Supply Chain and Operations Decision Making

www.scodm.reapress.com

Sup. Chain Oper. Decis. Mak. Vol. 2, No. 3 (2025) 105–114.

Paper Type: Original Article

A Fuzzy Multi-Criteria Decision-Making Approach for Green Supply Chain Management: Supplier Prioritization in the Automotive Industry

Fahimeh Tanhaie[1,*], Asma Izanloo[1]

[1] Department of Industrial Engineering, Faculty of Basic Science and Engineering, Kosar University of Bojnord, Bojnord, Iran; fahimeh.tanhaie@kub.ac.ir;

Citation:

Received: 03 April 2025 *Revised: 11 June 2025* *Accepted: 20 September 2025*	Tanhaie, F., & Izanloo, A. (2025). A fuzzy multi-criteria decision-making approach for green supply chain management: supplier prioritization in the automotive industry. *Supply chain and operations decision making, 2*(3), 105-114.

Abstract

Environmental sustainability has become a critical concern for industries worldwide, driving the adoption of Green Supply Chain Management (GSCM) practices. This study proposes a fuzzy multi-criteria decision-making approach to prioritize automotive component suppliers under GSCM principles within SAIPA Automotive Company. Using the Fuzzy TOPSIS method, suppliers are evaluated based on criteria including quality, delivery time, price, environmental management system, green design, recycling capability, and eco-friendly procurement. The results indicate that Iran Lavazem Company ranks first, followed by Pars Seat Systems Company among seat suppliers. This research highlights the importance of integrating environmental factors into supplier selection and provides a practical framework for sustainable decision-making in the automotive industry. The methodology supports manufacturers in enhancing supply chain sustainability while maintaining operational efficiencys.

Keywords: Green supply chain management, Supplier selection, Fuzzy TOPSIS, Automotive industry.

1 | Introduction

In the 21st century, environmental sustainability has emerged as a critical concern for businesses, governments, and consumers alike. The growing awareness of ecological degradation and the increasing pressure from regulatory bodies have compelled organizations to integrate environmental considerations into their operational and strategic decisions. This shift has led to the development of Green Supply Chain Management (GSCM), a comprehensive approach that incorporates environmental thinking into all stages of

Corresponding Author: fahimeh.tanhaie@kub.ac.ir
https://doi.org/10.48313/scodm.v2i3.36

the supply chain from raw material sourcing to end-of-life product recovery. Logistics, as a core component of supply chain operations, is no exception to this transformation. While logistics managers traditionally focus on minimizing costs and optimizing time and place utility, they now face dual challenges: achieving economic efficiency and complying with stringent environmental regulations. Moreover, rising consumer demand for eco-friendly products has further accelerated the adoption of green practices across industries. As a result, companies are increasingly investing in sustainable initiatives such as energy conservation, waste reduction, recycling systems, green design, and environmentally responsible procurement all of which contribute to enhanced operational efficiency, customer value, and long-term competitiveness.

The automotive industry, being one of the most resource-intensive and polluting sectors, plays a pivotal role in the implementation of GSCM practices. In developing countries like Iran, rapid industrialization and the use of outdated technologies have exacerbated environmental issues, including air pollution and industrial waste. Therefore, adopting green supply chain strategies is not only a regulatory necessity but also a strategic imperative for automotive manufacturers aiming to align with global standards, such as those required by the World Trade Organization (WTO), and to meet evolving customer expectations. Supplier selection is one of the most critical decisions in GSCM, as suppliers significantly influence the environmental performance of the entire supply chain. Traditional supplier evaluation criteria such as cost, quality, and delivery time are no longer sufficient. Modern approaches must incorporate environmental dimensions, including the supplier's environmental management system, green design capabilities, recycling practices, and use of eco-friendly materials and technologies.

