

Application of Decision Support Systems to Help the Selection of Moisturizing Cream

Erene Gernaria Sihombing¹, Linda Sari Dewi²

^{1,2}(STMIK Nusa Mandiri, Central Jakarta, Indonesia)

ABSTRACT: Moisturizing cream is a drug that is used to make facial skin moist because with skin that feels moist makes women avoid various problems such as blackheads and avoid acne. Keeping facial skin moist and oil free is not an easy thing to do. Most women's problems are having dry skin, and having oily skin. For women who have dry skin, it becomes a problem if they don't use moisturizers. Dry skin occurs due to a lack of serum production by the skin. Conversely women who have oily skin produce too much oil. Excess oil causes acne, so you need extra soap to reduce excess oil on your face. On the other hand, sensitive skin is easily irritated and becomes reddish. The number of moisturizing cream products makes many women confused in choosing a moisturizing cream. To solve this problem, the ELECTRE method of Decision Support System is used. The ELECTRE method is a multicriteria decision-making method based on each appropriate criterion. In this study the criteria used are a). product prices, b). side effects of use, c). product quality, d). customer commitment, e). customer trust and f). usage reaction. Alternatives used a). Hazeline Image, b). Fair & Lovely, c). Garnier, d). Olay, e). Sariayu and f). Wardah. From the results of calculations performed obtained by moisturizing cream with wardah brands to recommend the best moisturizing cream based on consumers and is expected to facilitate women in choosing a moisturizing cream according to skin type.

KEYWORDS -Decision Support System; ELECTRE Method; Consumer; Moisturizing Cream;

I. INTRODUCTION

One form of facial care that is often used by women. Facial moisturizers usually consist of a variety of minerals and vitamins and mixtures of water that can help moisturize the face. Usually facial moisturizers can be in the form of creams, which are also often known as daytime creams. nowadays, facial moisturizers have been visited by many cosmetic shops and supermarkets around us. brands of facial moisturizers also vary, some are from well-known brands and there are artificial face moisturizers. Today, many vendors offer good beauty products, from the cheapest to the most expensive. This is a dilemma for every woman in choosing a moisturizing cream both in terms of price and quality. Today, many moisturizing cream products at high prices but do not guarantee the quality of this product and there are moisturizing creams at affordable prices but have better quality. Every woman has a different level of sensitive

women. For women who have a high level of sensitivity must be careful in choosing a moisturizing cream that suits their skin type because it can cause skin irritation and so on. However, there are products that make women more suitable than those moisturizing creams. By using a skin moisturizing cream, women can avoid the effects of UVA and UVB rays, avoid dry skin, remove black spots on the face, brighten facial skin without excessive oil. Based on the above problems, we need a system that can provide moisturizing recommendations based on consumer choices. This research was conducted in Pematangsiantar City, North Sumatra. The data collection process was carried out by interviewing and taking samples through the transfer of questionnaires to 145 women using moisturizing creams. Many branches of computer science can be complex. Among the branches of artificial intelligence[1][2], [3], Data mining [4]–[6], decision support systems[7]–[9] and others[9]–[11]. In this case the researcher took the

branch of decision support system science with the ELECTRE method (Elimination of Et Choix Traduisant la Realite).

ELECTRE method is one of the multicriteria decision making methods based on the concept of outranking using pairwise comparisons of alternatives based on each appropriate criteria [12]–[14]. This is evidenced by several previous studies using the ELECTRE method. One of which is [15], the results of this study were able to recommend study programs suitable for prospective students to choose based on their academic abilities so as to improve accessibility by prospective students. Based on these problems, it is expected that the results of the study will produce a dynamic system that can help women to recommend a choice of moisturizing cream that suits the skin.

II. RELATED WORK

The Electre method is one of the multicriteria decision-making methods based on the Outranking concept by using paired comparisons of alternatives based on each appropriate criterion [16]. The Electre method is used in conditions where alternatives that are not in accordance with the criteria will be eliminated, and suitable alternatives can be produced [17]. The steps to completing the ELECTRE method are explained in a regular and detailed manner in accordance with the article written [18].

