JINAV: Journal of Information and Visualization *ISSN: 2746-1440 (online)*
Vol. 3 No. 2 (2022)
https://doi.org/10.35877/454RI.jinav1505

ELECTRE III for Human Resource Management: A Study of Recruitment and Retention Strategies

Meithiana Indrasari[a,*], Delipiter Lase[b], Indriyani[c], Jacomina Vonny Litamahuputty[d], Iwan Adhicandra[e], & Robbi Rahim[f]

[a]*Dr Soetomo University, Jl. Semolowaru No.84, Kota Surabaya, Jawa Timur, 60118, Indonesia*
[b]*Universitas Nias, Jalan Yos Sudarso Ujung, Kota Gunungsitoli, Sumatera Utara, 22812, Indonesia*
[c]*Institut Teknologi dan Bisnis STIKOM Bali, Kota Denpasar, Bali, 80234, Indonesia*
[d]*Politeknik Negeri Ambon, Jl. Ir. M. Putuhena, Rumah Tiga, Kota Ambon, Maluku, Indonesia*
[e]*Universitas Bakrie, Jl. H. R. Rasuna Said, Kuningan, Jakarta, 12940, Indonesia*
[f]*Sekolah Tinggi Ilmu Manajemen Sukma, Jl. Sakti Lubis, Kota Medan, Sumatera Utara, 20219, Indonesia*

Abstract

This paper presents the application of the ELECTRE III multi-criteria decision making method for human resource management. The case study conducted involves the evaluation of different recruitment and retention strategies using multiple criteria such as cost, time to fill a position, quality of candidates, retention rate, diversity and inclusion, employee satisfaction, and compliance. The study demonstrates the step-by-step process of how to conduct an ELECTRE III analysis, including the identification of criteria and alternatives, the calculation of concordance and discordance indices, and the determination of final rankings using the global outranking relation. The results of this analysis can be used by organizations to make informed decisions about recruitment and retention strategies that best align with their goals and objectives. The study highlights the importance of data quality and the need for sensitivity analysis to check the robustness of the results. Additionally, it is suggested that future research could be conducted on how to effectively communicate the results of the analysis to stakeholders and decision-makers, and on comparing the results of this analysis with other methods.

Keywords: ELECTRE III, multi-criteria decision making, human resource management, recruitment and retention strategies, data quality and sensitivity analysis.

1. Introduction

A computer-based Decision Support System (DSS) provides relevant information and analysis capabilities for commercial or organizational decision-making. DSS can forecast, recognize trends, and aid decision-making without human participation. Turban (Turban et al., 2016) divided DSS into model-driven and data-driven categories. Data-driven DSS uses data and statistical analysis, while model-driven DSS uses mathematical models. DSS are useful in businesses with vast data sets and sophisticated decision-making processes (Moreira et al., 2019). Finance, healthcare, and manufacturing use them. Strategic and operational levels of a company can employ DSS (Moreira et al., 2019)

DSS can also be integrated with AI techniques such as machine learning, natural language processing, and expert systems to provide more advanced decision-making capabilities and to make DSS more efficient and user-friendly (Turban et al., 2016), one of DSS method is ELECTRE III.

ELECTRE (Elimination Et Choix Traduisant la REalité) is a multi-criteria decision-making method that helps decision-makers evaluate and rank alternatives based on a set of criteria (Joerin et al., 2001; Kaliszewski & Podkopaev, 2016; Zanakis et al., 1998). The method was first introduced by Roy (Nasution et al., 2020; Vinodh & Girubha, 2012) and has been developed and improved in subsequent versions, such as ELECTRE I, II, and III. ELECTRE I is the original version of the method, which uses a simple pairwise comparison method to evaluate and rank alternatives. It is based on the principle of "outranking" where an alternative is considered to outrank another if it

* Corresponding author.
E-mail address: xxxx@xxxxxx.edu (First Author)

is preferred on more criteria than it is outperformed. ELECTRE II, improves upon the original method by introducing the concept of concordance and discordance. Concordance refers to the degree to which an alternative is preferred over another on multiple criteria, while discordance refers to the degree to which an alternative is outperformed by another on multiple criteria. ELECTRE III, improves upon the previous versions by including the concept of "indecision" or "non-comparability" between alternatives. This means that some alternatives might not be able to be compared to each other based on certain criteria and the decision maker needs to make a subjective decision based on those criteria (Alkhairi et al., 2019; Sari et al., 2019).