To address this complexity, Multi-Criteria Decision-Making (MCDM) methods have gained prominence in supplier evaluation. Among these, the Fuzzy TOPSIS technique is particularly effective in handling uncertainty and imprecision inherent in human judgments and qualitative assessments. By combining fuzzy logic [1] with TOPSIS, decision-makers can prioritize suppliers under both quantitative and qualitative criteria in a systematic and objective manner. This study aims to evaluate and rank automotive component suppliers within SAIPA Automotive Company using a fuzzy MCDM approach under the framework of GSCM. The research employs Fuzzy TOPSIS to assess suppliers based on a set of integrated economic and environmental criteria. The findings are expected to provide practical insights for managers seeking to enhance sustainability in supplier selection and to contribute to the growing body of knowledge on GSCM in the automotive sector, particularly in emerging economies.

2 | Literature Review

GSCM has emerged as a strategic imperative for organizations aiming to align economic performance with environmental responsibility. The concept integrates environmental thinking into all stages of the supply chain, from raw material sourcing to end-of-life product recovery. Zhu and Sarkis [2] provided one of the earliest and most comprehensive frameworks for GSCM, identifying key drivers such as regulatory compliance, customer demand, and competitive pressure, while emphasizing the importance of cross-functional and inter-organizational collaboration in achieving sustainability goals.

A critical component of GSCM is green supplier selection, which goes beyond traditional criteria such as cost, quality, and delivery time to include environmental performance. Govindan, Khodaverdi, and Jafarian [3] highlighted that sustainable procurement practices require the evaluation of suppliers based on their environmental management systems, green design capabilities, recycling programs, and use of eco-friendly materials. They proposed a fuzzy MCDM model to handle the uncertainty and subjectivity inherent in qualitative assessments, demonstrating the effectiveness of integrating fuzzy logic into supplier evaluation.

To address the complexity of green supplier selection, researchers have increasingly adopted hybrid MCDM methods. Kannan, Khodaverdi, Olfat, Jafarian, and Diabat [4] developed an integrated fuzzy AHP–TOPSIS model to prioritize green suppliers in the automotive industry. Their approach combined Fuzzy Analytic Hierarchy Process (FAHP) for weighting criteria and fuzzy TOPSIS for ranking suppliers, offering a systematic and robust framework for decision-makers. This study is particularly relevant to the current research, as it validates the applicability of fuzzy MCDM techniques in real-world industrial settings.

The evolution of GSCM has been supported by extensive literature reviews. Srivastava [5] conducted a state-of-the-art review of GSCM, defining it as the incorporation of environmental considerations into supply chain management, including product design, material sourcing, manufacturing, logistics, and reverse logistics. This foundational work laid the groundwork for subsequent empirical and methodological studies in the field. Moreover, Min and Galle [6] were among the first to emphasize the role of green purchasing in supply chain sustainability, identifying regulatory pressures and cost implications as key factors influencing green procurement decisions. Their findings underscore the need for organizations to develop strategic partnerships with environmentally responsible suppliers, a principle that remains central to modern GSCM practices.

Performance measurement in GSCM has also received significant attention. Hervani et al. [7] developed a performance measurement system for green supply chains, highlighting metrics such as pollution prevention, resource efficiency, and environmental compliance. Their work provides a valuable framework for assessing the environmental and operational impacts of GSCM initiatives. In the context of technological application, Wu et al. [8] applied a fuzzy TOPSIS model to green supplier selection in the magnetic refrigeration industry, demonstrating the method's flexibility and reliability in handling imprecise data. Their results confirmed that fuzzy MCDM techniques are well-suited for complex, multi-dimensional decision-making problems in sustainability contexts.

Finally, Büyüközkan and Çetiner [9] combined fuzzy AHP and fuzzy TOPSIS in a strategic analysis of service quality, showcasing the robustness of this hybrid approach in real-world applications. Although their study focused on the healthcare sector, the methodological rigor and clarity of their framework make it highly transferable to green supplier selection in manufacturing industries. Collectively, these studies confirm that integrating environmental criteria into supplier selection is not only feasible but essential for achieving long-term sustainability. The use of fuzzy MCDM methods, particularly fuzzy AHP and fuzzy TOPSIS, offers a powerful tool for managing uncertainty and subjectivity in decision-making. This body of literature provides a strong theoretical and methodological foundation for the present study, which aims to apply these techniques to evaluate and rank automotive component suppliers within SAIPA Company under a green supply chain framework.

