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Decision Support System for Service Development Priority Selection at Pitcar Service Using the ELECTRE Method

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Abstract

The increasing competition in the automotive industry is pushing companies like Pitcar Service, a car workshop in South Purwokerto, to develop efficient and quality services. However, this workshop faces limitations in assets, materials, and capabilities. Therefore, Pitcar Service requires a Decision Support System (DSS) to assist in determining the priority for service development. The DSS helps identify and prioritize the most important services or those that have the greatest impact on business growth. By focusing on strategic development that provides significant added value, the company can achieve its strategic goals in line with the company's vision. The method used in this study is ELECTRE (Elimination and Choice Translation Reality), a suitable algorithm for designing a decision support system. This method allows pairwise comparisons between alternatives based on relevant criteria. The assessment is done by comparing each criterion individually to determine whether an alternative dominates other alternatives. With this method, the assessment of workshop services can be done objectively. The service alternatives considered include Workshop Service, Pick Up Service, Emergency Service, Home Service, Variations, and B2B Services. Meanwhile, the criteria used for the assessment include the number of requests, average income per job, tool usage, the number of mechanics, and processing time. The calculation results show that B2B Service is the main priority for service development with a dominant aggregation matrix result is 2.

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INTRODUCTION

The increasing competition in the service industry sector, both at the national and international levels, forces companies to strive to be at the forefront among their competitors. One way to achieve this is by providing efficient and high-quality services to customers (Ramadhanti et al., 2022). Pitcar Service offers a variety of services to meet customer needs. Workshop Service provides standard repair and maintenance where customers bring their cars for mechanical repairs, part replacements, or general checks. Pick Up Service facilitates customers by collecting cars from a specified location when they cannot drive them to the workshop. Emergency Service addresses sudden issues like breakdowns or accidents, providing roadside assistance. Home Service sends technicians to customers' locations for repairs or maintenance, catering to those unable to visit the workshop. Variation Service offers customization and performance enhancements tailored to customer preferences. Finally, B2B (Business-to-Business) Service collaborates with other companies to maintain and repair vehicle fleets, ensuring smooth operations with regular maintenance and emergency support.

Based on the interview with the owner, it was concluded that Pitcar Service realizes there are limitations in terms of assets, materials, and capabilities that can affect the capacity and quality of Pitcar Service's services. This is an important concern in achieving Pitcar Service's strategic objectives, which focus on customer satisfaction and the best service in line with the company's vision. This is crucial because if customers are dissatisfied, it will reduce their likelihood of returning, which in turn can lead to a decrease in both profit and customer trust. Therefore, Pitcar Service needs a Decision Support System (DSS) to prioritize service development to help identify services that have the potential for development.

A decision support system is a component of a computer information system that functions to assist in making decisions within an organization or company. In this context, a decision support system is also known as a computer system that processes data and information to facilitate decision-making related to specific semi-structured problems (Putri Pratiwi et al., 2019). In this research, the ELECTRE method (Elimination and Choice Translation Reality) is used as a selection method to help Pitcar Service determine the priority of service development. ELECTRE is a decision support system algorithm that is well-suited for designing a decision support system. It uses pairwise comparisons of alternatives based on each relevant criterion (Fonou-Dombeu, 2019), (Wulan Sari & Perdana Windarto, 2019).

Another method besides ELECTRE in decision support systems is varied. For example, Simple Additive Weighting is used by Tej Singh to optimize the physico-mechanical and wear properties of wood waste, the TOPSIS method is used to select the best low-toxicity organic cosolvent by Xingren Pan et.al, healthcare supplier selection with MABAC by Santonab Chakraborty, and VIKOR for Soil ecological risk assessment of ten industrial areas in China (Chakraborty et al., 2023; Pan et al., 2025; Singh et al., 2022; Yang et al., 2024). Although there are many possibilities for decision-making procedures in the literature, approaches like MABAC, TOPSIS, VIKOR, etc, are not concerned with how alternatives behave in relation to each individual criterion. Instead, they use the total performance of all criteria to rank the available solutions. Conversely, outranking strategies—more especially, ELECTRE strategies—are renowned for giving each criterion information careful consideration (Akram et al., 2022, 2023).

