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Multi-Criteria Decision-Making Framework for Supplier Selection in the Power Industry: A Case Study of the Mazandaran Regional Electricity Company

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Abstract

In the power industry, selecting appropriate suppliers plays a significant role in improving performance, increasing reliability, and reducing costs. This study aims to develop evaluation criteria and rank suppliers in the electricity industry. First, the study identified effective supplier evaluation criteria through a literature review and expert opinions. Then, the study determined the weights and importance of these criteria using the Analytical Hierarchy Process (AHP). Next, the study selected seven suppliers of the Mazandaran Regional Electricity Company as alternatives and ranked them using the fuzzy TOPKOR method. The results showed that 33 criteria are effective for evaluating suppliers in the power industry, among which quality, reliability, and on-time delivery were identified as the most important criteria, respectively. The final ranking results also determined the order of the suppliers. This study's findings can serve as a practical guideline for decision-making in supplier selection and evaluation in the power industry.

Keywords: Multi-criteria decision making, Sustainable supply chain, Supplier selection, Analytical hierarchy process, TOPKOR method.

1 | Introduction

Selecting appropriate suppliers is one of the most critical decisions in supply chain management, as it can directly influence organizational efficiency, flexibility, and competitiveness. In the power industry, where timely provision of high-quality equipment, parts, and services is essential, poor supplier selection can lead to project delays, higher maintenance costs, service disruptions, and reduced customer satisfaction [1]. Therefore, supplier selection is not merely an operational issue but a strategic decision that strengthens competitive advantage and reduces overall supply chain costs. This decision affects not only purchase price but also product quality, delivery reliability, and the organization's ability to respond flexibly to changing

market demands. In many industries, a substantial portion of production costs is associated with the procurement of raw materials and components; hence, accurate and systematic supplier evaluation can significantly reduce risks and avoid unnecessary costs [2].

In the power industry, procured equipment must comply with strict technical standards and safety requirements. Even minor errors in supplier selection can reduce grid reliability, increase maintenance time, and create potential safety hazards. For this reason, developing scientific, structured frameworks for supplier evaluation is essential not only for economic reasons but also for operational performance and system safety [3]. In recent years, numerous studies have addressed supplier evaluation and ranking in various industries; however, research in the power sector, particularly those employing advanced fuzzy-based methods, remains limited.

This study identifies effective criteria for evaluating and ranking suppliers in the power industry and determines their relative importance using the Analytical Hierarchy Process (AHP). Subsequently, the study selects seven suppliers of the Mazandaran Regional Electricity Company as a case study and ranks them using the fuzzy TOPKOR method. The main innovation of this research lies in the comprehensive identification of 33 evaluation criteria for suppliers in the power industry and the application of the fuzzy TOPKOR method in this domain. The main research question is: Which criteria are effective for evaluating and ranking suppliers in the power industry, and how can they be used to rank suppliers of the Mazandaran Regional Electricity Company?

The sub-research questions are as follows:

- I. What Criteria are identified for supplier evaluation in the power industry?
- II. What is the relative importance of each evaluation criterion?
- III. What are the performance levels and scores of suppliers based on the identified criteria?

The paper is organized as follows. Section 2 reviews the relevant literature, Section 3 describes the research methodology, Section 4 presents the results, and Section 5 concludes the study and provides suggestions for future research.

2 | Literature Review

Selecting appropriate suppliers is one of the most important managerial issues in supply chains across industries, including the power industry, where uncertainty and complex decision environments make the problem inherently multidimensional. Therefore, numerous studies have used Multi-Criteria Decision-Making (MCDM) methods such as AHP, Differential Evolution Algorithm (DEA), fuzzy methods, and hybrid models to address supplier selection problems in different contexts.

Hendiani et al. [4] investigated sustainable supplier selection. They developed a new measurement and ranking approach based on the Multi-Attributive Rank Calculation Operation with Simple Ratio (MARCOS) method for the healthcare industry. This method improves decision-making by considering ideal and anti-ideal solutions from the initial matrix formation stage, providing more accurate utility assessment, introducing new utility aggregation mechanisms, and maintaining stability even with many criteria and alternatives. The study emphasized the importance of supplier selection in medical organizations and highlighted sustainability as a critical strategic issue that has been insufficiently implemented in the private healthcare sector. Their case study ranked eight suppliers based on 21 sustainability criteria, and comparative analysis with six other MCDM methods, along with sensitivity analysis, confirmed the validity and superiority of the MARCOS approach. In another study, Wang and Chen [5], focusing on supply chain resilience during the COVID-19 crisis, proposed a hybrid framework combining AHP, bi-objective Mixed-Integer Nonlinear Programming (MINLP), and Genetic Algorithm (GA) to support alternative supplier selection. Their model generated diverse supplier portfolios while maintaining optimality, enhancing decision-making flexibility, and improving computational efficiency by 75% through the use of GA. Similarly, Sharafi et al. [6] proposed a computational framework for green supplier selection in the automotive industry based on expert judgment aggregation and Fuzzy