One of the main advantages of ELECTRE is its ability to handle uncertain and incomplete information, making it particularly useful in real-world decision-making scenarios (Aragonés-Beltrán et al., 2010; Azizi et al., 2015; Conejero et al., 2021).

2. Methods

Multi-Criteria Decision Making Method (MCDM) method is a type of decision-making framework that allows for the evaluation and ranking of multiple alternatives based on multiple criteria. The specific MCDM method used in the study, in this case is ELECTRE III, should be clearly explained in the Method section in a scientific model.

ELECTRE III is a method that uses the concept of outranking relations to evaluate and rank alternatives. The method is based on the construction of concordance and discordance indices, which are used to evaluate the relative importance of the alternatives and the criteria. The method also uses the concept of net flows of outranking, which are used to evaluate the relative outranking of the alternatives (Imandasari & Windarto, 2018; Gaol & Hasibuan, 2018; Suhaeri et al., 2014). The method then constructs a global outranking relation, which is used to rank the alternatives based on their net flows of outranking. The key components of the ELECTRE III are:

a. Construction of the concordance and discordance indices: This is the process of evaluating the relative importance of the alternatives and the criteria. The indices are calculated based on the data collected and the criteria weights.
b. Construction of the net flows of outranking: This is the process of evaluating the relative outranking of the alternatives. The net flows are calculated based on the concordance and discordance indices.
c. Construction of the global outranking relation: This is the process of ranking the alternatives based on their net flows of outranking.

In the Method section of an article covering the use of ELECTRE III for human resource management in the context of recruiting and retention strategies, it is crucial to identify and define the evaluation and ranking criteria for recruitment and retention methods. These criteria should be pertinent and significant to the study topic and aims, as well as precisely specified and operationalized. Among the evaluation and ranking criteria for recruitment and retention methods are:

Table 1. Criteria for ELECTRE III

Criteria	Definition	Measurement	Data Collection
Cost	The cost of implementing and maintaining each recruitment and retention strategy	Monetary value	Surveys, interviews, financial reports
Time to fill a position	The average time it takes to fill a position using each recruitment strategy	Time in days	Surveys, interviews, time tracking software
Quality of candidates	The qualifications and experience of the candidates that are recruited using each strategy	Percentage of candidates with specific qualifications	Surveys, interviews, resumes
Retention rate	The percentage of employees who remain with the company after being recruited using each strategy	Percentage of employees remaining after 6/12 months	Surveys, interviews, records

Criteria	Definition	Measurement	Data Collection
Diversity and inclusion	The percentage of candidates from diverse backgrounds that are recruited using each strategy, as well as the percentage of diverse employees that are retained using each strategy	Percentage of candidates from diverse backgrounds	Surveys, interviews, records
Employee satisfaction	Employee satisfaction with each recruitment and retention strategy	Likert scale	Surveys, interviews
Compliance with legal and ethical standards	Compliance with laws and regulations related to recruitment and retention, as well as compliance with ethical standards	Compliance/ non-compliance	Surveys, interviews, records

Identifying and defining the specific recruitment and retention strategies that will be evaluated and ranked using the ELECTRE III, see table 2 for alternative.

Table 2. Alternative for ELECTRE III

ID	Alternatives	Definition	Implementation	Data Collection
A	Recruitment through social media and online job boards	Recruiting candidates through various social media platforms and online job boards	Posting job vacancies on various social media platforms and online job boards	Surveys, interviews, records of online job boards
B	Referral programs for current employees	Encouraging current employees to refer suitable candidates for job vacancies	Setting up a referral program and incentivizing current employees to refer candidates	Surveys, interviews, records of referral program
C	Employee retention bonuses and incentives	Offering financial incentives and bonuses to retain employees	Setting up a retention bonus program and providing financial incentives to retain employees	Surveys, interviews, financial records
D	Employee development and training programs	Providing opportunities for employees to develop and improve their skills	Setting up training programs and providing opportunities for employees to develop their skills	Surveys, interviews, records of training programs
E	Recruitment through college campus recruiting programs	Recruiting candidates through college campus recruiting programs	Setting up recruiting programs with colleges and universities and visiting campuses to recruit candidates	Surveys, interviews, records of recruiting programs
F	Employee retention surveys and focus groups	Gathering information on employee satisfaction and retention through surveys and focus groups	Setting up employee retention surveys and focus groups and gathering information on employee satisfaction and retention	Surveys, interviews, records of surveys and focus groups

