_2 = (l_2, m_2, u_2)$ are two TFNs, the degree of possibility of $\tilde{M}_2 = (l_2, m_2, u_2) \geq \tilde{M}_1 = (l_1, m_1, u_1)$ is defined as

$$V(\tilde{M}_2 \geq \tilde{M}_1) = \sup_{y \geq x} \left[\min \left(\mu_{\tilde{M}_1}(x), \mu_{\tilde{M}_2}(y) \right) \right] \text{--- (5)}$$

This can be equivalently expressed as follows

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

$$= \begin{cases} 1, & \text{if } m_2 \geq m_1 \\ 0, & \text{if } l_1 \geq u_2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}, & \text{otherwise} \end{cases} \text{-------- (6)}$$

It can be shown as in the figure.

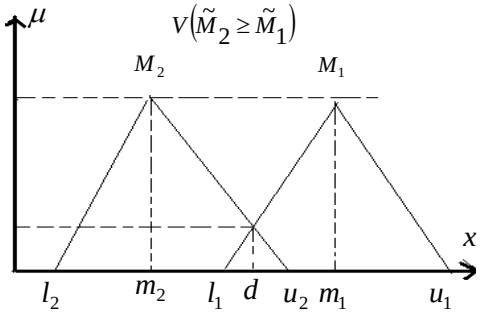

Fig 1:Intersection between M_1 and M_2

Step 3: The degree of possibility for convex fuzzy number to greater than k convex fuzzy number M_i (i=1, 2, 3….n)can be defined by

$$V(M \geq M_1, M_2, M_3 \ldots M_K)$$
$$= V\left[(M \geq M_1) \text{ and } (M \geq M_2) \text{ and } (M \geq M_3) \text{ and} \ldots (M \geq M_k)\right]$$
$$= Min\, V(M \geq M_i), i = 1,2,3 \ldots k \text{ -------(7)}$$

Assume that

$d'(A_i) = \min V(S_i \geq S_k)$ for $k = 1,2,3,\ldots. n; k \neq i$ Then the weight vector is given by

$$W' = \left(d'(A_1), d'(A_2), d'(A_3), \ldots\ldots d'(A_n)\right)^T \text{ --------- (8)}$$

Where A_i (i =1, 2, 3….n) are n elements.

Step 4: Via normalization, the normalized vectors are given by

$$W = \left(d(A_1), d(A_2), d(A_3), \ldots\ldots d(A_n)\right)^T \text{ ---------- (9)}$$

Where W is non-fuzzy number.

Another method is discussed here which takes the opinions as crisp numbers. The algorithm of the Stochastic Vector method is discussed here in detail.

3.2 GEOMETRIC MEAN METHOD

This method is used to find the weights to the criteria or alternatives. The pair wise comparison matrix of alternatives is shown in Table 4 where A_1, A_2 ….A_n represent the alternatives which are to be ranked. Also a_{11}, a_{12}……a_{nn} show the opinions of experts. The geometric mean Method is explained below where the priority weight vectors are calculated.

The Alternatives are denoted by { A_1, A_2,……A_n} where n is the number of compared alternatives and their current weights by { w_1, w_2,….w_n} .Hence the matrix of the ratios of all weights is shown in Table1

3.3 STOCHASTIC VECTOR METHOD(SVM)

In the previous section the opinions are taken as fuzzy numbers whereas in SVM the opinions are taken as crisp numbers.

Algorithm-1: The SVM Algorithm

Step1 If the PCM is consistent i.e. $a_{ij} = a_{ik}a_{kj}$ for each element, then use GEOMETRIC Mean method(GMM).

Go to Step-6.

