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Multi Criteria Decision Making Methodology on Selection of a Student for All Round Excellent Award

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ABSTRACT

Selecting a student for all round excellent award is based on a complex, elaborate combination of abilities and skills. A multi-criteria Decision Making method, AHP is used to help in making decision consistently by doing a pairwise comparison matrix process between criteria based on selected alternatives and determining the priority order of criteria and alternatives used. The results of these calculations are used to determine the outstanding student receiving a scholarship based on the final results of the AHP method calculation. The results demonstrated that the student ranking is more likely influenced by the relative importance of management, leadership and motivation by sub-criteria, education, cooperation, innovation, disciplinary, attendance, knowledge, sports activity, social activity and awards.

KEYWORDS: *Analytic Hierarchy Process (AHP); Multi Criteria Decision Making (MCDM); Pair wise Comparison Matrix; Consistency Ratio (CR); Normalization*

1. INTRODUCTION

This section provides an introduction of AHP with the presentation of the general methodology. The Analytic Hierarchy Process (AHP) was developed by Thomas Saaty in the Eightieth of the last century and has been extensively used in decision making for a complex situation, it is suitable where people work together to make a decision when human perception, judgment and consequences have a long term repercussion. This technique is especially suited for application to project evaluation in which qualitative factors dominated.

However, it can be characterized as multi-criteria decision making that can combine qualitative and quantitative factors in the overall evaluation of alternatives.

AHP can be characterized as a multi-criteria decision technique in which qualitative factors are of the prime of importance. A model of the problem of student's assessment is developed using a hierarchical representation. At the top of the hierarchy is the overall goal of selecting the best student is seeking to fulfill. The alternating lower levels then represent the progressive decomposition of the problem and represent the criteria and sub-criteria. Criteria depend on how is complex the decision problem under considerations. The individual team members complete pair-wise comparisons of all entries in each level relative to each of the entries in the next higher level of the hierarchy. The comparison of these judgments shows the relative priority of the entities at the lowest level relative to achieving the top final goal.

To describe the AHP technique in this article, it first needs to assess team performance by using traditional student questionnaires methods in spite of it is full description, followed by the description of what appears to be more meaningful results when AHP is used. Secondly, several complicating factors associated with this experiment, some tentative conclusions and a recommendation for continued investigation of the use of AHP for student evaluation.

2. METHODOLOGY

Four steps are used to solve a problem with an AHP methodology, the application by decomposed into a hierarchy of criteria so as to be more easily and simply analyzed and compared in an independent situation shown in Figure 1. After constructing the problem in a hierarchy way, the decision-maker can systematically assess the alternatives by doing pair-wise comparisons for each of the chosen criteria. This comparison may use data from alternatives or human judgments as a way to input information.

1. Building decision "hierarchy" diagram in Figure 1.
2. Getting relational data with performing student's assessment for criteria, sub-criteria and alternatives by using AHP relational scale.
3. Estimating relative priorities of decision criteria and alternatives by developing an Excel program.
4. Ranking and selecting the best student.

It is very essential in step 1 to start developing the hierarchical representation of the problem. At the top of the hierarchy is the overall objective (goal) while the decision alternatives are at the bottom. Between the top and bottom levels are the relevant attributes or criteria of the decision problem, such as the selection criteria and sub-criteria. The number level of levels in the hierarchy depends on the complexity of the problem under consideration.

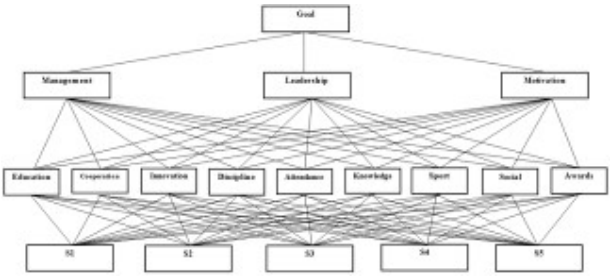

Figure.1: AHP example of approaching goal for selecting an outstanding student.

Table.1 Numerical relational scale

Intensity of important	Definition
1	Equal importance
3	More importance
5	Much More importance
7	Very Much More strong
9	Extremely More importance
2,4,6,8	Intermediate values

At step 2, we need to gather data to compare the alternatives. The decision-maker has to make pair-wise comparisons of criteria at each level relative to each activity at the next adjacent higher level in the hierarchy. In AHP, a relational scale of numbers from 1 to 9 is used to systematically assign preferences. When comparing two attributes, A and B, with respect to GOAL in a higher level, the numerical relational scale is used as shown in TABLE I.

