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# Web Based Application for Decision Support System with ELECTRE Method

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# Web Based Application for Decision Support System with ELECTRE Method

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**Abstract.** Decision Support System is a system commonly used to assist management in assisting decision-making in top managerial sections, Multi-Criteria Decision Making (MCDM) is one of many decision-making methods that can be used to select the best alternative from a number of alternatives based on certain criteria, one of the methods that can be utilized is the Elimination Et Choix Traduisant la Realite (ELECTRE) method that works based on the concept of outranking using pairwise comparisons of each alternative based on appropriate criteria, this paper applies the ELECTRE method in a web based application that can be employed for input and output dynamic for alternative, criteria, user values and also a fast ranking process, the choice of web based application because there is many research about decision support system but only few that applied to application, and this research tries to applied ELECTRE method to web based application.

## 1. Introduction

The development of technology and information continuously progressed rapidly can be utilized to facilitate all activities within the company. Decision support systems[1] are part of computer-based information systems that are included in knowledge-based systems or knowledge management that can be used to support decision making within an organization or company[2], [3]. This system can assist policy makers who complement them with information from data that has been processed with relevant and necessary to make decisions about a problem more quickly and accurately[1], [4], to facilitate the implementation of decision support system is not just a discussion theory but needs to be implemented directly, in this paper implementation web-based decision support system with the

method of ELECTRE is made with PHP programming language and MySQL database so that it can be accessed more widely.

ELECTRE[5] is one method of multi-criteria based decision support system [6], [7]. ELECTRE comes from the word ELimination Et Choix Traduisant la RealitÃ(ELimination and Choice Express Reality)[5]. The ELECTRE method can use in assessing and ranking based on advantages and disadvantages through pairwise comparisons on the same criteria[8]. The ELECTRE method is used for cases with many alternatives, but few criteria are involved. An alternative is said to dominate the other alternatives if one or more of the criteria exceed (compared to criteria of the other options) and equals the other remaining criteria[5], to facilitate the workings of this ELECTRE method, the case shown will generally be with some Alternative (A) and some Criteria (C) and the calculation formula will show as detailed as possible with some screenshots of the application

## 2. Methodology

The decision support system[9], [10] began to develop in the 1960s, but the term decision support system itself only emerged in 1971 namely the Management Decision System[9], [11], [12] created by G. Anthony Gorry and Micheal S.Scott Morton, both professors at MIT. They do so to create a framework for directing computer applications to management decision making.

Decision Support Systems (DSS) are part of computer-based information systems[13] including knowledge-based systems or knowledge management used to support decision making within an organization or company. With this understanding, it can be explained that decision support system is not a decision-making tool, but a system that can assist decision makers with information from data that has been processed with relevant and necessary to make decisions about a problem more quickly and accurately so that the system is not intended to replace decision-making in making decisions[7], [13].

ELECTRE [14] is one of the methods in MCDM based on the concept of ranking through pairwise comparison between alternatives on appropriate criteria, an alternative is said to dominate other alternatives if one or more criteria are exceeded (compared to criteria of the other options) and equal to the remaining criteria, in other words, ELECTRE are used for cases with many choices, but only a few criteria involved[14]–[16].

The basic method of ELECTRE is a sequential procedure that reduces the number alternative with a set of alternatives that do not dominate[5], to find the best alternative, the ELECTRE method also requires a weighted knowledge of all the criteria[5], below are problem-solving step with the ELECTRE method[5], [14]:

1. Normalization of Decision Matrix with the formula below:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x^2_{ij}}}$$

2. Weighting the Normalized Decision Matrix using the formula:

$$V = RW \ and \ \sum_{i-1}^{n} wi = 1$$

3. Determine concordance and discordance set by using function below:

$$C_{kl} = \{j, y_{kj} \geq y_{lj}\}, for \ j = 1,2,3,.....n$$
$$D_{kl} = \{j, y_{kj} < y_{lj}\}, for \ j = 1,2,3,.....n$$

