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SELECTION OF TENURE TEACHING FACULTY MEMBERS IN ENGINEERING INSTITUTES BY USING AN ANALYTICAL HIERARCHY PROCESS (AHP): A PROCEDURE PROPOSED

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ABSTRACT

The staffing management is simply a process for selecting the appropriate talent to carry out the goals of that institution. The success of any organization/Institute depends on skill or talent of their employees. For that, the organization adopts the appropriate selection procedure. The selection of tenure teaching faculty members in engineering institutes is so critical. In this paper, an Analytical Hierarchy Process (AHP) is used to select the most appropriate applicant for tenure teaching faculty member in engineering institutes. This procedure is completed in two rounds. A pairwise analysis is done to evaluate the most appropriate applicants in AHP. This analysis is done on the basis of four primary criteria as Ph.D./M. Tech (P/M), Teaching Experience (T/E), Research (R) and Industry Experience (I/E) in the first round and three secondary criteria as Oral presentation (O/P), Student Evluation (S/E) and Interview panel evaluation (IP/E) in the second round. These second criteria have higher importance as compared to the first criteria in the selection of tenure teaching faculty members. So, the second round has the higher weightage as compared to first round due to the selection of faculty members in academic institutions in this paper.

I. INTRODUCTION

The staffing management plays a significant role in hiring new members having appropriate skills or talent in order to fulfill organizational needs. It is very difficult to select most appropriate applicants. In corporate America, the organizations are using a variety of assessment methods such as ability test, interviews, personality tests, and work experience in order to select the appropriate job applicant [1]. Similarly, the selection of tenure track faculty member is also critical in academic institutions to carry out the goals in higher education [2]. Abuizam and Lucas [2] describe the selection procedure for a tenure track faculty position. To do so, make a search committee for conducting the selection process. Interviewer conduct interviews and then recommend the best candidate for the tenure teaching faculty position to the Department Head, the Dean of the School and/or other higher-level for the next step to interviews.

II. ANALYTICAL HIERARCHY PROCESS (AHP)

Analytical Hierarchy Process (AHP), which was developed by Thomas L. Saaty. AHP has already been used in almost all decision making applications such as government, business, industry, healthcare and education [3]. AHP is one of the MCDM method becoming popular among scientists and researchers because of its easy to use property and helpful in solving the complex problems [4,5,6]. The AHP methodology has also been used in student admissions, promotions of military personnel and for hiring decisions. The priorities for improving customer satisfaction criteria in Ford Motor has been established by using AHP in 1999 as per the research of [7]. Many researchers have used AHP in different fields and found it suitable in tenure track faculty position[2], suppliers/vendor selection [8], crane selection for the construction site [9]. Also, this method has been reported applications in engineering fields such as integrated manufacturing [10], flexible manufacturing systems [11], layout design [12], and other engineering problems [13]. In this paper, AHP will be used to propose a procedure for the selection of tenure teaching faculty members in engineering institutes.

III. METHODOLOGY AND PROCEDURE

In this paper, An AHP is used for the selection of tenure teaching faculty members in engineering institutes. The main aim of this paper is to select the most appropriate tenure teaching faculty members in engineering Institutes. A Hypothetical organization says ABC has been considered to to explain The selection of most appropriate applicant is based on four criteria as P/M, T/E, R and I/E in this study. Table 1 illustrates the applicant's criteria

TABLE 1
APPLICANT'S CRITERIA

Criteria	Applicant-1 (A1)	Applicant-2 (A2)	Applicant-3 (A3)	Applicant-4 (A4)
Education (Ph.D/M. Tech.) (P/M)	M. Tech. + Ph.D 3 Years	M. Tech. + Ph.D Recent	M. Tech. 3 Years	M. Tech. Recent
Teaching Experience (T/E)	3 Years (Post Ph.D)	2 Years (Post M. Tech.)	3 Years (Post M. Tech.)	No Teaching Experience
Research (R)	5 Publications	3 Publications	4 Publications	1 Publication
Industry Experience (I/E)	Nil	2 Years	1 Years	No Industry Experience

