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MADM Methods for Finding The Right Personnel in Academic Institutions

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Abstract

Human resource management plays a vital role in this competitive world .As everybody wants highly distinguished persons, evaluation of the right staff/employee is very difficult. It is also necessary to choose a better person among the others, where the success of any industry/organization/institution heavily depends. 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 staff, where seven candidates under seven different sub-criteria are evaluated and prioritized.

Keywords: *Human Resource Management, Staff Selection, MADM methods, AHP, TOPSIS*

1. Introduction

There has been a sea change in the field of professional teaching in India, due to recession times in the software industry. Many of masters degree holders are entering this field. Few of them are truly worthy and possess quality skills, but many of them are managing with the quality. Quite naturally, the faculty recruitment within an academic environment is a complex issue and, thus, management need to take appropriate measures when recruiting.

The selection of teaching personnel is the process of choosing individuals that have the necessary up-to-date knowledge, research performance, and language skills and those who match the qualifications required to perform a defined job in the best way [1].Recent studies show that, in the selection process, the teaching staff is assessed and evaluated based on written and oral exams, based on which the selection is made [3]. Although this pattern is needed, as the selection of criteria/weights for the assessment and evaluation have to be more clearly specified, this wholly isn't enough to take the right decisions.

When considering the institutional specific targets, the selection of appropriate teaching personnel, satisfying all the requirements amongst the selected criteria becomes a highly complex situation. As this, consists of both qualitative and quantitative factors, can be treated as an MADM problem which would greatly be affected by several conflicting factors [2]. Many works have been carried out on problem of personnel selection.few to mention are the fuzzy AHP method proposed by Gungor *et al.*, [4], the new TOPSIS method proposed by Kelemenis and Askounis [2], an MCDM method provided by Rouyendegh and Erkan [5] using a fuzzy ELECTRE algorithm and many more.A simple MADM procedure, besides the quantitative data, should be able to incorporate qualitative data like professional, creative, organizing and disciplinary skills. The primary objective of the present study is to identify the

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proper teaching staff and to evaluate the best one based on appropriate performance measurement.

Although this work considers a less number of alternatives for simplicity, but this model can be used in evaluating a number of alternatives. Further, this study is not limited to the evaluation of the right personnel in academic institutions, rather it can be used in multi-criteria decision making relevant to any field of study.

The rest of the paper is organized as follows: The following section presents a brief description of the problem considered. Section 3 outlines the methods used in detail along with procedural steps. The application of the methods is addressed in Section 4. Finally, conclusions are provided in Section 5.

2. Problem Formulation

A Relavent problem [13] of identifying the correct person for the post of Asst. Professor in an Engineering college has been considered , the important areas are identified and tabulated from all the applicants. The following assumptions are considered while tabulating.

Assumptions:

a. There are seven Applications and all evaluated on seven different criteria.

b. All the applicants are individuals and applying for the same post.

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

The decision making is complicated because , Rama has vast experience but in view of research , he is a bit down .Dev has good number of publications but his qualifications are not at most. Chaitu has the highest qualification and so he wants higher salary. Similarly, every person is having his own positives and negatives. It is not at all a straight problem to select the one directly. So the proposed approach is trying to find the best candidate , satisfying the requirements.

The Decision maker gives priorities to Qualification , Experience , No of subjects handled and Research Activities but always gives least importance to expected salary. Hence the column 1,2,4,5,6,7 are beneficiary variables whereas column 3 *i.e.*, salary as non beneficiary variable. The details of the various attributes considered for the selection are given below

Table 1: The Information Sorted From the Applications for the Post of Asst.Profe Engineering College

S.No	Criteria / Name of the Applicant	Qualification Marks	Experience In years	Salary Expecting Per month in Rupees	Ability to handle different subjects	Research activities (No of Papers Published)	Technical Skills	Presentation / Communication Skills
1	Rama	Pursuing Ph.D	12	40,000	5	3	Average	Average
2	Dev	M. Tech	10	30,000	5	8	Above Average	Average
3	Sasi	Pursuing Ph.D	5	25,000	8	8	Above Average	Poor
4	Uttam	M. Tech	1	20,000	1	3	Below average	Average
5	Radha	Pursuing Ph.D	10	35,000	3	1	Excellent	Above Average
6	Indra	B. Tech	1	12,000	1	1	Poor	Above Average
7	chaitu	Ph.D	10	65,000	6	4	Good	Below Average