ELECTRE uses concepts of concordance to analyze outranking relations, focusing on dominance relations among alternatives. These outranking relations can be used to compare alternatives (Teixeira de Almeida, 2007). In contrast to previous MCDMs, the ELECTRE technique employs a non-compensatory logic to investigate outranking relationships (Vincke, 1992). To deal with ambiguity and imprecision in the decision-making process, outranking techniques like ELECTRE are employed (Fahmi et al., 2016; Salvador et al., 2024).

Previous research used the ELECTRE method to help select LCGC cars based on the criteria of Price, Specifications, and Spare Parts. The research concludes that ELECTRE is an interesting and straightforward method for selection processes, with outcomes influenced by the preferences used. Comparing alternative values using the ELECTRE method produces an objective ranking of the best alternatives (Naufal et al., 2022).

There is also research to help determine students eligible for scholarships based on the criteria of GPA, Annual Income, Number of Dependents, and Parents' Occupation using the ELECTRE method. The study highlights the importance of determining criteria and assigning weight to each criterion when using ELECTRE. Adding criteria or changing decision weights can alter the outcomes, even with the same candidate data. ELECTRE effectively evaluates scholarship candidates based on the given criteria, successfully

eliminating those who do not meet the requirements (Satria et al., 2019).

Research aimed at helping people determine the right house according to their needs, based on criteria such as price, bedrooms, and bathrooms, was conducted using the ELECTRE method. Overall, the Elimination and Choice Translation Reality (ELECTRE) method aids consumers in choosing their desired homes. (Rahmalisa, 2019).

Through a DSS, various alternative solutions can be provided to individuals or groups facing challenges in making the right decisions that align with the company's needs (Aldo, 2019). With this research, it is hoped that Pitcar Service can consider various alternative solutions to improve services according to the company's needs.

RESEARCH METHOD

In the research method section, a more in-depth explanation of the application of the ELECTRE method in this study will be provided. The research process is visually explained in Figure 1.

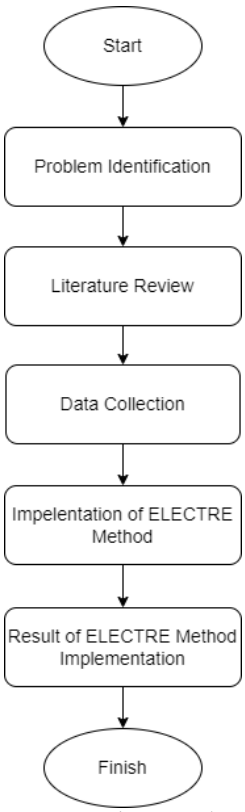

Figure 1. Research procedure

A. Problem Identification

Problem identification reveals that Pitcar Service has not determined which service is the most appropriate to prioritize for development. Limited resources and funding make it difficult for the workshop to optimally develop all services. Without a clear understanding of service development priorities, Pitcar Service tends to distribute resources evenly across various services, which can ultimately reduce the efficiency and quality of the services provided.

B. Literature Review

The researcher conducts a thorough search and analysis of the literature to find relevant and related references for the study. Through this process, the researcher can understand the approaches and findings from previous studies that used the ELECTRE method in the same context, as well as identify gaps or shortcomings in those studies. This literature review not only provides a strong theoretical foundation but also enriches the researcher's understanding and ensures that this research can make a meaningful contribution to the chosen field of study.

C. Data Collection

The researcher collects data to delve into the issues and important factors in determining the priority of service development at Pitcar Service through interviews with the CEO, Mr. Ilman Naafi'an, and company report documentation. The interviews provide direct information from a competent source, while the report documentation, which covers a 6-month period from June to November 2023, provides a basis for analysis and assessment of research criteria.

D. Implementation of the ELECTRE Method

ELECTRE (Elimination and Choice Translation Reality) is an algorithm used in designing decision support systems. This method can be used for various purposes, including determining service development priorities. The way this algorithm works is by processing the weight values of each criterion and alternative, then producing absolute and easily understood values for use in decision-making (Febriani et al., 2022).

RESULT AND DISCUSSION

The results of the data collection process through interviews and company report documentation are as follows: The alternatives used were obtained from all the services available at Pitcar Service, as shown in Table 1.

Table 1. Service Priority Alternatives

Code	Alternative
A1	Workshop Service
A2	Pick Up Service
A3	Emergency Service
A4	Home Service
A5	Variasi
A6	B2B

The criteria and weight assessments for determining service development priorities set by the company's CEO are found in Table 2.

