Enrichment: Journal of Management, 15 (1) (2025)

Published by: Instiute of Computer Science (IOCS)

Enrichment: Journal of Management

Journal homepage: www.enrichment.iocspublisher.org

Application of ELECTRE and TOPSIS methods in selecting synthetic lubricating oil suppliers to minimize delays in aircraft maintenance activities

Yasrin Zabidi[1], Esa Rengganis[2], Harliyus A, S[3], Fajar Khanif R[4]

[1,2] Departement of Industrial Engineering, Institut Teknologi Dirgantara Adisutjipto, Yogyakarta, Indonesia

[3] Departement of Informatic, Institut Teknologi Dirgantara Adisutjipto, Yogyakarta, Indonesia

[4] Departement of Aerospace Enggineering, Institut Teknologi Dirgantara Adisutjipto, Yogyakarta, Indonesia

ARTICLE INFO

Article history:

Received Mar 29, 2025
Revised Apr 03, 2025
Accepted Apr 10, 2025

Keywords:

Aircraft Maintenance;
ELECTRE;
Supplier;
TOPSIS.

ABSTRACT

One of the obstacles often faced when carrying out aircraft maintenance activities is the unavailability of lubricating oil that meets the established quality standards due to delays in the supply of lubricating oil from suppliers. In order for maintenance activities to be carried out according to the specified schedule, continuous availability of lubricating oil from suppliers is needed. Therefore, it is necessary to conduct research on the selection of reliable or trustworthy lubricating oil suppliers in supplying lubricating oil needs that meet the established quality standards. In selecting a lubricating oil supplier, the ELECTRE and TOPSIS methods are combined, where the ELECTRE method is used to process the weight of each supplier criterion and the TOPSIS method is used to rank alternative solutions obtained from the ELECTRE method classification.It is hoped that by combining these methods, recommendations for reliable suppliers can be provided. The suppliers selected as partners for providing lubricating oil are supplier C with an A* value of 3.090 and supplier B with an A* value of 2.973. The selection of suppliers is based on supplier performance with 6 criteria, namely the quality of lubricating oil, the price of lubricating oil, the responsiveness of the supplier's service and response, the speed of delivery to partner expeditions and the policy of replacing damaged or leaking lubricating oil.

Corresponding Author:

Yasrin Zabidi,
Department of Industrial Engineering,
Institut Teknologi Dirgantara Adisutjipto,
Jl. Janti Blok R Lanud Adisutjipto, Yogyakarta, Indonesia.
Email: yasrin@itda.ac.id

INTRODUCTION

Aircraft Maintenance is a periodic inspection that needs to be done on all components of a civil or commercial aircraft after a predetermined time limit or usage. In certain conditions, military aircraft also need to get the same thing at an aircraft repair shop. Airlines and other commercial operators with large or turbine-powered aircraft follow a continuous inspection program approved by the Federal Aviation Administration or FAA in the United States. In Indonesia, it is called the Directorate General of Civil Aviation. Under the supervision of each respective aviation authority, each operator needs to prepare a Maintenance Planning Document and approve the Continuous Airworthiness Maintenance Program or CAMP as a reference for aircraft maintenance by the operator, which includes routine and detailed maintenance. This is what makes many airlines carry out various aircraft maintenance efforts, for the comfort of their users.

Scheduled maintenance is maintenance that is carried out periodically and sequentially without looking at the aircraft being damaged or still in very good condition, for example, on a certain date the aircraft must undergo a maintenance process even though the aircraft is still relatively new, namely one month old, then the aircraft must still undergo a maintenance process according to existing procedural standards. In the maintenance process, no part, no matter how small, in the aircraft including the wheels, aircraft skin, wings, masts and floors is missed from the inspection process. Cost is the most important thing in this maintenance process because of course the replacement of damaged or defective spare parts is very expensive for one aircraft so that some airline company management needs to take action for maintenance efficiency such as only being able to operate one to three types of aircraft.

In aircraft maintenance, the need for materials or components is a fundamental thing besides certified workers, modern equipment and other facilities that support aircraft maintenance. One of the most important materials in aircraft maintenance is synthetic lubricating oil. The main function of lubricating oil is to reduce or control friction between two metal surfaces that are attached to each other. Thanks to the lubricant, the movement of the metal will be smoother. Almost all engines use lubricants and the selection of lubricants is highly dependent on the engine manufacturer. Aircraft engines in determining their lubricants must be truly selected in order to ensure their function and reliability so that they can meet engine operations during flight.

One of the obstacles often faced when carrying out aircraft maintenance activities is the unavailability of lubricating oil that meets the established quality standards due to delays in the supply of lubricating oil from suppliers. In order for maintenance activities to be carried out according to the specified schedule, it is necessary to have continuous availability of lubricating oil from suppliers. Therefore, it is necessary to conduct research on the selection of reliable or trustworthy lubricating oil suppliers in supplying lubricating oil needs that meet the established quality standards.

