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ELECTRE Method for the Selection of ALL ROUND EXCELLENCE AWARD-an Illustration

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Abstract

Multi The present study gives an application of Multi Criteria Decision Making (MCDM) methods for the selection of a branch of student for ALL ROUND EXCELLENCE AWARD of an engineering college by Elimination and Choice Translating Reality (ELECTRE) method with an illustration. ELECTRE method is one of the MCDM methods. This method is also a ranking method which gives the leading alternative by which we can chose best decisions to our problems. In the opinion of Evangelos Triantaphyllou ELECTRE method gives the fastest solution. In this regard this method is chosen in the present cut throat competitive study. ELECTRE method is used in many fields to obtain the best decisions to their complex situations. Its significance has reached the crux. In this wake many methods like ELECTRE 1, ELECTRE 2... have come into existence to bring out the best result. But in this present study we applied only ELECTRE method to the mentioned problem. Here seven criteria are chosen in which few criteria have sub criteria and identified five branches as alternatives. Hence it is analysed that the student of ECE branch has been selected for the award.

Keywords: A Multi Criteria Decision Making Method, Consistency, Elimination and Choice Translating Reality (ELECTRE), Ranking

1. Introduction

AHP was introduced and developed by Saaty on 1970's to capture the solution to the quantitative and qualitative factors for decision makers in MCDM. Since then this method has been applied into many real applications[5]. Kousalya et.al.[2] explained about the hierarchial structure of AHP and its application in the field of engineering education. Barzilai[3] discussed how to derive weights from pair-wise comparison matrices in detail. The pair wise comparison matrices contain the crisp judgments depending on their relative importance with respect to criteria and alternative. These pair wise comparison matrices may be consistent or inconsistent due to the limitations of decision maker. Application methodology and the priority of multi criteria decision making methods were explained by Hwang et.al.[5,7,8]. Later many methods under MCDM methods were introduced. ELECTRE is one of the MCDM methods. ELECTRE was first developed by Bernard Roy and was first applied in 1965. SEMA and European Consultancy Company is the origin of ELECTRE method. A research team at SEMA worked on complex real world problems involving multiple criteria. Multi criteria methodology for decision aiding a theory on out ranking approach and foundation of ELECTRE

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method was explained by Roy[1,8]. Earlier this outranking procedure was applied in many fields but not to a problem of selection of a branch of a student for the ALL ROUND EXCELLENCE AWARD.

2. Methodology

2.1 AHP

Saaty in 1980 devised the hierarchical methods to seek the solution for the problem involving multiple criteria. In this context he devised a pair-wise comparison method known as Analytical hierarchical process. This method gives best decision to our real life problems. This is one of the ranking methods of multi criteria decision making methods. This method gives the relative importance the alternative and criteria. To check the consistency Saaty provided a perfect formulation. Deriving the priorities by AHP was discussed in[6]. The decisions can be obtained by assigning ranks for the weights obtained in priority vector. This priority vector can be obtained by pair-wise comparison between the alternatives and criteria, was discussed by Evangelos Triantaphyllou[10]. But to apply AHP we need to follow few steps[4].

- Determine the aim/objective,
- Choose the Attributes,
- Select the Alternatives,
- Construct the Hierarchy,
- Formulate the hierarchy, and
- Design the Pair-wise Comparison matrices using Saaty's 9-point scale.

If a_{ij} represents priority of c_i with respect to c_j ,then form a reciprocal matrix A of order n whose elements satisfy the relation $a_{ij}=1/a_{ji}$ for $i\neq j$ and $a_{ii}=1$ for all i. Now check the consistency by using transitive relation $a_{ik} = a_{ij} . a_{jk}$ for all I,j &k. From the relation $A\omega = \lambda\omega$ find the nonzero vector ω known as priority vector and λ is the eigen value. Depending upon the values of priority vector we can chose the best alternative. The decision obtained is said to be consistent for λ= n. If the human judgments are inconsistent then the transitive relation $a_{ik} = a_{ij} . a_{jk}$ does not hold. Then find the nonzero vector ω from the relation $A\omega = \lambda_{max}\omega$ for $\lambda_{max}\geq n$. If $\lambda_{max}=n$ the decision obtained is said to be consistent. The difference between λ_{max} and n represents the inconsistency of the judgments. Now find the consistency index by using $\frac{\lambda_{max}-n}{n-1}$ .Finally find consistency ratio by using the obtained consistency index (CI) and the average Random consistency Index (RI) given by Saaty as consistency ratio = CI/RI. According to Saaty the decision obtained is perfectly consistent if consistency ratio is equal to 0, and the consistency ratio is more than 0.1 the decisions are said to be inconsistent. In general for some cases if consistency ratio goes beyond 0.1 also the decisions are taken into consideration.

