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Development of a Sustainability-Based Supplier Evaluation System in the Service Sector Supply Chain

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A B S T R A C T

Corporate S faces challenges in its procurement process, including delayed deliveries, incorrect item specifications, and increased costs that reduce profitability. Its current supplier evaluation system focuses solely on economic aspects, neglecting sustainability. This study aims to design a sustainable supplier evaluation system using the DEMATEL-ANP-VIKOR method, involving economic, social, and environmental criteria. ANP results show that the economic criterion holds the highest weight (0.648), followed by social (0.252) and environmental (0.099). VIKOR analysis (v = 0.5) ranks Supplier 3 as the most suitable, with a Q value of 0.000. Based on data collected in early 2025, this system offers a structured and objective approach to supplier selection, aligning operational efficiency with sustainability goals and the SDGs.

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INTRODUCTION

In the era of the Fourth Industrial Revolution (Industry 4.0), both manufacturing and service industries are required to enhance efficiency and competitiveness through supply chain optimization. One of the critical elements of the supply chain is supplier selection and evaluation, which plays a significant role in ensuring the sustainability of a company's operations (Ahmad et al., 2025). However, in Indonesia, supplier evaluation practices are still largely conventional and tend to ignore sustainability principles in a holistic manner (Modarress-Fathi et al., 2023).

Global trends indicate a growing awareness of sustainability. According to NielsenIQ (2023), 69% of global consumers now consider sustainability a more important factor than two years ago. In Indonesia, the number is even higher at 86%, the highest in Southeast Asia. This signals increased market pressure on businesses to adopt sustainable practices, driven by both regulatory demands and consumer preferences.

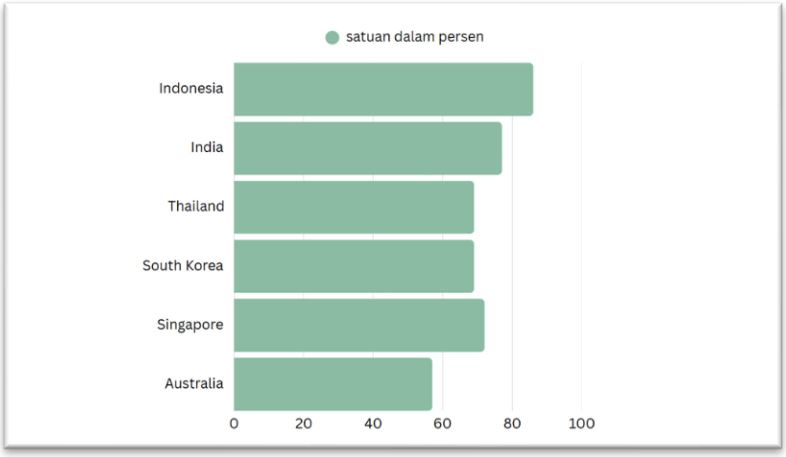

Figure 1. Consumer Sentiment Regarding the Increasing Importance of Sustainability

Despite this shift, the implementation of sustainability principles at the company level remains challenging. Corporate S, which specializes in topographic surveys, laboratory testing, and project supervision. Over the past few years, the company has faced serious procurement issues, including delayed equipment deliveries and incorrect item specifications, often resulting in returns and reorders. These problems have disrupted project schedules and led to increased operational costs, ultimately reducing overall efficiency and profitability. Currently, the supplier evaluation system in place focuses solely on economic aspects such as price and delivery speed, with no consideration for social or environmental dimensions. Evaluations are conducted subjectively, without a systematic and data-driven framework, limiting the accuracy and strategic value of decision-making (Rahardjo et al., 2023).

This situation highlights a gap between actual practices and the principles of Sustainable Supply Chain Management (SSCM), which emphasize the integration of economic, social, and environmental factors into decision-making processes (Pujawan, 2024). SSCM is not merely a "green" initiative but a long-term strategic approach aligned with corporate goals and the United Nations' Sustainable Development Goals (SDGs) (Kurniawan et al., 2023.). In this context, sustainable supplier selection (SSS) becomes a critical concern (Simanjuntak et al., 2025).