3 | Research Methodology

This study adopts a descriptive-analytical research design to evaluate and prioritize automotive component suppliers within SAIPA Company based on the principles of GSCM. The methodology integrates a hybrid MCDM approach, combining FAHP for criteria weighting and Fuzzy TOPSIS for supplier ranking. The research framework is structured into three main phases: 1) identification of evaluation criteria, 2) determination of criteria weights using Fuzzy AHP, and 3) supplier prioritization using Fuzzy TOPSIS.

3.1 | Selection of Evaluation Criteria

A comprehensive review of the literature and expert consultation led to the identification of seven key criteria for supplier evaluation, categorized into two main groups: Product-related criteria and Environmental criteria. These criteria are summarized in *Table 1*.

Table 1. Definition of evaluation criteria.

Criterion Code	Criterion Category	Sub Criterion Code	Sub Criterion Title	Definition and Measurement
C1	Product-related	SC1	Quality	Return rate = (Returned items/Total delivered items)
C2	Product-related	SC2	Delivery time	Time between order placement and delivery
C3	Product-related	SC3	Price	Unit price + transportation cost
C4	Environmental	SC4	Environmental management system	Level of compliance with ISO 14001 standards
C5	Environmental	SC5	Green design	Use of eco-friendly materials and sustainable design practices
C6	Environmental	SC6	Product recycling system	Capability to recycle returned products
C7	Environmental	SC7	Procurement of eco-friendly materials and technology	Adoption of environmentally compliant materials and technologies

These criteria were selected based on their prominence in GSCM literature and their applicability to the automotive industry [10].

3.2 | Decision-Making Model Selection

Among various MCDM techniques, the compromise-based group (e.g., TOPSIS, LINMAP) was selected due to its ability to identify the alternative closest to the ideal solution. The LINMAP method is suitable only when the optimal value of a criterion lies in the middle of its range (e.g., a value of 4 is preferred over 3 or 5), which is not applicable in supplier ranking, where higher performance always leads to a higher score. Therefore, TOPSIS was chosen for its suitability in this context.

The TOPSIS method is preferred for the following reasons:

It allows for trade-offs between criteria, enabling a supplier with strong performance in some areas to compensate for weaker performance in others [11].

It considers the interaction between criteria, accounting for both conflict and compatibility.

It is less sensitive to the method of weight assignment [12].

3.3 | Research Framework

The overall research process is illustrated in *Fig. 1*. The framework begins with problem definition, followed by the identification of key criteria, determination of their weights using Fuzzy AHP, and finally, supplier prioritization using Fuzzy TOPSIS. The results are then analyzed to derive conclusions and recommendations.

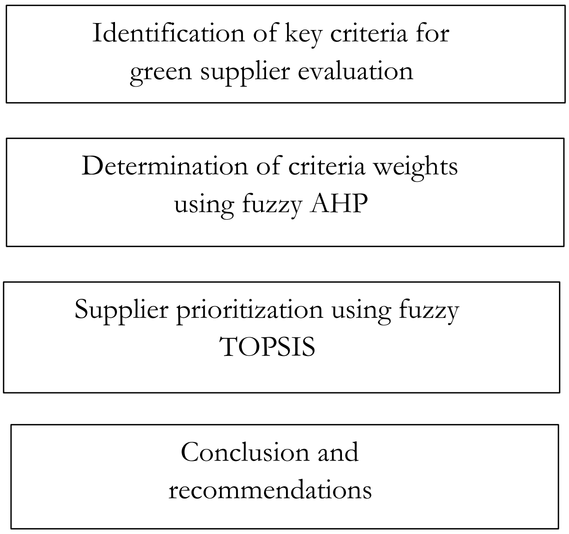

Fig. 1. Research framework.

