Proceedings of the Second International Conference on Research in Intelligent and Computing in Engineering pp. 229–233
DOI: 10.15439/2017R123
ACSIS, Vol. 10 ISSN 2300-5963

Application of MADM Methods for Selecting the Best Private Institution for Professional Courses in Uttarakhand State, India

Sanjeev Kumar
Department of Computer Science & Engineering
The ICFAI University, Dehradun
Email: sanjeev.kumar@iudehradun.edu.in

Rakesh P. Badoni
Department of Computer Science & Engineering,
BML Munjal University, Gurgaon
Email: rakeshbadoni@gmail.com

P. J. Mohan
Department of Mechanical Engineering, The ICFAI University, Dehradun
Email: jagan.mohan@iudehradun.edu.in

***Abstract*—Engineering and doctoral courses are considered to be golden professions for successful life. India is the largest Engineers' producing country, with changing technology, education system also has been changed from Gurukul to new modern technology based teaching system. Learning and knowledge are correlated terms, which go side by side and have imperative value and learning right knowledge from the best educational institute plays a vital role in one's life. IIT's, NIT's and Govt. institutes could not accommodate all the aspirants who have dreamed to be an engineer, certainly they are required to take admission in some private institutions. Due to numerous engineering institutes and universities this becomes a tedious job for both the parents and aspirants to select a perfect institution. Multi Attribute Decision Making (MADM) methods provide a ranking of the available alternatives thereby, decision of critical thinking become easier. The present paper examines the application of few MADM paradigms for selecting the most suitable academic institution, four state private universities of state Uttarakhand are considered as alternatives and evaluated and prioritized on seven major criterions.**

***Index Terms*—MADM Methods, AHP, Institute Selection**

I. Introduction

Since ages, engineering and doctoral courses are on top demanding professional programs. IIT's, NIT's and top ranked Govt. institutes / universities have limited seats to offer admission for newly and drooped aspirants in each academic session. Due to high number of admission seekers in engineering program the private institutes / universities are taken place in the market to offer admissions for those who have filtered out from premium institutes, it is a tedious job for parents and aspirant to select best institution. There are number of ways to choose institute, for example 1) institute where just seniors are pursuing their B. Tech, 2) institute which is nearest to home town, 3) through agents, 4) through recommendation either by school or coaching teachers, 5) high visibility through media or newspapers advertisements / hoarding, 6) state of the art infrastructure etc. These criteria's are not appropriate on the basis one should select the institute. However a self analysis among number of alternative on the basis of popular MADM methods [4] may lead to select a better institute in then this will be his first move towards the successful career. MADM methods are also applied on problem of personnel selection fuzzy AHP method proposed in [2], MADM methods for heterogeneous wireless networks are tested in [7] to evaluate the performance of each vertical handoff method under different applications such as voice, data, and cost-constrained connections. This paper is organized as follows; the following section presented modeling of the problem, section 3 consist problem solving methodologies, in section 4 the application of the methods and execution of AHP, SAW, WPM methods are addressed.

II. Problem Modeling

Four private engineering institutes of state Uttrakhand have been considered as inputs for the proposed MADM algorithms, survey was conducted and observed that institute CC has better placement records but lacking in good faculty staff, institute DD has renowned faculties but lacking in infrastructure, institute PP has good infrastructure as well as good curriculum but lacking in placement and MoU's, similarly other institutes having some positive and some negative in comparison to another one. The decision making is complicated because identifying the solution for this complex problem in the context of various parameters is varying from institute to institute. As per the problem similarities we are suggesting MADM approaches e.i. AHP, SAW and WPM to find the batter solution with qualitative

parameters. The following assumptions are considered while tabulating.
Assumptions are as follows:
a. There are four institutes and all evaluated on seven different criteria.

10	Excellent
9	Very good
8	Good
7	Above average
6	Average
5	Below average
6	Poor
3,2 &1	Very poor

Table 1 the Decision Maker's Judgment

	INF	FP	PL	RP	CU	AF	MoU
GG	7	8	8	5	6	5	8
CC	5	6	9	2	8	6	2
DD	8	7	5	4	6	6	7
PP	6	6	6	7	5	7	6

Table -2 Information extracted through survey for selecting best Institute

Abbreviation: Infrastructure –INF, Faculty Profile –FP, Placement –PL, Research and Patent –RP, Curriculum – CU, Academic Flexibility-AF, MoU- memorandum of understanding

3. PROBLEM SOLVING METHODOLOGIES

Following steps are to be followed to address the current problem
1. Identifying the suitable weights
2. Implementation of different MADM methodologies

Weights, which are determined based on preference factor among the attributes. Direct Weight Elicitation Technique and Rank-Order Centroid method [6] are used to assign the weights. The weights in this study have been assigned using the following equation

$$\frac{1}{N}W_j = \sum_{j=1}^{N} 1/\mathrm{j}$$

Where N is the number of criterion and W_j is the weight for j^{th} item. For example, in the present study, the criterion ranked first, is weighted (1 + 1/2 + 1/3 + 1/4+ 1/5 +1/6 + 1/7)

b. The problem considered here may vary with institution to institution and the requirements are not at all same all the times.