2.2 ELECTRE Method

B. Roy in 1960's devised the ELECTRE method, later it was applied in many fields to solve multi criterion problems. This method also follows the pair wise comparison process. This method gives the leading alternative, when one alternative is compared with another alternative. Depending on concordance matrix, discordance matrix and threshold values we can find dominance between the alternatives .Hence ranking of alternatives can be obtained by depending on the elements of concordance, discordance dominance matrices. According to Triyantaphyllu[10] the following steps are used for decision making by ELECTRE Method.

Step 1: Normalizing the Decision Matrix

The following equation can convert the elements of the decision matrix into comparable and dimensionless elements.

$$x_{ij} = \frac{a_{ij}}{\sqrt{\sum_{k=1}^{m} a_{kj}^2}}$$

Step 2: Weighted Normalized Decision Matrix

If $(W_{1,}$ W2, *W3,* •••, *Wn)* is the weight vector. Then Y gives the weighted normalized decision matrix.

$$y = xw. \text{ and } \sum_{i=1}^{n} wi = 1$$

Step 3: Concordance and Discordance Sets

If the alternative *Ak* is compared with the alternative *Al,* for $m \geq k, l \geq 1$, its concordance set C_{kl} is given by:

$$c_{kl} = \{j, y_{kj} \geq y_{lj}\}, \text{ for } \quad J= 1, 2, 3\ldots\ldots,n$$

and its complementary subset i.e: the discordance set d_{kl} is given by:

$$d_{kl} = \{j, y_{kj} < y_{lg}\}, \text{ for } \quad J=1, 2, 3\ldots\ldots,n$$

Step 4: Construct the Concordance and Discordance Matrices Concordance index *Ckl* can be obtained by using the following relation. This index gives the dominance relation between the alternatives A_k and A_l for $0 \leq C_{kl} \leq 1$

$$c_{kl} = \sum_{jec_{kl}} wj, \text{ for } \quad J=1, 2, 3\ldots\ldots n$$

for $k = l$ the elements of concordance matrix are not defined.

The elements *dkl* of the discordance matrix are defined as follows:

$$d_{kl} = \frac{\max_{j \in D_{kl}} \left| y_{kj} - y_{lj} \right|}{\max_{j} \left| y_{kj} - y_{lj} \right|}$$

for $k = l$ the elements of concordance matrix are not defined.

Step 5: Determine the Concordance and Discordance Dominance Matrices

Threshold value of C_{kl} will give concordance dominance matrix elements f_{kl} for $C_{kl} \geq \bar{C}$.

By following relation we get $\bar{c}$:

$$\bar{c} = \frac{1}{m(m-1)} \sum_{k=1 and k \neq l}^{m} \sum_{l=1 and l \neq k}^{m} c_{kl} \quad (9)$$

$$f_{kl} = 1 if c_{kl} \geq \underline{c}$$

$$f_{kl} = 0 if c_{kl} < \underline{c}$$

Threshold value $\underline{d}$ gives discordance dominance matrix G by using following relation:

$$\underline{d} = \frac{1}{m(m-1)} \sum_{k=1 and k \neq l}^{m} \sum_{l=1 and l \neq k}^{m} d_{kl}$$

$$g_{kl} = 1 ford_{kl} \geq \underline{d}$$

$$g_{kl} = 0 ford_{kl} < \underline{d}$$

Step 6: Determine the Aggregate Dominance Matrix

$$e_{kl} = f_{kl} \times g_{kl} \quad (10)$$

Step 7: In the aggregate dominance matrix e_{kl}= 1 represents the alternative A_k is preferable than the alternative A_l. A column is said to be *"ELECTREally"* dominated by the corresponding row when any column of the aggregate dominance matrix has at least one element equal to 1. We infer that, the best alternative is the one which dominates all other alternatives in this manner.