Table 1 :Sample table showing the ratio of weights

$[w_i/w_j]$=

	A_1	A_2	…	A_n
A_1	w_1/w_1	w_1/w_2		w_1/w_n
A_2	w_2/w_1	w_2/w_2		w_2/w_n
.				
A_n	w_n/w_1	w_n/w_2		w_n/w_n

Step2 If the PCM is not consistent, i.e $a_{ij} \neq a_{ik}a_{kj}$ for at least one i and j, then divide each row vector by its trace to get a stochastic row vector and let A^S be the stochastic matrix of such rows.

Step3 Let x_0 be the initial guess stochastic fixed vector and the next vector is obtained by

$x_1 = A^S x_0$.

Step4 While the error of $|x_0 - x_1|$ is less than the pre assigned value do $x_1 = A^S x_0$ and

$x_0 = x_1$

Step5 Write "The solution vector by SVM is ", x_1. Go to Step-7

Step6 Write " The solution vector by GMM is ", x_1

Step7 END

:

IV ILLUSTRATION & RESULTS

The problem of student absenteeism in engineering colleges, which management of educational institutions is facing in modern days is already discussed by Kousalya P et al[7] .In this study through the Delphi technique[7],

many criteria that cause student absenteeism were identified and of them 13 were finalized by the panellists which have nothing in common and 21 sub criteria were identified for many of the criteria. Some criteria like "*Evaluation system", "Lack of responsibility of student", " irregular conduct of classes "and "Participation in co-curricular /extra curricular/ cultural activities* "have no sub criteria. The sub criteria for the remaining 9 criteria are listed below:

Number of Criteria

A: Ill Health
B: Domestic problems
C: Preparation without teacher
D: Lack of motivation
E: Class environment
F: Socio-Economic factors
G: Psychological factors
H: Evaluation system
I: Distractions
J: Lack of responsibility of student
K: Irregular conduct of classes
L: Participation in Co curricular/extracurricular/ Cultural activities
M: Participation in Workshops/seminars/conferences

Number of sub criteria

A.1: Frequent Ill health
A.2: Ill health once in a way
B.1: Monetary problems
B.2: Responsibility being taken up
C.1: No teacher commitment
C.2: Teacher unprepared
D.1: Self-motivation
D.2: Motivation from teachers
D.3: Motivation from parents
E.1: Proper ventilation
E.2: Disturbances outside the room
F.1: Difficulty in changing from regional language to English
F.2: Uneducated parents
G.1: Influence of bad company
G.2: Effect of neighbouring colleges and their schedules
G.3: Indiscipline
G.4: Lack of interest for engineering education
I.1: Movies/Drugs/other attractions
I.2: Political/ communal activities
M.1: Preparation for GRE/TOEFL /GATE
M.2: Preparation for other courses

Number of alternatives

In this study through the Delphi technique, many alternatives that cause student absenteeism were identified and of them 7 were finalized by the panellists which have nothing in common as given below:

A1: Counselling
A2: Infrastructure
A3: Involvement of parents
A4: Making lecture more Attractive
A5: Curriculum revision/ Better Evaluation
A6: Punishment/Awards for attendance
A7: Peer pressure