3.4 | Data Collection and Expert Panel

The data were collected through a combination of document analysis and expert surveys. A panel of ten experts from SAIPA's procurement and supply chain departments in the Bojnourd branch participated in the evaluation process. Experts were selected based on their experience and familiarity with supplier performance and green practices.

For quantitative criteria (e.g., price, delivery time), data were obtained from company records.

For qualitative and environmental criteria, expert opinions were gathered using a structured questionnaire based on Saaty's 1–9 scale.

3.5 | Fuzzy Analytic Hierarchy Process (FAHP)

FAHP was used to determine the relative weights of the evaluation criteria. This method extends Saaty's traditional AHP by incorporating fuzzy set theory to handle uncertainty and linguistic judgments from experts. Triangular fuzzy numbers were used to represent pairwise comparison judgments.

To ensure the consistency of expert judgments, the Consistency Ratio (CR) was calculated. A CR value below 0.10 is considered acceptable for matrices larger than 4×4. For smaller matrices, stricter thresholds are applied: CR ≤ 0.05 for 3×3 matrices and CR ≤ 0.08 for 4×4 matrices [13].

The steps for calculating the CR are as follows:

I. Weighted sum vector: multiply the pairwise comparison matrix by the column vector of relative weights.

II. Inconsistency vector: divide each element of the weighted sum vector by the corresponding relative priority.

III. Calculate λ_max: the average of the inconsistency vector elements.

Consistency Index (CI)

$$II = \frac{\lambda_{max}}{n-1}.$$

where n is the number of criteria.

Consistency Ratio

$$CR = \frac{II}{IR}.$$

where RI is the Random Index (RI), obtained from *Table 2*.

Table 2. RI values.

N	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.51

3.6 | Fuzzy TOPSIS Technique

The Fuzzy TOPSIS method was used to rank the suppliers based on their performance across the seven criteria. This technique selects the alternative that is closest to the Positive Ideal Solution (PIS) and farthest from the Negative Ideal Solution (NIS).

The steps of the Fuzzy TOPSIS method are:

I. Construct the fuzzy decision matrix.

II. Normalize the fuzzy decision matrix.

III. Calculate the weighted normalized decision matrix.

IV. Determine the PIS and NIS.

V. Calculate the separation measures from PIS and NIS.

VI. Compute the relative closeness coefficient.

VII. Rank the suppliers based on the closeness coefficient.

3.7 | Statistical Population and Sampling

The statistical population consists of key decision-makers and supply chain specialists at SAIPA Company. Given the limited number of qualified experts directly involved in supplier evaluation, a census approach (total population sampling) was adopted to ensure comprehensive and reliable input.

4 | Results and Data Analysis

This section presents the findings of the research, including the application of the Fuzzy AHP method for criteria weighting and the Fuzzy TOPSIS technique for supplier prioritization within SAIPA Automotive Company. The analysis is based on expert judgments and real company data, focusing on four key seat suppliers: Iran Lavazem Qazieh, Pars Seat Systems, Soroush, and Hadeed Mobtakeran.

4.1 | Criteria and Alternatives

Based on the literature review and expert consultation, seven evaluation criteria were selected and categorized into two main groups: Product-related and Environmental. The four alternative suppliers are described in *Table 3*.

Table 3. Supplier Alternatives.

Supplier	Full Name	Main Product
A1	Iran Lavazem Qazieh Co.	Automotive seats
A2	Pars Seat Systems Co.	Automotive seats
A3	Soroush Co.	Automotive seats
A4	Hadeed Mobtakeran Co.	Automotive seats

4.2 | Criteria Definition

The evaluation criteria are defined in detail in *Table 4.* which includes both quantitative and qualitative measures. These criteria were used in both the FAHP and Fuzzy TOPSIS phases.