DEA, further enhanced with Fuzzy Combinative Distance-Based Assessment (CODAS) to address ranking limitations and improve discrimination among efficient suppliers. The results showed that the hybrid approach provides a more complete and distinct ranking of alternatives.

Nasri et al. [7] developed a multi-stage integrated framework for sustainable supplier selection in the oil industry using Fuzzy Decision-Making Trial and Evaluation Laboratory (DEMATEL), Analytic Network Process (ANP), and DEA to balance economic, social, and environmental objectives. Their results identified interdependencies among criteria, used these relationships to compute accurate weights, and validated the model through a case study involving fifteen oil supply companies using the Andersen–Petersen model for final efficiency evaluation.

Więckowski et al. [8] critically examined classical MCDA approaches and highlighted the challenge of aligning decision models with dynamic customer preferences in uncertain environments. They identified a theoretical gap in integrating ideal solutions with personalized preferences. They proposed a hybrid approach that combines preference-ranking mechanisms with ideal-solution-based methods, enabling more personalized and accurate decision-making, as validated in electric vehicle selection. Their findings demonstrated that the proposed framework improves interpretability and decision accuracy compared to advanced machine learning models.

Bayanati et al. [9] investigated innovative supplier selection, focusing on inter-organizational collaboration, using a hybrid Delphi, Fuzzy DEMATEL, and Fuzzy Analytic Network Process (FANP) approach. Their findings revealed that while supplier willingness plays a central role in system interactions, supplier capability is the most influential criterion in weighting, followed by willingness and supply risk, with geographical and organizational proximity identified as key sub-criteria driving innovative supplier selection.

Finally, Abdulla and Baryannis [10] proposed a hybrid framework integrating interpretable artificial intelligence techniques with classical MCDM methods to address complexity in large-scale procurement environments. Their model reduces dimensionality while preserving interpretability and stakeholder acceptance, and validation through case studies in the oil, gas, and aerospace industries showed performance comparable to advanced machine learning models, with the added advantage of transparency and alignment with managerial decision-making processes. Overall, the literature indicates that supplier selection is a complex and multidimensional problem, and fuzzy and MCDM-based approaches play a crucial role in handling uncertainty and human judgment. However, despite significant advancements, comprehensive studies that simultaneously consider a large set of evaluation criteria (such as 33 criteria) and apply the fuzzy TOPKOR method in the power industry remain limited, which is the research gap this study addresses.

3 | Methodology

This article focuses on developing evaluation and ranking criteria for suppliers in the power industry. This section describes the main stages of the research, the statistical sample, and the data collection methods used in the study.

3.1 | Research Steps

This research is applied in purpose and descriptive–analytical in methodology. The steps of the research are as follows:

Step 1. Identification of effective criteria in evaluating suppliers in the power industry.

Step 2. Determination of the weights and importance of criteria using the AHP method.

Step 3. Selection of the set of candidate suppliers.

Step 4. Determination of each supplier's score for each criterion.

Step 5. Final ranking of suppliers using the fuzzy TOPKOR method.

3.2 | Data Collection

In this study, an in-depth interview and two questionnaires were used to collect data. The in-depth interview identified the effective criteria. The first questionnaire included a pairwise comparison matrix to determine criterion weights using the AHP method. In contrast, the second questionnaire used a decision matrix to evaluate suppliers using triangular fuzzy numbers. Table 1 presents the responses to each questionnaire and their numerical equivalents.

The expert sample consisted of 12 academic and industrial specialists with experience in the power industry and MCDM, each with more than 10 years of work experience. The questionnaires were standard, and previous studies confirmed their validity [11], [12]. The reliability of the first questionnaire was confirmed with an inconsistency ratio of 0.06, and the reliability of the second questionnaire was verified with a Cronbach's alpha coefficient of 0.91.

Table 1. Linguistic scales of questionnaires and their numerical equivalents.