4. Calculate concordance and discordance matrix, the first function for concordance matrix and the second for discordance matrix

$$c_{kl} = \sum_{j\,C_w} W_j$$

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

5. Perform matrix calculations dominant concordance and discordance with the following formula:
   Concordance dominant matrix could do with the help of value threshold by comparing each value matrix element concordance with the threshold value $C_{kl} \geq \underline{C}$, where $(\underline{C})$ is:
   $$\underline{c} = \frac{\sum_{k=1}^{n} \sum_{l=1}^{n} c_{kl}}{m * (m-1)}$$
   for the matrix of concordance can determine by using formulas as :
   $f_{kl} = 1, if\ c_{kl} \geq \underline{c}\ and\ f_{kl} = 0, if\ c_{kl} < \underline{c}$
   for the dominant matrix can use this formula with the help of threshold value:
   $$\underline{d} = \frac{\sum_{k=1}^{n} \sum_{l=1}^{n} d_{kl}}{m * (m-1)}$$
   The element of matrix G  as dominant matrix discordance can use the below formula:
   $g_{kl} = 0, if\ c_{kl} \geq \underline{d}\ and\ g_{kl} = 1, if\ c_{kl} < \underline{d}$

6. Determining aggregate matrix dominance
   The next step is to identify dominance aggregate matrix (E) by using multiplication between the matrix elements F with G, the function as below:
   $e_{kl} = f_{kl}\, x\, g_{kl}$

7. Elimination of the less favorable alternative
   EMatrix E gives the order of selection of each alternative when $e_{kl} = 1$ when ekl at least one then $e_{kl} = 1$ can be eliminated; thus the best alternative is that dominates other options.

## 3.  Result and Discussion
Result and discussion in this paper describes the results of the implementation of the ELECTRE method in web applications, web applications that have been made could use for various cases that could solve with decision support systems, the ELECTRE process will be displayed step by step with the screenshot program that explains the results of the ELECTRE method, figure 1 is the initial display of the web application.
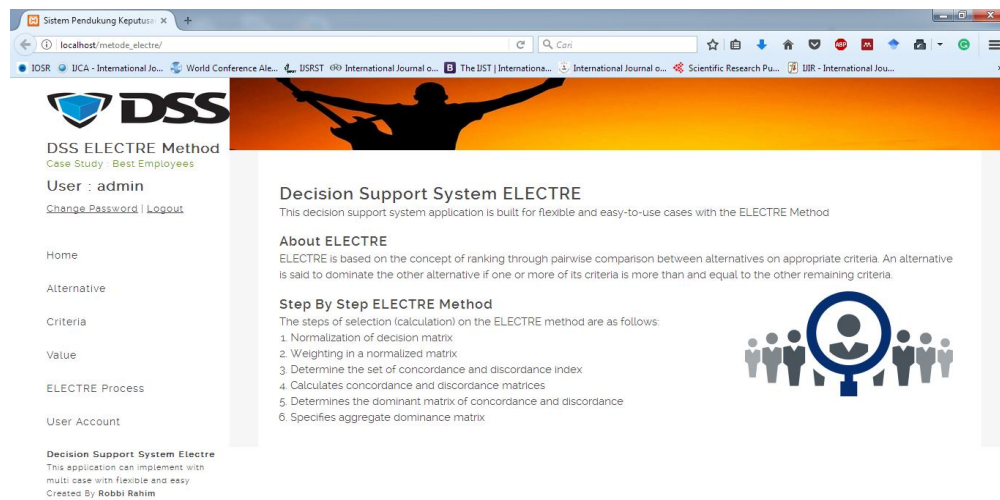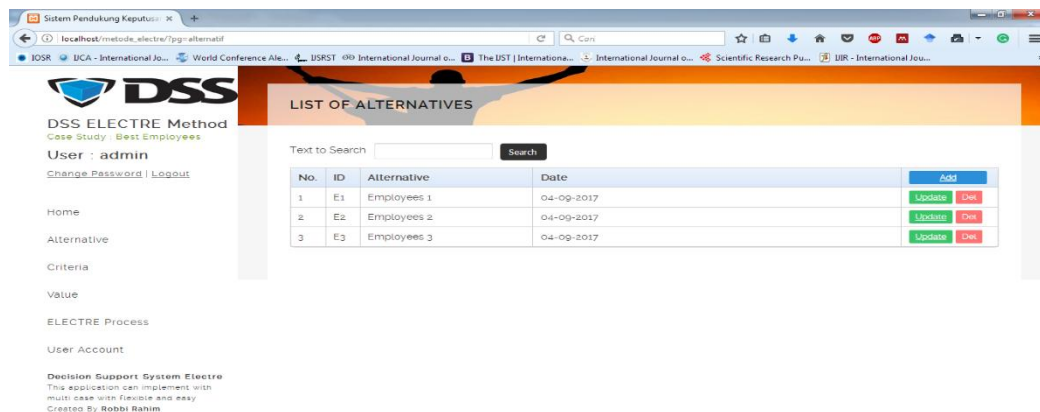
**Figure 1.** Main Display Web Application