The qualification preference and the skills (both Technical and Communication) were awarded in a rating of 10 and depends on the decision maker , given in Table 2

Table 2. The Decision Maker's Judgment to Qualification and Skills

Qualification	Technical Skills	Communication Skills	Rating for different criterion
B.Tech	Poor	Poor	5
M.Tech	Below Average	Below Average	6
M.Tech + other qualifications	Average	Average	7
Ph.D Pursuing	Above Average	Above Average	8
Ph.D	Good	Good	9
Post Doctoral Qualifications	Excellent	Excellent	10

The updated Decision making table to evaluate the right person and to apply different MADM methods are presented in the Table 3.

Table 3. The Equivalence Information and Final Table for Evaluation

Criteria / Name of the Applicant	Qualification Marks	Experience In years	Salary Expecting Per month in Rupees	Ability to handle different subjects	Research activities (No of Papers Published)	Technical Skills	Presentation / Communication Skills
Rama	8	12	40,000	5	3	7	7
Dev	6	10	30,000	5	8	8	7
Sasi	8	5	25,000	8	8	8	5
Uttam	6	1	20,000	1	3	6	7
Radha	8	10	35,000	3	1	10	8
Indra	5	1	12,000	1	1	5	8
chaitu	9	10	65,000	6	4	9	6

3. Problem Solving Methodologies

In order to solve the problem , two steps are to be followed

1. Identifying the suitable weights
2. Implementing different methodologies

3.1 Identifying the Suitable Weights:

Among different methods of calculating weights, Geometric Mean Method is popular because of its simplicity and consistency. It consists of the following steps [6, 8]

(i) Find the relative importance of different attributes with respect to achieving the goal.

a. Construct a pairwise comparison matrix by taking a suitable scale as given in Table 4.

b. When there is M number of attributes the relative importance matrix is a square matrix of size M X M.

c. all the diagonal elements Relative Importance matrix are 1, Because the attribute is checked by itself.

d. The remaining elements are to be filled from table 1. By following the rule $A1_{ij} = 1/ A1_{ji}$. Where A1 is Relative importance matrix.

(ii) Calculate the Geometric mean and weights

$$GM_j = [\prod_{j=1}^{M} A1ij]^{1/M}$$

$$w_j = GM / \sum GM$$

(iii) Calculate A3 and A4 matrices such that

$$A3 = A1 \text{ X } A2$$

$$A4 = A3/A2$$

Where A1 is the Relative Importance matrix and A2 is weight matrix [w_1 , w_2 , ….w_j upto j attributes]

(iv) Calculate the maximum eigen value λmax , by taking the average of A4 matrix.

(v) Determine Consistency index

$$CI = \lambda max – M / M-1.$$

(vi) Obtain the Random index value from Table 5 , for the required attributes.

(vii) Calculate Consistency ratio

$$CR = CI / RI$$

In general CR value <0.1 is acceptable , if CR value is greater 0.1 then we have to re think the relative importance.

Table 4. Relative Importance Scale

Intensity of importance	1	3	5	7	9	2,4,6,8
Scale	Equal Importance	Moderate importance	Strong Importance	Very Strong importance	Absolute Importance	Intermediate values

Table 5. Random Index Values

Attributes	3	4	5	6	7	8	9
RI	0.52	0.89	1.11	1.25	1.35	1.4	1.45

3.2. Implementing Different Methodologies:

Using the weights obtained by the geometric mean method , as explained above the problem can be moved further to implement different methodologies of MADM.

3.2.1. SAW Method:

SAW method is Simple Additive Weighing Method. As the name it suggests 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.

$$Pi = \sum_{j=1}^{m} wj\ (mij)_{normal} \quad (i)$$

Where w_j is weight matrix
M_{ij} Normal is a normalized matrix of basic table.

3.2.2. WPM Method

Weighted Product Method (WPM) is similar to SAW Method but where as instead of addition there is multiplication in the model. The normalized values are calculated and each normalized value is raised to the power of relative weight. The alternative with highest Pi is the better alternative among others.

$$Pi= \ [\ \prod_{j=1}^{m}(Mij)_{normal}\ ]^{w}{}_{j} \quad (ii)$$

3.2.3. AHP Method

This is the most popular Technique among all MADM methods. Saaty TL [7] developed Analytical Hierarchy Process (AHP) in 1980. As the name it has, it makes the whole problem into a system of hierarchies of objectives and alternatives. The procedure to solve a problem is as follows

(a) Obtain the weights to each attribute.