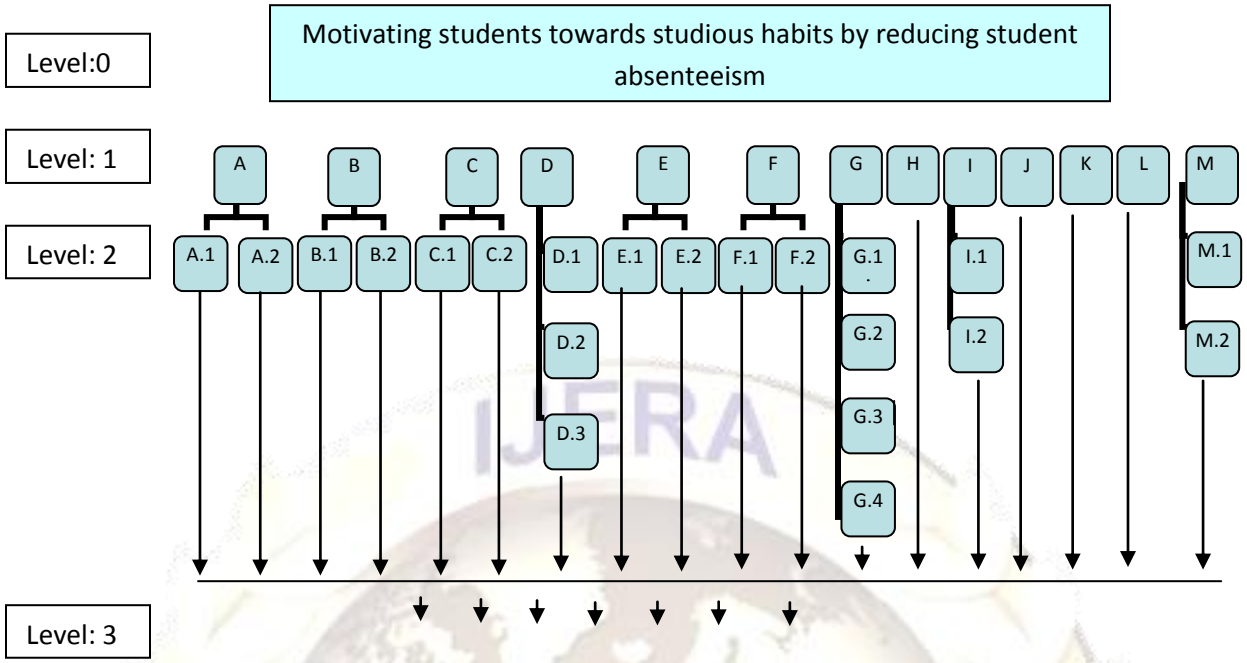

Fig2: Hierarchical decomposition of criteria in student absenteeism

The FAHP method discussed in section III is applied to the Criteria/ Sub Criteria of the given problem of student absenteeism. The weights of the criteria are obtained as shown in Table2.

The opinions which are collected by the experts are converted to fuzzy numbers using the fuzzy scale given in Table 3. Then these comparisons are pooled to give a weight vector to the Criteria.

V ANALYSIS & DISCUSSION

The opinions which are collected by the experts are converted to fuzzy numbers using the fuzzy scale given in Table 3. The priority vectors of alternatives with respect to the criteria/ sub criteria are calculated using FAHP. It is shown as a vector in the Table 2.

Table 2: Table of Criteria weights

Criteria	A	B	C	D	E	F	G	H	I
Weights	0.0787	0.0769	0.0741	0.0765	0.0752	.0755	0.0775	0.0775	0.0781

J	K	L	M
0.0788	0.0788	0.0786	0.0777

Table 3: Pair wise comparison scale

Linguistic Variables	Crisp AHP Scale	Fuzzy AHP Scale	
		TFS	Reciprocal TFS
Equally Preferred	1	(1, 1, 1)	(1, 1, 1)
Equally to Moderately Preferred	2	(1, 2, 3)	(1/3, 1/2, 1)
Moderately Preferred	3	(2, 3, 4)	(1/4, 1/3, 1/2)
Moderately to Strongly Preferred	4	(3, 4, 5)	(1/5, 1/4, 1/3)
Strongly Preferred	5	(4, 5, 6)	(1/6, 1/5, 1/4)
Strongly to very Strongly Preferred	6	(5, 6, 7)	(1/7, 1/6, 1/5)
Very Strongly Preferred	7	(6, 7, 8)	(1/8, 1/7, 1/6)
Very Strongly to Extremely Preferred	8	(7, 8, 9)	(1/9, 1/8, 1/7)
Extremely Preferred	9	(8, 9, 9)	(1/9, 1/9, 1/8)

Table 4 shows the weights of alternatives with respect to each criteria/ sub criteria. Then these opinions are pooled to give a weight vector to the criteria. The priority vector for alternatives is obtained by multiplying the weights of alternatives with respect to each criterion with their overall weights. Their priority weight vectors obtained by FAHP are shown in the Table 5. Also the ranks of the alternatives are given in Table 5. In this table, the priority vector obtained by SVM is also shown along with its rankings. The rankings by the two methods are compared. This analysis and comparison is given in the next section.