III. METHODOLOGY

The first step is to collect primary and secondary data used as material for the analysis process. Activities carried out to collect primary data are:

- 1) Observation: This study was conducted using a quantitative approach, which took a number of samples from women who used moisturizing cream in the transfer city. This process aims to gain an understanding of the process of selecting a moisturizing cream that suits the skin based on the respondent.
- 2) Questionnaire: After we got an overview of the selection process, we collected questionnaires from respondents involved in the process, which included women aged 17-30 years (students, career women, civil servants and private employees).

- 3) Interview: Conduct in-depth interviews with people involved in research such as providing questions about the reasons for choosing a moisturizing cream. The aim is to explore the process of selecting moisturizing cream recommendations that are suitable for the skin of the respondents.

From the results of questionnaires from 145 respondents (students, career women, civil servants and private employees), there are several problems faced by women with a choice of moisturizing cream, namely:

- a) There are women after using a moisturizing cream, the skin feels tight or dry, so it feels like a crack (2.8%);
- b) There are women after using a moisturizing cream, the skin feels slippery due to excess oil is a sign of how bad the moisturizer is used (13.5);
- c) There are women after using a moisturizing cream, the effect of dependence on high moisturizing cream (8.5%);
- d) There are women after using a moisturizing cream, excessive acne arises around the face (75.2%);

With the system developed, it is expected that the women helped in determining the expected moisturizing cream are:

- 1) Models that are able to provide recommendations in choosing a moisturizing cream according to the skin.
- 2) Models that can be developed to help students choose moisturizing creams dynamically over time.

IV. RESULTS AND DISCUSSION

Based on the results of the interview obtained an alternative moisturizing cream that will be processed using ELECTRE calculations as shown in the following table:

TABLE 1. ALTERNATIVE DATA

No.	Alternatif	Product name
1	A1	Citra Hazeline
2	A2	Fair & Lovely
3	A3	Garnier
4	A4	Olay
5	A5	Sariayu
6	A6	Wardah

Based on table 1, the alternatives used are 6 (A1-A6). The process is continued by determining the assessment criteria for moisturizing cream that suits the skin where the criteria are obtained based on the results of interviews with 145 respondents. The results of the criteria are weighted using fuzzy assessment (0-1). The closer to the value 1 means the dependence of the criteria on the alternative is higher and conversely the closer to the value of 0 means the dependence on the alternative is lower. The following are the complete results of criteria and weights such as the following table:

TABLE 2. CRITERIA AND GRANTING WEIGHT

No	Initial	Criteria	Weight
1.	C1	Product Prices	0,1
2.	C2	Side Effects Of Use	0,25
3.	C3	Product Quality	0,15
4.	C4	Customer Commitment	0,05
5.	C5	Customer Trust	0,1
6.	C6	Usage Reaction	0,35

The results of the recapitulation of 145 respondents were carried out by changing the value of interest according to the choice of respondents followed by taking an average value based on alternatives. The value of importance in question is to change linkert to fuzzy numbers (0-1) as follows: Very Good (0.9); Good (0.75); Neutral (0.5); Less (0.25). The following are the results of recapitulation of research data on the selection of moisturizing cream based on skin type such as the following table:

TABLE 3. DETERMINING THE COMPATIBILITY RATING OF EACH ALTERNATIVE AT EACH CRITERIA

Alternatif	C1	C2	C3	C4	C5	C6
Citra Hazeline (A1)	0,75	0,43	0,82	0,6	0,75	0,76
Fair & Lovely (A2)	0,59	0,4	0,69	0,65	0,7	0,66
Garnier (A3)	0,68	0,4	0,71	0,54	0,64	0,63
Olay (A4)	0,71	0,42	0,67	0,68	0,44	0,56
Sariayu (A5)	0,71	0,58	0,62	0,45	0,71	0,57
Wardah (A6)	0,66	0,42	0,75	0,65	0,65	0,65