This paper describes the proposed procedure for the selection of most appropriate applicant in the considered hypothetical engineering institute by using AHP. The procedure has total 7 steps in two rounds. The first round has 3 steps as follows-

Step-1:A hierarchy is an arrangement of items (goal, criteria, alternatives, etc.) [7](Saaty, 2008). This hierarchy is made generally in pyramid-shaped. Figure 1 illustrates the hierarchy used for selecting the most appropriate applicant for the post of tenure teaching faculty position in an engineering institute.

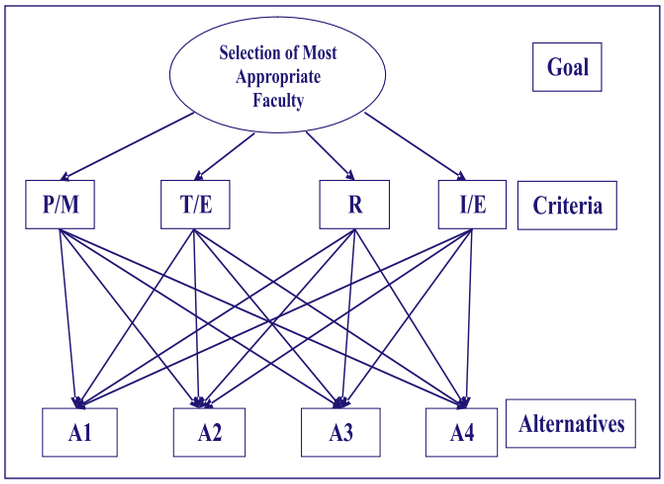


Figure 1: Hierarchy used for selecting most appropriate applicants

Step-2: In the second step, criteria are compared by calculating their weight matrix in this study. A pairwise comparison is also done against each of the criteria for preference. AHP is used to rank the importance of each objective. The alternatives are applicants. The number of comparisons are n(n-1)/2 in AHP. In this study, *n* is the number of applicants, i.e. 4, therefore the number of comparisons 4(3)/2 = 6 are needed to compute the priorities.

The decision makers have suggested relative weights for various criteria, P/M, T/E, R, and I/E as well as for applicants as shown in table 2 in this study. Refer the table 3 for the scale of relative importance in quantitative analysis [5,14].

To determine the weights for each four criteria, this weight matrix needs to be normalized and calculate weights by averaging four values. Table 4 illustrates the weight matrix and normalized weight matrix for given 4 primary criteria in the first round.

Also check the consistency of judgements. First of all calculate the value of λmax by adding the products of the SUM and weight of each criteria. The deviation can be measured by this Consistency Index (CI). The formula used for this calculation is: CI= (λmax – *n*) / (*n*-1). The Random Consistency Index (RCI) for appropriate comparison is as shown in Table 5 [6](Saaty, 1994).

TABLE 5 RANDOM CONSISTENCY INDEX

n	2	3	4	5	6	7	8	9	10
RCI	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.51

TABLE 2
RELATIVE WEIGHT FOR CRITERIA AND APPLICANTS UNDER P/M, T/E, R AND I/E

Weight for Criteria				Weight for P/M				Weight for T/E				Weight for R				Weight for I/E			
P/M	5	T/E	1	A1	3	A2	1	A1	5	A2	1	A1	3	A2	1	A1	3	A2	1
P/M	7	R	1	A1	4	A3	1	A1	3	A3	1	A1	5	A3	1	A1	5	A3	1
P/M	4	I/E	1	A1	7	A4	1	A1	7	A4	1	A1	7	A4	1	A1	6	A4	1
T/E	2	R	1	A2	2	A3	1	A2	1	A3	3	A2	2	A3	1	A2	3	A3	1
T/E	3	I/E	1	A2	3	A4	1	A2	1	A4	1	A2	3	A4	1	A2	5	A4	1
R	3	I/E	1	A3	3	A4	1	A3	4	A4	1	A3	3	A4	1	A3	2	A4	1

