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Identification, Weighting, and Ranking of Green Suppliers Using Multi-Criteria Decision-Making Methods

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1. ABSTRACT

This research aims to identify, weight, and rank green suppliers for the National Iranian Oil Products Distribution Company (NIORDC). A comprehensive review of the scientific literature and expert opinions led to the identification of 73 preliminary criteria. These were screened down to 10 key criteria using the Content Validity Index (CVI). Weighting of criteria was performed using AHP, CRITIC, and Shannon Entropy methods, while supplier ranking was achieved using TOPSIS, CoCoSo, and MARCOS methods. The projector product was selected as a case study, with three suppliers (Golnoor, MaziNoor, and Shayan Bargh) evaluated. The results indicated that the most influential criteria in the decision-making process were cost, product quality, on-time delivery, greenhouse gas emissions, and employee training. Golnoor achieved the highest rank across all methods with a final weight of 0.394, followed by Shayan Bargh and Mazi Noor with weights of 0.316 and 0.291, respectively. The findings demonstrate the effectiveness of Multi-Criteria Decision-Making methods in enhancing the transparency and objectivity of the supplier selection process. By integrating environmental and social criteria with traditional economic considerations, this study offers valuable insights into sustainable procurement practices. The results provide NIORDC with a clear framework for selecting green suppliers, contributing to the company's environmental goals and overall efficiency.

Keywords: Multi-Criteria Decision Making, National Iranian Oil Products Distribution Company, Green Supplier Selection, Expert Choice Software.

2. INTRODUCTION

In recent decades, environmental concerns have become a central issue for organizations, particularly in industries with significant ecological footprints, such as the oil and gas sector. The demand for sustainable practices and compliance with environmental regulations has led organizations to adopt green supply chain management approaches. This includes integrating environmental, social, and economic factors in the decision-making process for selecting suppliers. The importance of green supply chain management is evident in the increasing awareness of environmental impacts and the pressures from stakeholders to minimize such effects. The concept of green supplier selection focuses on evaluating suppliers not only based on traditional performance metrics such as cost and quality but also considering their environmental and social responsibility, including energy use, emissions, and waste management practices.

Several studies have employed MCDM methods to enhance the green supplier selection process. These methods offer a systematic way to integrate multiple criteria, making the decision-making process more transparent and objective.

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Previous works, such as those by Ahi and Searcy [1], and Rao and Holt [2], have explored various MCDM techniques like Analytic Hierarchy Process (AHP), TOPSIS, and Shannon Entropy for evaluating green suppliers in diverse industries. However, limited studies have focused on the application of these methods in the oil and gas industry, particularly for organizations like the National Iranian Oil Products Distribution Company.

This research aims to fill this gap by providing a comprehensive framework for selecting green suppliers using MCDM methods. The study presents a case of the projector product procurement in NIORDC, evaluating suppliers based on both traditional and green criteria to contribute to sustainable supply chain practices.

3. MATERIALS AND METHODS

In the initial phase of this study, influential criteria for green supplier selection were identified through a review of academic literature and expert opinions. These criteria included service quality, cost, compliance with environmental standards, waste management, energy consumption, and social responsibility. The criteria were then weighted using the AHP, CRITIC, and Shannon Entropy methods. AHP determined the relative importance of each criterion through pairwise comparisons and expert judgments, while CRITIC and Shannon Entropy calculated weights based on the dispersion and objectivity of the data. For the final supplier ranking, three Multi-Criteria Decision-Making methods of TOPSIS [3], CoCoSo [4], and MARCOS [5] were employed. TOPSIS assessed suppliers based on their distance from ideal and anti-ideal solutions. CoCoSo combined geometric and arithmetic averages to identify the best alternative, and MARCOS provided a more comprehensive analysis using both positive and negative ideal references. The study adopted a mixed-method (quantitative and qualitative) approach to analyze and rank green suppliers for the National Iranian Oil Products Distribution Company. Data analysis was conducted using AHP, TOPSIS, CoCoSo, MARCOS, and CRITIC methods, supported by Expert Choice, Excel, and MATLAB software.