Previous studies have employed various multi-criteria decision-making (MCDM) methods to support supplier selection. For instance, Rahardjo et al. (2023) used a combination of DEMATEL and VIKOR in the electronics industry to identify interrelationships among criteria and provide compromise-based supplier recommendations. Masudin et al., (2024) integrated ANP and TOPSIS in the selection of sustainable raw material suppliers, concluding that economic factors remained dominant. Meanwhile, Nurhayati et al., (2023) AHP in marine engine supplier selection, but failed to account for interdependencies between criteria—an important limitation considering that economic, social, and environmental factors often influence one another.

To address these limitations, this study proposes a more comprehensive approach by integrating the Decision-Making Trial and Evaluation Laboratory (DEMATEL), Analytical Network Process (ANP), and VIšekriterijumska Optimizacija Kompromisno Resenje (VIKOR) methods. DEMATEL is used to identify causal relationships among criteria and sub-criteria based on the Triple Bottom Line (TBL) framework; ANP assigns priority weights considering interdependence; and VIKOR ranks supplier alternatives based on a compromise solution (Samosir et al., 2021). This integrated model aims to provide a systematic and objective evaluation system that supports efficient, sustainable procurement decisions.

This research contributes to the enrichment of sustainable supplier evaluation literature, particularly in the service sector, which has received less attention in previous studies. The proposed model is expected to enable the company to select suppliers who are not only technically and economically competent but also socially and environmentally responsible. It also aligns with the company's long-term strategy and supports the achievement of SDG Goal 9 (industry, innovation, and infrastructure) and Goal 12 (responsible consumption and production) (Pujawan, 2024).

The primary objective of this study is to design a sustainability-based supplier evaluation system that integrates operational efficiency, profitability, and sustainability principles, ultimately providing accurate and strategic procurement decision support for the company.

LITERATURE REVIEW

Sustainable Supply Chain Management

Sustainable Supply Chain Management (SSCM) is a strategic approach that integrates economic, social, and environmental aspects into supply chain management processes (Xing, 2023). According to Pujawan (2024), SSCM aims to optimize company performance without neglecting sustainability impacts. This approach emphasizes that cost efficiency must go hand in hand with social responsibility and environmental preservation.

The implementation of SSCM includes evaluating supplier performance based on their contribution to sustainability, rather than solely on price or product quality (Siregar & Pinagara, 2022). This has become increasingly crucial, especially in an era where both markets and regulators are demanding greater transparency and sustainability.

Triple Bottom Line Framework

A company's sustainability is not only measured by financial profit and Return on Investment (ROI), but also by its impact on society and the environment (Jao et al., 2023). The Triple Bottom Line (TBL) approach emphasizes a balance between profit, people, and planet. This concept encourages companies to not only focus on economic gains but also to consider the social and environmental consequences of their operations (Hilmi et al., 2021).

Multi Criteria Decision Making

Multi-Criteria Decision Making (MCDM) is an approach or method for decision-making based on alternative solutions evaluated through multiple criteria (Jaya et al., 2020). The hybrid MCDM approach based on the DANP method has been widely applied in various sectors, including the assessment of corporate sustainability indicators, the development of green building rating systems, and the formulation of innovative strategies in financial services (Rahardjo et al., 2023). The use of the VIKOR method to rank and improve overall performance gaps among various criteria and dimensions has also been implemented in several previous studies (Yang et al., 2020). As illustrated in Figure 2, the hybrid MCDM model consists of three main stages: (1) generating a comprehensive influence matrix and developing the Influential Network Relation Map (INRM) among the criteria through the DEMATEL approach; (2) determining the weight of each criterion's influence using the ANP methodology; and (3) prioritizing and enhancing the ranking of dimensions or criteria with the help of the VIKOR method, aiming to minimize performance gaps and reach the optimal performance target known as the aspiration level.

DEMATEL

DEMATEL is a technique designed to analyze and visualize cause-and-effect relationships among various criteria within complex systems (Kuo et al., 2015). The DEMATEL method examines causal relationships between factors using matrix operations. This process helps measure the level of influence of each factor and visualizes these relationships in the form of a relationship map. DEMATEL utilizes a directed graph (digraph) to classify factors into two groups: causal factors and effect factors (Nisrina, 2024).