In step 3, the pair-wise comparison matrix can be created by using the Eigenvalue method in step 2. These Eigenvalues can be determined the relative priority of each attribute to each attribute level up in the hierarchy. The method of pairwise comparisons is systematic and comprehensive. One might want to repeat a set of pairwise comparison if the consistency ratio is alarmingly high. In spite of the decision-maker has the option of redoing the comparison matrix if desired to improve the consistency.

In step 4, after all comparisons have been made, and the relative weights between each one of the criteria to be evaluated have been found, the numerical probability of each alternative is calculated. The probability determines the likelihood that the alternative has to achieve the expected goal. The high the probability, the better chances the alternative has to satisfy the final goal. The priorities (or weight) of the lowest level alternatives relative to the top objective are determined and displayed. AHP facilitates a comprehensive and logical analysis of problems for which considerable uncertainty exists. In fact, the power of AHP (and to a large degree is uniqueness) is the ability to consider qualitative goal and attributes within its framework. Generally speaking, the mathematical calculation involved in the AHP may seem simple at first, but if dealing with a more complex scenario, the calculations become more complicated.

3. DEVELOPMENT AND RESEARCH OF METHODS FOR SELECTING THE BEST STUDENT

A. Defining the pairwise comparison matrix of the student by focusing on sub-criteria Supervisors and the students work together to get the comparison matrix after considering the hierarchy structure for achieving the final goal. The student did of all comparisons for all sub-criteria education, cooperation, innovation, disciplinary, attendance, knowledge, sports activity, social activity and awards. If the consistency ratio (CR) of their comparisons were significantly high, supervisors need to rearrange student's assessment to get the proper CR [9-11]. Comparison matrix and eigenvector are presented in TABLE II-IX.

Table.2 Comparison matrix for focusing student's education

Education	S1	S2	S3	S4	S5
S1	1	3	6	1	4
S2	0.3333	1	2	0.5	2
S3	0.1667	0.5	1	0.25	1
S4	1	2	4	1	4
S5	0.25	0.5	1	0.25	1
Sum	2.75	7	14	3	12

Table.3 Normalization comparison matrix and eigenvector (CR=0.0059)

Normalization	S1	S2	S3	S4	S5	Eigen Vector
S1	0.3636	0.4286	0.4286	0.3333	0.3333	0.3775
S2	0.1212	0.1429	0.1429	0.1667	0.1667	0.1481
S3	0.0606	0.0714	0.0714	0.0833	0.0833	0.0740
S4	0.3636	0.2857	0.2857	0.3333	0.3333	0.3203
S5	0.0909	0.0714	0.0714	0.0833	0.0833	0.0801

Table.4 Comparison matrix for focusing student's cooperation

Co-operation	S1	S2	S3	S4	S5
S1	1	0.5	3	2	0.25
S2	2	1	6	4	2
S3	0.33	0.167	1	0.5	0.2
S4	0.5	0.25	2	1	0.25
S5	4	0.5	5	4	1
Sum	7.83	2.417	17	11.5	3.7

Table.5 Normalization comparison matrix and eigenvector (CR=0.0396)

Normalization	S1	S2	S3	S4	S5	Eigen Vector
S1	0.1277	0.2069	0.1765	0.1739	0.0676	0.1505
S2	0.2553	0.4138	0.3529	0.3478	0.5405	0.3821
S3	0.0426	0.0690	0.0588	0.0435	0.0541	0.0536
S4	0.0638	0.1034	0.1176	0.0870	0.0676	0.0879
S5	0.5106	0.2069	0.2941	0.3478	0.2703	0.3259

Table.6 Comparison matrix for focusing student's innovation

Innovation	S1	S2	S3	S4	S5
S1	1	4	0.25	0.5	5
S2	0.25	1	0.2	0.25	1
S3	4	5	1	2	6
S4	2	4	0.5	1	5
S5	0.2	1	0.167	0.2	1
Sum	7.45	15	2.117	3.95	18