Table 4: Table of solution vectors using FAHP method and SVM

Criteria/sub criteria	FAHP-method	SVM
A.1 : Frequent ill health	0.0170	0.1100
	0.6350	0.3860
	0.3480	0.2950
	0.0000	0.0430
	0.0000	0.0440
	0.0000	0.0610
	0.0000	0.0610
A.2 : Ill health once in a way	0.0931	0.1532
	0.5015	0.3410
	0.4054	0.3090
	0.0000	0.0920
	0.0000	0.0240
	0.0000	0.0385
	0.0000	0.0404
B.1 : Monetary Problems	0.3269	0.2440
	0.0000	0.1140

	0.6731	0.4360
	0.0000	0.0420
	0.0000	0.0290
	0.0000	0.0240
	0.0000	0.1110
B.2:Responsibility being taken up	0.3388	0.3425
	0.1703	0.1400
	0.4909	0.3102
	0.0000	0.0783
	0.0000	0.0242
	0.0000	0.0356
	0.0000	0.0692
C.1 : No teacher commitment	0.0000	0.0440
	0.1291	0.1000
	0.2671	0.2690
	0.3981	0.3820
	0.2058	0.1430
	0.0000	0.0230
	0.0000	0.0390
C.2 :Teacher unprepared	0.0000	0.0330
	0.3153	0.2950
	0.0613	0.0522
	0.0621	0.0975
	0.3153	0.2712
	0.1497	0.0993
	0.0962	0.1513
D.1 :Self Motivation	0.0000	0.0240
	0.0000	0.0610
	0.0000	0.0450
	0.3267	0.2650
	0.2054	0.1590
	0.2853	0.2560
	0.1825	0.1890
D.2 : Motivation from Teachers	0.0000	0.0511
	0.2098	0.1205
	0.0000	0.0391
	0.7872	0.4443
	0.0031	0.1707
	0.0000	0.1410
	0.0000	0.0334
D.3 : Motivation From Parents	0.2999	0.1650
	0.1424	0.1280
	0.5577	0.3940
	0.0000	0.0420
	0.0000	0.0260
	0.0000	0.1030
	0.0000	0.1430
E.1 : Proper Ventilation	0.0000	0.0893
	0.4296	0.2531
	0.0000	0.0518
	0.2956	0.2059
	0.0000	0.0518
	0.2171	0.1827
	0.0577	0.1654

E.2 : Disturbances outside the room	0.0000 0.4331 0.0000 0.2868 0.0000 0.1792 0.1009	0.0370 0.3900 0.0560 0.1960 0.0280 0.1450 0.1480
F.1:Difficulty in changing from regional language to English	0.2616 0.1859 0.0000 0.2438 0.0000 0.1008 0.2079	0.2839 0.1643 0.0446 0.1901 0.0303 0.0941 0.1928
F.2 : Uneducated Parents	0.3697 0.2053 0.4250 0.0000 0.0000 0.0000 0.0000	0.0440 0.1000 0.2690 0.3820 0.1430 0.0230 0.0390
G.1 : Influence of bad company	0.3304 0.0000 0.2389 0.0000 0.0000 0.0000 0.4307	0.3219 0.0374 0.1595 0.0652 0.0210 0.0959 0.2992
G.2 : Effect of neighboring colleges and their schedules	0.1034 0.2429 0.0000 0.1707 0.0000 0.2340 0.2490	0.0240 0.0610 0.0450 0.2650 0.1590 0.2560 0.1890
G.3 : Indiscipline	0.2379 0.0000 0.0000 0.0568 0.0000 0.2170 0.4883	0.1943 0.0449 0.0962 0.1047 0.0271 0.1544 0.3784
G.4 : Lack of interest for Engineering education	0.1173 0.0000 0.0000 0.3419 0.0000 0.1891 0.3518	0.1090 0.0640 0.0410 0.2600 0.0270 0.1600 0.3390
H : Evaluation system	0.2419 0.2570 0.0000 0.1631 0.3380 0.0000	0.2522 0.1444 0.0752 0.1189 0.3209 0.0468