First Questionnaire		Second Questionnaire	
Linguistic Term	Value	Linguistic Term	Value
Equally important	1	Very low	(0, 0, 0.75)
Moderate importance	3	Low	(0.5, 1.25, 2)
Important	5	Medium	(1.75, 2.5, 3.25)
Very important	7	High	(3, 3.75, 4.5)
Absolutely important	9	Very high	(4.25, 5, 5)
Intermediate values	2,4,6,8		

3.3 | AHP Method

The AHP method is an MCDM method that uses a pairwise comparison matrix to determine criterion weights and rank alternatives. The steps for determining criterion weights are as follows [13].

Step 1 (construction of the pairwise comparison matrix). For this purpose, we used a pairwise comparison matrix questionnaire. In this questionnaire, we evaluate the relative preferences of the criteria. If there are n criteria, the pairwise comparison matrix is $n \times n$, as shown below. To determine the preference of one criterion over another, the options presented in *Table 1* are used.

$$A = [a_{ij}]_{n \times n} = \begin{bmatrix} a_{11} & a_{12} & a_{13} & \dots & a_{1n} \\ a_{21} & a_{22} & a_{23} & \dots & a_{2n} \\ a_{31} & a_{32} & a_{33} & \dots & a_{3n} \\ \dots & \dots & \dots & \dots & \dots \\ a_{n1} & a_{n2} & a_{n3} & \dots & a_{nn} \end{bmatrix} \quad i, j = 1, 2, \dots, n. \quad (1)$$

Step 2 (normalization of the pairwise comparison matrix). In this step, the above pairwise comparison matrix must be normalized, where the normalized value of the matrix is denoted by H_{ij} , and it is calculated as follows.

$$H_{ij} = a_{ij} / \sum_{j=1}^n a_{ij}. \quad (2)$$

Step 3 (calculation of criteria weights). Finally, to obtain the weight of each criterion, given the number of criteria (n) and the normalized matrix obtained in the previous step, calculate the weights using the following formula.

$$w_i = \sum_{i=1}^n \frac{H_{ij}}{n} \quad i, j = 1, 2, \dots, n. \quad (3)$$

$$W = \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{bmatrix}.$$

4.3 | Fuzzy TOPKOR Method

The TOPKOR method is an MCDM approach that integrates concepts from TOPSIS and VIKOR to rank alternatives in complex problems with conflicting criteria. In this study, we employ the fuzzy version of this algorithm.

If $\tilde{M} = (m_1, m_2, m_3)$ and $\tilde{L} = (l_1, l_2, l_3)$ are two triangular fuzzy numbers, then their arithmetic operations are obtained using the following relation.

$$\tilde{L} + \tilde{M} = (l_1 + m_1, l_2 + m_2, l_3 + m_3), \quad (4)$$

$$\tilde{L} - \tilde{M} = (l_1 - m_3, l_2 - m_2, l_3 - m_1), \quad (5)$$

$$\begin{aligned} \tilde{L} \times \tilde{M} = & (\min(l_1 m_1, l_1 m_3, l_3 m_1, l_3 m_3), \\ & l_2 m_2, \max(l_1 m_1, l_1 m_3, l_3 m_1, l_3 m_3)), \end{aligned} \quad (6)$$

$$\begin{aligned} \tilde{L} / \tilde{M} = & (\min(l_1 / m_1, l_1 / m_3, l_3 / m_1, l_3 / m_3), \\ & l_2 / m_2, \max(l_1 / m_1, l_1 / m_3, l_3 / m_1, l_3 / m_3)). \end{aligned} \quad (7)$$

Also, to defuzzify a fuzzy number such as $\tilde{M} = (m_1, m_2, m_3)$, use the following relation.

$$M = \frac{m_1 + 4m_2 + m_3}{6}. \quad (8)$$

The steps of the fuzzy TOPKOR method are as follows [14].