The results of the recapitulation in table 3 will be analyzed and implemented using the ELECTRE method as follows:

- a. Normalization of the decision matrix. At this stage each attribute is changed to a comparable value:

$$R_{1,1(X1)} = \frac{x_{1,1}}{\sqrt{(x_{1,1})^2 + (x_{1,2})^2 + (x_{1,3})^2 + (x_{1,4})^2 + (x_{1,5})^2 + (x_{1,6})^2}}$$

$$R_{1,1(X1)} = \frac{0,75}{\sqrt{(0,75)^2 + (0,59)^2 + (0,68)^2 + (0,71)^2 + (0,71)^2 + (0,66)^2}}$$

$$R_{1,1(X1)} = \frac{0,75}{1,6783} = R_{1,1(X1)} = 0,4468$$

Do the same thing until X6 so that the full results of the R matrix are obtained as normalized in the following table:

TABLE 4. RESULTS OF NORMALIZATION OF DECISION MATRIX

R (Normalization)					
0,44687	0,3935	0,46965	0,40811	0,46672	0,48347
0,35154	0,36605	0,3952	0,44212	0,43561	0,41985
0,40516	0,36605	0,40665	0,3673	0,39827	0,40077
0,42304	0,38435	0,38374	0,46252	0,27381	0,35624
0,42304	0,53077	0,3551	0,30608	0,44183	0,3626
0,39325	0,38435	0,42956	0,44212	0,40449	0,41349

- b. Weighting on normalized matrices. The V matrix is the product of multiplication of R with W (weight), where $W = \{0,1 (C1); 0,25 (C2); 0,15 (C3); 0,05 (C4); 0,1 (C5); 0,35 (C6)\}$. The results of the multiplication of preference weights for each criterion with normalized decision matrices can be seen in the following matrix table:

TABLE 5. WEIGHTING ON MATRIX AFTER NORMALIZATION

V(Normalization *Weight)(R*W)					
0,04469	0,09838	0,07045	0,02041	0,04667	0,16921
0,08788	0,09151	0,05928	0,02211	0,04356	0,14695
0,06077	0,09151	0,061	0,01836	0,03983	0,14027
0,02115	0,09609	0,05756	0,02313	0,02738	0,12468
0,0423	0,13269	0,05327	0,0153	0,04418	0,12691
0,13764	0,09609	0,06443	0,02211	0,04045	0,14472

- c. Determine the set of concordance and discordance index.

- 1) Determine the set of concordance:

The following is the calculation of the concordance set as shown in the following table:

TABLE 6. CONCORDANCE SET

C	Set
C ₁₂	{1,2,3,5,6}
C ₁₃	{1,2,3,4,5,6}
C ₁₄	{1,2,3,5,6}
C ₁₅	{1,3,4,5,6}
C ₁₆	{1,2,3,5,6}
C ₂₁	{4}
C ₂₃	{2,4,5,6}
C ₂₄	{3,5,6}
C ₂₅	{3,4,6}
C ₂₆	{3,5,6}
C ₃₁	{0}
C ₃₂	{1,2,3}
C ₃₄	{3,5,6}
C ₃₅	{3,4,6}
C ₃₆	{1}
C ₄₁	{4}
C ₄₂	{1,2,4}
C ₄₃	{1,2,4}
C ₄₅	{1,3,4}
C ₄₆	{1,2,4}
C ₅₁	{2}
C ₅₂	{1,2,5}
C ₅₃	{1,2,5}
C ₅₄	{1,2,5,6}
C ₅₆	{1,2,5}
C ₆₁	{4}
C ₆₂	{1,2,3,4}
C ₆₃	{2,3,4,5,6}
C ₆₄	{2,3,5,6}
C ₆₅	{3,4,6}