(b) Make a pairwise comparison to each attribute . If there are N number of alternatives, then there will be M NXN matrices of judgments.

i. To make necessary comparisons two different modes , Relative mode and Ideal mode are used .

ii. Relative mode is used when the decision maker has good knowledge of attributes for different alternatives , whereas the other method i.e. Ideal method is used

(c) The next step is to obtain the overall performance for alternatives by multiplying the relative normalized weight of each attribute with its corresponding normalized weight value of each alternative and summing over the attributes for each alternative just like SAW Method.

(d) Ranking will be given to each alternate based on the score ,then judge the best person.

3.2.4. TOPSIS Method

The TOPSIS (**T**echnique for **O**rder **P**reference by **S**imilarity to **I**deal **S**olution) method was developed by Hwang and Yoon in1981. This method involves the concepts of calculating Euclidian distances. TOPSIS method gives the solution that is not only closest to the hypothetically best, that is also from hypothetically worst. The selection procedure for the best alternative using TOPSIS method is as follows[6].

(a) Based on the basic decision table , prepare the normalized matrix to satisfy the required objective , considering both beneficial and non beneficial variables.

(b) Obtain normalized decision matrix R_{ij}

$$R_{ij} = m_{ij} / \left[\sum_{j=1}^{M} m_{ij}^2 \right]^{1/2} \quad \text{(iii)}$$

where m_{ij} is the element on decision table of ith alternative and jth attribute

(c) Find the weighted Normalized matrix V_{ij}

$$V_{ij} = w_j R_{ij} \quad \text{(iv)}$$

(d) Obtain Ideal and Negative Ideal solutions by the expressions given below

$$V^+ = \left\{ \left(\sum_i^{max} v_{ij} / j \in J \right), \left(\sum_i^{min} v_{ij} / j \in J \right) / i = 1,2,M \right\} = \{V_1^+, V_2^+, V_3^+, \ldots\ldots\ldots, V_N^+\} \quad \text{(v)}$$

$$V^- = \left\{ \left(\sum_i^{min} \frac{V_{ij}}{j} \in J \right), \left(\sum_i^{max} \frac{V_{ij}}{j} \in J \right) / i = 1,2,3..N \right\} = \{V_1^-, V_2^-, V_3^-, \ldots\ldots\ldots V_N^-\} \quad \text{(vi)}$$

V^+ and V^- are the best and worst value of considered attribute among the values of the same attribute in different alternatives. In case of non beneficiary variables V^+ is the lower and V^- is the higher value.

(e) Calculate Separation measures, *i.e.*, Euclidian distance of each alternative

(f)

$$S_i^+ = \left\{ \sum_{j=1}^{M} (V_{ij} - V_j^+)^2 \right\}^{0.5} \quad i = 1,2 \ldots\ldots N \quad \text{(vii)}$$

$$S_i^- = \left\{ \sum_{j=1}^{M} (V_{ij} - V_j^-)^2 \right\}^{0.5} \quad i = 1,2 \ldots\ldots N \quad \text{(viii)}$$

(g) The relative closeness of each alternative Pi is calculated by the formula

$$P_i = S_i^- / (S_i^+ + S_i^-) \quad \text{(ix)}$$

(h) Based on the step f, give a ranking to each alternate

4. Results and Discussions

From the basic data , the normalized values of both beneficial and non beneficial attributes are calculated and are tabulated in Table 6.

Table 6. Normalized Data of Final Selection Table

S.NO	Criteria / Persons applied	Qualification Marks	Experience In years	Salary Expecting Per month	Ability to handle different subjects	Research activities (No of Papers Published)	Technical Skills	Presentation / Communication Skills
1	Rama	0.8889	1	0.3000	0.625	0.3750	0.7000	0.8750
2	Dev	0.6667	0.8333	0.4000	0.6250	1	0.8000	0.8750
3	Sasi	0.8889	0.4167	0.4800	1	1	0.8000	0.625
4	Uttam	0.6667	0.0833	0.6000	0.1250	0.3750	0.6000	0.8750
5	Radha	0.8889	0.8333	0.3429	0.3750	0.1250	1	1
6	Indra	0.5556	0.0833	1	0.1250	0.1250	0.5000	1
7	Chaitu	1	0.8333	0.1846	0.7500	0.5000	0.9000	0.7500