Table 2. Service Selection Criteria

Code	Criteria
C1	Number of Requests
C2	Average Revenue per Job
C3	Tools
C4	Mechanics
C5	Work Time

The weight assessment for criteria C1, Number of Requests, is explained in Table 3.

Table 3. Weight Criteria for Number of Requests

Number of Requests	Weight
>50	5
35-49	4
20-35	3
7-20	2
<7	1

The weight assessment for criteria C2, Average Revenue per Job, is explained in Table 4.

Table 4. Weight Criteria for Average Revenue per Job

Average Revenue per Job	Weight
>Rp 1.000.000	5
Rp 750.000 – Rp 1.000.000	4
Rp 500.000 – Rp 750.000	3
Rp 200.000 – Rp 500.000	2
<Rp 200.000	1

The weight assessment for criteria C3, Tools, is explained in Table 5.

Table 5. Weight Criteria for Tools

Tools	Weight
Non-moving equipment in workshop	5
Service vehicle	4
Several toolboxes & service vehicles	3
Towing/Third-party equipment	2

The weight assessment for criteria C4, Mechanics, is explained in Table 6.

Table 6. Weight Criteria for Mechanics

Mechanics	Weight
1-2 Mechanics	5
3-5 Mechanics	3
>5 Mechanics	1

The weight assessment for criteria C5, Work Time, is explained in Table 7.

Table 7. Weight Criteria for Work Time

Work Time	Weight
<2 Hours	5
<6 Hours	4
<24 Hours	3
>24 Hours	2

The steps in data management using the ELECTRE method (Novaliendry & Pusparani, 2019) are as follows:

A. Determination of the Decision Matrix (X)

This stage is crucial because the weighting assigned to each criterion and alternative will impact the results of the research. The weighting of alternatives and criteria used in the research is presented in Table 8.

Table 8. Weighting of Alternatives and Criteria

	C1	C2	C3	C4	C5
A1	5	4	5	5	5
A2	5	5	4	5	4
A3	5	3	2	3	4
A4	2	3	3	5	4
A5	3	2	3	5	4
A6	2	5	5	5	4

If the tables above are represented in the form of a decision matrix, the result is as follows:

$$X = \begin{bmatrix} 5 & 4 & 5 & 5 & 5 \\ 5 & 5 & 4 & 5 & 4 \\ 5 & 3 & 2 & 3 & 4 \\ 2 & 3 & 3 & 5 & 4 \\ 3 & 2 & 5 & 3 & 4 \\ 2 & 5 & 5 & 5 & 4 \end{bmatrix}$$

B. Normalization of the Decision Matrix (R)

The purpose of normalizing the decision matrix is to convert each attribute into comparable values. This is essential because different criteria may have different units or scales, making direct comparison difficult. Normalization is performed using the following formula:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij^2}}} \quad (1)$$

Explanation:
r_{ij} = Normalized performance rating
x_{ij} = Row and column of the matrix
m = Number of alternatives

Thus, matrix R is obtained as the result of the normalization process.

$$R = \begin{bmatrix} 0{,}5213 & 0{,}4264 & 0{,}4903 & 0{,}4603 & 0{,}4880 \\ 0{,}5213 & 0{,}5330 & 0{,}3922 & 0{,}4603 & 0{,}3904 \\ 0{,}5213 & 0{,}3198 & 0{,}1961 & 0{,}2762 & 0{,}3904 \\ 0{,}2085 & 0{,}3198 & 0{,}2942 & 0{,}4603 & 0{,}3904 \\ 0{,}3128 & 0{,}2132 & 0{,}4903 & 0{,}2762 & 0{,}3904 \\ 0{,}2085 & 0{,}5330 & 0{,}4903 & 0{,}4603 & 0{,}3904 \end{bmatrix}$$

C. Assigning Weight Values (W)

Criteria weighting is carried out to understand the importance of each criterion in decision-making, as presented in Table 9.

Table 9. Criteria Weighting

Code	Criteria	Weight
C1	Number of Requests	3
C2	Average Revenue per Job	3
C3	Tools	1
C4	Mechanics	1
C5	Work Time	2

The weight values were obtained through interviews with the owner, who provided insights into which criteria hold the highest priority. The weights were assigned on a scale from 1 to 5, with 1 representing the lowest priority and 5 representing the highest. Table 9 shows that the highest weight are number of request and average revenue per job. Meanwhile, the lowest is for tools and mechanics.