Analytic Network Process (ANP)

ANP is a relative measurement method used to derive composite priority ratios from individual ratio scales that reflect the relative influence of interrelated elements with respect to control criteria (Annisa, 2022). ANP is an extension of the Analytic Hierarchy Process (AHP), developed to overcome its limitations in handling interdependencies and feedback between criteria and alternatives in decision-making processes (Syafirullah et al., 2024). One of the key advantages of ANP is its accuracy in capturing dependencies and feedback among alternatives and criteria, making it a suitable method to support the resolution of complex decision problems in this research (Anissa et al., 2020).

VIKOR

VIKOR method is part of the Multi-Criteria Decision Making (MCDM) approach, which supports decision-making processes involving multiple criteria (Ulfa et al., 2020). VIKOR is used to rank a set of available alternatives by considering utility values, closeness to the ideal solution, and deviation, where the weights of each criterion are typically obtained using the AHP method (Akram et al., 2021). VIKOR ranks the alternatives and identifies the one that is closest to the optimal compromise solution (Dhiya Ulhaq, 2021). This method is particularly useful when decision-makers are unable to define a preferred alternative at the early stages of system design (Syahputra, 2020).

METHODOLOGY

This study adopts a descriptive mixed-methods approach, combining quantitative and qualitative methods to design a sustainability-based supplier evaluation system in the context of the geotechnical services industry. The quantitative component applies Multi-Criteria Decision Making (MCDM) methods—DEMATEL, ANP, and VIKOR—to analyze supplier alternatives. The qualitative aspect involves determining criteria and sub-criteria through literature review and expert interviews. Primary data were obtained via questionnaires distributed to three internal experts familiar with procurement and supplier evaluation.

The analysis was conducted in three stages: (1) DEMATEL identified cause-effect relationships among sub-criteria; (2) the results were used in ANP to calculate priority weights; and (3) VIKOR ranked supplier alternatives based on compromise solutions. Data processing was carried out using Microsoft Excel and Super Decisions software.

This study applies the Triple Bottom Line (TBL) framework as the basis for sustainability evaluation, incorporating three key dimensions: economic (profit), social (people), and environmental (planet), which are considered highly relevant to procurement practices in the geotechnical service industry. The selected criteria and sub-criteria used in this study are summarized in Table 1, along with their definitions. These were derived from several academic sources and validated through expert judgment by the respondents.

Table 1. Criteria and Sub-criteria

Criteria	Sub-Criteria	Definition	Reference
Economy	Cost (A1)	The price offered by the supplier is competitive and proportional to the quality of service received.	Memari et al., (2019)
	Service Quality (A2)	The reliability and condition of the fleet (transportation, heavy equipment, logistics, etc.) or service insurance provided by the supplier to ensure quality and contract-compliant service delivery.	Nsikan et al., (2022)
	Delivery Timeliness (A3)	The supplier's ability to meet delivery schedules in accordance with the agreed dates and times, with a very low frequency of delays.	Jain, N. (2020)
	Technical Capability (A4)	The extent to which the supplier possesses technical facilities and infrastructure such as transport fleets, heavy equipment, and certified skilled labor to support operational execution	(Alavi et al., 2021)
Social	Workforce Competence (B1)	Emphasizes the personal capacity of the supplier's workforce to work effectively, skillfully, and in accordance with assigned tasks, including both technical and non-technical competencies.	Restuputri, D.P. (2023)
	Occupational Health and Safety (B2))	The supplier applies occupational health and safety (OHS) standards for its workers throughout operational activities to ensure their safety and well-being.	Kannan et al., (2020)
	Supplier Social Responsibility (B3)	The supplier contributes positively to the surrounding community, for example through Corporate Social Responsibility (CSR) programs.	(Khan, S.A (2018)
Environment	Energy Efficiency and Emissions (C1)	The supplier utilizes transportation fleets, heavy equipment, and vehicles that are fuel-efficient and produce minimal greenhouse gas emissions.	Feng, J. (2020)
	Environmental Certification and Regulatory Compliance (C2)	The supplier complies with environmental regulations, such as possessing ISO 14001 certification or internal policies related to environmental impact management.	Durmić (2019)
	Insurance and Operational Safety (C3)	The supplier undertakes efforts to provide protection through heavy equipment insurance and risk mitigation measures for accidents that may lead to environmental pollution.	Çalık, A. (2020)