For the survey we have been used qualitative values like Excellent, Very good etc. are converted in quantities values as mentioned in table 1 for analysis purpose.
/ 7 = 0.37, the second criterion is weighted (1/2 + 1/3 + 1/4 + 1/5 + 1/6 + 1/7) / 7 = 0.22, and so on. In order to avoid complexity, weights are rounded off to nearest decimal value.
Implementation of different MADM methodologies:

The weights are obtained by Direct Weight Elicitation Technique, as explained in section III can be moved forward to implement different methodologies of MADM.

3.1 SIMPLE ADDITIVE WEIGHING METHOD (SAW)

The SAW method [2] is Simple Additive Weighing Method and also called grading method. This method is simple and basic of all MADM methods. The score to each alternative can be calculated by the formula. Based on the score, select the alternate.

$$K_i = \sum_{y=1}^{B} Z_{xy} w_y \quad \text{……………………} \quad (1)$$

Where K_i is the SAW score of the best alternative, B is the number of decision criteria, w_Y is weight matrix, and Z_{XY} is a normalized matrix of basic table 2.

3.2 WEIGHTED PRODUCT METHOD (WPM)

Weighted Product Method (WPM) [4] is similar to SAW Method but where as instead of addition there is multiplication in the model. Each ratio is raised to the power equivalent to the relative weight of the corresponding criterion.

$$Ji = \prod_{Y=1}^{B} (Z_{xy})^{W_j} \quad \text{..………………} \quad (2)$$

Where J_i is the WPM score of the best alternative, B is the number of decision criteria, w_Y is weight matrix, and Z_{XY} is a normalized matrix of basic table 2.

3.3 ANALYTICAL HIERARCHY PROCESS (AHP)

This is the most popular Technique in MADM methods. Saaty T.L [5] developed Analytical Hierarchy Process (AHP) in 1980 the whole problem into a system of hierarchies of objectives and alternatives. The steps to solve a problem is as follows

Step1: Make a pair wise comparison to each attribute. If there is B number of alternatives and A number of criterion then there will be A X B matrices of judgments. Use a preference scale (Table 8) to grade the relative preferences for two criterions. While comparison of any alternative against itself must equally preferred, so all elements on the diagonal of the pair wise comparison matrix become unity.

Step 2. Synthesis. Developing relative priority matrix for each decision. First, formulation of normalized pair wise comparison matrix by sums the values in each column of the matrix and then divides each element in the matrix by its column total. The resulting matrix is referred to as normalized matrix. Finally, the relative priorities by compute the average of the elements in each row of the normalized matrix

Step 3. The consistency check . The consistency of judgments that we considered during the series of pairwise comparison. If the degree of consistency is acceptable, the decision process can continue, otherwise the decision maker should reconsider their judgments before proceeding any further with the analysis. Consistency ratio exceeding 0.10 are indicative of inconsistent judgments.

The consistency index (CI) is calculated as $CI = \frac{\lambda_{max} - n}{n-1}$

where λ_{max} is the average of the elements of A_4 matrix and n is the number of items being compared.
Consistency ratio (CR) is calculated as follows $CR = \frac{CI}{RI}$

Random index (RI), randomly generated pairwise comparison matrix. The values of RI can be obtained as per Table 3. [5]

Size of matrix	Random consistency
1	0
2	0
3	0.58
4	0.9
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49

Table 3 Random Index

Step 4. Final step is to develop a priority ranking. First, establish reaming all pairewise matrices and compute relative priority vector then overall priority for each decision alternative is obtained by summing the product of the criterion priority (with respect to the overall goal) times the priority of the decision alternative with respect to that criterion. Ranking these priority and we will have ranking of the alternatives.

4. RESULTS AND DISCUSSIONS

The MADM based approach for selecting best professional institute is described in conjunction with the survey data presented in table 2. As discussed in section 2, there are four different institutions (GG,CC,DD and PP) that are desirable according to different criteria such as Infrastructure –INF, Faculty Profile –FP, Placement –PL, Research and Patent –RP, Curriculum –CU, Academic Flexibility-AF, MoU-MoU . From practical perspective, always desire to arrive at a single and best possible alternative among such non-unique outcomes. Three MADM techniques such as simple additive weighting, weighted product model and analytic hierarchy process used to choose the best possible alternative.