3.1 Identification and Screening of Criteria

Initially, a list of 73 potential criteria was identified based on a review of the scientific literature and expert opinions. These criteria were divided into four categories: environmental, social, economic, and operational. Using the Content Validity Index (CVI), 10 key criteria were selected for further analysis, ensuring they met the criteria of simplicity, clarity, and relevance. The selected criteria included cost, product quality, on-time delivery, greenhouse gas emissions, and employee training.

3.2 Weighting of Criteria

For the weighting of the criteria, three methods were used: AHP (Analytic Hierarchy Process), CRITIC (Criteria Importance Through Intercriteria Correlation), and Shannon Entropy. AHP was used for pairwise comparisons between criteria, with input from industry experts. CRITIC was applied to assess the variance and correlation between criteria, while Shannon Entropy was used to calculate the degree of uncertainty in the weighting process. These methods provided a comprehensive assessment of the relative importance of each criterion.

3.3 Supplier Ranking

The ranking of suppliers was performed using three Multi-Criteria Decision-Making methods: TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution), CoCoSo (Complex Proportional Assessment), and MARCOS (Measurement of Alternatives and Ranking according to Compromise Solution). These methods were applied to the weighted criteria to rank the suppliers based on their performance in each category. Golnoor, MaziNoor, and Shayan Bargh were selected as the case study suppliers. The mathematical formulation for the TOPSIS method is as follows:

$$d_i^+ = \sqrt{\sum_{j=1}^{m}\left(x_{ij} - x_j^+\right)^2} \quad , \quad d_i^- = \sqrt{\sum_{j=1}^{m}\left(x_{ij} - x_j^-\right)^2} \quad , \quad C_i = \frac{d_i^-}{d_i^- + d_i^+} \tag{1}$$

where d_i^+ and d_i^- represent the distances from the positive and negative ideal solutions, respectively, and x_{ij} represents the normalized value for each criterion. Also, C_i denotes the final score of alternative i, while x_j^+ and x_j^- are positive and negative ideal solutions regarding all criteria.The CoCoSo method combines weighted sum and weighted product models for ranking green suppliers. After normalizing the decision matrix, the method uses the weights derived from AHP and CRITIC. The normalization of positive and negative criteria is performed using equations (2). The weighted sum (S_i) and weighted product (P_i) for each alternative are calculated, and the final score (K_i) is determined by combining three strategies.

$$K_a = \frac{P_i + S_i}{\sum_{i=1}^{m}(P_i + S_i)} \quad , \quad K_b = \frac{P_i}{P_{min}} + \frac{S_i}{S_{min}} \quad , \quad K_c = \frac{\lambda S_i + P_i(1-\lambda)}{\lambda S_{max} + (1-\lambda)P_{max}} \quad , \quad K_{\mathrm{i}} = \frac{K_a + K_b + K_c}{3} + \left(K_a . K_b . K_c\right)^{\frac{1}{3}} \tag{2}$$

3.4 Data Analysis and Software

Data collected from the suppliers were analyzed using various software tools. AHP calculations were performed using Expert Choice software, while MATLAB was employed for implementing CRITIC, Shannon Entropy, and the MCDM methods. Excel was also used for organizing the data and performing preliminary calculations.

4. RESULTS AND DISCUSSION

The results of this study highlight the importance of environmental and social responsibility in the evaluation and selection of green suppliers. Using AHP, the weights of the main criteria were calculated, as shown in Table 1. Among the evaluated criteria, "Availability" received the highest weight (0.995), indicating its top priority in the supplier selection process. It was followed by "Waste Management" (0.605) and "Occupational Health / Safety" (0.550), confirming that sustainable environmental practices are critical considerations for the organization.