TABLE 3
SCALE OF RELATIVE IMPORTANCE

Intensity of Importance	Definitions
1	Equally significance
3	Weak significance of one over another
5	Essential significance
7	Established significance
9	Absolute significance
2,4,6,8	Intermediate values between the two adjacent judgments

TABLE 4
WEIGHT MATRIX AND NORMALIZED WEIGHT MATRIX FOR CRITERIA

Weight Matrix					Normalized Weight Matrix				
Criteria	**P/M**	**T/E**	**R**	**I/E**	**P/M**	**T/E**	**R**	**I/E**	**Weight**
P/M	1	5	7	4	0.628	0.732	0.677	0.363	0.600
T/E	1/5	1	2	3	0.125	0.146	0.193	0.272	0.184
R	1/7	1/2	1	3	0.089	0.073	0.096	0.272	0.132
I/E	1/4	1/3	1/3	1	0.156	0.048	0.032	0.090	0.018
SUM	**1.59**	**6.83**	**10.33**	**11**	**λ_{max} = 4.26, CI = (λ_{max}-n)/(n-1) = 0.086, CR = CI/RCI = 0.096**				

Now the Consistency Ratio (CR) is then be calculated as: CR= CI / RCI. The value of CR is deciding that the judgments are consistent or not. If CR is less than 0.10, the degree of consistency for the judgements is satisfactory and if greater than 0.10 means inconsistent judgements. In this study, CR = 0.096 which is less than 0.10, Therefore judgements are consistent. Also calculate the value of CR of other normalized weight matrices to check the consistency. Decision makers use the same scale as given in table 3 to make weight matrix and normalized weight matrix of applicants for each criteria. The weight matrix and normalized weight matrix of each applicant for each primary criteria as P/M, T/E, R, and I/E are as shown in table 6.

TABLE 6
WEIGHT MATRIX AND NORMALIZED WEIGHT MATRIX

For Ph.D/M. Tech. (P/M)									
Weight Matrix					Normalized Weight Matrix				
Applicant	**A1**	**A2**	**A3**	**A4**	**A1**	**A2**	**A3**	**A4**	**Weight**
A1	1	3	4	7	0.578	0.621	0.546	0.500	0.561
A2	1/3	1	2	3	0.193	0.207	0.273	0.214	0.222
A3	1/4	1/2	1	3	0.145	0.103	0.136	0.214	0.149
A4	1/7	1/3	1/3	1	0.083	0.051	0.045	0.071	0.063
SUM	**1.78**	**4.83**	**7.33**	**14**	**λ_{max} = 4.02, CI = (λ_{max}-n)/(n-1) = 0.006, CR = CI/RCI = 0.0074**				
For Teaching Experience (T/E)									
Weight Matrix					Normalized Weight Matrix				
Applicant	**A1**	**A2**	**A3**	**A4**	**A1**	**A2**	**A3**	**A4**	**Weight**
A1	1	5	3	7	0.598	0.500	0.655	0.538	0.572
A2	1/5	1	1/3	1	0.120	0.100	0.073	0.076	0.092
A3	1/3	3	1	4	0.199	0.300	0.218	0.308	0.256
A4	1/7	1	1/4	1	0.086	0.100	0.055	0.076	0.079
SUM	**1.67**	**10**	**4.58**	**13**	**λ_{max} = 4.08, CI = (λ_{max}-n)/(n-1) = 0.025, CR = CI/RCI = 0.028**				
For Research (R)									
Weight Matrix					Normalized Weight Matrix				
Applicant	**A1**	**A2**	**A3**	**A4**	**A1**	**A2**	**A3**	**A4**	**Weight**
A1	1	3	5	7	0.598	0.621	0.600	0.500	0.579
A2	1/3	1	2	3	0.199	0.207	0.240	0.214	0.215
A3	1/5	1/2	1	3	0.119	0.103	0.120	0.214	0.139
A4	1/7	1/3	1/3	1	0.085	0.068	0.040	0.071	0.066
SUM	**1.67**	**4.83**	**8.33**	**14**	**λ_{max} = 4.09, CI = (λ_{max}-n)/(n-1) = 0.029, CR = CI/RCI = 0.032**				
For Industry Experience (I/E)									
Weight Matrix					Normalized Weight Matrix				
Applicant	**A1**	**A2**	**A3**	**A4**	**A1**	**A2**	**A3**	**A4**	**Weight**
A1	1	3	5	6	0.591	0.662	0.526	0.428	0.551
A2	1/3	1	3	5	0.197	0.220	0.315	0.357	0.272
A3	1/5	1/3	1	2	0.118	0.073	0.105	0.142	0.109
A4	1/6	1/5	1/2	1	0.098	0.044	0.052	0.071	0.066
SUM	**1.69**	**4.53**	**9.5**	**14**	**λ_{max} = 4.12, CI = (λ_{max}-n)/(n-1) = 0.040, CR = CI/RCI = 0.045**				