TABLE 7. DISCORDANCE SET

D	Set
D ₁₂	{4}
D ₁₃	{0}
D ₁₄	{4}
D ₁₅	{2}
D ₁₆	{4}
D ₂₁	{1,2,3,5,6}
D ₂₃	{1,3}
D ₂₄	{1,2,4}
D ₂₅	{1,2,5}
D ₂₆	{1,2,3}
D ₃₁	{1,2,3,4,5,6}
D ₃₂	{4,5,6}
D ₃₄	{1,2}
D ₃₅	{1,2,5}
D ₃₆	{2,3,4,5,6}
D ₄₁	{1,2,3,5,6}
D ₄₂	{3,5,6}
D ₄₃	{3,5,6}
D ₄₅	{2,5,6}
D ₄₆	{3,5,6}
D ₅₁	{1,3,4,5,6}
D ₅₂	{3,4,6}
D ₅₃	{3,4,6}
D ₅₄	{3,4}
D ₅₆	{3,4,6}
D ₆₁	{1,2,3,5,6}
D ₆₂	{5,6}
D ₆₃	{1}
D ₆₄	{1,4}
D ₆₅	{1,2,5}

2) Determine the set of discordance:

The following is the calculation of the discordance set as shown in the following table:

d. Calculating matrix concordance and discordance.

1) Count concordance

The following is the complete calculation of the Concordance Matrix as shown in the following table:

TABLE 8. CONCORDANCE MATRIX (CM)

CM	A1	A2	A3	A4	A5	A6
A1	-	0,95	1	0,95	0,75	0,95
A2	0,05	-	0,75	0,6	0,55	0,5
A3	0	0,5	-	0,6	0,55	0,1
A4	0,005	0,4	0,4	-	0,3	0,4
A5	0,25	0,45	0,45	0,8	-	0,45
A6	0,05	0,55	0,9	0,85	0,55	-

2) Count discordance

The following is the complete calculation of the discordance Matrix as shown in the following table:

TABLE 9. DISCORDANCE MATRIX (DC)

DC	A1	A2	A3	A4	A5	A6
A1	-	0,03936	0	0,0611	0,81121	0,01729
A2	1	-	1	1	1	1
A3	1	1	-	0,5558	0,5558	0,5558
A4	1	1	1	-	1	1
A5	1	1	1	0,40617	-	1
A6	1	0,26349	1	1	1	-

e. Determine dominant concordance and discordance matrices.

- 1) The following results from the calculation of the concordance Threshold dominant matrix obtained from the sum of all matrix elements divided by the matrix size.

TABLE 10. DOMINANT CONCORDANCE MATRIX

Matriks Dominan Concordance	A1	A2	A3	A4	A5	A6
Citra Hazeline (A1)	-	1	1	1	1	1
Fair & Lovely (A2)	0	-	1	1	1	0
Garnier (A3)	0	0	-	1	1	0
Olay (A4)	0	0	0	-	0	0
Sariayu (A5)	0	0	0	1	-	0
Wardah (A6)	0	1	1	1	1	-

- 2) The following results from the calculation of the discordance Threshold dominant matrix obtained from the sum of all matrix elements divided by the matrix size.

TABLE 11. DOMINANT DISCORDANCE MATRIX

Matriks Dominan Concordance	A1	A2	A3	A4	A5	A6
Citra Hazeline (A1)	-	0	0	0	1	0
Fair & Lovely (A2)	1	-	1	1	1	1
Garnier (A3)	1	1	-	0	0	0
Olay (A4)	1	0	1	-	1	1
Sariayu (A5)	1	1	1	0	-	1
Wardah (A6)	1	0	1	1	1	-

- f. Determine the aggregate matrix to give a sequence of alternative choices so that in matrices that have number 1 are eliminated. Thus, the best alternative is an alternative that dominates other alternatives. Following are the complete results of the Dominance Aggregate Matrix as shown in the following table:

TABLE 11. DOMINANCE AGGREGATE MATRIX

Citra Hazeline (A1)	-	0	0	0	1	0
Fair & Lovely (A2)	0	-	1	1	1	0
Garnier (A3)	0	-	-	0	0	0
Olay (A4)	0	-	0	-	0	0
Sariayu (A5)	0	-	0	0	-	0
Wardah (A6)	0	-	1	1	1	-

- g. Eliminate less favorite alternatives.