The first step is to determine the alternatives to be selected, for the alternative can see in table 1 below:

**Table 1.** Alternative Name

| No | ID | Name |
|----|----|------|
| 1 | E1 | Employees 1 |
| 2 | E2 | Employees 2 |
| 3 | E3 | Employees 3 |

Alternative data on web applications can see in the following figure 2:



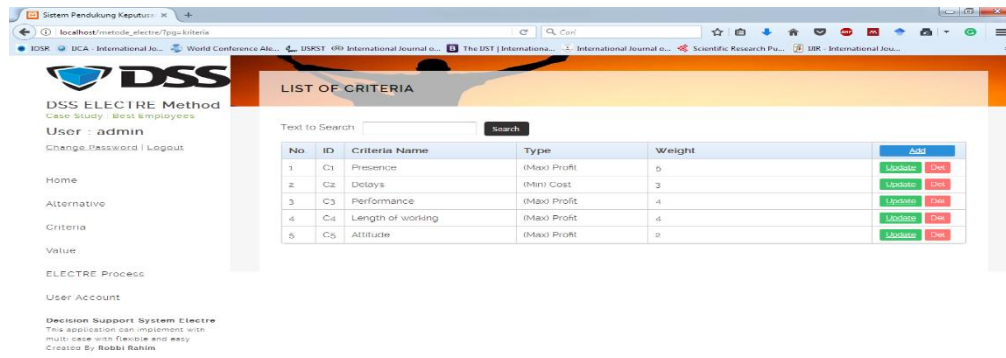**Figure 2.** List of Alternative in Web Application

The next process is to determine the criteria data that contains the weight value to calculate every alternative that exists, for the criteria used as in table 2 below:

**Table 2.** Criteria Name

| No | ID | Name | Weight |
|----|----|------|--------|
| 1 | C1 | Presence | 5 |
| 2 | C2 | Delays | 3 |
| 3 | C3 | Performance | 4 |
| 4 | C4 | Working Time | 4 |

| 5 | C5 | Attitude | 2 |
|---|----|----------|---|

The data criteria on the web can be seen in Figure 3 below:



**Figure 3.** List of Criteria in Web Application

Figure 3 above shows criteria and weighting criteria with each type of Profit and Cost that will affect the calculation process, the next step determines the value of each alternative for each criterion, for its value shown in table 3 below:

**Table 3.** Alternative Value

| No | Alternative | C1 | C2 | C3 | C4 | C5 |
|----|-------------|----|----|----|----|----|
| 1 | E1 | 15 | 5 | 19 | 15 | 7 |
| 2 | E2 | 13 | 4 | 21 | 13 | 6 |
| 3 | E3 | 15 | 7 | 17 | 15 | 6 |

The value of weighting criteria for each alternative on web application can be seen in figure 4 below:
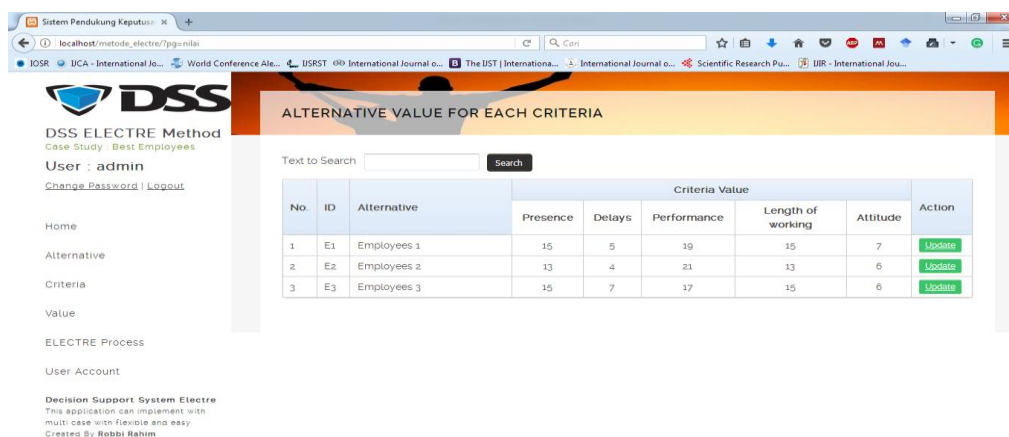