RESEARCH RESULT

In an effort to promote sustainability, Company S has initiated a supplier evaluation process targeting its long-term partners. Issues such as delivery delays and material specification discrepancies have highlighted the need for an objective and structured evaluation system. Until now, the supplier selection process in Company S has been largely subjective, lacking a systematic methodological foundation. The company currently collaborates with five transportation service providers responsible for mobilization and demobilization activities, namely Supplier 1 through Supplier 5. This study focuses on designing a supplier performance evaluation system for these five suppliers, with the goal of identifying the best-performing supplier to serve as the company's main partner. The evaluation employs an integrated Multi-Criteria Decision Making (MCDM) model, which combines the DEMATEL, ANP, and VIKOR methods. Three experienced respondents are involved in the evaluation process: a manager with two years of experience, and two senior staff members with six and nine years of experience, respectively. The assessment is conducted through three types of questionnaires. The first questionnaire adopts the DEMATEL method to identify the relationships between criteria and sub-criteria, using a scale of 0–4. The resulting cause-effect relationships serve as input for pairwise comparisons in the ANP questionnaire. The second questionnaire applies the ANP method with a 1–9 scale to determine the weight of each criterion. Finally, the third questionnaire uses a 1–5 Likert scale to evaluate the performance of each supplier. The final performance scores are analyzed using the VIKOR method, wherein the supplier with the lowest score is considered the most optimal and recommended as the primary supplier for Company S.

Table 2 presents the initial direct-relation matrix, which is the averaged result of assessments provided by the three respondents. These data were obtained through Questionnaire 1, in which the respondents were asked to evaluate the level of influence between criteria. The calculation process follows the standard DEMATEL methodology as outlined in the study by Widiasih (2017). In Table 2, the values were derived by summing the responses of each respondent for every column and then dividing the total by three, reflecting the number of respondents. Table 3 was generated by calculating the sum of each row in Table 2 to identify the maximum value. This maximum value was then used to normalize each value in the matrix by dividing the maximum by the respective column values, ensuring the proportionality of the data and preparing it for the next stage of computation. Table 4 displays the total relation matrix, which was calculated using the MMULT function in Microsoft Excel based on the values in Table 2. From Table 4, the D vector (row sums) and R vector (column sums) were computed and presented in Table 5.

Additionally, the threshold value was determined from Table 4 by calculating the average value of all columns in the matrix. The resulting threshold value was 0.146600715, which served as the reference point for constructing Table 6. In this context, if a matrix value exceeds the threshold, the corresponding sub-criterion is considered to have an influence on other sub-criteria. Conversely, if the matrix value is below the threshold, the sub-criterion is regarded as having no influence. Based on these results, an impact-relation map (IRM) was constructed to visually represent the cause-and-effect relationships among the sub-criteria.

Table 2. Average Values of DEMATEL Questionnaire Results

Sub criteria	A1	A2	A3	A4	B1	B2	B3	C1	C2	C3
A1	0.0	3.3	3.3	3.3	3.0	3.3	3.3	3.3	3.3	3.3
A2	3.3	0.0	3.0	2.3	3.0	0.0	1.0	0.0	2.7	1.3
A3	2.7	3.7	0.0	1.0	1.3	1.0	1.0	1.0	0.0	0.0
A4	4.0	3.3	3.3	0.0	3.0	1.7	2.7	1.7	1.0	0.0
B1	4.0	3.3	2.0	3.7	0.0	3.0	1.0	1.0	3.0	0.0
B2	3.3	1.7	1.7	1.7	2.7	0.0	3.0	0.0	0.7	0.7
B3	2.3	2.7	3.0	2.0	1.7	2.0	0.0	0.7	3.3	1.3
C1	1.3	0.0	1.0	0.7	1.0	0.0	0.7	0.0	0.0	2.0
C2	4.0	2.3	2.3	2.0	3.7	2.0	2.7	0.0	0.0	0.7
C3	1.3	0.0	0.0	0.0	0.0	0.7	4.0	0.0	0.7	0.0