4.1 SIMPLE ADDITIVE WEIGHTING

As described in section 3.1, simple additive weighting method is applied to choose the best possible alternative. Table 2 shows the selective details for seven different selection criteria corresponding to the four best possible alternatives and the respective weights are determined based on Rank-Order Centroid method as discussed in section 3.

Attributes/ Alternatives	INF	FP	CU	PR	AF	PL	MoU
GG	7	8	8	5	6	5	8
CC	5	6	9	2	8	6	2
DD	8	7	5	4	6	6	7
PP	6	6	6	7	5	7	6
Weights	0.37	0.23	0.16	0.1	0.04	0.07	0.04

Table 4 the preference Table for Evaluation

The SAW scores are furnished in Table 5 and the best possible institute has been ranked as 1 (refer equation 1). According to simple additive weighting method GG institute is the best among the alternatives

Attributes/Alternatives	INF	FP	CU	PR	AF	PL	MoU	SAW Score	RANK
GG	0.88	1.00	0.89	0.71	0.75	0.71	1.00	0.90	1
CC	0.63	0.75	1.00	0.29	1.00	0.86	0.25	0.71	4
DD	1.00	0.88	0.56	0.57	0.75	0.86	0.88	0.85	2
PP	0.75	0.75	0.67	1.00	0.63	1.00	0.75	0.79	3

Table 5 the normalized preference table for SAW

4.2 WEIGHTED PRODUCT MODEL

For calculating the WPM score same preference matrix is used as shown in Table 3. The WPM scores and ranking of different alternatives (calculated following equation 2) are presented in Table 6, According to Weighted Product Model GG institute is the best among the alternatives materials. The result following WPM method is further validated with AHP method.

Attributes/Alternatives	INF	FP	CU	PR	AF	PL	MoU	WPM Score	RANK
GG	0.88	1	0.9	0.7	0.8	0.7	1	6.8621	1
CC	0.63	0.8	1	0.3	1	0.9	0.25	6.5829	4
DD	1	0.9	0.6	0.6	0.8	0.9	0.875	6.7928	2
PP	0.75	0.8	0.7	1	0.6	1	0.75	6.7421	3

Table 6 the normalized preference table for WPM

4.3 ANALYTIC HIERARCHY PROCESS

AHP is applied further make a decision among the four alternatives. The AHP method as stated in section 3.3 applied to the present investigation. A pair-wise comparison matrix is formed based on relative preference among each criterion as presented in Table 7.

Criteria/ Criteria	INF	FP	CU	PR	AF	PL	MoU	Eigen Vector
INF	1.000	3.000	3.000	3.000	3.000	2.000	3.000	0.292
FP	0.333	1.000	3.000	3.000	2.000	3.000	5.000	0.237
CU	0.333	0.333	1.000	3.000	3.000	5.000	2.000	0.116
PR	0.333	0.333	0.333	1.000	0.500	0.500	0.333	0.052
AF	0.333	0.500	0.333	2.000	1.000	0.500	0.500	0.071
PL	0.500	0.333	2.000	2.000	2.000	1.000	4.000	0.152
MoU	0.333	0.200	0.500	3.000	2.000	0.250	1.000	0.080

Table 7 pair-wise comparison matrix (criteria Vs criteria)

The values considered in Table 6 are checked for their consistency in further steps. If the consistency criterion not satisfied, these values are needed to be changed and the entire procedure is to be repeated.. The consistency check to validation of the assumptions made in Table 6 is calculated as consistency ratio (CR) = CI / RI = 0.091. (CI=0.123284, RI= 1.35).). As CR ≤ 0.10, the degree of consistency exhibited and acceptable for further analysis. another pair wise comparison matrix is formed separately for each of the seven criteria (Table 8)

INF	GG	CC	DD	PP	Eigen vector
GG	1.00	3.00	2.00	2.00	0.39
CC	0.33	1.00	0.20	0.33	0.08
DD	0.50	5.00	1.00	4.00	0.37
PP	0.50	3.00	0.25	1.00	0.16
C.I.= 0.0970192 and CR = 0.10					

CU	GG	CC	DD	PP	Eigen vector
GG	1.00	0.25	0.33	0.33	0.08
CC	4.00	1.00	4.00	3.00	0.52
DD	3.00	0.25	1.00	0.33	0.14
PP	3.00	0.33	3.00	1.00	0.26
C.I.= 0.0793234 and CR=0.08					

AF	GG	CC	DD	PP	Eigen vector
GG	1.00	0.50	2.00	3.00	0.28
CC	2.00	1.00	3.00	4.00	0.47
DD	0.50	0.33	1.00	2.00	0.16
PP	0.33	0.25	0.50	1.00	0.10
C.I.= 0.0103278 and CR=0.01					