TABLE 7
CALCULATIONS FOR THE SELECTION OF BEST APPLICANT

Criteria/ Applicant	P/M	T/E	R	I/E		Criteria Weight		Weighted Score	Applicant 1 and 2 has the highest score
A1	0.561	0.572	0.579	0.551		0.600		**0.563**	
A2	0.222	0.092	0.215	0.272	.	0.184	=	**0.201**	
A3	0.149	0.256	0.139	0.109		0.132		0.164	
A4	0.063	0.079	0.066	0.066		0.018		0.066	

Now again check the consistency of judgements for all the applicants by calculating the value of CR. The value of CR of all the applicants for P/M, T/E, R and I/E are 0.0074, 0.028, 0.032, and 0.045 respectively. These values represent the highest degree of consistency because these values are less than 0.10. **A1 (0.563) A2 (0.201) A3 (0.164) A4 (0.066) Selection of Most Appropriate Faculty P/M (0.600) T/E (0.184) R (0.132) I/E (0.081) Alternatives Criteria Goal Step-3:**The judgements of the decision maker's for all the applicants will be merged with the overall priorities of each applicant in this step. After calculating weights of each applicant on each criteria, these weights should be combined with the weight of individual each criteria as P/M, T/E, R, and I/E as shown in table 7. The result shows the applicant 1 and applicant 2 has the highest weighted score as compared to remaining two applicants. Figure 2 illustrates the hierarchy with their weights.

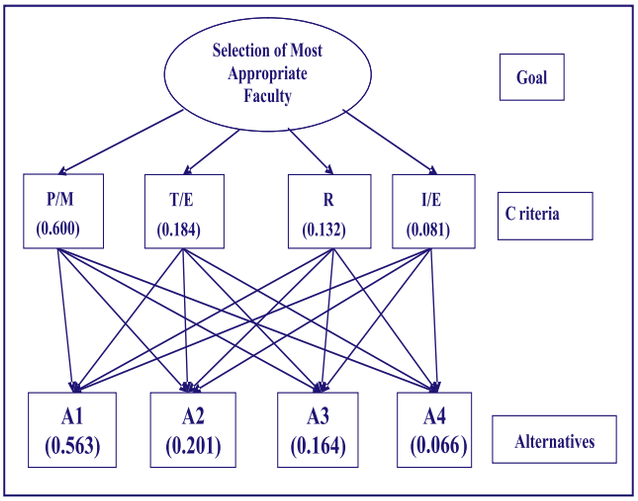


Figure 2: Hierarchy used for selecting most appropriate applicants with their weights

Step-4: In the second round, decision maker's again check the eligibility of first two applicants having a higher weight score. Applicant 1 and applicant 2 has the highest weighted score. Also check the other criteria of these selected applicants. The other criteria are oral presentation (O/P), Student evaluation (S/E) and Interview panel evaluation (IP/E) in the second round. These three criteria are used to finalize the most appropriate applicant in this study. Figure 3 illustrates the hierarchy model used for selecting most appropriate applicants (secondround).