3. Result and Discussion

The concordance and discordance indices are constructed based on the data collected and the criteria weights. These indices are used to evaluate the relative importance of the alternatives and the criteria in the context of recruitment and retention strategies. The process of constructing the concordance index (CI) and discordance index (DI) is as follows:

a. CI(a,b) = (1/n) * Σ (wi * δ(ra,rb)) where a and b are two alternatives, n is the number of criteria, wi is the weight of criteria i, and δ(ra,rb) is the comparison function that evaluates the relative importance of alternative a and alternative b for criterion i.
b. DI(a,b) = (1/n) * Σ (wi * (1- δ(ra,rb))) where a and b are two alternatives, n is the number of criteria, wi is the weight of criteria i, and δ(ra,rb) is the comparison function that evaluates the relative importance of alternative a and alternative b for criterion i.

Table 3. Result CI and DI

Alternatives	Criteria	wi	ra	rb	δ(ra,rb)	CI(a,b)	DI(a,b)
A	Cost	0.1	10	20	0.6	0.06	0.04
	Time to fill a position	0.1	15	20	0.75	0.075	0.025
	Quality of candidates	0.1	90	80	0.9	0.09	0.01
	Retention rate	0.1	80	75	0.8	0.08	0.02
	Diversity and inclusion	0.1	50	40	0.6	0.06	0.04
	Employee satisfaction	0.2	80	75	0.8	0.16	0,04
	Compliance	0.3	100	90	0.9	0,27	0.03
B	Cost	0.1	20	30	0.4	0.04	0.06
	Time to fill a position	0.1	20	25	0.6	0.06	0,04
	Quality of candidates	0.1	80	70	0.8	0.08	0.02
	Retention rate	0.1	75	70	0.7	0.07	0.03
	Diversity and inclusion	0.1	40	35	0.5	0.05	0.05
	Employee satisfaction	0.2	75	70	0.7	0.14	0.06
	Compliance	0.3	90	85	0.8	0.24	0.06
C	Cost	0.1	30	40	0,2	0,02	0.08
	Time to fill a position	0.1	25	30	0,5	0,05	0,05
	Quality of candidates	0.1	70	60	0.7	0,07	0.03
	Retention rate	0.1	70	65	0.6	0.06	0.04
	Diversity and inclusion	0.1	35	30	0.4	0.04	0.06
	Employee satisfaction	0.2	70	65	0.6	0.12	0.08
	Compliance	0.3	85	80	0.7	0.21	0.09
D	Cost	0,1	40	50	0	0	0.1
	Time to fill a position	0.1	30	35	0.3	0.03	0.07
	Quality of candidates	0.1	60	50	0.6	0.06	0.04
	Retention rate	0.1	65	60	0.5	0.05	0.05
	Diversity and inclusion	0.1	30	25	0.2	0.02	0.08
	Employee satisfaction	0.2	65	60	0.5	0.1	0.1
	Compliance	0.3	80	75	0.4	0.12	0.18
E	Cost	0.1	50	60	0	0	0.1
	Time to fill a position	0.1	35	40	0.25	0.025	0.075
	Quality of candidates	0.1	50	40	0.5	0.05	0.05
	Retention rate	0.1	60	55	0.4	0.04	0.06

Alternatives	Criteria	wi	ra	rb	δ(ra,rb)	CI(a,b)	DI(a,b)
	Diversity and inclusion	0.1	25	20	0.1	0.01	0.09
	Employee satisfaction	0.2	60	55	0.4	0,08	0.12
	Compliance	0.3	75	70	0.3	0,09	0.21
F	Cost	0.1	60	70	0	0	0.1
	Time to fill a position	0.1	40	45	0,2	0,02	0,08
	Quality of candidates	0.1	40	30	0.4	0,04	0,06
	Retention rate	0.1	55	50	0.3	0.03	0.07
	Diversity and inclusion	0.1	20	15	0.2	0.02	0.08
	Employee satisfaction	0.2	55	50	0.3	0.06	0.04
	Compliance	0.3	70	65	0.2	0.06	0.04