Table 3. Normalized Direct-Relation Matrix

Sub criteria	A1	A2	A3	A4	B1	B2	B3	C1	C2	C3
A1	0	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112
A2	0.112	0	0.101	0.078	0.101	0	0.033	0	0.089	0.044
A3	0.089	0.123	0	0.033	0.044	0.033	0.033	0.033	0	0
A4	0.134	0.112	0.112	0	0.101	0.056	0.089	0.056	0.033	0
B1	0.134	0.112	0.067	0.123	0	0.101	0.033	0.033	0.101	0
B2	0.112	0.056	0.056	0.056	0.089	0	0.101	0	0.022	0.022
B3	0.078	0.089	0.101	0.067	0.056	0.067	0	0.022	0.112	0.044
C1	0.044	0	0.033	0.022	0.033	0	0.022	0	0	0.067
C2	0.134	0.078	0.078	0.067	0.123	0.067	0.089	0	0	0.022
C3	0.044	0	0	0	0	0.022	0.134	0	0.022	0

Table 4. Total-Relation Matrix

Sub criteria	A1	A2	A3	A4	B1	B2	B3	C1	C2	C3
A1	0.218	0.282	0.274	0.250	0.259	0.223	0.259	0.174	0.235	0.183
A2	0.247	0.127	0.209	0.175	0.205	0.088	0.134	0.054	0.175	0.094
A3	0.182	0.199	0.083	0.105	0.122	0.087	0.099	0.069	0.068	0.042
A4	0.292	0.252	0.243	0.122	0.225	0.151	0.198	0.116	0.143	0.067
B1	0.304	0.257	0.211	0.241	0.146	0.197	0.160	0.097	0.205	0.068
B2	0.236	0.171	0.163	0.151	0.187	0.081	0.188	0.051	0.113	0.073
B3	0.228	0.215	0.217	0.169	0.174	0.150	0.109	0.073	0.198	0.098
C1	0.089	0.042	0.069	0.054	0.066	0.030	0.061	0.019	0.031	0.084
C2	0.294	0.223	0.212	0.187	0.246	0.166	0.202	0.063	0.112	0.085
C3	0.097	0.050	0.050	0.041	0.044	0.058	0.170	0.020	0.064	0.025

Table 5. Calculation Results of D+R Vector and D–R Vector

Sub Criteria	D	R	D+R	D-R
Cost (A1)	2.36071	2.1926	4.55331	0.16811
Service Quality (A2)	1.51261	1.82148	3.33409	-0.30887
Delivery Timeliness (A3)	1.05996	1.73591	2.79587	-0.67595
Technical Capability (A4)	1.81326	1.50119	3.31445	0.31206
Workforce Competence (B1)	1.89039	1.67912	3.56951	0.21126
Occupational Health and Safety (B2)	1.41818	1.23583	2.65401	0.18235
Supplier Social Responsibility (B3)	1.63551	1.58317	3.21869	0.05234
Energy Efficiency and Emissions (C1)	0.54981	0.73981	1.28962	-0.19001
Environmental Certification and Regulatory Compliance (C2)	1.79607	1.349	3.14507	0.44708
Insurance and Operational Safety (C3)	0.62357	0.82195	1.44551	-0.19838

Table 6. Impact-Relation Map (IRM)

Sub criteria	A1	A2	A3	A4	B1	B2	B3	C1	C2	C3
A1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
A2	Yes	-	Yes	Yes	Yes	-	-	-	Yes	-
A3	Yes	Yes	-	-	-	-	-	-	-	-
A4	Yes	Yes	Yes	-	Yes	Yes	Yes	-	-	-
B1	Yes	Yes	Yes	Yes	-	Yes	Yes	-	Yes	-
B2	Yes	Yes	Yes	Yes	Yes	-	Yes	-	-	-
B3	Yes	Yes	Yes	Yes	Yes	Yes	-	-	Yes	-
C1	-	-	-	-	-	-	-	-	-	-
C2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-	-	-
C3	-	-	-	-	-	-	-	-	-	-

Following the identification of interrelationships among criteria and sub-criteria through the DEMATEL analysis, the next step in designing the supplier evaluation system involves weighting the elements using the Analytic Network Process (ANP). This method is employed to derive the priority weights of each element within the network, taking into account interdependence and feedback among the criteria and sub-criteria.