Step 1 (decision matrix construction). Consider the decision matrix X , where x_{ij} represents the score of the i -th alternative under the j -th criterion, and w_i denotes the weight of the i -th criterion. Also, n is the number of criteria and m is the number of alternatives.

$$\tilde{X} = [\tilde{x}_{ij}]_{m \times n}, \quad W_j = [w_1, w_2, \dots, w_n]. \quad (9)$$

Step 2 (normalization of the decision matrix). The decision matrix is normalized using the following relation, where r_{ij} represents the normalized value of the i -th alternative.

$$\tilde{r}_{ij} = \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*} \right), \quad c_j^* = \max_i \{c_{ij}\}, \text{ For benefit criteria,} \quad (10)$$

$$\tilde{r}_{ij} = \left(\frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}} \right), \quad a_j^- = \min_i \{a_{ij}\}, \text{ For cost criteria.} \quad (11)$$

Step 3 (construction of the weighted normalized matrix). Construct the weighted normalized decision matrix according to the following relation.

$$\tilde{V} = [\tilde{v}_{ij}]_{m \times n}, \quad \tilde{v}_{ij} = w_j \times \tilde{r}_{ij}. \quad (12)$$

Step 4 (determination of positive ideal and negative ideal solutions). Calculate the positive-ideal solution and the negative-ideal solution.

$$FPIS_j = \text{Max}_i \tilde{V}_{ij} \quad j = 1, 2, \dots, n. \quad (13)$$

$$FNIS_j = \text{Min}_i \tilde{V}_{ij} \quad j = 1, 2, \dots, n. \quad (14)$$

Step 5 (calculation of distances from ideal solutions). Calculate the distance of each alternative from the positive ideal solution and the negative ideal solution.

$$d_i^+ = \sum_{j=1}^n d(\tilde{V}_{ij}, FPIS_j), \quad i = 1, 2, \dots, m. \quad (15)$$

$$d_i^- = \sum_{j=1}^n d(\tilde{V}_{ij}, FNIS_j), \quad i = 1, 2, \dots, m. \quad (16)$$

d_i^+ and d_i^- represent the total distances of each alternative from the positive ideal solution and the negative ideal solution, respectively.

Step 6 (determination of maximum regret measure). Obtain the maximum distance of each alternative from the positive ideal solution across all criteria. This parameter is called the regret index in the VIKOR method and is denoted by R .

$$R_i = \max_j d(\tilde{V}_{ij}, FPIS_j), \quad i = 1, 2, \dots, m. \quad (17)$$

Step 7 (calculation of the VIKOR index (Q)). The VIKOR index Q_i is obtained using the following relation.

$$Q_i = v \times \left[\frac{d_i^+ - dp_i^+}{dn_i^+ - dp_i^+} \right] + (1 - v) \times \left[\frac{R_i - R^+}{R^- - R^+} \right]. \quad (18)$$

$$dp_i^+ = \min_i d_i^+ \quad dn_i^+ = \max_i d_i^+, \quad R^+ = \min_i R_i, \quad R^- = \max_i R_i.$$

Furthermore, v is a parameter ranging from zero to one that represents the relative importance of the sum of distances from the positive ideal solution and the regret index. In this study, the value of this parameter is considered to be 0.5.

Step 8 (calculation of the TOPKOR index). The TOPKOR index for the i -th alternative (C_i) is calculated using the following relation. The alternative with a lower value of the C_i index is considered a better option.

$$C_i = \frac{d_i^-}{d_i^- + Q_i}, \quad i = 1, 2, \dots, m. \quad (19)$$

4 | Results

This section presents the results of implementing the research steps. Table 2 presents the criteria and their corresponding weights obtained using the AHP method. The fuzzy and defuzzified decision matrices are also provided in *Tables 3* and *4*, respectively. Furthermore, the supplier ranking results obtained using the TOPKOR method are presented in *Table 5*.

Table 2. List of criteria and their corresponding weights.

Criterion	Symbol	Weight	Criterion	Symbol	Weight
Performance history	C1	0.0329	Job creation	C19	0.0185
Technology and capability	C2	0.0349	Environmental resource consumption	C20	0.0226
Mutual trust and ease of communication	C3	0.0308	Occupational health and safety	C21	0.0287
Communication system	C4	0.0267	Payback period	C22	0.0308
Supplier reputation and market position	C5	0.0287	Price	C23	0.0349
Supplier innovation	C6	0.0329	On-time delivery	C24	0.037
Management attitude	C7	0.0246	Quality	C25	0.039
Support services	C8	0.0349	Warranty period	C26	0.0329
Flexibility	C9	0.0287	Maintenance and repair cost	C27	0.0308
Service diversity	C10	0.0267	Investment Cost	C28	0.0349
Quality certifications	C11	0.037	Installation and implementation time	C29	0.0329
Employment of specialists	C12	0.0349	Access to technology	C30	0.0349
Emissions	C13	0.0226	Development capacity	C31	0.0308
Noise pollution	C14	0.0205	Reliability	C32	0.037
Production capacity	C15	0.0329	Energy efficiency	C33	0.0329
Green design	C16	0.0246			
Environmental management	C17	0.0267			
Local development and social benefits	C18	0.0205			

Table 3. Decision matrix.