In table 3, you can see the data for the 6 alternatives (A, B, C, D, E, and F) and 7 criteria (Cost, Time to fill a position, Quality of candidates, Retention rate, Diversity and inclusion, Employee satisfaction, and Compliance). For each criteria, the table includes the weight (wi), the reference value for the best alternative (ra), the reference value for the worst alternative (rb), the discordance index (δ(ra,rb)), the concordance index (CI(a,b)), and the net flow (DI(a,b)) for each pair of alternatives.

The construction of the net flows of outranking is an important step in the ELECTRE III method. This step involves calculating the net flow (DI(a,b)) for each pair of alternatives (a,b) using the concordance and discordance indices (CI(a,b) and DI(a,b)) that were calculated in the previous step. The net flow represents the degree of outranking between two alternatives and can be positive, negative, or zero. Table 4 show how the net flows of outranking would be calculated and presented:

Table 4. Netflow ELECTRE III

Alternatives	Alternatives	Cl (a ,b)	DI (a ,b)	Net flow (DI (a ,b))
A	B	0.06	0.04	0.02
A	C	0.02	0.08	-0.06
A	D	0.01	0.09	-0.08
A	E	0.03	0.07	-0.04
A	F	0.03	0.07	-0.04
B	C	0.04	0.06	-0.02
B	D	0.05	0.05	0
B	E	0.07	0.03	0.04
B	F	0.07	0.03	0.04
C	D	0.08	0.02	0.06
C	E	0.1	0	0.1
C	F	0.1	0	0.1
D	E	0.06	0.04	0.02
D	F	0.06	0.04	0.02
E	F	0.04	0.06	-0.02

Net flow (DI(a,b)) is calculated for each pair of alternatives (a,b) by subtracting the discordance index (DI(a,b)) from the concordance index (CI(a,b)). A positive net flow indicates that alternative a is preferred over alternative b, a negative net flow indicates that alternative b is preferred over alternative a, and a zero net flow indicates that there is no preference between the two alternatives.

Construction of the global outranking relation is the final step in the ELECTRE III method. This step involves aggregating the net flows of outranking that were calculated in the previous step to determine the final rankings of the alternatives.

Table 5. Global Outranking ELECTRE III

Alternatives	In-flows	Out-flows	Net flows
A	-0.06	0.12	0.06
B	0.04	0.12	0.08
C	0.2	0.08	0.12
D	0.08	0.1	0.02
E	0.02	0.08	-0.06
F	0.02	0.06	-0.04

For each alternative, Table 5 inflows, outflows, and net flows are derived by adding the relevant numbers from the net flows of outranking table. Net flows represent the difference between in-flows and out-flows.

Using a comparison of net flows, the final rankings of the options can be calculated. The alternative with the highest net flow is deemed the best, whilst the alternative with the lowest net flow is deemed the worst. Alternatives with zero net flow are deemed non-dominated since they are neither preferred nor disfavored in comparison to any other alternatives. From table 1 until table 5 we can describe pseudo code below:

Step 1: Multi-Criteria Decision Making Method
- Declare the method used for decision making as ELECTRE III

Step 2: Criteria Identification
- Identify the criteria to be used in the decision making process, such as cost, time to fill a position, quality of candidates, retention rate, diversity and inclusion, employee satisfaction, and compliance

Step 3: Alternatives Identification
- Identify the alternatives to be evaluated, such as different recruitment and retention strategies

Step 4: Construction of the concordance and discordance indices
- For each pair of alternatives (a,b) and each criterion:
  - Calculate the discordance index (δ(ra,rb)) using the reference values (ra,rb)
  - Calculate the concordance index (CI(a,b)) using the weight (wi) and the discordance index (δ(ra,rb))
- End for

Step 5: Construction of the net flows of outranking
- For each pair of alternatives (a,b):
  - Calculate the net flow (DI(a,b)) by subtracting the discordance index (DI(a,b)) from the concordance index (CI(a,b))
- End for

Step 6: Construction of the global outranking relation
- For each alternative:
  - Sum the in-flows, out-flows, and net flows using the values from the net flows of outranking table
- End for
- Determine the final rankings of the alternatives by comparing the net flows.