D. Forming the Weighted Eliminated Matrix (V)

The calculation process to obtain the preference matrix is shown below:

$$V_{ij} = W_i R_{ij} \quad (2)$$

Explanation:
V_{ij} = Final value of Alternatives and Criteria
W_i = Assigned weight
R_{ij} = Normalized matrix

Thus, matrix V is obtained as follows:

$$V = \begin{bmatrix} 1{,}5639 & 1{,}2792 & 0{,}4903 & 0{,}4603 & 0{,}9759 \\ 1{,}5639 & 1{,}5990 & 0{,}3922 & 0{,}4603 & 0{,}7808 \\ 1{,}5639 & 0{,}9594 & 0{,}1961 & 0{,}2762 & 0{,}7808 \\ 0{,}6255 & 0{,}9594 & 0{,}2942 & 0{,}4603 & 0{,}7808 \\ 0{,}9383 & 0{,}6396 & 0{,}4903 & 0{,}2762 & 0{,}7808 \\ 0{,}6255 & 1{,}5990 & 0{,}4903 & 0{,}4603 & 0{,}7808 \end{bmatrix}$$

By multiplying the assigned weights W_i by the corresponding normalized value R_{ij} the final matrix is obtained, which shows the weighted values for each alternative relative to each criterion. This matrix V represents the weighted values of the alternatives across all criteria after applying the weights to the normalized values. These weighted values are then used to evaluate the alternatives based on their performance across different criteria.

E. Determining the Concordance (C) and Discordance (D) Sets

The concordance set $\{C_{kl}\}$ indicates that the weighted criteria calculation of A_k

$$C_{kl} = \{j | V_{kj} \geq V_{ij}\} \text{ dengan j = 1,2,...,n} \quad (3)$$

as a better value than A1 with other possible outcomes.

$$D_{kl} = \{j | V_{kj} < V_{ij}\} \text{ dengan j = 1,2,...,n} \quad (4)$$

Explanation:
C_{kl} = Concordance Set
D_{kl} = Discordance Set
V_{kJ} = Matrix value for alternatives and criteria
V_{IJ} = Matrix value for alternatives and criteria

Below are the results of determining the Concordance set:

$$C_{kl} = \begin{bmatrix} - & 1,3,4,5 & 1,2,3,4,5 & 1,2,3,4,5 & 1,2,3,4,5 & 1,3,4,5 \\ 1,2,4 & - & 1,2,3,4,5 & 1,2,3,4,5 & 1,2,4,5 & 1,2,4,5 \\ 1 & 1,5 & - & 1,2,5 & 1,2,4,5 & 1,5 \\ 4 & 4,5 & 2,3,4,5 & - & 2,4,5 & 1,4,5 \\ 3 & 3,5 & 3,4,5 & 1,3,5 & - & 1,3,5 \\ 2,3,4 & 2,3,4,5 & 2,3,4,5 & 1,2,3,4,5 & 2,3,4,5 & - \end{bmatrix}$$

Below are the results of determining the Discordance set:

$$D_{kl} = \begin{bmatrix} - & 2 & - & - & - & 2 \\ 3,5 & - & - & - & 3 & 3 \\ 2,3,4,5 & 2,3,4 & - & 3,4 & 3 & 2,3,4 \\ 1,2,3,5 & 1,2,3 & 1 & - & 1,3 & 2,3 \\ 1,2,4,5 & 1,2,4 & 1,2 & 2,4 & - & 2,4 \\ 1,5 & 1 & 1 & - & 1 & - \end{bmatrix}$$

C_{kl} indicates which alternatives of A_k have higher or equal weighted values. Conversely, D_{kl} indicates the criteria where alternative A_k is lower than A_l. In conclusion, the Discordance Set collects the criteria where alternative is less favorable than alternative based on the weighted values.