**Figure 4.** List of alternative value in Web Application

The next process is to calculate each alternative value with a weighted value using the ELECTRE method, the value of the weight is:

$$W = (5, 3, 4, 4, 2)$$

From w value created a matrix as follows:

$$X = \begin{bmatrix} 15 & 5 & 19 & 15 & 7 \\ 13 & 4 & 21 & 13 & 6 \\ 15 & 7 & 17 & 15 & 6 \end{bmatrix}$$

The next process is to perform the calculation process with ELECTRE method step by step
1.  Normalization of Matrix

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x^2_{ij}}}$$

$|X_1| = \sqrt{15^2 + 13^2 + 15^2} = 24.87$

$r_{11} = \frac{x_{11}}{|x_1|} = \frac{15}{24.87} = 0.6029$

$r_{21} = \frac{x_{11}}{|x_1|} = \frac{13}{24.87} = 0.5225$

$r_{31} = \frac{x_{11}}{|x_1|} = \frac{15}{24.87} = 0.6029$

The above process is the calculation of one of the criteria of table 2 against all the alternatives contained in table 3, here is the matrix R obtained from the above calculation results:

$$R = \begin{bmatrix} 0.6029 & 1.8974 & 0.5752 & 0.6029 & 0.6364 \\ 0.5225 & 2.3717 & 0.6358 & 0.5225 & 0.5455 \\ 0.6029 & 13553 & 0.5147 & 0.6029 & 0.5455 \end{bmatrix}$$

For the normalization of matrix results in the application can be seen in picture 5 below:
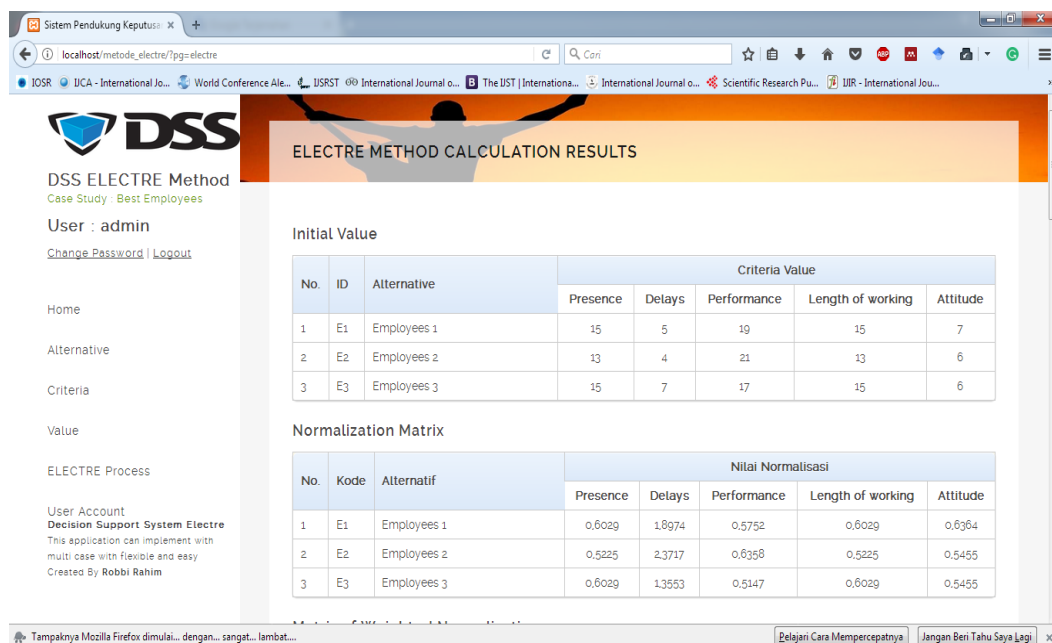