As mentioned in 3.1, the weightage to each attribute has to be calculated first based on the geometric mean method. So the relative importance of different factors satisfying the required objective considered are shown below.

$$A1=\begin{pmatrix} 1.0000 & 2.0000 & 5.0000 & 3.0000 & 2.0000 & 4.0000 & 5.0000 \\ 0.5000 & 1.0000 & 5.0000 & 3.0000 & 6.0000 & 9.0000 & 2.0000 \\ 0.2000 & 0.2000 & 1.0000 & 2.0000 & 4.0000 & 3.0000 & 3.0000 \\ 0.3333 & 0.3333 & 0.5000 & 1.0000 & 3.0000 & 3.0000 & 4.0000 \\ 0.5000 & 0.1667 & 0.2500 & 0.3333 & 1.0000 & 1.0000 & 2.0000 \\ 0.2500 & 0.1111 & 0.3333 & 0.3333 & 1.0000 & 1.0000 & 1.0000 \\ 0.2000 & 0.5000 & 0.3333 & 0.2500 & 0.5000 & 1.0000 & 1.0000 \end{pmatrix}$$

Based on the data considered above and calculating further steps ,the following results were obtained

The eigenvalue of above relative matrix is $\lambda max = 7.8593$

Consistency ratio , CR = CI / RI = 0.0988

The CR value is 0.0988 < 0.1 , hence the relative importance matrix is acceptable.

Hence the weightage to individual attributes are given in Table 7

Table 7. Weights to each Attribute

Attributes	Attribute 1	Attribute 2	Attribute 3	Attribute 4	Attribute 5	Attribute 6	Attribute 7
Weights	0.3039	0.2873	0.1284	0.1218	0.0599	0.0483	0.0504

4.1. SAW Method

Using the weights obtained as above , the overall performance score to be calculated for each alternate as explained in 3.2.1 and ranked to get the best alternative. For example for alternate 1 , the performance score is

0.3039x0.8889 + 0.2873x1 + 0.1284x0.3000 + 0.1218x0.625 + 0.0599x0.3750 + 0.0483x 0.7000 + 0.0504x0.8750 = 0.7725

Similarly all applicants performance score and ranking based on SAW method is

S.NO	Alternate	Performance scores by SAW Method	Ranking
1	Rama	0.7725	1
2	Dev	0.7122	3
3	Sasi	0.7033	5
4	Uttam	0.4144	7
5	Radha	0.7054	4
6	Indra	0.4184	6
7	Chaitu	0.7696	2

Hence , the selection priority obtained by the SAW method as Rama – Chaitu – Dev – Radha – Sasi – Indra – Uttam.

4.2. WPM Method:

The overall performance score for each alternative is calculated by using weighted and Normalized matrices based on Weighted Product Method (WPM) formulae as explained in 3.2.2

S.NO	Alternate	Performance scores by WPM Method	Ranking
1	Rama	0.7187	1
2	Dev	0.6921	3
3	Sasi	0.6597	4
4	Uttam	0.2876	6
5	Radha	0.6252	5
6	Indra	0.2715	7
7	Chaitu	0.6939	2

WPM method suggests Rama is designated as the best alternate where as Indra is the last choice.

4.3. AHP Method

As the weights are already available, the alternatives are compared pairwise for the better understanding of each attribute w.r.t. other. Distributed (or) Relative mode is used to assess the order of preference of alternatives. Sample data on pairwise comparison of first alternate are shown below, Table 8.

Table 8. Attribute 1 Pairwise Comparison with other Attributes in AHP Method

Attribute	1	2	3	4	5	6	7
1	1.0000	1.3333	1.0000	1.3333	1.0000	1.6000	0.8889
2	0.7500	1.0000	0.7500	1.0000	0.7500	1.2000	0.6667
3	1.0000	1.3333	1.0000	1.3333	1.0000	1.6000	0.8889
4	0.7500	1.0000	0.7500	1.0000	0.7500	1.2000	0.6667
5	1.0000	1.3333	1.0000	1.3333	1.0000	1.6000	0.8889
6	0.6250	0.8333	0.6250	0.8333	0.6250	1.0000	0.5556
7	1.1250	1.5000	1.1250	1.5000	1.1250	1.8000	1.0000

After getting Pairwise comparisons for each attribute , obtain the overall performance score as explained in Section 3.2.3 and the selection criterion table is as follows