The E matrix gives a sequence of choices for each alternative, namely if $e_{kl} = 1$ then the alternative A_k is a better choice than A_l . So the lines in matrix E that have the least amount of $e_{kl} = 1$ can be eliminated. Thus the best alternative is to dominate other alternatives. The results of the calculation by the ELECTRE method, the highest ranking obtained is **Wardah (A6)**.

V. CONCLUSION

Based on the results of research and discussion of the decision support system in the selection of skin moisturizing cream using the ELECTRE method it can be concluded that the Electre Method can be used to determine moisturizing cream based on the skin using 6 criteria: product price (C1), use side effects (C2), product quality (C3), customer commitment (C4), customer trust (c5), usage reaction (C6) and 6 alternatives, namely: Hazeline Image (A1), Fair & Lovely (A2), Garnier (A3), Olay (A4), Sariayu (A5) and Wardah (A6). The calculation results obtained by wardah moisturizing cream (A6) became the best recommended moisturizing cream offered by the system.

REFERENCES

- [1] Sumijan, A. P. Windarto, A. Muhammad, and Budiharjo, "Implementation of Neural Networks in Predicting the Understanding Level of Students Subject," *Int. J. Softw. Eng. Its Appl.*, vol. 10, no. 10, pp. 189–204, 2016.
- [2] T. Budiharjo, Soemartono, T., Windarto, A.P., Herawan, "Predicting tuition fee payment problem using backpropagation neural network model," *Int. J. Adv. Sci. Technol.*, 2018.
- [3] T. Budiharjo, Soemartono, T., Windarto, A.P., Herawan, "Predicting school participation in indonesia using back-propagation algorithm model," *Int. J. Control Autom.*, 2018.
- [4] B. Supriyadi, A. P. Windarto, T. Soemartono, and Mungad, "Classification of natural disaster prone areas in Indonesia using K-means," *Int. J. Grid Distrib. Comput.*, vol. 11, no. 8, pp. 87–98, 2018.
- [5] Sudirman, A. P. Windarto, and A. Wanto, "Data mining tools | rapidminer: K-means method on clustering of rice crops by province as efforts to stabilize food crops