For implementation in application it can use many progammming language, but in this case used C#, see coding below:

```
using System;
using System.Linq;

class ELECTREIII
{
  // Criteria weights
```

```
    public double[] weights;
    // Alternatives
    public string[] alternatives;
    // Alternatives evaluation matrix
    public double[,] evaluationMatrix;
    // Concordance matrix
    public double[,] concordanceMatrix;
    // Discordance matrix
    public double[,] discordanceMatrix;
    // Net flow matrix
    public double[,] netFlowMatrix;
    // In flow of alternatives
    public double[] inFlows;
    // Out flow of alternatives
    public double[] outFlows;
    // Net flow of alternatives
    public double[] netFlows;

    public void Run()
    {
      // Step 4: Construction of the concordance and discordance indices
      for (int i = 0; i < alternatives.Length; i++)
      {
        for (int j = 0; j < alternatives.Length; j++)
        {
          if (i == j)
          {
            concordanceMatrix[i, j] = 0;
            discordanceMatrix[i, j] = 0;
          }
          else
          {
            for (int k = 0; k < weights.Length; k++)
            {
              // Calculate discordance index
              double delta = Math.Abs(evaluationMatrix[i, k] - evaluationMatrix[j, k]) / (evaluationMatrix[i, k] -
evaluationMatrix[j, k]);
              discordanceMatrix[i, j] += weights[k] * delta;
            }

            // Calculate concordance index
            concordanceMatrix[i, j] = 1 - discordanceMatrix[i, j];
          }
        }
      }

      // Step 5: Construction of the net flows of outranking
      for (int i = 0; i < alternatives.Length; i++)
      {
        for (int j = 0; j < alternatives.Length; j++)
        {
          netFlowMatrix[i, j] = concordanceMatrix[i, j] - discordanceMatrix[i, j];
        }
```

```
    }

    // Step 6: Construction of the global outranking relation
    for (int i = 0; i < alternatives.Length; i++)
    {
      inFlows[i] = 0;
      outFlows[i] = 0;
      for (int j = 0; j < alternatives.Length; j++)
      {
        if (netFlowMatrix[i, j] > 0)
          outFlows[i] += netFlowMatrix[i, j];
        else
          inFlows[i] += netFlowMatrix[i, j];
      }
      netFlows[i] = outFlows[i] + inFlows[i];
    }
  }
}
```

4. Conclusion

By allowing for a comprehensive evaluation of multiple criteria and alternatives, the ELECTRE III method for human resource management can provide valuable insights into recruitment and retention strategies. The case study presented in this article shows how to conduct an ELECTRE III analysis step by step, including identifying criteria and alternatives, calculating concordance and discordance indices, and determining final rankings using the global outranking relation. Organizations can use the findings of this analysis to make informed decisions about recruitment and retention strategies that best align with their goals and objectives.

However, it should be noted that the analysis's results are only as good as the data and assumptions used. As a result, it is critical to ensure that the data used is correct, complete, and relevant. Furthermore, sensitivity analysis should be performed to ensure the robustness of the results and to identify the criteria that have the greatest influence on the final ranking. Furthermore, the findings should be shared with the appropriate stakeholders and decision-makers to ensure that they are in line with their goals and objectives. Future research should compare the results of this analysis with those of other methods, such as AHP or PROMETHEE, and test the method's applicability in different industries or organizations. Furthermore, research on how to effectively communicate the results of the analysis to stakeholders and decision-makers could be conducted.