**Figure 5.** Normalization Matrix in Web Application

2.  Matrix of Weighted Normalization
    At this stage is done multiplication calculation of matrix R with the formula $v_{ij} = w_i r_{ij}$, the following is the result of the multiplication obtained for each value of the matrix R
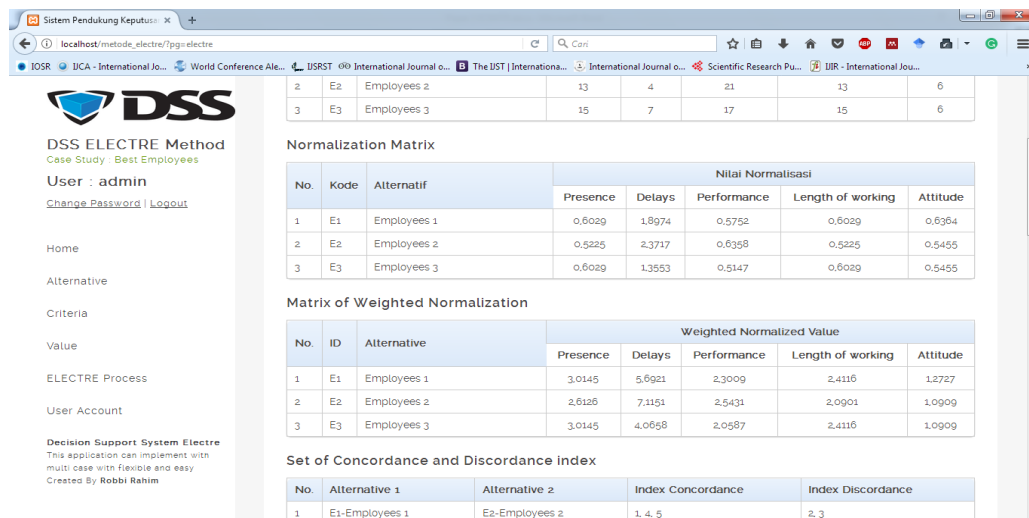
$v_{11} = 0.6029 \; x \; 5 = 3.0145$
$v_{12} = 0.5225 \; x \; 5 = 2.6126$
$v_{13} = 0.6029 \; x \; 5 = 3.0145$

After all matrix R is done multiplication obtained result as follows:

$$V = \begin{bmatrix} 3.0145 & 5.6921 & 2.3009 & 2.4116 & 1.2727 \\ 2.6126 & 7.1151 & 2.5431 & 2.0901 & 1.0909 \\ 3.0145 & 4.0658 & 2.0587 & 2.4116 & 1.0909 \end{bmatrix}$$

For Matrix of Weighted Normalization results in the application can be seen in figure 6 below:



**Figure 6.** Matrix of Weighted Normalization in Web Application

3.  Set of concordance and discordance index by using the equation:
    $C_{kl} = \{ j, y_{kj} \geq y_{lj} \}, for \; j = 1,2,3,\ldots.n$
    and the discordance index using equation:
    $D_{kl} = \{ j, y_{kj} < y_{lj} \}, for \; j = 1,2,3,\ldots.n$

**Table 4.** Concordance and Discordance Index

| No | Alternative 1 | Alternative 2 | Index Concordance | Index Discordance |
|----|---------------|---------------|-------------------|-------------------|
| 1 | E1 | E2 | 1,4,5 | 2,3 |
| 2 | E1 | E3 | 1,2,3,4,5 | |
| 3 | E2 | E1 | 2,3 | 1,4,5 |
| 4 | E2 | E3 | 2,3,5 | 1,4 |
| 5 | E3 | E1 | 1,4 | 2,3,5 |
| 6 | E3 | E2 | 1,4,5 | 2,3 |