The initial step in ANP involves developing a network model that visualizes the interactions between elements, based on the causal relationships identified in the DEMATEL stage. This model consists of three main clusters: economic, social, and environmental dimensions, each comprising several sub-criteria. The influence among sub-criteria, as previously mapped, serves as the foundation for constructing the pairwise comparison matrices. Next, pairwise comparisons are conducted within and between clusters. These comparisons were assessed by three expert respondents using Saaty's 1–9 fundamental scale, which reflects the relative importance between two elements being compared.

The evaluation results were input into the SuperDecisions software to generate the comparison matrices and calculate the local weights of each criterion and sub-criterion. This step also included consistency ratio (CR) testing to ensure the reliability of the responses. A matrix is considered consistent if the CR value is less than 0.1. Based on the analysis, all matrices in this study met the acceptable consistency threshold.

Once the local weights were established, the next stage involved constructing the unweighted supermatrix, which lists the priority vectors without normalization across clusters. This matrix was then multiplied by the cluster weights to form the weighted supermatrix, followed by iterative computation to obtain the limit supermatrix. The limit supermatrix reflects the global priority weights of each sub-criterion, which were subsequently used in the final ranking of alternatives through the VIKOR method.

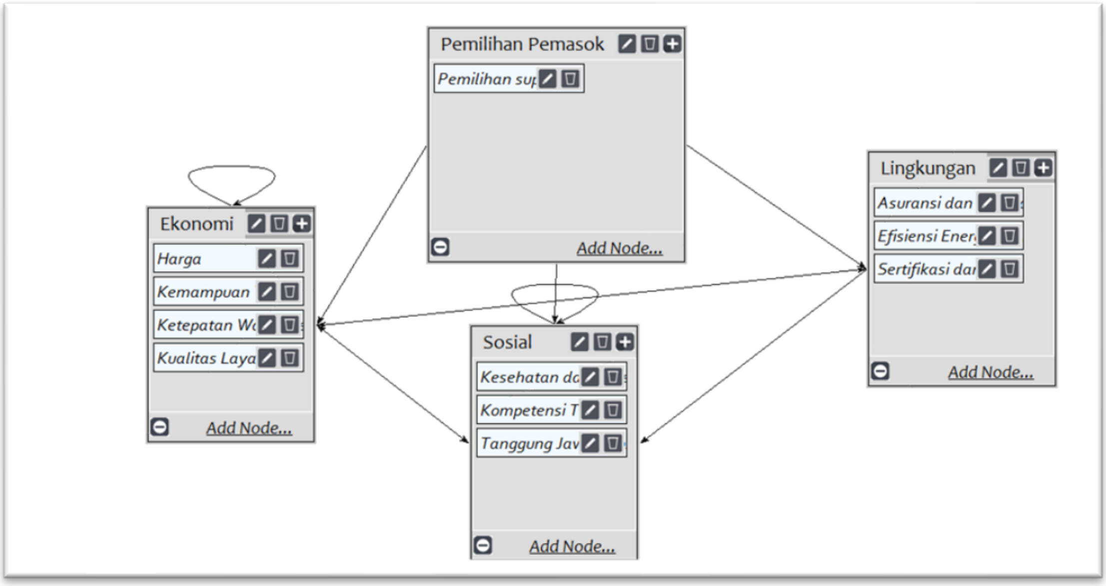

Figure 2. ANP Model Network

Table 7. Results of Inconsistency Analysis for Sub-Criteria

Node (Subcriteria)	*Cluster* (criteria)	*Inconsistency*
Cost	Economy	0.05156
	Social	0.00000
	Environment	0.00000
Technical Capability	Economy	0.05787
Delivery Timeliness	Economy	0.00000
Service Quality	Economy	0.05156
Environmental Certification and Regulatory Compliance	Economy	0.04417
	Social	0.00000
Occupational Health and Safety	Economy	0.04417
	Social	0.00000
Workforce Competence	Economy	0.00000
Supplier Social Responsibility	Economy	0.06560
	Social	0.00000

Table 8. Results of Inconsistency Analysis for Criteria

Cluster (Criteria)	*Inconsistency*
Economics	0.00000
Social	0.00000
Milieu	0.00000

Table 9. Results of Weight Calculation for Sub-Criteria

Subcriteria	*Normalized by Cluster*	*Limiting*
Price	0.42957	0.278502
Technical Capabilities	0.17501	0.113465