Criterion	Supplier 1	Supplier 2	Supplier 3	Supplier 4	Supplier 5	Supplier 6	Supplier 7
Performance history	(2.25,3.25,4.25)	(1.17,2.17,3.17)	(3.17,4.17,5)	(1.142,2.42)	(2.33,3.33,4.33)	(1.08,2.08,3.08)	(3.33,4.33,5)
Technology and capability	(3.17,4.17,5)	(2.42,3.42,4.42)	(1.25,2.25,3.25)	(1.142,2.42)	(3.42,4.42,5)	(2.42,3.42,4.42)	(1.17,2.17,3.17)
Mutual trust and ease of communication	(1.25,2.25,3.25)	(3.25,4.25,5)	(2.17,3.17,4.17)	(1.52,5,3,5)	(1.1.33,2.33)	(3.08,4.08,5)	(2.5,3.5,4.5)
Communication system	(3.17,4.17,5)	(1.17,2.17,3.17)	(2.08,3.08,4.08)	(1.1.33,2.33)	(2.25,3.25,4.25)	(3.42,4.42,5)	(1.25,2.25,3.25)
Supplier reputation and market position	(2.17,3.17,4.17)	(3.33,4.33,5)	(1.33,2.33,3.33)	(2.17,3.17,4.17)	(1.42,2.42,3.42)	(1.1.25,2.25)	(3.08,4.08,5)
Supplier innovation	(1.08,2.08,3.08)	(2.08,3.08,4.08)	(3.42,4.42,5)	(1.1.17,2.17)	(1.33,2.33,3.33)	(3.25,4.25,5)	(2.25,3.25,4.25)
Management attitude	(3.17,4.17,5)	(2.25,3.25,4.25)	(1.33,2.33,3.33)	(2.33,3.33,4.33)	(1.1.33,2.33)	(3.33,4.33,5)	(1.33,2.33,3.33)
Support services	(2.33,3.33,4.33)	(3.33,4.33,5)	(1.33,2.33,3.33)	(1.1.33,2.33)	(3.33,4.33,5)	(2.42,3.42,4.42)	(1.25,2.25,3.25)
Flexibility	(1.52,5,3,5)	(2.33,3.33,4.33)	(3.25,4.25,5)	(1.1.25,2.25)	(2.25,3.25,4.25)	(3.25,4.25,5)	(1.42,2.42,3.42)
Service diversity	(1.25,2.25,3.25)	(2.08,3.08,4.08)	(3.25,4.25,5)	(1.1.33,2.33)	(1.33,2.33,3.33)	(3.25,4.25,5)	(2.17,3.17,4.17)
Quality certifications	(3.33,4.33,5)	(1.17,2.17,3.17)	(2.17,3.17,4.17)	(1.1.58,2.58)	(1.25,2.25,3.25)	(3.33,4.33,5)	(2.42,3.42,4.42)
Employment of specialists	(2.25,3.25,4.25)	(3.33,4.33,5)	(1.52,5,3,5)	(2.08,3.08,4.08)	(1.1.42,2.42)	(3.42,4.42,5)	(1.25,2.25,3.25)
Emissions	(1.83,2.83,3.83)	(2.92,3.92,4.92)	(1.1.52,5)	(3.92,4.92,5)	(1.67,2.67,3.67)	(3.33,4.33,5)	(2.83,3.83,4.83)
Noise pollution	(2.67,3.67,4.67)	(1.92,2.92,3.92)	(3.58,4.58,5)	(3.92,4.92,5)	(2.75,3.75,4.75)	(1.1.83,2.83)	(1.58,2.58,3.58)
Production capacity	(3.67,4.67,5)	(2.75,3.75,4.75)	(3.92,4.92,5)	(1.92,2.92,3.92)	(3.75,4.75,5)	(2.92,3.92,4.92)	(3.92,4.92,5)
Green design	(1.25,2.25,3.25)	(3.17,4.17,5)	(2.17,3.17,4.17)	(1.1.33,2.33)	(1.25,2.25,3.25)	(3.25,4.25,5)	(2.17,3.17,4.17)