This study uses a combination of 2 methods, namely the ELECTRE and TOPSIS methods in selecting lubricating oil suppliers, where the ELECTRE method is used to process the weights of each supplier criterion and the TOPSIS method is used to rank alternative solutions obtained from the results of the ELECTRE method classification (Liern & Pérez-Gladish, 2022). This is because ELECTRE cannot perform the ranking process so that by using the TOPSIS method it is expected to find the best alternative supplier (Ali Al-Shamiri et al., 2023). The combination of these two methods is what distinguishes this study from previous studies that only use ELECTRE or TOPSIS. In addition, the object studied is also different from previous studies, where in this study the object is in the aircraft maintenance manufacturing industry, especially lubricating oil.

The TOPSIS method can be used for the selection of environmentally friendly suppliers in the food industry (Hajiaghaei-Keshteli et al., 2023), assessment of sustainable cities and communities (Wątróbski et al., 2022), evaluation of geothermal energy applications published in the region (Li et al., 2022), evaluation and selection of strategies in urban flood resilience (Ji & Wang, 2023), selection of doctors based on sentiment based (Wang et al., 2023), selection of suppliers to support environmental poverty (Asadabadi et al., 2023), selection of virtual team members for smart port development projects(Jin, 2023), ranking of food baskets for stunting prevention (Yaqin et al., 2024), evaluation of Metaverse traffic safety implementation (Deveci et al., 2023) and can be used for decision-making problems with hierarchical and non-monotonic criteria (Corrente & Tasiou, 2023).

The ELECTRE method can be used for emergency shelter site selection (Fei et al., 2024), supplier selection (Salvador et al., 2024), comparative bicycle path selection for sustainable tourism in Franciacorta (Carra et al., 2023), cotton fabric selection (Ye & Chen, 2023), determining the Priority of Poor Rice Recipients (Yosi et al., 2020). In addition, the ELECTRE method can be used in multicriteria decision making for sustainable deep sea mining transportation plans (Ma et al., 2022), risk evaluation with (Akram et al., 2022) and can be used in multicriteria group decision making for optimal air supply management (Akram et al., 2023). It is expected that the combination of TOPSIS and ELECTRE methods can provide reliable supplier recommendations.

RESEARCH METHOD

To solve the problem of selecting a lubricating oil supplier, it is necessary to collect data. The method that will be used in collecting data is as follows:

1) Respondent Selection

Respondents of the questionnaire for selecting suppliers of lubricant oil are all personnel working in the Purchasing and warehousing division totaling 5 people consisting of 1 Purchasing Manager, 1 Purchasing Planning Manager, 1 Buyer, 1 Assistant and 1 Logistic Inventory Controller. The Purchasing and warehousing division has the authority to determine suppliers and consider supplier management, so that the data taken will be representative, valid and unbiased.

2) Distribution of questionnaires by respondents

The data used is supplier performance data for each criterion as a comparison material in the respondent's assessment. Here, the level of importance of the criteria from the existing criteria will also be explained. The criteria to be used in the supplier selection questionnaire are as follows:

a. Lubricating oil quality.

This quality criterion is the most important criterion according to the maintenance section. In this criterion, the best quality offered by the supplier will be sought.

b. Supplier response agility when ordering and complaints when purchasing

Criteria for response to claims are included, because suppliers must have the ability to provide services to companies that complain, for goods sent by suppliers by responding quickly and responsively.

c. Accuracy of fulfillment of shipping schedules.

Accuracy of fulfillment of shipping schedules is something that must be considered by suppliers. It is expected that suppliers must pay attention to when orders are sent immediately so that orders arrive on time so that maintenance activities are not disrupted.

d. Accuracy of the Number of Products Sent

This reflects how well the company is in sending the amount that matches the order placed by customers or other internal units. This can be influenced by efficiency in the process of picking, packaging, and shipping goods, as well as accuracy in processing orders.

e. Speed of delivery of lubricating oil.

The delivery speed criteria are used as a benchmark for suppliers in sending goods to the company, because suppliers often delay delivery and do not comply with the specified schedule. The delivery speed criteria are seen from the supplier's ability to send goods on time, because in this case if the supplier experiences a delay in delivery, it will hinder maintenance and repair activities.

f. Price

This criterion will look for prices offered by suppliers with cheap prices, prices that are not fluctuating and there is no price difference that is far from the company's target.

Data processing to be carried out in this study is carried out in two stages, where stage 1 is to find recommended suppliers based on predetermined criteria using the ELECTRE method (Chen et al., 2024). Stage 2 is to select suppliers who have the highest preference value using the TOPSIS method (Maulita et al., 2018) , (Chakraborty, 2022).

