

# Implementation of Elimination and Choice Expressing Reality (ELECTRE) Method in Selecting the Best Lecturer (Case Study STMIK BUDI DARMA)

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**Abstract**— Measurement of the performance index lecturer at a college should be obliged to do. Performance indexes the basis for university lecturer in determining the best lecturer owned by the university. The right solution to the problems faced by university leaders as a decision maker to consider several criteria relating to the determination of the best computer lecturer, in this case the determination of best computer lecturer using ELECTRE method

**Keywords**— Decision making, Multi-Criteria Decision Making, Multi-Criteria Decision Making, Best Lecturer, ELECTRE

## I. INTRODUCTION

The lecturer is the one resource that must have either PTN or PTS. Lecturers who have a good performance will improve the quality of universities. For faculty performance can be enhanced, it is no doubt anymore that universities must be able to assess the extent to which performance of the lecturers, so they know the performance generated by faculty lecturer at the college. For lecturers who earn top performance ratings. Certainly, the senior lecturers are the best that have high ratings on performance accomplishments. In conducting the selection of best lecturers can use decision support system, which has many methods that can apply to Weight Product (WP), Analytics Hierarchy Process (AHP), Simple Addictive Weighting (SAW) and some other methods [1] [2]. Decision support systems should have some alternative, criteria, and weighting that is a crucial factor in the decision support system [1] [3] [4].

Based on the above, this research is to apply the method Elimination and Choice expressing Reality (ELECTRE) in making decisions for determining best computer lecturer of STMIK Budi Darma with the criteria used, ie rank (C1), research (C2), scientific publications (C3), dedication (C4), supporting element (C5). Another variant of the ELECTRE approach is TOPSIS method [5] [6].

## II. THEORY

### A. Lecturer

Under Law 14, 2015, which referred to the lecturers are professional educators and scientists with the primary task of transforming, developing and disseminating science, technology, and the arts through education, research, and community service [7].

**B. Elimination and Choice Expressing Reality (ELECTRE)**  
ELECTRE methods introduced by Roy (1966), which uses a comprehensive evaluation approach by trying to create a ranking of the number of each alternative described on some criteria [8].

The steps of the method ELECTRE can see as below [6] [9] [10]:

### Step 1: Preparing for Decision Matrix

In the column, there is a decision matrix criteria (n) and the row in the form of alternative (m). The initial stage and the base for processing to decision support

$$x_{ij} = \begin{bmatrix} x_{11} & x_{12} & x_{13} & \dots & x_{1n} \\ x_{21} & x_{22} & x_{23} & \dots & x_{2n} \\ \cdot & \cdot & \cdot & \dots & \cdot \\ x_{m1} & x_{m2} & x_{m3} & \dots & x_{mn} \end{bmatrix} \quad (1)$$

### Step 2: Normalizing the Decision Matrix

Decision matrix will be normalized by using the following formula and produces the normalized model.

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}} \quad \begin{matrix} i=1,2,\dots,m \\ j=1,2,\dots,n \end{matrix} \quad (2)$$

For cost parameters using the following equation.

$$r_{ij} = \frac{1}{\sqrt{\sum_{i=1}^m \left(\frac{1}{r_{ij}}\right)^2}} \quad \begin{matrix} i=1,2,\dots,m \\ j=1,2,\dots,n \end{matrix} \quad (3)$$

The results of processing the normalized decision matrix, as shown below.

$$r_{ij} = \begin{bmatrix} r_{11} & r_{12} & r_{13} & \dots & r_{1n} \\ r_{21} & r_{21} & r_{22} & \dots & r_{2n} \\ \dots & \dots & \dots & \dots & \dots \\ r_{m1} & r_{m2} & r_{m3} & \dots & r_{mn} \end{bmatrix} \quad (4)$$

Step 3: Giving weight value

Furthermore, decision makers provide interest factor (weight) on each of the criteria which express its relative importance ( $w_j$ ).

$$W = (w_1, w_2, \dots, w_n);$$

$$\sum_{j=1}^n w_j = 1 \quad (5)$$

Step 4: Calculate the normalized weighted matrix

Each column of the r matrix multiplied by the weights ( $w_j$ ) determined by the decision maker, can be seen below.