3. Illustration (Figure 1)

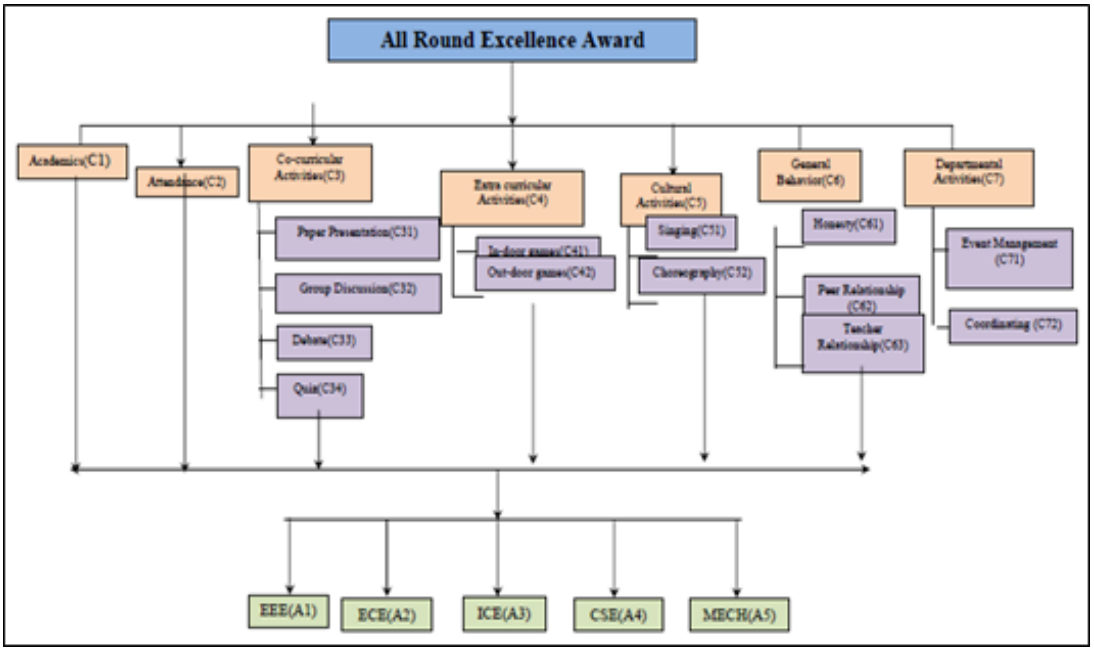

Figure 1. Hierarchical decomposition of criteria, sub criteria and alternatives.

4. Calculations by ELECTRE Method (Table 1-3)

Table 1. Normalised decision matrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15
W_i	0.316	0.04	0.2	0.2	0.2	0.2	0.5	0.5	0.5	0.5	0.33	0.33	0.33	0.5	0.5
A1	0.507	0.192	0.419	0.585	0.349	0.359	0.266	0.381	0.555	0.377	0.557	0.447	0.557	0.487	0.619
A2	0.801	0.980	0.821	0.585	0.846	0.759	0.171	0.169	0.228	0.377	0.557	0.447	0.557	0.592	0.405
A3	0.114	0.019	0.091	0.192	0.110	0.179	0.209	0.487	0.147	0.156	0.183	0.447	0.185	0.169	0.213
A4	0.272	0.038	0.346	0.468	0.349	0.439	0.495	0.487	0.555	0.587	0.557	0.447	0.557	0.487	0.491
A5	0.112	0.019	0.145	0.240	0.165	0.259	0.781	0.592	0.555	0.587	0.183	0.447	0.185	0.381	0.405

Table 2. Weighted normalised decision matrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15
Wi	0.316	0.04	0.2	0.2	0.2	0.2	0.5	0.5	0.5	0.5	0.33	0.33	0.33	0.5	0.5
A1	0.160	0.007	0.083	0.117	0.069	0.071	0.133	0.190	0.277	0.188	0.183	0.147	0.183	0.243	0.309
A2	0.253	0.039	0.164	0.117	0.169	0.151	0.085	0.084	0.114	0.188	0.183	0.147	0.183	0.296	0.202
A3	0.036	0.0007	0.018	0.038	0.022	0.035	0.104	0.243	0.073	0.078	0.060	0.147	0.061	0.084	0.106
A4	0.085	0.001	0.069	0.093	0.069	0.087	0.247	0.243	0.277	0.293	0.183	0.147	0.183	0.243	0.245
A5	0.035	0.0007	0.029	0.048	0.033	0.051	0.390	0.296	0.277	0.293	0.060	0.147	0.061	0.190	0.202

Table 3. Threshold values

$\underline{C}$=4.3785	$\underline{d}$ =0.5065
$\begin{bmatrix} M & 0 & 1 & 0 & 0 \\ 0 & M & 0 & 0 & 0 \\ 0 & 0 & M & 0 & 0 \\ 0 & 0 & 1 & M & 0 \\ 0 & 0 & 1 & 0 & M \end{bmatrix}$	
Concordance dominance matrix	
$\begin{bmatrix} 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \end{bmatrix}$	
Discordance dominance matrix	

Table 3 Continued

$\begin{bmatrix} 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$
Aggregate Dominance matrix

5. Conclusion

A *c* As per Triantaphyllou[10] ELECTRE method gives swift and unrivalled solution to the problem. By this work it is analysed that it is justifying the outcome. With this illustration we can conclude that ELECTRE method is a useful method to find solutions to our real world problems. It is also observed that if the data in the comparison matrices is consistent then we will obtain more accurate result by an ELECTRE method.

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