RESULTS AND DISCUSSIONS

The initial process of supplier selection begins with filling out a questionnaire by the Purchasing Manager, Purchasing Planning Manager, Purchaser, Assistant, Logistic Inventory Controller for 5 supplier companies with 6 criteria, namely lubricating oil quality (K1), lubricating oil price (K2), supplier response agility (K3), accuracy of the amount of lubricating oil sent (K4), speed of delivery to partner expeditions (K5) and replacement policy for leaking lubricating oil packaging (K6). The questionnaire is then tabulated into a table. The recapitulation results can be seen in the following table 1.

Table 1. Summary Results of Questionnaire Completion

No	Alternative	C1 (5)	C2 (5)	C3 (3)	C4 (4)	C5 (3)	C6 (4)	Supplier Average Rating	Pk Preference Value	Supplier ranking A*
1	A	4.2	4.4	3.4	4.2	4.4	4.4	4.167	-1.134	5
2	B	4.6	4.4	4.4	3.6	3.2	4.2	4.067	2.973	2
3	C	4.4	3.6	3.2	3.2	4.2	4.4	3.833	3.090	1
4	D	4.6	4.4	4.6	3.6	4.6	4.4	4.367	0.078	3
5	E	4.2	3.6	3.2	4.4	3.4	4.2	3.833	0.000	4
Average Value of Criteria		4.4	4.08	3.76	3.8	3.96	4.32			

Looking at the data in table 1 it can be said that supplier D has the highest average score of 4.367, with the highest scores in K1, K3 and K5, and has the lowest score in K4. After reviewing the conditions in the field, supplier D is indeed superior for criteria K1, K3 and K5. For K4, supplier D often sends orders that are not in accordance with the amount ordered. The cause of the lack of orders sent is supplier D's inaccuracy when calculating and packing orders before sending. Meanwhile, supplier C has the lowest average score when compared to the other four suppliers. Supplier C has the highest score for lubricating oil quality and accuracy.

Based on the results of data processing using a combination of ELECTRE and TOPSIS methods, the results of supplier ranking are obtained. Supplier C has an A* value of 3.090, supplier B has an A* value of 2.973, supplier D has an A* value of 0.078, supplier E has an A* value of 0, and supplier A has an A* value of -1.134. It can be said that suppliers who are worthy of being partners are suppliers C, B and D. While suppliers E and supplier A are not recommended as partners or suppliers of lubricating oil. This is because supplier E has an A* value of 0, and supplier A has an A* value of -1.134. The A* value of zero and negative for suppliers E and supplier A means that suppliers E and supplier A have performance that does not meet the criteria set by lubricating oil users.

This TOPSIS method can be used in determining alternative rankings by calculating the ideal solution to a problem and determining the weight of each criterion (Ciardiello & Genovese, 2023). However, it is not good if used in obtaining weights that take into account the relationship between criteria. Although it can be done with pairwise comparison, it requires a more complicated matrix and calculation.

In the process using the TOPSIS method, the ranking and weighting of the criteria have definite values. In fact, in its application in real life, there is incomplete information or the information needed is not available. An example of the cause of incomplete information is because of human judgment which is often uncertain/fuzzy and cannot estimate the ranking in definite numerical data. This uncertainty is something that cannot be overcome using the TOPSIS method, unless further algorithm calculations are carried out in the formulation of the TOPSIS method. The TOPSIS method determines the solution based on the shortest distance to the ideal solution and the greatest distance from the ideal negative solution (Nurhaliza & Adha, 2022). However, this method does not consider the relative importance of each of these distances. In the TOPSIS method, the alternative with the highest ranking is the best solution, but it is not necessarily the highest ranking that is closest to the ideal solution. So it is necessary to do another calculation to make sure.

CONCLUSION

This research that combines the ELECTRE and TOPSIS methods produces suppliers selected as partners for providing lubricating oil, namely supplier C with an A* value of 3,090 and supplier B with an A* value of 2,973. Supplier selection is based on supplier performance with 6 criteria, namely lubricating oil quality, lubricating oil price, responsiveness of service and supplier response, speed of delivery to partner expeditions and policies for placing damaged or leaking lubricating oil. The combination of the ELECTRE and TOPSIS methods can be used for further research in the aircraft maintenance industry for objects other than lubricating oil, such as spare parts, oil filters, and others so that reliable suppliers can be obtained. Practical implications for aircraft maintenance industry companies (decision makers) are that this research can be directly applied in selecting oil suppliers, it is hoped that this research can be continued for logistics other than lubricating oil. Practical implications for academics, that the combination of these two methods can be applied in multi-criteria supplier selection, where the ELECTRE method is used to process the weight of each supplier criterion and the TOPSIS method is used to rank alternative solutions obtained from the results of the ELECTRE method classification. This is because ELECTRE cannot perform the ranking process so that the use of the TOPSIS method is expected to find the best alternative supplier.

ACKNOWLEDGEMENTS

The researcher would like to thank the Institut Teknologi Dirgantara Adisutjipto for funding this research through the middle internal research fund.

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