$$v_{ij} = w_j \cdot r_{ij} \quad (6)$$

Where v is

$$v_{ij} = \begin{bmatrix} v_{11} & v_{12} & \dots & v_{1n} \\ v_{21} & v_{22} & \dots & v_{2n} \\ \dots & \dots & \dots & \dots \\ v_{m1} & v_{m2} & \dots & v_{mn} \end{bmatrix} \quad (7)$$

Step 5: Determining the set of concordance and discordance index

The set of concordance index  $\{c_{kl}\}$  indicates where the sum of weighted criteria  $A_k$  alternatively is better than the alternative  $A_l$ .

$$C_{kl} = \{j | v_{kj} \geq v_{lj}\} \quad \text{with } j=1,2,\dots,n \quad (8)$$

The set of discordance index  $\{d_{kl}\}$  given as follows:

$$D_{kl} = \{j | v_{kj} < v_{lj}\} \quad \text{with } j=1,2,\dots,n \quad (9)$$

Step 5: Calculating concordance and discordance matrix

To calculate or determine the value of the elements in the concordance model is by adding weights are included in the set of concordance

$$c_{kl} = \sum_{j \in C_{kl}} w_j \quad (10)$$

To determine the value of the elements in the discordance matrix is by dividing the maximum difference of criteria including into subsets discordance with the highest difference between the value of all existing criteria

$$d_{kl} = \frac{\max\{|v_{kj} - v_{lj}|\}_{j \in D_{kl}}}{\max\{|v_{kj} - v_{lj}|\}_{\forall j}} \quad (11)$$

d matrix is also a dimension of  $m \times m$  and did not take the value of the 1 column and k row, d array as below.

$$d = \begin{bmatrix} - & d_{12} & \dots & d_{1n} \\ d_{21} & - & \dots & d_{2n} \\ \dots & \dots & \dots & \dots \\ d_{m1} & d_{m2} & \dots & - \end{bmatrix} \quad (12)$$

Step 6: Determine the dominant concordance matrix and discordance

This array could construct with the aid of a threshold value (threshold)  $\underline{c}$ . The formula can obtain c value.

$$c = \frac{\sum_{k=1}^m \sum_{l=1}^m c_{kl}}{m(m-1)} \quad (13)$$

The alternative  $A_k$  can have the opportunity to dominance  $A_l$  if the concordance index  $c_{kl}$  exceed the threshold  $\underline{c}$  with  $c_{kl} \geq \underline{c}$  and elements of the dominant F concordance matrix defined as:

$$f_{kl} = \begin{cases} 1, & \text{if } c_{kl} \geq \underline{c} \\ 0, & \text{if } c_{kl} < \underline{c} \end{cases} \quad (14)$$

The same also applies to the dominant discordance matrix G with threshold  $\underline{d}$ . The following formula can obtain d value:

$$d = \frac{\sum_{k=1}^m \sum_{l=1}^m d_{kl}}{m(m-1)} \quad (15)$$

The elements of the dominant F discordance matrix defined as:

$$g_{kl} = \begin{cases} 1, & \text{if } d_{kl} \geq \underline{d} \\ 0, & \text{if } d_{kl} < \underline{d} \end{cases} \quad (16)$$

Step 7: Determining aggregate dominance matrix

The model e as total dominance matrix is a matrix which each element is the multiplication between the matrix elements f, and g corresponding form elements.

$$e_{kl} = f_{kl} \times g_{kl} \quad (17)$$

Step 8: Elimination of the less favorable alternative

The matrix e gives the preferred order of each option, ie when  $e_{kl} = 1$  then the alternative is  $A_k$  better alternative than the  $A_l$ . That the rows in a matrix e which has a total of at least  $e_{kl} = 1$  can be eliminated.

### III. RESULT & DISCUSSION

The initial step to find the best lectures which provide 5 criteria and three alternatives. The criteria and the weights show in Table I and choices could see in Table II.