Table.7 Normalization comparison matrix and eigenvector (CR=0.0404)N

Normalization	S1	S2	S3	S4	S5	Eigen Vector
S1	0.1342	0.2667	0.1181	0.1266	0.2778	0.1847
S2	0.0336	0.0667	0.0945	0.0633	0.0556	0.0627
S3	0.5369	0.3333	0.4724	0.5063	0.3333	0.4365
S4	0.2685	0.2667	0.2362	0.2532	0.2778	0.2605
S5	0.0268	0.0667	0.0787	0.0506	0.0556	0.0557

Table.8 Comparison matrix for focusing student's disciplinary

Disciplinary	S1	S2	S3	S4	S5
S1	1	0.25	3	0.5	4
S2	4	1	6	2	5
S3	0.333	0.167	1	0.50	1
S4	2	0.5	2	1	4
S5	0.25	0.2	1	0.25	1
Sum	7.583	2.117	13	4.25	15

Table.9 Normalization comparison matrix and eigenvector (CR=0.0412)N

Normalization	S1	S2	S3	S4	S5	Eigen Vector
S1	0.132	0.118	0.231	0.117	0.267	0.1730
S2	0.528	0.472	0.462	0.471	0.333	0.4531
S3	0.044	0.079	0.078	0.118	0.067	0.0768
S4	0.264	0.236	0.154	0.235	0.267	0.2312
S5	0.033	0.095	0.077	0.059	0.067	0.0660

Table.10 Comparison matrix for focusing student's attendance

Attendance	S1	S2	S3	S4	S5
S1	1	3	0.5	2	0.25
S2	0.33	1	0.25	1	0.2
S3	2	4	1	4.00	1
S4	0.5	1	0.25	1	0.25
S5	4	5	1	4	1
Sum	7.83	14	3	12	2.7

Table.11 Normalization comparison matrix and eigenvector (CR=0.0197)N

Normalization	S1	S2	S3	S4	S5	Eigen Vector
S1	0.128	0.2143	0.167	0.1667	0.0926	0.1536
S2	0.0426	0.0714	0.083	0.0833	0.0741	0.0709
S3	0.2553	0.2857	0.333	0.3333	0.3704	0.3156
S4	0.0638	0.0714	0.083	0.0833	0.0926	0.0789
S5	0.5106	0.3571	0.333	0.3333	0.3704	0.3810

Table.12 Comparison matrix for focusing student's general knowledge

Knowledge	S1	S2	S3	S4	S5
S1	1	5	4	3	1
S2	0.2	1	1	2	0.2
S3	0.25	1	1	0.50	0.25
S4	0.33	0.5	2	1	0.5
S5	1	5	4	2	1
Sum	2.78	12.5	12	8.5	2.95

Table.13 Normalization comparison matrix and eigenvector (CR=0.0625)N

Normalization	S1	S2	S3	S4	S5	Eigen Vector
S1	0.3593	0.4000	0.3333	0.3529	0.3390	0.3569
S2	0.0719	0.0800	0.0833	0.2353	0.0678	0.1077
S3	0.0898	0.0800	0.0833	0.0588	0.0847	0.0793
S4	0.1198	0.0400	0.1667	0.1176	0.1695	0.1227
S5	0.3593	0.4000	0.3333	0.2353	0.3390	0.3334

Table.14 Comparison matrix for focusing student's sport activity

Sport	S1	S2	S3	S4	S5
S1	1	3	2	2	1
S2	0.333	1	2	1	0.5
S3	0.5	0.5	1	1	0.5
S4	0.5	1	1	1	1
S5	1	2	2	1	1
Sum	3.33	7.5	8	6	4

Table.15 Normalization comparison matrix and eigenvector (CR=0.0358)

Normalization	S1	S2	S3	S4	S5	Eigen Vector
S1	0.3000	0.40	0.25	0.3333	0.25	0.3067
S2	0.100	0.133	0.25	0.167	0.125	0.1550
S3	0.150	0.067	0.125	0.167	0.125	0.1267
S4	0.150	0.133	0.125	0.167	0.25	0.1650
S5	0.30	0.267	0.25	0.167	0.25	0.2467

Table.16 Comparison matrix for focusing student's social activity

Social	S1	S2	S3	S4	S5
S1	1	4	2	3	2
S2	0.25	1	0.5	1	0.5
S3	0.5	2	1	2.00	1
S4	0.33	1	0.5	1	0.5
S5	0.5	2	1	2	1
Sum	2.583	10	5	9	5