S.NO	Alternate	Performance scores by AHP Method	Ranking
1	Rama	0.1718	1
2	Dev	0.1634	3
3	Sasi	0.1598	4
4	Uttam	0.0891	7
5	Radha	0.1528	5
6	Indra	0.0944	6
7	Chaitu	0.1688	2

4.4. TOPSIS Method

After having the normalized matrix, Weight matrix (already mentioned above) calculates Normal Decision matrix R_{ij} and Wegihted Normalized matrix V_{ij}. The Weighted Normalizematrix V_{ij}, 7x7 is shown below

Table 9. Weighted Normalized Matrix V_{ij} ,TOPSIS Method

0.1264	0.1588	0.0538	0.0480	0.0140	0.0165	0.0193
0.0948	0.1324	0.0403	0.0480	0.0374	0.0189	0.0193
0.1264	0.0662	0.0336	0.0768	0.0374	0.0189	0.0138
0.0948	0.0132	0.0269	0.0096	0.0140	0.0142	0.0193
0.1264	0.1324	0.0470	0.0288	0.0047	0.0236	0.0220
0.0790	0.0132	0.0161	0.0096	0.0047	0.0118	0.0220
0.1422	0.1324	0.0874	0.0576	0.0187	0.0212	0.0165

From the above matrix , the Ideal and Negative ideal (or) best and worst solutions (V+ , V-) and The separation measures (S+,S-)for each alternate form ideal one can be calculated by eucledian distance as

S.NO	V^+	V^-	s+	s-
		Attributes	Alternatives	
1	0.1422	0.0790	0.0557	0.1618
2	0.1588	0.0132	0.0633	0.1389
3	0.0161	0.0874	0.0961	0.1165
4	0.0768	0.0096	0.1695	0.0635
5	0.0374	0.0047	0.0727	0.1365
6	0.0236	0.0118	0.1758	0.0717
7	0.0220	0.0138	0.0808	0.1442

The relative closeness to the ideal solution (or) performance score to each alternative by using TOPSIS method is

S.NO	Alternate	Performance scores by TOPSIS Method	Ranking
1	Rama	0.7440	1
2	Dev	0.6769	2
3	Sasi	0.5481	5
4	Uttam	0.2725	7
5	Radha	0.6526	3
6	Indra	0.2897	6
7	Chaitu	0.6408	4

The summarized data about all the rankings is given in Figure1.

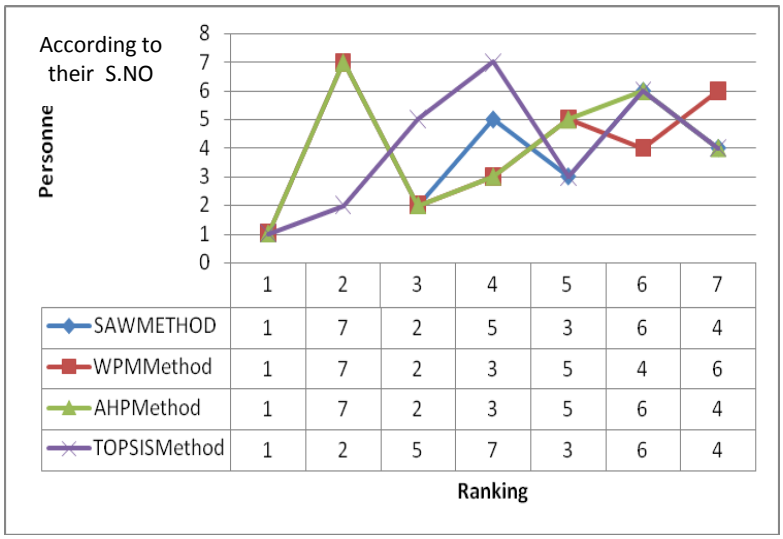

Figure 1. The Priority in Selection of Personnel by Different Methods

From the plot, it can be clearly seen that all the methods have proposed Rama as a good choice for consideration .Therefore the priority to be given in selecting the right candidate is

Rama – Chaitu - Dev – Sasi – Radha – Indra - Uttam.

5. Conclusions

This paper presented the successful implementation of SAW , WPM , AHP and TOPSIS methods for choosing the best candidate among various applicants in an academic institution. These methods provided simple and powerful ranking criteria to applicants. The person Ranked high among the others is Rama and the least preferred is Uttam. 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.

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