- in Indonesia,” *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 420, p. 12089, 2018.
- [6] A. P. Windarto, “Implementation of Data Mining on Rice Imports by Major Country of Origin Using Algorithm Using K-Means Clustering Method,” *Int. J. Artif. Intell. Res.*, vol. 1, no. 2, pp. 26–33, 2017.
- [7] A. P. W. Budiharjo and A. Muhammad, “Comparison of Weighted Sum Model and Multi Attribute Decision Making Weighted Product Methods in Selecting the Best Elementary School in Indonesia,” *Int. J. Softw. Eng. Its Appl.*, vol. 11, no. 4, pp. 69–90, 2017.
- [8] Ermatita, Sri Hartati, R. Wardoyo, and A. Harjoko, “Electre Methods in Solving Group Decision Support System Bioinformatics on Gene Mutation Detection Simulation,” *Int. J. Comput. Sci. Inf. Technol.*, vol. 3, no. 1, pp. 40–52, 2011.
- [9] S. Alharbi and I. Venkat, “A Genetic Algorithm Based Approach for Solving the Minimum Dominating Set of Queens Problem,” *J. Optim.*, vol. 2017, pp. 1–8, 2017.
- [10] R. Rahim *et al.*, “Enhanced pixel value differencing with cryptography algorithm,” in *MATEC Web of Conferences 197*, 2018, vol. 3011, pp. 1–5.
- [11] Yuhefizar, B. Santosa, I. K. E. Purnama, and Y. K. Suprpto, “Combination of cluster method for segmentation of web visitors,” *Telkonnika*, vol. 11, no. 1, pp. 207–214, 2013.
- [12] X. Wang and E. Triantaphyllou, “Ranking irregularities when evaluating alternatives by using some ELECTRE methods,” *Omega*, vol. 36, no. 1, pp. 45–63, 2008.
- [13] A. V. Devadoss and M. Rekha, “A New Intuitionistic Fuzzy ELECTRE II approach to study the Inequality of women in the society,” *Glob. J. Pure Appl. Math.*, vol. 13, no. 9, pp. 6583–6594, 2017.
- [14] W.-C. C. Huang and C.-H. H. Chen, “Using the ELECTRE II method to apply and analyze the differentiation theory,” *Proc. East. Asia Soc. Transp. Stud.*, vol. 5, no. January 2005, pp. 2237–2249, 2005.
- [15] M. Sudarma, A. Agung, K. Oka, I. Cahya, A. Info, and W. Application, “Decision Support System for the Selection of Courses in the Higher Education using the Method of Elimination Et Choix Tranduit La Realite,” *Int. J. Electr. Comput. Eng.*, vol. 5, no. 1, pp. 129–135, 2015.
- [16] M. J. Mahase, C. Musingwini, and A. S. Nhleko, “A survey of applications of multi-criteria decision analysis methods in mine planning and related case studies,” *J. South. African Inst. Min. Metall.*, vol. 116, no. 11, pp. 1051–1056, 2016.
- [17] V. M. Athawale and S. Chakraborty, “A comparative study on the ranking performance of some multi-criteria decision-making methods for industrial robot selection,” *Int. J. Ind. Eng. Comput.*, vol. 2, no. 4, pp. 831–850, 2011.
- [18] M. Mesran, G. Ginting, S. Suginam, and R. Rahim, “Implementation of Elimination and Choice Expressing Reality (ELECTRE) Method in Selecting the Best Lecturer (Case Study STMIK BUDI DARMA),” *Int. J. Eng. Res. Technol.*, vol. 6, no. 2, NaN-2017, pp. 141–144, 2017.
- [1] Sumijan, A. P. Windarto, A. Muhammad, and Budiharjo, “Implementation of Neural Networks in Predicting the Understanding Level of Students Subject,” *Int. J. Softw. Eng. Its Appl.*, vol. 10, no. 10, pp. 189–204, 2016.