Table.17 Normalization comparison matrix and eigenvector (CR=0.0022)

Normalization	S1	S2	S3	S4	S5	Eigen Vector
S1	0.3871	0.40	0.40	0.33	0.40	0.3841
S2	0.0968	0.10	0.10	0.11	0.10	0.1016
S3	0.1935	0.20	0.20	0.22	0.20	0.2032
S4	0.1290	0.100	0.1	0.11	0.10	0.1080
S5	0.1935	0.2	0.2	0.2	0.2	0.2032

Table.18 Comparison matrix for focusing student's awards

Award	S1	S2	S3	S4	S5
S1	1	2	0.5	0.25	0.25
S2	0.5	1	0.25	0.167	0.2
S3	2	4	1	0.50	0.5
S4	4	6	2	1	1
S5	4	5	2	1	1
Sum	11.5	18	5.75	2.917	2.95

Table.19 Normalization comparison matrix and eigenvector (CR=0.0058)

Normalization	S1	S2	S3	S4	S5	Eigen Vector
S1	0.0870	0.1111	0.087	0.086	0.0847	0.0911
S2	0.0435	0.0556	0.044	0.057	0.0678	0.0535
S3	0.1739	0.2222	0.174	0.171	0.1695	0.1822
S4	0.3478	0.3333	0.348	0.343	0.3390	0.3422
S5	0.3478	0.2778	0.348	0.343	0.3390	0.3311

In order to find Eigenvalues for each alternative by focusing each sub-criterion, it is necessary to normalize each comparison Matrix by dividing each table value by the total column (TABLE III, V, VII, IX, XI, XIII, XV, XVII, and XIX).

B. Defining a comparison matrix of sub-criteria by focusing criteria

The definition of sub-criteria is presented in TABLE XX. Firstly, we need to get comparison matrix of sub-criteria by calculating each sufficient CR values. Then, the Eigenvector of these sub-criteria by focusing criteria can be calculated after normalizing each comparison matrix of sub-criteria by dividing each column values.

Table.20 Definition of sub-criteria

C1	Education
C2	Co-operation
C3	Innovation
C4	Disciplinary
C5	Attendance
C6	General knowledge
C7	Sport activity
C8	Social activity
C9	Awards

The values found in the Eigenvector have a direct physical meaning in the AHP technique. They determine the weight of those criteria relative to the total result of the goal. The Eigenvector shows the relative weights between each criterion by calculating the arithmetic average of all criteria. So, we can observe that the sum of all values from the vector is always equal to one. The relative weight values of the comparison matrix of sub-criteria by focusing on each criteria Management, Leadership and Motivation and its overall weight vector are presented in TABLE XXI.

Table.21 Relative weight of criteria and overall Eigenvector

CRITERIA	Management	Leadership	Motivation	Eigen Vector
C1	0.2893	0.2414	0.2238	0.2515
C2	0.0528	0.1594	0.1049	0.1057
C3	0.1640	0.1229	0.1939	0.1603
C4	0.0603	0.1488	0.0506	0.0865
C5	0.1847	0.0656	0.1666	0.1389
C6	0.0811	0.1021	0.0790	0.0874
C7	0.0317	0.0411	0.0403	0.0377
C8	0.0345	0.0429	0.0427	0.0400
C9	0.1016	0.0759	0.0982	0.0919
Total	1.0000	1.0000	1.0000	1.0000

The results are showing that C1 (education) and C3 (innovation) sub-criteria are higher and C7 (sports activity) and C8 (social activity) are lower values relative to the other sub-criteria. This means that higher weight values have a higher priority to achieving the final goal. Comparing result weight values are presented in Figure 2.

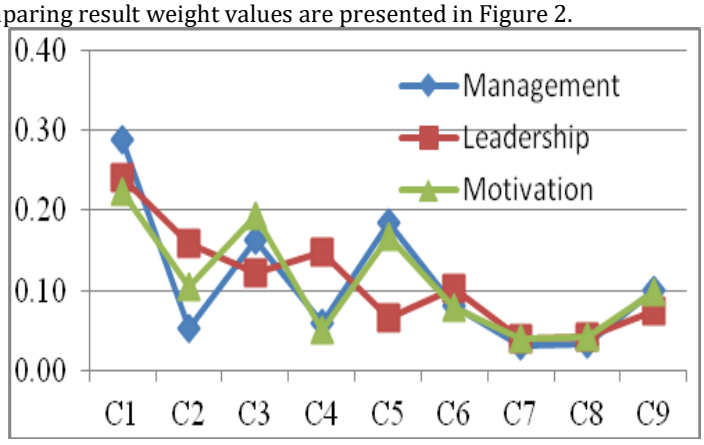

Figure .2: Priorities of sub-criteria by focusing third level criteria.