Delivery Timeliness	0.21432	0.138947
Quality of Service	0.18110	0.117413
Insurance and Operational Security	0.33333	0.033141
Energy and Emission Efficiency	0.33333	0.033141
Certification and Compliance with Environmental Regulations	0.33333	0.033141
Occupational Health and Safety	0.22398	0.056499
Workforce Competencies	0.51777	0.130608
Supplier Social Responsibility	0.25824	0.065142

Table 10. Results of Weight Calculation for Criteria

***Cluster* (Criteria)**	**Weight**
Economics	0.648327
Social	0.252249
Milieu	0.099423

After obtaining the global weights of each sub-criterion through the ANP method, the final step in this study involved evaluating the performance of each supplier using the VIKOR method. The evaluation was carried out using performance data collected through Questionnaire 3, where three respondents provided assessments of each supplier's performance based on all the defined sub-criteria. A Likert scale of 1 to 5 was used, where 1 indicates very poor performance and 5 represents excellent performance. The average performance score for each supplier was then calculated and used as input for the VIKOR computation. The VIKOR method involves several steps. First, the best and worst values for each criterion were identified across all alternatives. Using these values, the utility measure (S) and regret measure (R) were calculated for each supplier. The utility measure represents the overall distance of an alternative from the ideal solution across all criteria, while the regret measure reflects the maximum individual deviation from the ideal performance.

Subsequently, the Q index was calculated, which represents the overall VIKOR score. The formula incorporates a weighting factor (v), typically set at 0.5, to balance the importance of the group utility and the individual regret. The supplier with the lowest Q value is considered the best compromise solution, as it demonstrates both high overall performance and minimal deviation from the best possible outcomes. Through this analysis, the supplier alternatives were ranked based on their Q values, allowing the identification of the most appropriate supplier to serve as the main logistics partner for Company S. The results from the VIKOR method serve as a strategic recommendation for enhancing supplier selection through structured, data-driven decision-making.

Tabel 11. Initial Decision Matrix (Average Values)

Subcriteria	**Supplier 1**	**Supplier 2**	**Supplier 3**	**Supplier 4**	**Supplier 5**
Price	5	5	3	4	2
Quality of Service	5	5	4	3	3
Delivery Timeliness	5	4	3	3	2
Technical Capabilities	4	4	3	3	2

Workforce Competencies	4	4	3	2	2
Occupational Health and Safety	5	5	4	4	3
Supplier Social Responsibility	5	5	4	4	4
Energy and Emission Efficiency	4	5	3	3	2
Certification and Compliance with Environmental Regulations	3	4	3	3	2
Insurance and Operational Security	5	5	4	4	3

Tabel 12. Supplier Ranking Results Based on VIKOR Implementation

Supplier	Utility Measures (S)	Regret Measures (R)	Indeks Vikor (Qi), v = 0.5	Ranking
1	0.73483	0.2785	0.85301	4
2	0.84743	0.2785	1	5
3	0.46442	0.13061	0	1
4	0.68126	0.19591	0.50386	3
5	0.63202	0.19591	0.43957	2

Tabel 13. Sensitivity Analysis of VIKOR Scores (Qi)

Supplier	Qi, v = 0	Qi, v = 0.25	Qi, v = 0.5	Qi, v = 0.75	Qi, v = 1	Ranking
1	1	0.92651	0.85301	0.77952	0.70602	4
2	1	1	1	1	1	5
3	0	0	0	0	0	1
4	0.44156	0.47271	0.50386	0.53501	0.56616	3
5	0.44156	0.44057	0.43957	0.43858	0.43758	2

DISCUSSION

The analysis using the DEMATEL method reveals that not all criteria and sub-criteria play an equal role in influencing the system. Several sub-criteria act as primary drivers, and improvements in these areas are likely to generate a broader impact on supply chain sustainability. One of the key findings is that the sub-criteria Price and On-Time Delivery function as the main drivers within the evaluation system. This indicates that although sustainability is a strategic goal, timeliness and cost-efficiency remain the primary focal points for the company in supplier selection processes.

Conversely, sub-criteria such as Supplier Social Responsibility and Environmental Compliance and Certification tend to be influenced rather than influential. This suggests that the company perceives socio-environmental sustainability as a consequence of operational efficiency, rather than as a primary decision-making factor. These findings indicate that the transition toward a sustainable supply chain is still in its early adaptation phase, where business logic continues to dominate the decision-making direction.