FP	GG	CC	DD	PP	Eigen vector
GG	1.00	6.00	0.50	3.00	0.33
CC	0.17	1.00	0.17	0.20	0.05
DD	2.00	6.00	1.00	3.00	0.46
PP	0.33	5.00	0.33	1.00	0.16
C.I.= 0.0558126 and CR=0.06					

PR	GG	CC	DD	PP	Eigen vector
GG	1.00	6.00	2.00	3.00	0.45
CC	0.17	1.00	0.17	0.20	0.05
DD	0.50	6.00	1.00	4.00	0.35
PP	0.33	5.00	0.25	1.00	0.15
C.I.= 0.079447 and CR=0.08					

PL	GG	CC	DD	PP	Eigen vector
GG	1.00	2.00	2.00	2.00	0.38
CC	0.50	1.00	2.00	2.00	0.27
DD	0.50	0.50	1.00	3.00	0.22
PP	0.50	0.50	0.33	1.00	0.12
C.I.= 0.0717532 and CR=0.07					

MoU	GG	CC	DD	PP	Eigen vector
GG	1.00	3.00	4.00	3.00	0.51
CC	0.33	1.00	0.33	2.00	0.14
DD	0.25	3.00	1.00	2.00	0.23
PP	0.33	0.50	0.50	1.00	0.11
C.I.= 0.097924 and CR=0.10					

Table 8 Other pair-wise comparison matrices

Judgment of Preference	Numerical Rating
Extremely Preferred	9
Very strongly to extremely preferred	8
Very strongly preferred	7
Strongly to very strongly preferred	6
Strongly preferred	5
Moderately to strongly preferred	4
Moderately preferred	3
Equally to moderately preferred	2
Equally preferred	1

Table 9 Saaty's preference scale

Overall Priority	INF	FP	CU	PR	AF	PL	MoU	Criteria vs Criteria	Priority	Rank
GG	0.392	0.326	0.081	0.449	0.277	0.383	0.514	0.292	**0.344**	1
CC	0.078	0.052	0.517	0.050	0.467	0.273	0.142	0.237	0.183	3
DD	0.371	0.459	0.142	0.349	0.160	0.219	0.235	0.116	0.315	2
PP	0.159	0.164	0.260	0.151	0.095	0.125	0.109	0.052	0.158	4
								0.071		
								0.152		
								0.080		

Table 10. Overall priorities for each decision alternatives and rank matrix

Based on Saaty's (T.L. Saaty 1988) preference scale (Table 8). Overall relative priority matrix is formulated as described in section 4.4. Finally score respective to each of the alternatives (Table 9) are calculated by matrix multiplication, wherein it is evident that GG is the best alternative as per AHP. Thus SAW, WPM and AHP algorithms suggest that GG is the best suitable among the prospective four alternatives on the basis of seven different desirable criterion

V. Conclusion

A novel MADM based approach for selecting most preferable institute has been proposed in this article among four equally competent institutes of Uttarakand state. These methods provided simple and powerful ranking criteria to institute. The institute Ranked high among the others is GG and the least preferred is PP. The same problem can be extended not only to engineering college staff selection but also to any organization / Industry so on by varying different attributes and selection criteria. Fine tuning of weightage to individuals, creating more fuzziness in the problem can be implemented in the future.

References

[1] Kelemenis, Alecos, and Dimitrios Askounis. "A new TOPSIS-based multi-criteria approach to personnel selection." Expert Systems with Applications 37.7 (2010): 4999-5008.

[2] Güngör, Zülal, Gürkan Serhadlıoğlu, and Saadettin Erhan Kesen. "A fuzzy AHP approach to personnel selection problem." Applied Soft Computing 9.2 (2009): 641-646.

[3] Ahmed, Faez, Kalyanmoy Deb, and Abhilash Jindal. "Multi-objective optimization and decision making approaches to cricket team selection." Applied Soft Computing 13.1 (2013): 402-414.

[4] Sajja, Radhika, D. Sameer Kumar, and D. Swapna. "VIKOR Method for Multi Criteria Decision Making in academic staff Selection." Journal of Production Research & Management 3.2 (2013): 30-35.

[5] Saaty, Thomas L. "What is the analytic hierarchy process?." Mathematical models for decision support. Springer Berlin Heidelberg, 1988. 109-121.

[6] Roszkowska, Ewa. "Rank Ordering Criteria Weighting Methods–a Comparative Overview." (2013).

[7] Stevens-Navarro, E., J. D. Martinez-Morales, and U. Pineda-Rico. "Evaluation of vertical handoff decision algorightms based on madm methods for heterogeneous wireless networks." Journal of applied research and technology 10.4 (2012): 534-548.