- [2] T. Budiharjo, Soemartono, T., Windarto, A.P., Herawan, “Predicting tuition fee payment problem using backpropagation neural network model,” *Int. J. Adv. Sci. Technol.*, 2018.
- [3] T. Budiharjo, Soemartono, T., Windarto, A.P., Herawan, “Predicting school participation in indonesia using back-propagation algorithm model,” *Int. J. Control Autom.*, 2018.
- [4] B. Supriyadi, A. P. Windarto, T. Soemartono, and Mungad, “Classification of natural disaster prone areas in Indonesia using K-means,” *Int. J. Grid Distrib. Comput.*, vol. 11, no. 8, pp. 87–98, 2018.
- [5] Sudirman, A. P. Windarto, and A. Wanto, “Data mining tools | rapidminer: K-means method on clustering of rice crops by province as efforts to stabilize food crops in Indonesia,” *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 420, p. 12089, 2018.
- [6] A. P. Windarto, “Implementation of Data Mining on Rice Imports by Major Country of Origin Using Algorithm Using K-Means Clustering Method,” *Int. J. Artif. Intell. Res.*, vol. 1, no. 2, pp. 26–33, 2017.
- [7] A. P. W. Budiharjo and A. Muhammad, “Comparison of Weighted Sum Model and Multi Attribute Decision Making Weighted Product Methods in Selecting the Best Elementary School in Indonesia,” *Int. J. Softw. Eng. Its Appl.*, vol. 11, no. 4, pp. 69–90, 2017.
- [8] Ermatita, Sri Hartati, R. Wardoyo, and A. Harjoko, “Electre Methods in Solving Group Decision Support System Bioinformatics on Gene Mutation Detection Simulation,” *Int. J. Comput. Sci. Inf. Technol.*, vol. 3, no. 1, pp. 40–52, 2011.
- [9] S. Alharbi and I. Venkat, “A Genetic Algorithm Based Approach for Solving the Minimum Dominating Set of Queens Problem,” *J. Optim.*, vol. 2017, pp. 1–8, 2017.
- [10] R. Rahim *et al.*, “Enhanced pixel value differencing with cryptography algorithm,” in *MATEC Web of Conferences 197*, 2018, vol. 3011, pp. 1–5.
- [11] Yuhefizar, B. Santosa, I. K. E. Purnama, and Y. K. Suprpto, “Combination of cluster method for segmentation of web visitors,” *Telkonnika*, vol. 11, no. 1, pp. 207–214, 2013.
- [12] X. Wang and E. Triantaphyllou, “Ranking irregularities when evaluating alternatives by using some ELECTRE methods,” *Omega*, vol. 36, no. 1, pp. 45–63, 2008.
- [13] A. V. Devadoss and M. Rekha, “A New Intuitionistic Fuzzy ELECTRE II approach to study the Inequality of women in the society,” *Glob. J. Pure Appl. Math.*, vol. 13, no. 9, pp. 6583–6594, 2017.
- [14] W.-C. C. Huang and C.-H. H. Chen, “Using the ELECTRE II method to apply and analyze the differentiation theory,” *Proc. East. Asia Soc. Transp. Stud.*, vol. 5, no. January 2005, pp. 2237–2249, 2005.
- [15] M. Sudarma, A. Agung, K. Oka, I. Cahya, A. Info, and W. Application, “Decision Support System for the Selection of Courses in the Higher Education using the Method of Elimination Et Choix Tranduit La Realite,” *Int. J. Electr. Comput. Eng.*, vol. 5, no. 1, pp. 129–135, 2015.
- [16] M. J. Mahase, C. Musingwini, and A. S. Nhleko, “A survey of applications of multi-criteria decision analysis