Again the decision maker's have suggested relative weights for various criteria, O/P, S/E and IP/E as well as for applicants as shown in table 8 in this study. Refer the table 3 again for the scale of relative importance in quantitative analysis (Saaty 1980, Albright and Winston, 2009).

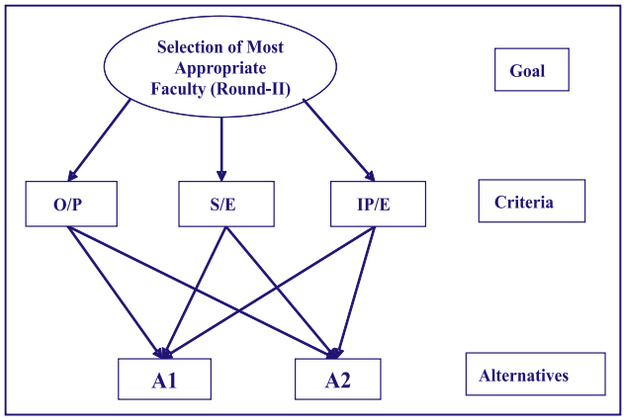


Figure 3: Hierarchy used for selecting most appropriate applicants (second round)

TABLE 8 RELATIVE WEIGHT FOR CRITERIA AND APPLICANTS UNDER O/P, S/E AND IP/E

Relative Weight for Criteria				Relative Weight for O/P, S/E and IP/E			
O/P	1	**S/E**	3		**O/P**	**S/E**	**IP/E**
O/P	1	**IP/E**	4	**A1**	1	3	1
S/E	3	**IP/E**	1	**A2**	4	1	2

Step-5: In this step, again prepare weight matrix and normalized weight matrix for various criteria as similar as prepared in the first round. Decision maker's again used the same scale described in table 3 to prepare weight matrix and normalized weight matrix for each criteria as shown in table 9.

TABLE 9 WEIGHT MATRIX AND NORMALIZED WEIGHT MATRIX FOR CRITERIA

Criteria	O/P	S/E	IP/E	O/P	S/E	IP/E	Weight
O/P	1	1/3	1/4	0.125	0.181	0.076	0.127
S/E	3	1	2	0.375	0.545	0.615	0.512
IP/E	4	1/2	1	0.500	0.272	0.307	0.359
SUM	**8**	**1.83**	**3.25**	**λ_{max} = 3.11, CI = (λ_{max}-n)/(n-1) = 0.055, CR = CI/RCI = 0.094**			

Also check the consistency of the judgements (Second round) by calculating the value of CR. The value of CR is 0.094, which is less than 0.10, means judgements are satisfactory consistent according to Saaty 2006. Now check how well each applicant scores on each available criteria. The other three matrices have only two comparisons, therefore there is no need to check the consistency. Decision makers use the same scale as given in table 3 to make weight matrix and normalized weight matrix of applicants for each criteria. The weight matrix and normalized weight matrix of each criteria as O/P, S/E and IP/E are as shown in table 10.