Environmental management	(3.17,4.17,5)	(2.25,3.25,4.25)	(1.25,2.25,3.25)	(1.1.33,2.33)	(3.17,4.17,5)	(2.42,3.42,4.42)	(1.42,2.42,3.42)
Local development and social benefits	(2.33,3.33,4.33)	(3.33,4.33,5)	(3.17,4.17,5)	(1.1.25,2.25)	(2.33,3.33,4.33)	(3.17,4.17,5)	(1.42,2.42,3.42)
Job creation	(1.25,2.25,3.25)	(2.17,3.17,4.17)	(3.17,4.17,5)	(1.1.33,2.33)	(1.17,2.17,3.17)	(3.25,4.25,5)	(2.33,3.33,4.33)
Environmental resource consumption	(1.75,2.75,3.75)	(2.92,3.92,4.92)	(1.1.75,2.75)	(3.92,4.92,5)	(1.67,2.67,3.67)	(3.5,4.5,5)	(2.75,3.75,4.75)
Occupational health and safety	(3.17,4.17,5)	(1.25,2.25,3.25)	(2.25,3.25,4.25)	(1.1.17,2.17)	(1.25,2.25,3.25)	(3.33,4.33,5)	(2.08,3.08,4.08)
Payback period	(3.67,4.67,5)	(2.5,3.5,4.5)	(3.92,4.92,5)	(1.75,2.75,3.75)	(3.67,4.67,5)	(2.67,3.67,4.67)	(3.92,4.92,5)
Operating cost	(2.83,3.83,4.83)	(1.83,2.83,3.83)	(3.75,4.75,5)	(3.92,4.92,5)	(2.83,3.83,4.83)	(1.1.67,2.67)	(1.67,2.67,3.67)
On-Time delivery	(3.25,4.25,5)	(2.33,3.33,4.33)	(1.25,2.25,3.25)	(1.1.42,2.42)	(3.17,4.17,5)	(2.17,3.17,4.17)	(1.33,2.33,3.33)
Quality	(1.25,2.25,3.25)	(3.17,4.17,5)	(2.25,3.25,4.25)	(1.1.25,2.25)	(1.25,2.25,3.25)	(3.17,4.17,5)	(2.17,3.17,4.17)
Warranty period	(3.08,4.08,5)	(1.08,2.08,3.08)	(2.17,3.17,4.17)	(1.1.33,2.33)	(1.52,5,3,5)	(3.17,4.17,5)	(2.25,3.25,4.25)
Maintenance and repair cost	(1.75,2.75,3.75)	(2.83,3.83,4.83)	(1.1.75,2.75)	(3.92,4.92,5)	(1.58,2.58,3.58)	(3.75,4.75,5)	(2.75,3.75,4.75)
Investment cost	(2.92,3.92,4.92)	(1.42,2.42,3.42)	(3.83,4.83,5)	(3.92,4.92,5)	(2.75,3.75,4.75)	(1.1.75,2.75)	(1.75,2.75,3.75)
Installation and implementation time	(1.83,2.83,3.83)	(2.75,3.75,4.75)	(1.1.67,2.67)	(3.92,4.92,5)	(1.67,2.67,3.67)	(3.75,4.75,5)	(2.75,3.75,4.75)
Access to technology	(2.33,3.33,4.33)	(1.25,2.25,3.25)	(3.25,4.25,5)	(1.1.52,5)	(2.17,3.17,4.17)	(1.25,2.25,3.25)	(3.33,4.33,5)
Development capacity	(3.08,4.08,5)	(2.08,3.08,4.08)	(1.25,2.25,3.25)	(1.1.17,2.17)	(3.25,4.25,5)	(2.17,3.17,4.17)	(1.25,2.25,3.25)
Reliability	(2.33,3.33,4.33)	(3.25,4.25,5)	(1.25,2.25,3.25)	(2.25,3.25,4.25)	(1.1.42,2.42)	(3.25,4.25,5)	(1.33,2.33,3.33)
Energy efficiency	(3.42,4.42,5)	(2.33,3.33,4.33)	(1.25,2.25,3.25)	(1.1.42,2.42)	(3.25,4.25,5)	(2.17,3.17,4.17)	(1.17,2.17,3.17)