Table 4. Evaluation criteria and measurement indicators.

Criterion Code	Criterion Category	Sub Criterion Code	Sub Criterion Title	Definition and Measurement Method
C1	Product-related	SC1	Quality	Return rate = (Returned items / Total delivered items)
C2	Product-related	SC2	Delivery Time	Time between order placement and delivery (in days)
C3	Product-related	SC3	Price	Unit price + transportation cost (in IRR)
C4	Environmental	SC4	Environmental Management System	Compliance level with ISO 14001 standard (Expert score: 1–10)
C5	Environmental	SC5	Green Design	Use of eco-friendly materials and sustainable design (Expert score: 1–10)
C6	Environmental	SC6	Product Recycling System	Capability to recycle returned products (Expert score: 1–10)
C7	Environmental	SC7	Procurement of Eco-Friendly Materials and Technology	Adoption of environmentally compliant materials and technologies (Expert score: 1–10)

$$W=\{W1, W2, \dots, Wn\} \approx V= N_D - \ W_{n\times n} = \begin{vmatrix} v11, \dots, v1j, \dots, v1n \\ \dots \\ vm1, \dots, vmj, \dots, vmn \end{vmatrix}.$$

4.3 | Criteria Weighting Using Fuzzy AHP

To determine the relative importance of the criteria, a pairwise comparison questionnaire was administered to a panel of ten experts from SAIPA's procurement and planning department. The linguistic judgments were converted into triangular fuzzy numbers [14], and the Fuzzy AHP method was applied.

$$\{v_1^+, v_2^+, \dots, v_j^+, v_j^+\} \ = \{(\max_i v_{ij} | j\epsilon J), (\min_i v_{ij} | j\epsilon J^`) | i = 1,2, \dots, m\} \ A^+,$$

$$\{v_1^-, v_2^-, \dots, v_j^-, v_j^-\} \ = = \{(\min_i v_{ij} | j\epsilon J), (\max_i v_{ij} | j\epsilon J^`) | i = 1,2, \dots, m\} \ A^-,$$

$$d_i^+ = \left\{\sum_{j=1}^{n} (v_{ij} - v_j^+)^2\right\}^{0.5}, \quad i = 1,2, \dots, m,$$

$$d_i^- = \left\{\sum_{j=1}^{n} (v_{ij} - v_j^-)^2\right\}^{0.5}, \quad i = 1,2, \dots,$$

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

The final weights of the main criteria were calculated using the geometric mean method and are presented in *Table 5*.

Table 5. Weights of main criteria (fuzzy ahp results).

Criterion	Weight	Normalized Weight
C1 (quality)	1.73	0.577
C2 (delivery time)	0.75	0.250
C3 (Price)	0.52	0.173
Product-related Total	—	1.000
C4 (EMS)	0.38	0.210
C5 (green design)	0.30	0.165
C6 (Recycling)	0.42	0.235
C7 (Eco-procurement)	0.70	0.390
Environmental Total	—	1.000

Consistency check

The CR for all pairwise comparison matrices was calculated and found to be below the acceptable threshold of 0.10, confirming the reliability of expert judgments.

I. CR for Product-related criteria: 0.06.

II. CR for Environmental criteria: 0.04.

These results indicate that the decision matrices are consistent.

4.4 | Supplier Prioritization Using Fuzzy TOPSIS

The Fuzzy TOPSIS method was applied to rank the four suppliers based on their performance across the seven criteria. The steps followed were:

I. Construct the fuzzy decision matrix using expert scores and company data.

II. Normalize the matrix.

III. Calculate the weighted normalized decision matrix.

IV. Determine the Positive Ideal Solution (PIS) and Negative Ideal Solution (NIS).

V. Compute separation measures from PIS and NIS.

VI. Calculate the relative closeness coefficient (CC_i).

VII. Rank the suppliers based on CC_i.

The final closeness coefficients and rankings are presented in *Table 6*.