TABLE 10
WEIGHT MATRIX AND NORMALIZED WEIGHT MATRIX

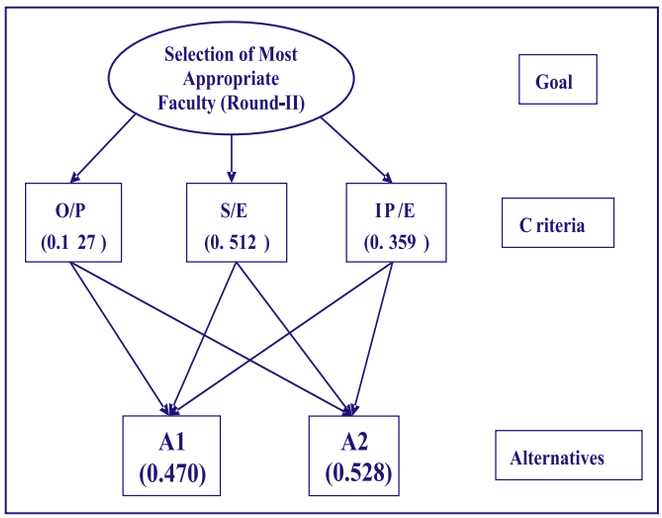
For Oral Presentation					
Applicant	**A1**	**A2**	**A1**	**A2**	**Weight**
A1	1	4	0.8	0.8	0.8
A2	1/4	1	0.2	0.2	0.2
SUM	1.25	5			
For Student Evaluation					
Applicant	**A1**	**A2**	**A1**	**A2**	**Weight**
A1	1	1/3	0.25	0.25	0.25
A2	3	1	0.75	0.75	0.75
SUM	4	1.33			
For Interview Panel Evaluation					
Applicant	**A1**	**A2**	**A1**	**A2**	**Weight**
A1	1	2	0.67	0.67	0.67
A2	1/2	1	0.33	0.33	0.33
SUM	1.5	3			

Step-6: The judgements of the decision maker's for both the applicants will be merged with the overall priorities of each applicant in this step of the second round. After calculating weights of each applicant on each criteria, these weights should be combined with the weight of individual criteria as O/P, S/E and IP/E as shown in table 11. The result shows the Applicant 1 and applicant 2 has the highest weighted score in this study. Applicant 1 has a highest weighted score as compared to applicant 2 in the first round, but in second round applicant 2 has the highest weighted score as compared to applicant 1. So AHP suggests that the decision maker's will finalize a decision to select applicant 1 or applicant 2 or both if the institute required. Figure 4 illustrates the second round hierarchy with their weights. Therefore the final decision using AHP is to select applicant 2 as the most appropriate tenure teaching faculty member in this hypothetical engineering institution on the basis of higher weightage of the second round as already described previously.

TABLE 11

CALCULATIONS FOR THE SELECTION OF BEST APPLICANT (SECOND ROUND)

Criteria/ Applicant	O/P	S/E	IP/E		Criteria Weight	=	Weighted Score	Applicant 2 has the highest score
A1	0.8	0.25	0.67	.	0.127		0.470	
A2	0.2	0.75	0.33		0.512		**0.528**	
					0.359			



IV.CONCLUSION

AHP is a multi criteria decision making (MCDM) tool. It has been used by many researchers for various purposes. This paper is focused on the application of AHP to select most appropriate applicants for the tenure teaching faculty members in an engineering institution. A pairwise comparison is developed and prepare weight matrix and normalized weight matrix of criteria as well as of applicants in both the rounds. First of all, prepare weight matrix and normalized weight matrix on the basis of four primary criteria as P/M, T/E, R and I/E in the first round and again on the basis of three secondary criteria as O/P, S/E and IP/E in the second round. The judgements of decision maker's are consistent as checked by CR which is less than 0.10. Applicant 1 and applicant 2 has the highest weighted score in this study. Applicant 1 has a highest weighted score as compared to applicant 2 in the first round, but in second round applicant 2 has the highest weighted score as compared to applicant 1. So the decision maker's are the final authority to select applicant 1 or applicant 2 or both if the institute required. Therefore the final decision using AHP is to select applicant 2 as the most appropriate tenure teaching faculty member in this hypothetical engineering institution on the basis of higher weightage of the second round in this study. This paper concludes that the AHP methodology has the potential to use for the selection of tenure teaching faculty members in engineering institution in order to fulfill the strategic goals. AHP becomes popular for the selection of faculty members within the academic institutions also.

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