For determining a set of concordance and discordance index results in the application can be seen in picture 6 below:
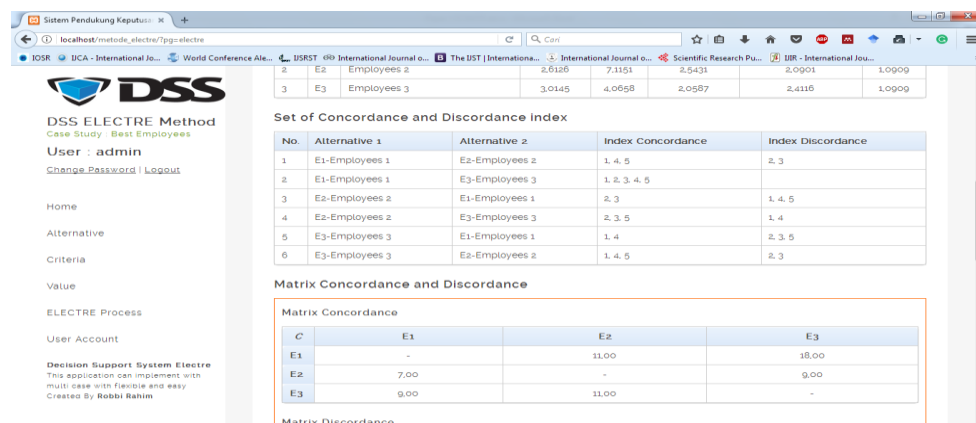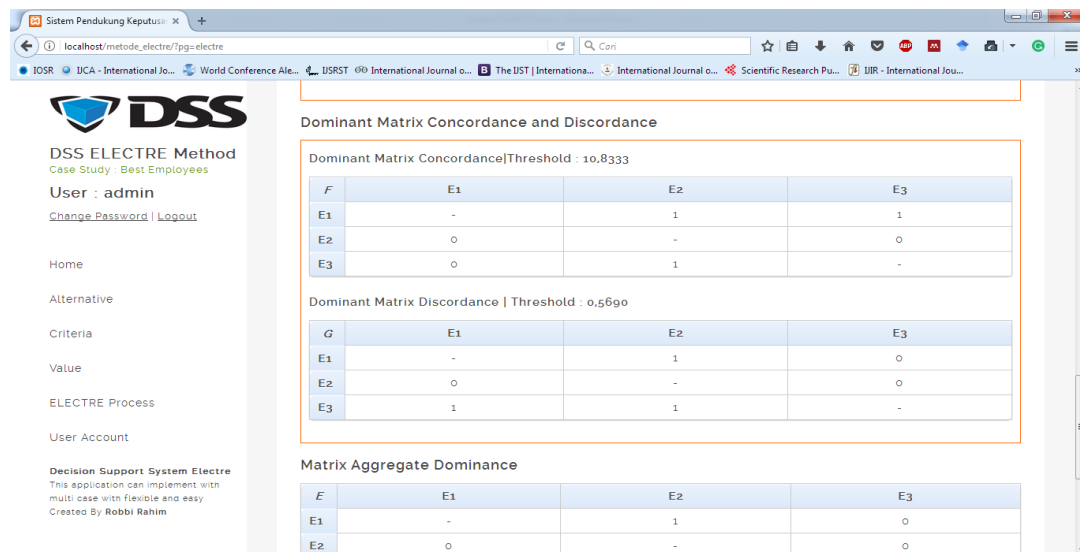
**Figure 7.** Set of Concordance and Discordance index in Web Application