Table 6. Fuzzy topsis results and supplier rankings.

Supplier	PIS	NIS	CC_i	Rank
A1 (Iran Lavazem Qazieh)	0.112	0.298	0.726	1
A2 (Pars seat systems)	0.135	0.265	0.663	2
A3 (Soroush)	0.187	0.210	0.528	3
A4 (Hadeed Mobtakeran)	0.241	0.156	0.393	4

4.5 | Discussion of Results

The results indicate that Iran Lavazem Qazieh (A1) is the top-ranked supplier, followed by Pars Seat Systems (A2). This ranking is primarily driven by superior performance in quality (C1), which had the highest weight (0.577) among all criteria. High quality significantly reduces return rates and enhances supply chain reliability. Although environmental criteria collectively have lower weights compared to product-related criteria, they played a decisive role in differentiating suppliers with similar product performance. Among the environmental factors, Procurement of Eco-Friendly Materials and Technology (C7) and Product Recycling System (C6) had the highest weights (0.390 and 0.235, respectively), indicating their critical importance in green supplier evaluation.

Notably, Pars Seat Systems (A2), despite having lower quality scores than A1, achieved the second rank due to its strong environmental performance, particularly in recycling and green procurement. This highlights the balancing effect of the Fuzzy TOPSIS method, which allows compensatory trade-offs between criteria. The lowest-ranked supplier, Hadeed Mobtakeran (A4), scored poorly in both quality and environmental performance, confirming the model's sensitivity to poor performance in high-weight criteria.

This chapter presented the application of a hybrid Fuzzy AHP–Fuzzy TOPSIS model for green supplier prioritization in the automotive industry. The Fuzzy AHP method was used to determine the weights of evaluation criteria based on expert opinions, ensuring consistency through CR analysis. The Fuzzy TOPSIS technique was then applied to rank the suppliers based on a combination of product and environmental performance. The results demonstrate that integrating environmental criteria into supplier selection is feasible and impactful, even when traditional factors like quality dominate the decision. The proposed model provides a structured, transparent, and reliable framework for decision-makers in automotive companies aiming to enhance sustainability in their supply chains.

5 | Conclusion

This study presented a hybrid Fuzzy AHP–Fuzzy TOPSIS model for green supplier prioritization within the automotive industry, with a focus on SAIPA Company. By integrating economic and environmental criteria—such as Quality, Price, Delivery Time, Environmental Management System, Green Design, Product Recycling, and Eco-Friendly Procurement—the research provided a systematic framework for evaluating suppliers under conditions of uncertainty. The results revealed that Iran Lavazem Qazieh ranked first, followed by Pars Seat Systems, while Soroush and Hadeed Mobtakeran ranked third and fourth, respectively. Notably, the criterion of Quality had the highest weight, confirming its dominant role in supplier selection. However, environmental factors, particularly Eco-Friendly Procurement and Product Recycling, significantly influenced the final ranking, demonstrating that green practices can serve as a strategic differentiator even in cost- and quality-driven industries.

The findings highlight the importance of adopting GSCM as a strategic imperative rather than an optional initiative. The proposed model offers a transparent, structured, and repeatable decision-making process for automotive manufacturers seeking to enhance sustainability in their supplier selection process. It also provides actionable insights for suppliers: for instance, Soroush should improve its quality control to reduce return rates, while Hadeed Mobtakeran needs to strengthen its environmental performance. The integration of fuzzy logic into MCDM methods proved effective in handling the subjectivity and imprecision inherent in expert judgments, making the model suitable for real-world industrial applications. Future research can extend this framework to other high-impact industries such as petrochemicals, cement, and healthcare, where environmental challenges are significant. Additionally, incorporating reverse logistics, circular economy principles, or advanced methods like Fuzzy ANP and DEMATEL could further enhance the model's robustness. This study contributes to the growing body of knowledge on sustainable supply chains in emerging economies and provides a practical roadmap for aligning operational excellence with environmental responsibility.