C. Ranking

The overall priorities to each individual student can find after completed all pairwise comparisons to the low level of the hierarchy. The low level consists of nine sub-criteria, co-operation, innovation, disciplinary, attendance, knowledge, sports activity, social activity and awards, as illustrated above in Figure 3.

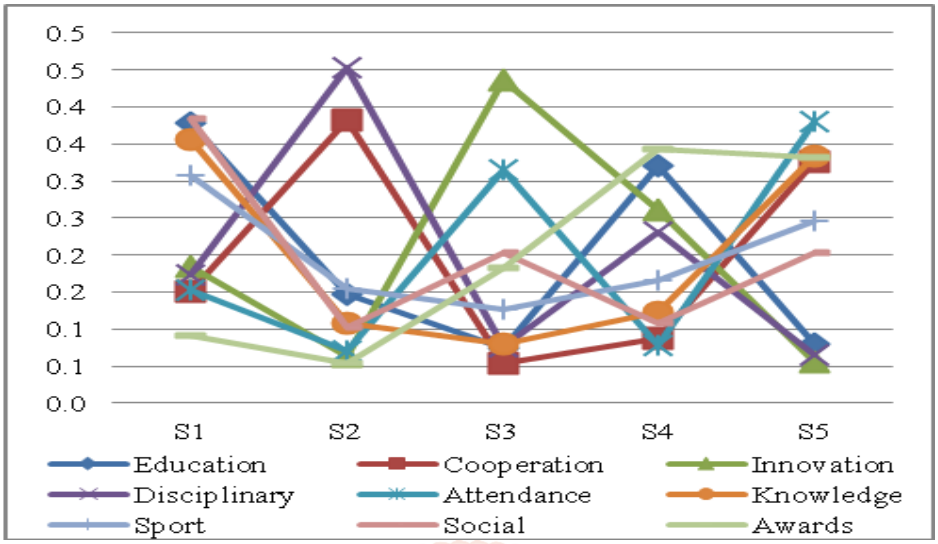

Figure .3: Overall priorities of five students

The results appear in TABLE XXII indicate that the perceived relative importance of criteria determinate varies from one student to another. This finding and the above reveals that there are a number of attributes that are of particular importance to students to decide their contribution regardless of past doing. Such students' attributes mainly pertain to personnel differences. TABLE XVIII show that S1 takes the highest priority [0.2433], S4 has gotten [0.2153], while S3 gets [0.1813] and S2 gets the lower priority [0.161]. So that, if we assume that S1 deserves excellent grade [95], however, this will help us to assign a grade to other individual students as, [90, 84, 75 and 65] to S4, S5, S3 and S2 respectively.

Table.22 Ranking of selecting excellent student

Alternatives	Ranking
S1	0.2433
S2	0.1610
S3	0.1813
S4	0.2153
S5	0.1992

4. CONCLUSION

This is a good exercise of selecting the best student in many ways. The use of co-operative learning was a good educational experience between students and supervisors. The main conclusions in this article are:

1. The structured approach AHP technique is used to perform problem formulation by seeking student's opinions.
2. The student's assessments have an important role in performing multi-criteria decision making analysis and expert choice.
3. All results are carried out by developing a software medium based on Microsoft Excel.
4. The results are showing that the perceived relative importance of criteria vary from one to another. The relative weight values of criteria are education [0.2515], cooperation [0.1057], innovation [0.1603], disciplinary [0.0865], attendance [0.1389], knowledge [0.0874], sport activity [0.0377], social activity [0.0400] and awards [0.0919].
5. The results also reveal in order of priority, S1 [0.2433], S4 [0.2153], S5 [0.1992], S3 [0.1813] and S2 [0.161].
6. Finally, the article opens the door for further studies to enhance the learning and teaching process at high education institutes.

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