Table 1. The weights of the main criteria based on AHP

Main Criteria	AHP weight	Main Criteria	AHP weight
Availability	0.995	Employee Training	0.163
Product and Service Quality	0.351	Waste Reduction	0.524
On-Time Delivery	0.333	Waste Management	0.605
Cost	0.001	Regulatory Compliance	0.385
Occupational Health / Safety	0.550	Greenhouse Gas Emissions	0.333

Table 2 shows the final scores of three suppliers across several key sustainability and performance criteria. The scores were calculated using the AHP and CRITIC methods, which are presented below.

Table 2. Final Decision Matrix for Suppliers

Criteria	Shayan Bargh	MaziNoor	Golnoor
Availability	0.004	0.001	0.995
Product and Service Quality	0.298	0.351	0.351
On-Time Delivery	0.334	0.333	0.333
Cost	0.666	0.333	0.001
Occupational Health and Safety	0.424	0.025	0.550
Employee Training	0.501	0.336	0.163
Waste Reduction	0.052	0.384	0.564
Waste Management	0.084	0.312	0.605
Regulatory Compliance	0.288	0.327	0.385
Greenhouse Gas Emissions	0.334	0.333	0.333

The final rankings of suppliers were generated using three different MCDM techniques: CoCoSo, TOPSIS, and MARCOS. Each method was applied to the normalized decision matrix, considering the calculated weights of both main and sub-criteria. The results from these methods were consistent, highlighting the robustness of the evaluation framework.

Table 3. Comparison of Supplier Scores Using Different MCDM Methods

Method	Shayan Bargh	MaziNoor	Golnoor
TOPSIS	1.114	0.491	1.910
CoCoSo	2.033	1.758	2.452
MARCOS	0.611	0.562	0.762

As shown in Table 3, the scores obtained from TOPSIS, CoCoSo, and MARCOS methods were very similar, with Golnoor emerging as the highest-ranked supplier. This consistency across methods suggests that the applied decision-making techniques are effective for supplier selection, ensuring reliability and minimizing decision errors.

The results emphasize the importance of integrating sustainability practices into supplier selection. Golnoor, with its superior performance in key criteria such as Availability, Occupational Health and Safety and Waste Management, clearly stands out as the most sustainable and efficient supplier among the three evaluated. These findings are crucial for companies seeking to prioritize environmental and operational sustainability in their supply chain decisions.

5. CONCLUSION

This study developed a framework for evaluating and ranking green suppliers using methods like AHP, TOPSIS, CRITIC, and MARCOS. Ten key criteria, including cost, product quality, and timely delivery, were identified and weighted. The results showed that Golnoor was the top-ranked supplier, followed by Shayan Bargh and MaziNoor. The findings demonstrate the effectiveness of these decision-making methods in selecting sustainable suppliers. These methods can also enhance supplier selection processes in similar industries, contributing to cost reduction and environmental sustainability.

6. REFERENCES

[1] Ahi, P., & Searcy, C., A comparative literature analysis of green supply chain management: A framework for sustainability, International Journal of Production Economics, 140, pp. 152–163, 2013.

[2] Rao, P., & Holt, D., Do green supply chains lead to competitiveness and economic performance? International Journal of Operations & Production Management, 25, pp. 898–916, 2005.

[3] Madanchian, M., & Taherdoost, H., A comprehensive guide to the TOPSIS method for multi-criteria decision making, Sustainable Social Development, 1, pp. 1-6, 2023.

[4] Yazdani, M., & Zarate, P., A combined compromise solution (CoCoSo) method for multi-criteria decision-making problems, Management Decision, vol. 57, pp. 2501-2519, 2019.

[5] Stević, Z., Pamučar, D., Puška, A., & Chatterjee, P., Sustainable supplier selection in healthcare industries using a new MCDM method: Measurement Alternatives and Ranking according to Compromise Solution (MARCOS), Computers and Industrial Engineering, 140, pp. 106231, 2020.