Table I. The Criteria and Weights

Criteria (C)	Weights(W)
Rank (C1)	0.35
Research (C2)	0.15
Scientific Publications (C3)	0.2
Dedication (C4)	0.2
Supporting Element (C5)	0.1

Table II. Alternative of Lecturer

Name of Lecturer (A)	C1	C2	C3	C4	C5
	A <sub>1</sub>	4	5	5	3
A <sub>2</sub>	3	4	4	2	4
A <sub>3</sub>	5	5	2	2	2

By using equation (2), then in the process of normalization matrix.

$$|x_1| = \sqrt{4^2 + 3^2 + 5^2} = 7.7011 \quad |x_2| = \sqrt{5^2 + 4^2 + 5^2} = 8.1240$$

$$r_{11} = \frac{x_{11}}{|x_1|} = \frac{4}{7.7011} = 0.5657 \quad r_{12} = \frac{x_{12}}{|x_2|} = \frac{5}{8.1240} = 0.6155$$

$$r_{21} = \frac{x_{21}}{|x_1|} = \frac{3}{7.7011} = 0.4243 \quad r_{22} = \frac{x_{22}}{|x_2|} = \frac{4}{8.1240} = 0.4924$$

$$r_{31} = \frac{x_{31}}{|x_1|} = \frac{5}{7.7011} = 0.7071 \quad r_{32} = \frac{x_{32}}{|x_2|} = \frac{5}{8.12401} = 0.6155$$

So on the same way, it will get normalized r matrix :

$$r = \begin{bmatrix} 0.5657 & 0.6155 & 0.7454 & 0.7276 & 0.6667 \\ 0.4243 & 0.4924 & 0.5963 & 0.4851 & 0.6667 \\ 0.7071 & 0.6155 & 0.2981 & 0.4851 & 0.3333 \end{bmatrix}$$

Matrix V is calculated based on the equation (6) as follows:

$$v_{11} = w_1 r_{11} = (0.35) (0.5657) = 0.1980$$

$$v_{12} = w_2 r_{12} = (0.15) (0.6155) = 0.0923$$

$$v_{13} = w_3 r_{13} = (0.2) (0.7454) = 0.1491$$

$$v_{14} = w_4 r_{14} = (0.2) (0.7276) = 0.1455$$

$$v_{15} = w_5 r_{15} = (0.1) (0.6667) = 0.0667$$

From the above results obtained matrix v as follows:

$$v = \begin{bmatrix} 0.1980 & 0.0923 & 0.1491 & 0.1455 & 0.0667 \\ 0.1485 & 0.0739 & 0.1193 & 0.0970 & 0.0667 \\ 0.2475 & 0.0923 & 0.0596 & 0.0970 & 0.0333 \end{bmatrix}$$

Next calculate the set of concordance index:

k=1    i=1 c<sub>11</sub>=identity    j=1,2,3,4,5  
 i=2 c<sub>12</sub>  
 j=1 if v<sub>11</sub> ≥ v<sub>21</sub> ≈ 0.1980 ≥ 0.1485 yes then j=1  
 j=2 if v<sub>12</sub> ≥ v<sub>22</sub> ≈ 0.0923 ≥ 0.0739 yes then j=2  
 j=3 if v<sub>13</sub> ≥ v<sub>23</sub> ≈ 0.1491 ≥ 0.1193 yes then j=3  
 j=4 if v<sub>14</sub> ≥ v<sub>24</sub> ≈ 0.1455 ≥ 0.0970 yes then j=4  
 j=5 if v<sub>15</sub> ≥ v<sub>25</sub> ≈ 0.0667 ≥ 0.0667 yes then j=5  
 c<sub>12</sub>={1,2,3,4,5}

i=3    c<sub>13</sub>  
 j=1 if v<sub>11</sub> ≥ v<sub>31</sub> ≈ 0.1980 ≥ 0.2475 no  
 j=2 if v<sub>12</sub> ≥ v<sub>32</sub> ≈ 0.0923 ≥ 0.0923 yes then j=2  
 j=3 if v<sub>13</sub> ≥ v<sub>33</sub> ≈ 0.1491 ≥ 0.0596 yes then j=3  
 j=4 if v<sub>14</sub> ≥ v<sub>34</sub> ≈ 0.1455 ≥ 0.0970 yes then j=4  
 j=5 if v<sub>15</sub> ≥ v<sub>35</sub> ≈ 0.0667 ≥ 0.0333 yes then j=5  
 c<sub>13</sub>={2,3,4,5}

