Eksakta : Berkala Ilmiah Bidang MIPA
VOLUME 27 NO 04 2026, pp 743-758
ISSN : Print 1411-3724 — Online 2549-7464
DOI : https://doi.org/10.24036/eksakta/vol27-iss04/718

Eksakta
Berkala Ilmiah Bidang MIPA
http://www.eksakta.ppj.unp.ac.id/index.php/eksakta

Article

A Decision-Making Framework for Supplier Selection in High Tech Industry Based on Analytical Hierarchy Process

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Article Info

Article history :
Received June 30, 2026
Revised August 22, 2026
Accepted August 26, 2026
Published August 30, 2026

Keywords :
Supply chain, sustainable supplier selection, high-tech industry, analytical hierarchy process (AHP), multi-criteria decision making (MCDM)

Abstract. In the high-tech industry, effective supply chain management is essential to ensure product quality, innovation, competitiveness, and sustainability. Ideally, supplier selection should be conducted using a comprehensive framework that balances economic, quality, environmental, governance, and social considerations. However, in real-world conditions, many organizations still prioritize cost and quality while giving less attention to sustainability-related factors, creating risks to long-term performance and compliance. This situation highlights the urgency of developing a structured and reliable approach for sustainable supplier evaluation. Therefore, this study aims to identify and prioritize the criteria and subcriteria required for sustainable supplier selection in the high-tech industry using the Analytical Hierarchy Process (AHP). Through literature reviews and expert interviews, five main criteria and 25 subcriteria were established. Pairwise comparisons were conducted by three experts with extensive supplier management experience, and the results were analyzed using geometric mean calculations, normalization, and consistency ratio testing. The findings show that economic criteria have the highest priority (0.490), followed by quality (0.253), environment (0.109), governance (0.083), and social factors (0.064). Key subcriteria include long-term price consistency, technical troubleshooting support, RoHS compliance, ISO 9001 certification, and material purity. The proposed framework provides a practical solution for decision-makers to select sustainable suppliers, enhance competitiveness, and support long-term collaboration. Although the consistency ratios indicate reliable results, future studies should involve a larger and more diverse group of experts to improve generalizability.

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1. Introduction

The supply chain has become a critical global concern in contemporary business environments. Effective supply chain management can enhance a firm's competitiveness and strengthen its corporate image [1]. Moreover, ensuring a secure and reliable supply chain from upstream to downstream activities is a key determinant of organizational productivity [2]. A robust supply chain enables companies to fulfill customer demand promptly and in accordance with expectations.

Supplier selection represents the initial and one of the most important stages in supply chain management. In recent years, particularly following the COVID-19 pandemic, the need for sustainable supplier selection has become increasingly significant. Sustainable supplier selection requires the integration of economic, social, and environmental considerations [3]. Although the specific criteria for supplier selection may vary across industries depending on their unique requirements, these three sustainability dimensions are generally recognized as fundamental. Each dimension can be further decomposed into detailed and complex criteria that support informed decision-making.

In the high-tech industry, supplier selection is especially critical, as it directly influences the final quality of products. High-tech products are expected to meet stringent quality standards and deliver high functionality for end users, which is essential in today's digital era. Therefore, the criteria used for supplier evaluation must be clearly defined and systematically structured to ensure the selection of suitable suppliers.

The high-end industry plays a vital role in fostering innovation and enhancing global competitiveness. Products developed in this sector typically incorporate advanced technologies, exhibit superior quality, and deliver high added value to both consumers and related industries [4]. Furthermore, this industry contributes to economic development by setting new benchmarks in efficiency, safety, and sustainability.

However, the success of high-end industries depends not only on internal technological capabilities but also on the selection of appropriate suppliers. Reliable suppliers are capable of delivering consistent, high-quality components that comply with international standards. Poor supplier selection can lead to diminished product quality, production delays, and financial losses [5]. Therefore, the supplier selection process must involve comprehensive evaluation criteria, including supplier reputation, production capacity, and compliance with regulatory standards.

In addition, establishing long-term relationships with strategic suppliers can provide significant advantages for high-end companies. Close collaboration facilitates joint innovation, supports the development of new technologies, and enhances the ability to respond flexibly to dynamic market conditions. By selecting the right suppliers, high-end industries can maintain product excellence while simultaneously building a sustainable and globally competitive ecosystem.

In the context of sustainable supplier selection, the Multi-Criteria Decision Making (MCDM) approach is widely employed. This approach offers a structured and systematic framework for evaluating suppliers based on multiple criteria, including economic, social, and environmental aspects. MCDM methods assist decision-makers in identifying optimal alternatives among several options by analyzing the relative importance of different criteria. Commonly used MCDM methods include the Analytic Hierarchy Process (AHP), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) [6-7], and Complex Proportional Assessment (COPRAS) [8-9].

Among these methods, the Analytic Hierarchy Process (AHP) is one of the most widely applied [10-12]. Its popularity is largely due to its simplicity and ease of implementation. AHP relies on expert judgments collected through questionnaires, which are then processed using pairwise comparisons to determine the relative importance of each criterion and sub-criterion [13].

Supplier selection in high-tech industries has been extensively studied using various Multi-Criteria Decision-Making (MCDM) methods, including AHP, TOPSIS, and COPRAS. However, most previous studies have either focused on conventional economic and quality-related factors or have examined sustainability dimensions separately. In addition, the rapid evolution of high-tech industries has increased the importance of governance aspects, such as traceability systems, ISO certification, ethical business practices, and compliance with environmental regulations.