Table 4. Defuzzified decision matrix.

Criterion	Supplier 1	Supplier 2	Supplier 3	Supplier 4	Supplier 5	Supplier 6	Supplier 7
Performance history	3.25	2.167	4.139	1.514	3.333	2.083	4.278
Technology and capability	4.139	3.417	2.25	1.514	4.347	3.417	2.167
Mutual trust and ease of communication	2.25	4.208	3.167	2.5	1.444	4.069	3.5
Communication system	4.139	2.167	3.083	1.444	3.25	4.347	2.25
Supplier reputation and market position	3.167	4.278	2.333	3.167	2.417	1.375	4.069
Supplier innovation	2.083	3.083	4.347	1.306	2.333	4.208	3.25
Management attitude	4.139	3.25	2.333	3.333	1.444	4.278	2.333
Support services	3.333	4.278	2.333	1.444	4.278	3.417	2.25
Flexibility	2.5	3.333	4.208	1.375	3.25	4.208	2.417
Service diversity	2.25	3.333	4.208	1.444	2.333	4.208	3.167
Quality certifications	4.278	2.167	3.167	1.653	2.25	4.278	3.417
Employment of specialists	3.25	4.278	2.5	3.083	1.514	4.347	2.25
Emissions	2.833	3.917	1.583	4.764	2.667	4.278	3.833
Noise pollution	3.667	2.917	4.486	4.764	3.75	1.861	2.583
Production capacity	4.556	3.75	4.764	2.917	4.625	3.917	4.764
Green design	2.25	4.139	3.167	1.444	2.25	4.208	3.167
Environmental management	4.139	3.25	2.25	1.444	4.139	3.417	2.417
Local development and social benefits	3.333	4.278	2.25	1.375	3.333	4.139	2.417
Job creation	2.25	3.167	4.139	1.444	2.167	4.208	3.167
Environmental resource consumption	2.75	3.917	1.792	4.764	2.667	4.417	3.75
Occupational health and safety	4.139	2.25	3.25	1.306	2.25	4.278	3.083
Payback period	4.556	3.5	4.764	2.75	4.556	3.667	4.764
Operating cost	3.833	2.833	4.625	4.764	3.833	1.722	2.667
On-time delivery	4.208	3.333	2.25	1.514	4.139	3.167	2.333
Quality	2.25	4.139	3.25	1.375	2.25	4.139	3.167
Warranty period	4.069	2.083	3.167	1.444	2.5	4.139	3.25
Maintenance and repair cost	2.75	3.833	1.792	4.764	2.583	4.625	3.75
Investment cost	3.917	2.417	4.694	4.764	3.75	1.792	2.75
Installation and implementation time	2.833	3.75	1.722	4.764	2.667	4.625	3.75
Access to technology	3.333	2.25	4.208	1.583	3.167	2.25	4.278
Development capacity	4.069	3.083	2.25	1.306	4.208	3.167	2.25
Reliability	3.333	4.208	2.25	3.25	1.514	4.208	2.333
Energy efficiency	4.347	3.333	2.25	1.514	4.208	3.167	2.167

Table 5. Final ranking of suppliers based on the fuzzy TOPKOR method.

Supplier	TOPKOR	Rank
Supplier 1	0.919	1
Supplier 2	0.886	2
Supplier 3	0.676	5
Supplier 4	0.333	7
Supplier 5	0.660	6
Supplier 6	0.841	3
Supplier 7	0.800	4

5 | Conclusion

Selecting appropriate suppliers in the power industry is strategically important because this sector is infrastructure-oriented and highly sensitive. The results showed that applying MCDM approaches, particularly integrating the AHP and Fuzzy TOPSIS methods, provides an efficient, systematic tool for supplier evaluation and ranking. The findings indicate that qualitative and performance-related criteria, such as quality,

reliability, and on-time delivery, play a more decisive role than purely economic criteria in the supplier selection process within the power industry. This finding suggests that excessive emphasis on cost-related factors, without adequate consideration of technical and operational criteria, may pose significant risks to the sustainable operation of power networks. The proposed model can serve as a practical decision-making framework for companies operating in the power sector, particularly electricity distribution companies and regional power utilities, and can be employed in supplier selection, periodic evaluation, and supplier performance management processes.

For future research, advanced MCDM methods such as the Best–Worst Method (BWM), DEMATEL, ANP, and gray theory-based approaches may be integrated for criteria weighting, and their results may be compared with those obtained using the AHP method. Furthermore, supplier ranking can be conducted using alternative methods such as VIseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR), Weighted Aggregated Sum Product Assessment (WASPAS), Complex Proportional Assessment (COPRAS), and MARCOS, and the degree of convergence or divergence between their results and those of the Fuzzy TOPKOR method can be examined. In addition, applying the proposed framework to other regional electricity companies across Iran and comparing the results may help enhance the generalizability and external validity of the proposed model.