k=2    i=1 c<sub>21</sub>  
 j=1 if v<sub>21</sub> ≥ v<sub>11</sub> ≈ 0.1485 ≥ 0.1980 no  
 j=2 if v<sub>22</sub> ≥ v<sub>12</sub> ≈ 0.0739 ≥ 0.0923 no  
 j=3 if v<sub>23</sub> ≥ v<sub>13</sub> ≈ 0.1193 ≥ 0.1491 no  
 j=4 if v<sub>24</sub> ≥ v<sub>14</sub> ≈ 0.0970 ≥ 0.1455 no  
 j=5 if v<sub>25</sub> ≥ v<sub>15</sub> ≈ 0.0667 ≥ 0.0667 yes then j=5  
 c<sub>21</sub>={5}

i=2 c<sub>22</sub> = identity j=1,2,3,4,5  
 i=3 c<sub>23</sub>  
 j=1 if v<sub>21</sub> ≥ v<sub>31</sub> ≈ 0.1485 ≥ 0.2475 no  
 j=2 if v<sub>22</sub> ≥ v<sub>32</sub> ≈ 0.0739 ≥ 0.0923 no  
 j=3 if v<sub>23</sub> ≥ v<sub>33</sub> ≈ 0.1193 ≥ 0.0596 yes then j=3  
 j=4 if v<sub>24</sub> ≥ v<sub>34</sub> ≈ 0.0970 ≥ 0.0970 yes then j=4  
 j=5 if v<sub>25</sub> ≥ v<sub>35</sub> ≈ 0.0667 ≥ 0.0333 yes then j=5  
 c<sub>23</sub>={3,4,5}

k=3    i=1 c<sub>31</sub>  
 j=1 if v<sub>31</sub> ≥ v<sub>11</sub> ≈ 0.2475 ≥ 0.1980 yes then j=1  
 j=2 if v<sub>32</sub> ≥ v<sub>12</sub> ≈ 0.0923 ≥ 0.0923 yes then j=2  
 j=3 if v<sub>33</sub> ≥ v<sub>13</sub> ≈ 0.0596 ≥ 0.1491 no  
 j=4 if v<sub>34</sub> ≥ v<sub>14</sub> ≈ 0.0970 ≥ 0.1455 no  
 j=5 if v<sub>35</sub> ≥ v<sub>15</sub> ≈ 0.0333 ≥ 0.0667 no  
 c<sub>31</sub> = {1,2}

i=2 c<sub>32</sub>  
 j=1 if v<sub>31</sub> ≥ v<sub>21</sub> ≈ 0.2475 ≥ 0.1485 yes then j=1  
 j=2 if v<sub>32</sub> ≥ v<sub>22</sub> ≈ 0.0923 ≥ 0.0739 yes then j=2  
 j=3 if v<sub>33</sub> ≥ v<sub>23</sub> ≈ 0.0596 ≥ 0.1193 no  
 j=4 if v<sub>34</sub> ≥ v<sub>24</sub> ≈ 0.0970 ≥ 0.0970 yes then j=4  
 j=5 if v<sub>35</sub> ≥ v<sub>25</sub> ≈ 0.0333 ≥ 0.0667 no  
 c<sub>32</sub> = {1,2,4}

i=3 c<sub>33</sub> = Identity j=1,2,3,4,5

Then for d<sub>kl</sub> value can synchronize with a value that is not contained in c<sub>kl</sub> to set of d<sub>kl</sub>

$$d_{12} = \{ \} \quad d_{23} = \{ 1, 2 \}$$

$$d_{13} = \{ 1 \} \quad d_{31} = \{ 3, 4, 5 \}$$

$$d_{21} = \{ 1, 2, 3, 4 \} \quad d_{32} = \{ 3, 5 \}$$

The member states set of d<sub>ij</sub> columns on v<sub>ij</sub>  
 Then the concordance matrix is formed. c<sub>kl</sub> element is calculated by equation (10)

$$c_{12} = w_1 + w_2 + w_3 + w_4 + w_5 = 0.35 + 0.15 + 0.2 + 0.2 + 0.1 = 1$$

$$c_{13} = w_2 + w_3 + w_4 + w_5 = 0.15 + 0.2 + 0.2 + 0.1 = 0.65$$

$$c_{21} = w_5 = 0.1$$

$$c_{23} = w_3 + w_4 + w_5 = 0.2 + 0.2 + 0.1 = 0.5$$

$$c_{31} = w_1 + w_2 = 0.35 + 0.15 = 0.5$$

$$c_{32} = w_1 + w_2 + w_4 = 0.35 + 0.15 + 0.2 = 0.7$$

The concordance matrix is:

$$C = \begin{bmatrix} - & 1 & 0.65 \\ 0.1 & - & 0.50 \\ 0.5 & 0.7 & - \end{bmatrix}$$