F. Forming the Concordance (C) and Discordance (D) Matrices

To obtain the concordance matrix, add the weights found in the concordance matrix using the following formula:

$$C_{kl} = \sum_{j \in C_{kl}} W_j \quad (5)$$

The discordance matrix is calculated by dividing the maximum difference between criteria included in the discordance set by the highest difference among all existing criteria values.

$$D_{kl} = \frac{max\{|V_{kj} - V_{ij}\}\ j \epsilon D_{kl}}{max\{|V_{kj} - V_{ij}\}\quad v_j} \quad (6)$$

Below are the results of the concordance matrix calculations:

$$C = \begin{bmatrix} - & 7 & 10 & 10 & 10 & 7 \\ 7 & - & 10 & 10 & 9 & 9 \\ 3 & 5 & - & 8 & 9 & 5 \\ 1 & 3 & 7 & - & 6 & 6 \\ 1 & 3 & 4 & 6 & - & 6 \\ 5 & 7 & 7 & 10 & 7 & - \end{bmatrix}$$

Below are the results of the discordance matrix calculations:

$$D = \begin{bmatrix} - & 1 & 0 & 0 & 0 & 0{,}3408 \\ 0{,}6103 & - & 0 & 0 & 0{,}1022 & 0{,}1045 \\ 1 & 1 & - & 0{,}1962 & 0{,}4703 & 0{,}6816 \\ 1 & 1 & 1 & - & 0{,}9780 & 1 \\ 1 & 1 & 1 & 1 & - & 1 \\ 1 & 1 & 1 & 0 & 0{,}3260 & - \end{bmatrix}$$

The Discordance Matrix D indicates the degree of discordance between pairs of alternatives based on the weighted values of the criteria. For example, D_{12}=1 in D, indicates that there is a strong discordance between alternative 1 and alternative 2 for the relevant criteria.

G. Determining the Dominant Concordance Matrix (F)

The first step in calculating the dominant concordance matrix is to determine the threshold value $\underline{C}$ using the following formula:

$$\underline{C} = \frac{\sum_{k=1}^{m} \sum_{t=1}^{m} C_{kl}}{m(m-1)} \quad (7)$$

$$F_{kl} = \left\{ \frac{1, jika\ C_{kl} \geq \underline{C}}{0, jika\ C_{kl} \leq \underline{C}} \right\} \quad (8)$$

The results of the dominant concordance matrix calculation are as follows:

$$F = \begin{bmatrix} - & 1 & 1 & 1 & 1 & 1 \\ 1 & - & 1 & 1 & 1 & 1 \\ 0 & 0 & - & 1 & 1 & 0 \\ 0 & 0 & 1 & - & 0 & 0 \\ 0 & 0 & 0 & 0 & - & 0 \\ 0 & 1 & 1 & 1 & 1 & - \end{bmatrix}$$

The dominant concordance matrix is generated by comparing each element of the original concordance matrix with the threshold value. If the element is greater than or equal to the threshold, it is marked as 1 (indicating dominance); otherwise, it is marked as 0 (indicating no dominance).

H. Determining the Dominant Discordance Matrix (G)

The process for determining the threshold value $\underline{D}$ uses the following formula:

$$\underline{D} = \frac{\sum_{k=1}^{m} \sum_{l=1}^{m} D_{kl}}{m\ (m-1)} \quad (9)$$

The result of the threshold value $\underline{D}$ calculation is 0.6270. The dominant element in the discordance matrix G is defined as follows:

$$G_{kl} = \left\{ \frac{1, jika\ D_{kl} \geq \underline{D}}{0, jika\ D_{kl} < \underline{D}} \right. \quad (10)$$

The result of forming the dominant discordance matrix is as follows:

$$G = \begin{bmatrix} - & 1 & 0 & 0 & 0 & 0 \\ 0 & - & 0 & 0 & 0 & 0 \\ 1 & 1 & - & 0 & 0 & 1 \\ 1 & 1 & 1 & - & 1 & 1 \\ 1 & 1 & 1 & 1 & - & 1 \\ 1 & 1 & 1 & 0 & 0 & - \end{bmatrix}$$

The threshold $\underline{D}$ is calculated by averaging all the values in the discordance matrix and normalizing by the number of alternatives. The dominant discordance matrix is generated by comparing each element of the original discordance matrix to the threshold value. Same as above explanation, the discordance matrix also indicates that 1 is dominance and 0 is no dominance.

I. Determining the Dominant Aggregation Matrix (E)

The overall dominant matrix is the result of the multiplication between the elements of matrix F and the equal elements of matrix G.

$$E_{kl} = F_{kl} * G_{kl} \quad (11)$$

The result of the dominant aggregation matrix calculation is as follows:

$$E = \begin{bmatrix} - & 1 & 0 & 0 & 0 & 0 \\ 0 & - & 0 & 0 & 0 & 0 \\ 0 & 0 & - & 0 & 0 & 0 \\ 0 & 0 & 1 & - & 0 & 0 \\ 0 & 0 & 0 & 0 & - & 0 \\ 0 & 1 & 1 & 0 & 0 & - \end{bmatrix}$$

If the matrix is presented in tabular form, the result will appear as in Table 10.