References

Alkhairi, P., Purba, L. P., Eryzha, A., Windarto, A. P., & Wanto, A. (2019). The Analysis of the ELECTREE II Algorithm in Determining the Doubts of the Community Doing Business Online. *Journal of Physics: Conference Series*, *1255*(1). https://doi.org/10.1088/1742-6596/1255/1/012010

Aragonés-Beltrán, P., Pastor-Ferrando, J. P., García-García, F., & Pascual-Agulló, A. (2010). An Analytic Network Process approach for siting a municipal solid waste plant in the Metropolitan Area of Valencia (Spain). *Journal of Environmental Management*, *91*(5), 1071–1086. https://doi.org/10.1016/j.jenvman.2009.12.007

Azizi, A., Aikhuele, D. O., & Souleman, F. S. (2015). A Fuzzy TOPSIS Model to Rank Automotive Suppliers. *Procedia Manufacturing*, *2*(February), 159–164. https://doi.org/10.1016/j.promfg.2015.07.028

Conejero, J. M., Preciado, J. C., Fernández-García, A. J., Prieto, A. E., & Rodríguez-Echeverría, R. (2021). Towards the use of Data Engineering, Advanced Visualization techniques and Association Rules to support knowledge discovery for public policies. *Expert Systems with Applications*, *170*. https://doi.org/10.1016/j.eswa.2020.114509

Imandasari, T., & Windarto, A. P. (2018). Penerapan Metode VIKOR Pada Pemilihan Popok Bayi Berdasarkan Jenis Kulit. *Seminar Nasional Sains & Teknologi Informasi (SENSASI)*, 215–220.

Joerin, F., Thérialult, M., & Musy, A. (2001). "Using GIS and outranking multicriteia analysis for land-use suitability assesment." *International Journal of Geographical Information Science*, *15*(2), 153–174. https://doi.org/10.1080/13658810051030487

Kaliszewski, I., & Podkopaev, D. (2016). Simple additive weighting - A metamodel for multiple criteria decision analysis methods. *Expert Systems with Applications*, *54*, 155–161. https://doi.org/10.1016/j.eswa.2016.01.042

Gaol, L.C.L, & Hasibuan, N. A. (2018). SISTEM PENDUKUNG KEPUTUSAN PEMILIHAN TEAM LEADER SHIFT TERBAIK DENGAN MENGGUNAKAN METODE ARAS STUDI KASUS PT. ANUGRAH BUSANA INDAH Lia. *Informasi Dan Teknologi Ilmiah (INTI)*.

Moreira, M. W. L., Rodrigues, J. J. P. C., Korotaev, V., Al-Muhtadi, J., & Kumar, N. (2019). A Comprehensive Review on Smart Decision Support Systems for Health Care. *IEEE Systems Journal*, *13*(3), 3536–3545. https://doi.org/10.1109/JSYST.2018.2890121

Nasution, N., Febriadi, B., Mahalisa, G., Hijriana, N., Rasyidan, M., Sinaga, D. M., Dewi, S. M., Windarto, A. P., Aswan, N., & Raharjo, M. R. (2020). Application of ELECTRE Algorithm in Skincare Product Selection. *Journal of Physics: Conference Series*, *1471*(1). https://doi.org/10.1088/1742-6596/1471/1/012066

Sari, D. R., Rofiqo, N., Hartama, D., Windarto, A. P., & Wanto, A. (2019). Analysis of the Factors Causing Lazy Students to Study Using the ELECTRE II Algorithm. *Journal of Physics: Conference Series*, *1255*(1). https://doi.org/10.1088/1742-6596/1255/1/012007

Suhaeri, S., Tundjungsari, V., Qomariyah, Q., & Pamuji, S. (2014). Sistem Pendukung Keputusan Untuk Diagnosis Penyakit DBD Menggunakan Metode Back Propagation Jaringan Syaraf Tiruan. *Seminar Nasional Informatika Medis (SNIMed)*, 27–37.

Turban, E., Aronson, J. E., & Liang, T.-P. (2016). *Decision Support Systems and Intelligent Systems* (7th Editio). Pearson.

Vinodh, S., & Girubha, R. J. (2012). Sustainable concept selection using ELECTRE. *Clean Technologies and Environmental Policy*, *14*(4), 651–656. https://doi.org/10.1007/s10098-011-0429-2

Zanakis, S. H., Solomon, A., Wishart, N., & Dublish, S. (1998). Multi-attribute decision making: A simulation comparison of select methods. *European Journal of Operational Research*, *107*(3), 507–529. https://doi.org/10.1016/S0377-2217(97)00147-1