Acknowledgments

The authors would like to express their sincere appreciation to all individuals whose valuable comments and support contributed to the successful completion of this study.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Refrences

[1] Naderipour, M., Zarandi, M. H. F., & Bastani, S. (2022). A fuzzy cluster-validity index based on the topology structure and node attribute in complex networks. *Expert systems with applications*, *187*, 115913. https://doi.org/10.1016/j.eswa.2021.115913

[2] Moors, E. H. M. (2006). Technology strategies for sustainable metals production systems: a case study of primary aluminium production in The Netherlands and Norway. *Journal of cleaner production*, *14*(12–13), 1121–1138. https://doi.org/10.1016/j.jclepro.2004.08.005

[3] Ho, J. W., & Fang, C. C. (2013). Production capacity planning for multiple products under uncertain demand conditions. *International journal of production economics*, *141*(2), 593–604. https://doi.org/10.1016/j.ijpe.2012.09.016

[4] Kannan, D., Khodaverdi, R., Olfat, L., Jafarian, A., & Diabat, A. (2013). Integrated fuzzy multi criteria decision making method and multi-objective programming approach for supplier selection and order allocation in a green supply chain. *Journal of cleaner production*, *47*, 355–367. https://doi.org/10.1016/j.jclepro.2013.02.010

[5] Srivastava, S. K. (2007). Green supply-chain management: a state-of-the-art literature review. *International journal of management reviews*, *9*(1), 53–80. https://doi.org/10.1111/j.1468-2370.2007.00202.x

[6] Min, H., & Galle, W. P. (2001). Green purchasing practices of US firms. *International journal of operations & production management*, *21*(9), 1222–1238. https://doi.org/10.1108/EUM0000000005923

[7] Hervani, A. A., Helms, M. M., & Sarkis, J. (2005). Performance measurement for green supply chain management. *Benchmarking: an international journal*, *12*(4), 330–353. https://doi.org/10.1108/14635770510609015

[8] Zhao, S., Du, X., Ge, Z., & Yang, Y. (2016). Cascade utilization of flue gas waste heat in combined heat and power system with high back-pressure (CHP-HBP). *Energy procedia*, *104*, 27–31. https://doi.org/10.1016/j.egypro.2016.12.006

[9] Kim, B., & Han, I. (2011). The role of utilitarian and hedonic values and their antecedents in a mobile data service environment. *Expert systems with applications*, *38*(3), 2311–2318. https://doi.org/10.1016/j.eswa.2010.08.019

[10] Ajukumar, V. N., & Gandhi, O. P. (2013). Evaluation of green maintenance initiatives in design and development of mechanical systems using an integrated approach. *Journal of cleaner production*, *51*, 34–46. https://doi.org/10.1016/j.jclepro.2013.01.010

[11] Lai, Y. J., Liu, T. Y., & Hwang, C.-L. (1994). Topsis for MODM. *European journal of operational research*, *76*(3), 486–500. https://doi.org/10.1016/0377-2217(94)90282-8

[12] Tavana, M., Sodenkamp, M. A., & Suhl, L. (2010). A soft multi-criteria decision analysis model with application to the European Union enlargement. *Annals of operations research*, *181*(1), 393–421. https://doi.org/10.1007/s10479-010-0727-9

[13] Saaty, T. L., & Wind, Y. (1980). Marketing applications of the analytic hierarchy process. *Management science*, *26*(7), 641–658. https://faculty.wharton.upenn.edu/wp-content/uploads/2012/04/8002_Marketing_Applications_of_the_Analytic.pdf

[14] Naderipour, M., Fazel Zarandi, M. H., & Bastani, S. (2022). Fuzzy community detection on the basis of similarities in structural/attribute in large-scale social networks. *Artificial intelligence review*, *55*(2), 1373–1407. Fuzzy community detection on the basis of similarities in structural/attribute in large-scale social networks