Through the ANP method, it was found that the Economic criterion still holds the dominant weight, with sub-criteria such as Price and On-Time Delivery ranking at the top. This reinforces the idea that operational competitiveness and logistical efficiency remain difficult priorities to shift. While Social and Environmental criteria have begun to be considered, their level of urgency has yet to match that of economic factors. These results reflect that the transition toward sustainability is still driven primarily by considerations of direct benefit.

Nevertheless, the presence of weights assigned to socio-environmental criteria suggests that the company has started to open space for non-financial aspects, even if only marginally. This represents a positive early indication that sustainability is becoming part of the evaluation system, rather than being symbolic only.

The VIKOR method produced the final ranking of suppliers based on their performance as the best compromise solution. In this process, suppliers that consistently perform well across multiple aspects—particularly On-Time Delivery and Energy and Emissions Efficiency—emerged as the top alternatives. This means that suppliers capable of balancing technical performance and sustainability aspects have a greater likelihood of being selected. Moreover, sensitivity testing involving changes to the preference parameter (value of v) demonstrated that the ranking results were relatively stable, even when the emphasis shifted between utility and regret. This reinforces confidence that the best-performing supplier excels not just in one dimension, but performs consistently across a broad range of criteria.

Beyond numerical results, the ranking also reflects the actual operational conditions of each supplier. Based on field data, the five suppliers exhibit differing characteristics in terms of operational experience and service coverage. The top-ranked supplier (Supplier 3) is a company with over 10 years of experience, a strong track record in managing heavy logistics operations, and a demonstrated commitment to sustainability and regulatory compliance. In contrast, the lowest-ranked supplier (Supplier 2) is a relatively new company with only two years of experience and has yet to show significant sustainability indicators such as certification or formal reporting. The remaining suppliers fall in intermediate positions, with operational experience ranging from 5 to 10 years. However, notable differences appear in technical criteria such as On-Time Delivery and Service Quality, which significantly influence their positions in the final ranking. This demonstrates that length of experience alone is not the sole determinant; rather, a combination of consistent performance, accountability in service delivery, and commitment to sustainability serve as the key differentiators in this evaluation system.

CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of this study, it can be concluded that supplier evaluation processes that incorporate sustainability aspects can be conducted in a more structured and objective manner through the integration of the DEMATEL, ANP, and VIKOR methods. This hybrid approach not only produces a final ranking of alternatives but also offers insight into the interrelationships among sub-criteria and the priority weights that influence decision-making. Among the evaluated alternatives, Supplier 3 achieved the highest rank and is recommended as the company's primary supplier. This supplier excels in maintaining on-time delivery, offering competitive pricing, and providing consistent service quality. Moreover, with ten years of operational experience, the supplier has demonstrated strong consistency in supporting the company's projects. These findings indicate that technical performance and economic efficiency remain dominant factors in supplier selection, while social and environmental aspects are increasingly recognized as essential complements within the evaluation framework.

To enhance the quality of supplier evaluations in the future, it is recommended that the company reassess the criteria and sub-criteria currently in use. Additional aspects such as digital technology readiness, supply chain transparency, supplier reputation based on customer feedback, and waste and carbon emission management could be incorporated as part of a more comprehensive sustainability indicator framework. On the methodological side, it is also advisable for the company to explore various decision-making approaches, rather than relying on a single method. Alternative techniques such as TOPSIS, PROMETHEE, or even data-driven approaches such as integrating machine learning with MCDM could offer more adaptive and context-specific evaluation outcomes. Ideally, supplier evaluation should not be a static process, but rather a component of continuous improvement aligned with industry developments and global challenges. In doing so, the company will be better positioned to maintain operational competitiveness while simultaneously fulfilling its social and environmental responsibilities in a balanced manner.

ADVANCED RESEARCH

This study has certain limitations that offer opportunities for future research. The evaluation was conducted within a single company context with a limited number of respondents, which may affect the generalizability of the findings. Future studies could expand the scope by involving different industries or incorporating perspectives from external stakeholders. Methodologically, exploring alternative decision-making approaches such as TOPSIS, PROMETHEE, or integrating data-driven techniques like machine learning may enhance the adaptability and precision of supplier evaluations in dynamic environments.

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