The calculation process described above is some process of the overall calculations in the ELECTRE method, for the results of each process can be seen in the picture below:
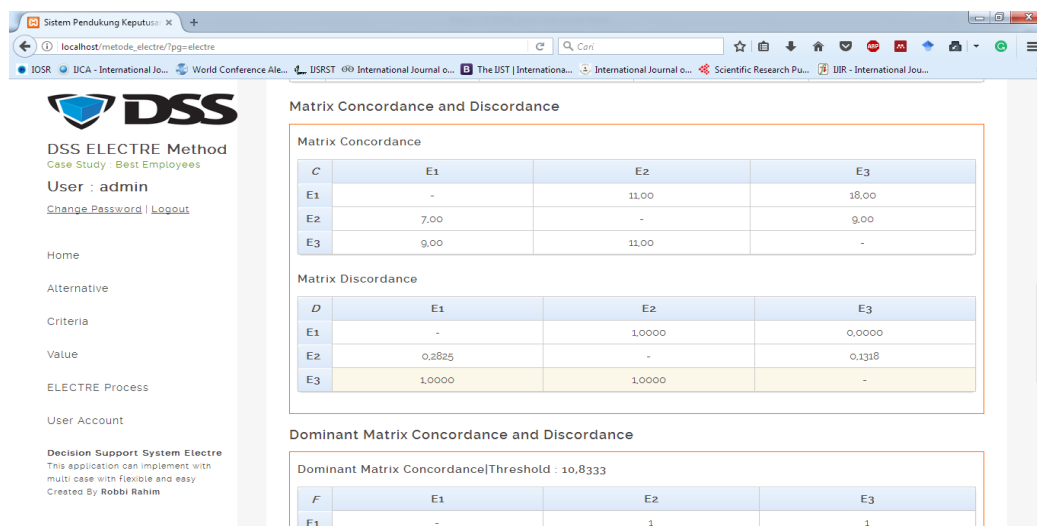


**Figure 8.** Matrix Concordance and Discordance index in Web Application

The next result is displaying the value of Dominant Matrix Concordance and Discordance, and figure 10 is the result of calculation based on the formula previously described.

**Figure 9.** Dominant Matrix Concordance and Discordance in Web Application

The final process is to do the Matrix Aggregate Dominance calculation used to get the final result of the calculation of ELECTRE, the result in the following figure 10:
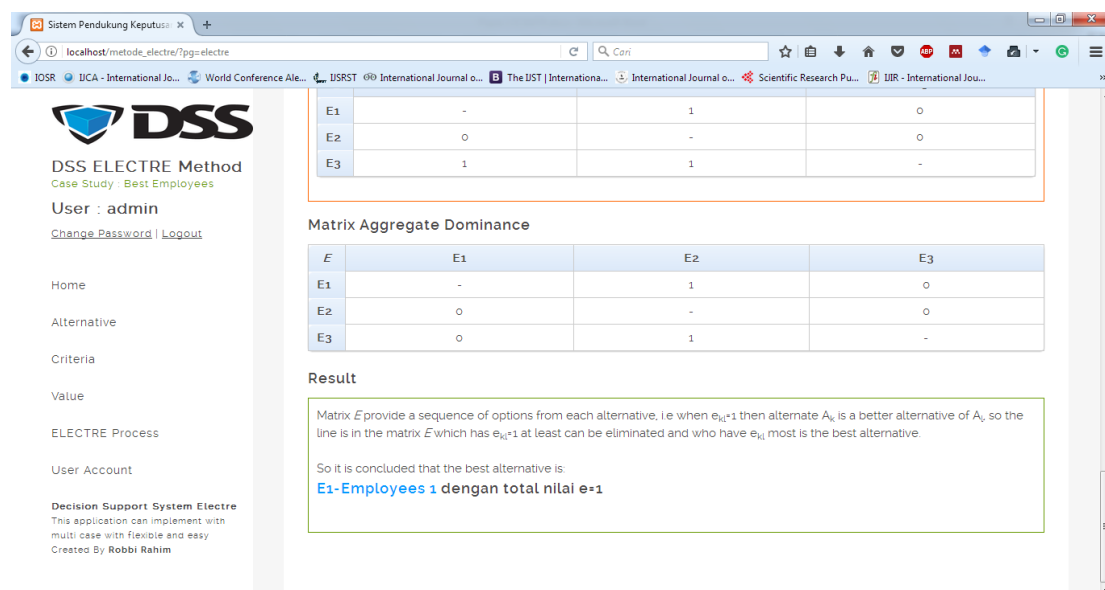


**Figure 10.** Matrix Aggregate Dominance and Result

Figure 10 is the result of the created application and the results of the calculation of the ELECTRE method.

## 4. Conclusion
The web application with the application of the ELECTRE method provides an overview of the application of a decision support system to be applied to the application so that the examples shown are not just theoretical but also the direct implementation, the experiments shown in this paper are presented the calculation process gradually with the ELECTRE method and the results of each -in the process contained within the application, in the created application can be displayed the final result of the application of the ELECTRE method to solve the case discussed.

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