Table 10. Dominant Aggregation Results

	A1	A2	A3	A4	A5	A6	Total	Rank
A1	-	1	0	0	0	0	1	2
A2	0	-	0	0	0	0	0	4
A3	0	0	-	0	0	0	0	5
A4	0	0	1	-	0	0	1	3
A5	0	0	0	0	-	0	0	6
A6	0	1	1	0	0	-	2	1

J. Alternative Elimination Process

Based on the ranking results, service A6, which is B2B (Business-to-Business), ranks the highest. This indicates that the alternative that is the top priority for development at Pitcar Service Purwokerto is the B2B service. B2B service in the context of a car workshop can be understood as establishing partnerships through work contracts to maintain and repair a number of vehicles owned by business partners. B2B customers usually have long-term relationships, resulting in stable and sustainable revenue.

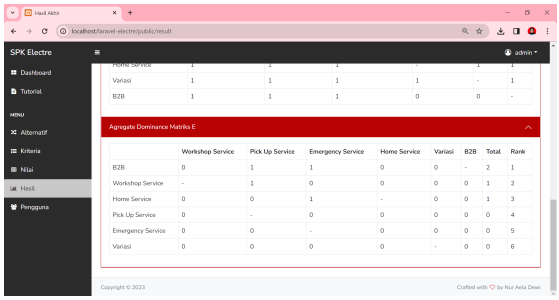

Figure 2. Dominant aggregations result in the system

To ensure that the system built is successful and in line with the calculation process above, the result is compared with each other. The calculation shown in Table 10 shows that the highest dominant aggregation is in alternative 6. Meanwhile, as shown in Figure 2, the result of the system also depicts the same result.

Based on the results, B2B (Business-to-Business) services are ranked highest. This shows that the alternative, which is the main priority for development in the Pitcar Service Purwokerto car workshop, is B2B services. B2B services in the context of a car workshop can be interpreted as establishing cooperation through work contracts to maintain and repair a number of vehicles owned by business partners. B2B customers usually have long-term relationships that have an impact on stable and sustainable income. Therefore, by prioritizing the development of B2B services, Pitcar Service Purwokerto can take advantage of opportunities to increase revenue and business growth of the company. However, it is also important not to ignore other services. Each service has its own potential and opportunities, the right strategy can help maximize the potential of each service

CONCLUSION

The research on decision support systems for determining service development priorities at Pitcar Service Purwokerto provides information about the ranking of all services. This data is expected to serve as a guideline for the company in setting service development priorities. This study confirms that the ELECTRE method assists in decision-making, indicating that the main focus of service development at Pitcar Service Purwokerto is in the B2B (Business-to-Business) sector.

In future research, the priority selection of services can be calculated using other methods. This allows the analysis results to be used to compare service rankings for stakeholders. By comparing the results from various methods, the company can better understand the service development priorities that need to be undertaken.

REFERENCES

Akram, M., Luqman, A., & Alcantud, J. C. R. (2022). An integrated ELECTRE-I approach for risk evaluation with hesitant Pythagorean fuzzy information. *Expert Systems with Applications*, *200*, 116945.

Akram, M., Zahid, K., & Deveci, M. (2023). Multi-criteria group decision-making for optimal management of water supply with fuzzy ELECTRE-based outranking method. *Applied Soft Computing*, *143*, 110403.

Aldo, D. (2019). Pemilihan Bibit Lele Unggul dengan Menggunakan Metode Weighted

Product. *Jurnal Teknologi Dan Open Source*, *2 No. 1*.

Chakraborty, S., Raut, R. D., Rofin, T. M., Chatterjee, S., & Chakraborty, S. (2023). A comparative analysis of Multi-Attributive Border Approximation Area Comparison (MABAC) model for healthcare supplier selection in fuzzy environments. *Decision Analytics Journal*, *8*, 100290. https://doi.org/10.1016/j.dajour.2023.100290

Fahmi, A., Kahraman, C., & Bilen, Ü. (2016). ELECTRE I Method Using Hesitant Linguistic Term Sets: An Application to Supplier Selection. *International Journal of Computational Intelligence Systems*, *9*(1), 153. https://doi.org/10.1080/18756891.2016.1146532

Febriani, A., Melyanti, R., & Gunawan. (2022). Sistem Pendukung Keputusan Penerimaan Bantuan Pendidikan Menggunakan Metode Electre di SMP Negeri 2 Rengat Barat. *Jurnal Ilmu Komputer*, *11*(1), 57–61. https://doi.org/10.33060/jik/2022/vol11.iss1.255

Fonou-Dombeu, J. V. (2019). *Ranking Semantic Web Ontologies with ELECTRE*.