	0.0000	0.0415
I.1 : Movies/drugs/other attractions	0.0000	0.0800
	0.0000	0.0560
	0.0332	0.0820
	0.3510	0.2600
	0.0000	0.0270
	0.3030	0.1760
	0.3128	0.3160
I.2 : Communal/political activities	0.1362	0.1264
	0.0000	0.0505
	0.0608	0.0857
	0.3052	0.2492
	0.0000	0.0263
	0.2420	0.2030
	0.2558	0.2587
J: Lack of responsibility of student	0.0000	0.2620
	0.5329	0.0960
	0.0000	0.2430
	0.3572	0.1040
	0.0000	0.0240
	0.1031	0.0470
	0.0069	0.2240
K : Irregular conduct of classes	0.0000	0.0605
	0.6974	0.3945
	0.3026	0.2807
	0.0000	0.0392
	0.0000	0.0957
	0.0000	0.0562
	0.0000	0.0732
L:Participation in co curricular/extra curricular/cultural act.	0.0000	0.0440
	0.3127	0.1890
	0.0000	0.1100
	0.0000	0.0520
	0.648	0.4100
	0.0000	0.0480
	0.0393	0.1480
M.1 : Preparation for GRE/TOEFL/GATE	0.1848	0.1480
	0.3833	0.2846
	0.0487	0.0733
	0.0000	0.0575
	0.0000	0.0260
	0.0971	0.1359
	0.2861	0.2747
M.2 : Preparation for other courses	0.1444	0.1210
	0.2853	0.1240
	0.0000	0.0750
	0.0511	0.1020
	0.0074	0.0420
	0.2409	0.1470
	0.2709	0.3880

Table 5:Table of priority values & ranks of alternative

VI CONCLUSIONS AND SCOPE

It can be observed from the above table, Table 5 that , the alternative which is ranked first using FAHP is "*Infrastructure*" since this attracts the students first rather than others to be in college. The second ranked alternative is "*Involvement of parents".* This can bring down student absenteeism to a greater extent as the parents are the best motivators of their wards. The next ranked alternative by FAHP is "*Peer pressure*".

Alternatives	**Priority values (FAHP)**	Ranks (FAHP)	**Priority values(SVM)**	Ranks**(SVM)**
A1: Counseling	0.2471	4	0.1723	2
A2: Infrastructure	0.4656	1	0.1238	6
A3: Involvement of parents	0.2998	2	0.1838	1
A4: Making lecture more Attractive	0.0341	7	0.1278	5
A5: Curriculum revision/ Better Evaluation	0.1325	6	0.0928	7
A6: Punishment/ Awards for attendance	0.1977	5	0.1445	4
A7: Peer pressure	0.2588	3	0.1547	3

This pressure developed in students distracts them and takes them away from studies and hence they absent themselves to class work. The alternatives "*Curriculum revision /better evaluation* "and "*Punishment/ Awards for attendance"* are given low ranks as they are given lesser priorities. The same theory when studied with SVM, the rankings are different. When studied with SVM, "*Involvement of Parents"* is given highest priority and "*Counseling"* is given next priority.

As the nature of the priority judgement is fuzzy, FAHP has been shown to be a better method with the proper choice of Member ship function. The opinions collected are converted to fuzzy numbers with the Table 3.

The study can be extended to Group decision making in FAHP by considering many Experts and then synthesizing them.

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