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Data Availability

The data used in this study are available from the corresponding author upon reasonable request.

References

- [1] Evcio Uglu, H. E., & Kabak, M. (2023). Supplier selection in supply chain network using MCDM methods. *Sigma Journal of Engineering and Natural Sciences*, 41(1), 1–16. <https://doi.org/10.14744/sigma.2023.00001>
- [2] Liao, C. N., & Kao, H. P. (2011). An integrated fuzzy TOPSIS and MCGP approach to supplier selection in supply chain management. *Expert Systems with Applications*, 38(9), 10803–10811. <https://doi.org/10.1016/j.eswa.2011.02.031>
- [3] Cakmak, E. (2023). Supplier selection for a power generator sustainable supplier park: Interval-valued neutrosophic SWARA and EDAS application. *Sustainability*, 15(18), 13973. <https://doi.org/10.3390/su151813973>
- [4] Hendiani, S., Liao, H., Ren, R., & Lev, B. (2020). A likelihood-based multi-criteria sustainable supplier selection approach with complex preference information. *Information Sciences*, 536, 135–155. <https://doi.org/10.1016/j.ins.2020.05.065>
- [5] Wang, Y. C., & Chen, T. (2021). A Bi-objective AHP-MINLP-GA approach for flexible alternative supplier selection amid the COVID-19 pandemic. *Soft Computing Letters*, 3, 100016. <https://doi.org/10.1016/j.socl.2021.100016>
- [6] Sharafi, H., Soltanifar, M., & Lotfi, F. H. (2022). Selecting a green supplier utilizing the new fuzzy voting model and the fuzzy combinative distance-based assessment method. *EURO Journal on Decision Processes*, 10, 100010. <https://doi.org/10.1016/j.ejdp.2021.100010>
- [7] Nasri, S. A., Ehsani, B., Hosseini-ninezhad, S. J., & Safaie, N. (2023). A sustainable supplier selection method using integrated Fuzzy DEMATEL-ANP-DEA approach (Case study: Petroleum Industry). *Environment, Development and Sustainability*, 25(11), 12791–12827. <https://doi.org/10.1007/s10668-022-02590-2>

- [8] Więckowski, J., Wątróbski, J., Shkurina, A., & Sałabun, W. (2024). Adaptive multi-criteria decision making for electric vehicles: A hybrid approach based on RANCOM and ESP-SPOTIS. *Artificial Intelligence Review*, 57(10), 270. <https://doi.org/10.1007/s10462-024-10901-4>
- [9] Bayanati, M., Asadi, A., Asghari, H., Motevalli, S. H., & Sheikhhasani, M. (2024). Presenting a model for selecting an innovative supplier from the perspective of cooperation using a fuzzy multi-criteria decision making approach. *Journal of Industrial Engineering and Management Studies*, 11(1), 110–126. http://jiems.icms.ac.ir/article_202607_0dab9e56a7763a78af21f2b8d8fb8d48.pdf
- [10] Abdulla, A., & Baryannis, G. (2024). A hybrid multi-criteria decision-making and machine learning approach for explainable supplier selection. *Supply Chain Analytics*, 7, 100074. <https://doi.org/10.1016/j.sca.2024.100074>
- [11] Beheshtinia, M. A., Safarzadeh, M. S., Fathi, M., Ghobakhloo, M., Al-Emran, M., & Tseng, M. L. (2025). Enhancing healthcare waste management: A novel hybrid multi-criteria decision-making method. *Management of Environmental Quality: An International Journal*, 36(5), 1095–1124. <https://doi.org/10.1108/MEQ-09-2024-0368>
- [12] Beheshtinia, M. A., Yaghobian, S. N., Fathi, M., Ghobakhloo, M., & Foroughi, B. (2025). Overcoming barriers to renewable energy adoption: A decision-making framework for strategy evaluation and implementation prioritization. *Cleaner Environmental Systems*, 18, 100314. <https://doi.org/10.1016/j.cesys.2025.100314>
- [13] Beheshtinia, M. A., & Omid, S. (2017). A hybrid MCDM approach for performance evaluation in the banking industry. *Kybernetes*, 46(8), 1386–1407. <https://doi.org/10.1108/K-03-2017-0105>
- [14] Sedady, F., & Beheshtinia, M. A. (2019). A novel MCDM model for prioritizing the renewable power plants' construction. *Management of Environmental Quality: An International Journal*, 30(2), 383–399. <https://doi.org/10.1108/MEQ-05-2018-0102>