Naufal, M. R., Rifqi Maulana, M., & Aly, M. K. (2022). *Sistem Pendukung Keputusan dalam Pemilihan Mobil LCGC dengan Metode ELECTRE Berbasis Website*.

Novaliendry, D., & Pusparani, Y. (2019). Rancang Bangun Aplikasi Sistem Pendukung Keputusan Seleksi Pemilihan Destinasi Pariwisata Sumatera Barat Menggunakan Metode Electre. *Jurnal Teknologi Informasi Dan Pendidikan*, *12*(1), 1–10. https://doi.org/10.24036/tip.v12i1.178

Pan, X., Kang, Y., Lu, J.-F., & Yu, X.-Z. (2025). Using the TOPSIS method to select the best low-toxicity organic cosolvent for rice-based toxicity tests. *Ecotoxicology and Environmental Safety*, *290*, 117733. https://doi.org/10.1016/j.ecoenv.2025.117733

Putri Pratiwi, I., Ferdinandus, F., Daniel Limantara, A., Tinggi Teknologi Cahaya Surya Kediri, S., & Tinggi Teknik Surabaya, S. (2019). *Sistem Pendukung Keputusan Penerima Program Keluarga Harapan (PKH) Menggunakan Metode Simple Additive Weighting* (Vol. 8, Issue 2).

Rahmalisa, U. (2019). Sistem Pendukung Keputusan Pemilihan Rumah Menggunakan Metode Electre Berbasis Web. *Jurnal Ilmu Komputer*, *8*(1), 123–127.

Ramadhanti, L. C., Ida Bagus Sumantri, & Koswara, A. (2022). Integrasi Digital Lean Automation dengan IoT untuk Efisiensi Proses Assembly di Industri Otomotif. *Journal of Engineering Environtmental Energy and Science*, *1*(1), 15–28. https://doi.org/10.31599/joes.v1i1.971

Salvador, G., Moura, M., Campos, P., Cardoso, P., Espadinha-Cruz, P., & Godina, R. (2024). ELECTRE applied in supplier selection – a literature review. *Procedia Computer Science*, *232*, 1759–1768. https://doi.org/10.1016/j.procs.2024.01.174

Satria, B., Santoso, A., Wahyuni, S., Winata, N., Annisa, S., Lubis, Z., & Muhazzir, A. (2019). Penerapan Metode Electre Sebagai Sistem Pendukung Keputusan Dalam Penerimaan Beasiswa. *Cetak) Buletin Utama Teknik*, *14*(3), 1410–4520.

Singh, T., Pattnaik, P., Kumar, S. R., Fekete, G., Dogossy, G., & Lendvai, L. (2022). Optimization on physicomechanical and wear properties of wood waste filled poly(lactic acid) biocomposites using integrated entropy-simple additive weighting approach. *South African Journal of Chemical Engineering*, *41*, 193–202. https://doi.org/10.1016/j.sajce.2022.06.008

Teixeira de Almeida, A. (2007). Multicriteria decision model for outsourcing contracts selection based on utility function and ELECTRE method. *Computers & Operations Research*, *34*(12), 3569–3574. https://doi.org/10.1016/j.cor.2006.01.003

Vincke, P. (1992). *Multicriteria Decision-Aid*. John Wiley & Sons, Inc.

Wulan Sari, R., & Perdana Windarto, A. (2019). *Penerapan ElectreePada Seleksi Proposal Program Kreativitas Mahasiswa (PKM) di STIKOM Tunas Bangsa*.

Yang, G., Wang, L., Gu, W., Gu, J., Fan, D., Liang, M., Liu, J., & Wang, Z. (2024). Soil ecological risk assessment of ten industrial areas in China based on the TRIAD and VIKOR methods. *Ecological Indicators*, *166*, 112270. https://doi.org/10.1016/j.ecolind.2024.112270