- methods in mine planning and related case studies,” *J. South. African Inst. Min. Metall.*, vol. 116, no. 11, pp. 1051–1056, 2016.
- [17] V. M. Athawale and S. Chakraborty, “A comparative study on the ranking performance of some multi-criteria decision-making methods for industrial robot selection,” *Int. J. Ind. Eng. Comput.*, vol. 2, no. 4, pp. 831–850, 2011.
- [18] M. Mesran, G. Ginting, S. Suginam, and R. Rahim, “Implementation of Elimination and Choice Expressing Reality (ELECTRE) Method in Selecting the Best Lecturer (Case Study STMIK BUDI DARMA),” *Int. J. Eng. Res. Technol.*, vol. 6, no. 2, NaN-2017, pp. 141–144, 2017.
- [1] Sumijan, A. P. Windarto, A. Muhammad, and Budiharjo, “Implementation of Neural Networks in Predicting the Understanding Level of Students Subject,” *Int. J. Softw. Eng. Its Appl.*, vol. 10, no. 10, pp. 189–204, 2016.
- [2] T. Budiharjo, Soemartono, T., Windarto, A.P., Herawan, “Predicting tuition fee payment problem using backpropagation neural network model,” *Int. J. Adv. Sci. Technol.*, 2018.
- [3] T. Budiharjo, Soemartono, T., Windarto, A.P., Herawan, “Predicting school participation in indonesia using back-propagation algorithm model,” *Int. J. Control Autom.*, 2018.
- [4] B. Supriyadi, A. P. Windarto, T. Soemartono, and Mungad, “Classification of natural disaster prone areas in Indonesia using K-means,” *Int. J. Grid Distrib. Comput.*, vol. 11, no. 8, pp. 87–98, 2018.
- [5] Sudirman, A. P. Windarto, and A. Wanto, “Data mining tools | rapidminer: K-means method on clustering of rice crops by province as efforts to stabilize food crops in Indonesia,” *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 420, p. 12089, 2018.
- [6] A. P. Windarto, “Implementation of Data Mining on Rice Imports by Major Country of Origin Using Algorithm Using K-Means Clustering Method,” *Int. J. Artif. Intell. Res.*, vol. 1, no. 2, pp. 26–33, 2017.
- [7] A. P. W. Budiharjo and A. Muhammad, “Comparison of Weighted Sum Model and Multi Attribute Decision Making Weighted Product Methods in Selecting the Best Elementary School in Indonesia,” *Int. J. Softw. Eng. Its Appl.*, vol. 11, no. 4, pp. 69–90, 2017.
- [8] Ermatita, Sri Hartati, R. Wardoyo, and A. Harjoko, “Electre Methods in Solving Group Decision Support System Bioinformatics on Gene Mutation Detection Simulation,” *Int. J. Comput. Sci. Inf. Technol.*, vol. 3, no. 1, pp. 40–52, 2011.
- [9] S. Alharbi and I. Venkat, “A Genetic Algorithm Based Approach for Solving the Minimum Dominating Set of Queens Problem,” *J. Optim.*, vol. 2017, pp. 1–8, 2017.
- [10] R. Rahim *et al.*, “Enhanced pixel value differencing with cryptography algorithm,” in *MATEC Web of Conferences 197*, 2018, vol. 3011, pp. 1–5.
- [11] Yuhefizar, B. Santosa, I. K. E. Purnama, and Y. K. Suprpto, “Combination of cluster method for segmentation of web visitors,” *Telkomnika*, vol. 11, no. 1, pp. 207–214, 2013.
- [12] X. Wang and E. Triantaphyllou, “Ranking irregularities when evaluating alternatives by using some ELECTRE methods,” *Omega*, vol. 36, no. 1, pp. 45–63, 2008.
- [13] A. V. Devadoss and M. Rekha, “A New Intuitionistic Fuzzy ELECTRE II approach to study the Inequality of women in the society,” *Glob. J. Pure Appl. Math.*, vol. 13, no. 9, pp. 6583–6594, 2017.
- [14] W.-C. C. Huang and C.-H. H. Chen, “Using the ELECTRE II method to apply and analyze the differentiation theory,” *Proc. East. Asia Soc. Transp. Stud.*, vol. 5, no. January 2005, pp. 2237–2249, 2005.
- [15] M. Sudarma, A. Agung, K. Oka, I. Cahya, A. Info, and W. Application, “Decision Support System for the Selection of Courses in the Higher Education using the Method of Elimination Et Choix Tranduit La Realite,” *Int. J. Electr. Comput. Eng.*, vol. 5, no. 1, pp. 129–135, 2015.
- [16] M. J. Mahase, C. Musingwini, and A. S. Nhleko, “A survey of applications of multi-criteria decision analysis methods in mine planning and related case studies,” *J. South. African Inst. Min. Metall.*, vol. 116, no. 11, pp. 1051–1056, 2016.
- [17] V. M. Athawale and S. Chakraborty, “A comparative study on the ranking performance of some multi-criteria decision-making methods for industrial robot selection,” *Int. J. Ind. Eng. Comput.*, vol. 2, no. 4, pp. 831–850, 2011.
- [18] M. Mesran, G. Ginting, S. Suginam, and R. Rahim, “Implementation of Elimination and Choice Expressing Reality (ELECTRE) Method in Selecting the Best Lecturer (Case Study STMIK BUDI DARMA),” *Int. J. Eng. Res. Technol.*, vol. 6, no. 2, NaN-2017, pp. 141–144, 2017.