At concordance model the elements of  $d_{kl}$  are calculated based on the equation (11) as follows:

$$d_{12} = \frac{\max\{0\}}{\max\{0.0495;0.0185;0.0298;0.0485;0\}} = \frac{0}{0.0495} = 0$$

$$d_{13} = \frac{\max\{0.0495\}}{\max\{0.0495;0;0.0894;0.0485;0.0333\}} = \frac{0.0495}{0.0894} = 0.5534$$

$$d_{21} = \frac{\max\{0.0495;0.0185;0.0298;0.0485\}}{\max\{0.0495;0.0185;0.0298;0.0485;0\}} = \frac{0.0495}{0.0495} = 1$$

$$d_{23} = \frac{\max\{0.0495;0.0185\}}{\max\{0.0990;0.0185;0.0596;0;0.0333\}} = \frac{0.0495}{0.0990} = 0.5$$

$$d_{31} = \frac{\max\{0.0894;0.0485;0.0333\}}{\max\{0.0495;0;0.0894;0.0485;0.0333\}} = \frac{0.0894}{0.0894} = 1$$

$$d_{32} = \frac{\max\{0.0596;0;0.0333\}}{\max\{0.0990;0.0185;0.0596;0;0.0333\}} = \frac{0.0596}{0.0596} = 1$$

concordance matrix is:

$$D = \begin{bmatrix} - & 0 & 0.5534 \\ 1 & - & 0.5000 \\ 1 & 1 & - \end{bmatrix}$$

The value of c and d can be obtained by equation (13) and (15) as follows:

$$c = \frac{1 + 0.65 + 0.1 + 0.5 + 0.5 + 0.7}{3(3-1)} = \frac{3.45}{6} = 0.575$$

$$d = \frac{0 + 0.5534 + 1 + 0.5000 + 1 + 1}{3(3-1)} = \frac{4.0534}{6} = 0.6756$$

Dominant concordance matrix is calculated based on the equation (14) as follows:

with  $C = \begin{bmatrix} - & 1 & 0.65 \\ 0.1 & - & 0.50 \\ 0.5 & 0.7 & - \end{bmatrix}$  then  $F = \begin{bmatrix} - & 1 & 1 \\ 0 & - & 0 \\ 0 & 1 & - \end{bmatrix}$

Discordance dominant pattern calculated by equation (16) as follows:

with  $D = \begin{bmatrix} - & 0 & 0.5534 \\ 1 & - & 0.5000 \\ 1 & 1 & - \end{bmatrix}$  then  $G = \begin{bmatrix} - & 0 & 0 \\ 1 & - & 0 \\ 1 & 1 & - \end{bmatrix}$

Aggregation dominant matrix obtained from the combination (long multiplication) between the f and g model by equation (17) is  $E_{kl}=f_{kl} \times g_{kl}$  as follows:

$$E = \begin{bmatrix} - & 0 & 0 \\ 0 & - & 0 \\ 0 & 1 & - \end{bmatrix} \approx \begin{bmatrix} A_1 \\ A_2 \\ A_3 \end{bmatrix}$$

With the ELECTRE methods of calculation indicated  $e_{kl}=1$  then the alternative is better than the  $A_1$ . Alternative  $A_3$  better than  $A_2$ , but not necessarily be able to draw connections between  $A_1$  to  $A_2$  and the  $A_1$  and  $A_3$ .

#### IV. CONCLUSION

In this case using ELECTRE method to solve the problem of selecting the best computer lecturer. The results of the study are expected to be useful for decision makers in STMIK Budi Darma, especially for policy makers. Selection of the best computer lecturer believed to be able to motivate the lecturers at the university, so the faculty performance becomes better. Application of this method by using data from a sample of cases contained in STMIK Budi Darma.

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