Despite the growing significance of these factors, there remains limited research that integrates economic, social, environmental, governance, and quality dimensions into a comprehensive supplier selection framework specifically designed for the current high-tech industry context. Therefore, a research gap exists in developing a decision-making framework that reflects both sustainability requirements and the operational characteristics of modern high-tech supply chains.

Among the available MCDM methods, the Analytic Hierarchy Process (AHP) was selected because it is well suited for problems involving multiple criteria and limited numbers of expert evaluators. Unlike other methods that often require extensive alternative data or more complex computational procedures, AHP enables decision-makers to systematically structure criteria, perform pairwise comparisons, and assess judgment consistency even with a relatively small expert panel. This characteristic is particularly relevant to the present study, which involved three experts with substantial experience in supplier management.

Furthermore, the novelty of this research lies in the identification and prioritization of five integrated criteria comprising 25 subcriteria that capture not only economic and quality considerations but also governance and sustainability-related factors relevant to contemporary high-tech industries. The findings are expected to provide a practical and updated framework that complements existing supplier selection approaches and supports more sustainable and transparent decision-making processes.

This study aims to identify and analyze the criteria and sub-criteria influencing supplier selection in the high-end industry. The research involves three industry experts with more than five years of experience who participated in the AHP questionnaire assessment. Pairwise comparisons were conducted based on the experts' responses to derive priority weights. The findings of this study are expected to provide a structured basis for supplier selection decisions in the high-end industry, aligned with the sustainability criteria identified.

2. Experimental Section

2.1. Materials

This study employed the Analytic Hierarchy Process (AHP) to determine the criteria and sub-criteria for supplier selection in the high-end industry. AHP was chosen due to its systematic and structured approach to handling complex decision-making problems involving multiple criteria. The framework methodology for this research shown in Figure 1.

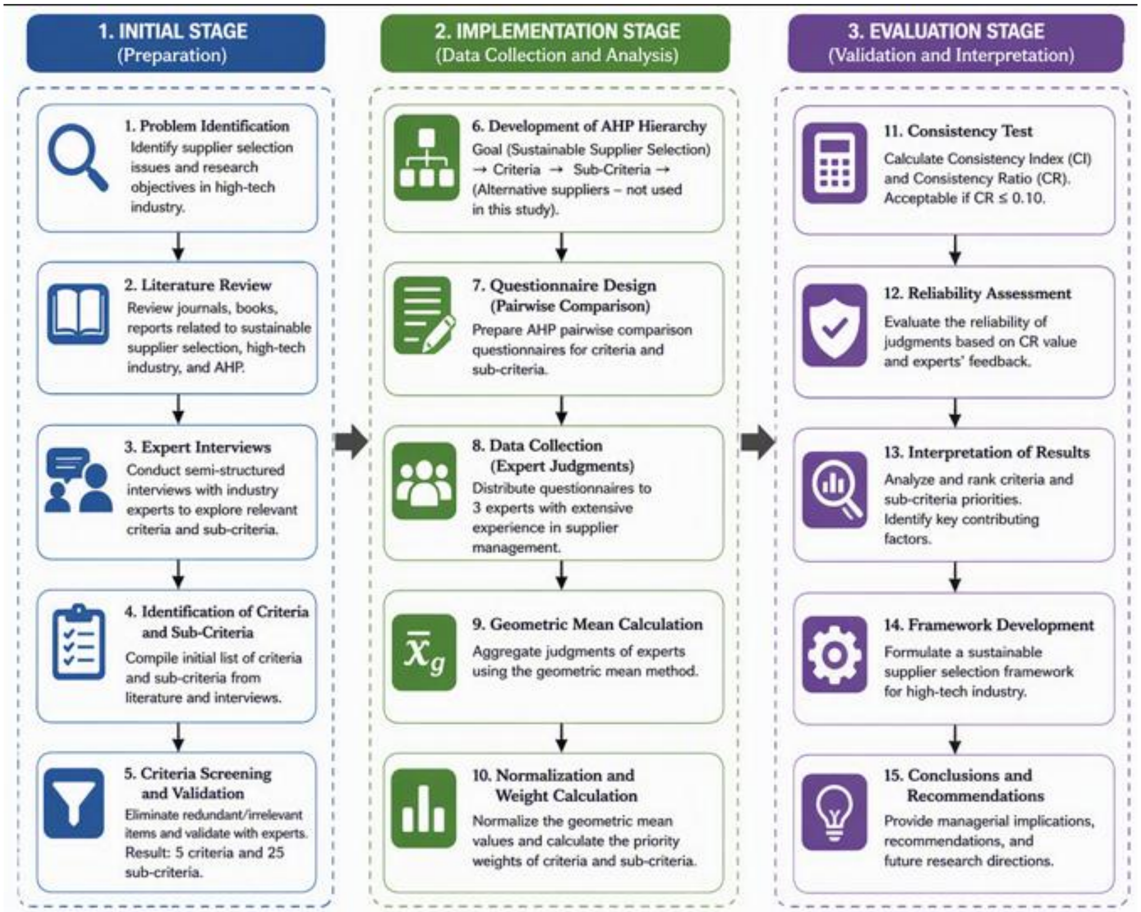

Figure 1. Research Methodology Framework

2.2. Tips

The initial pool of supplier selection criteria was identified through a comprehensive review of previous studies on sustainable supplier selection, high-tech supply chain management, and MCDM-based supplier evaluation methods. The reviewed literature highlighted economic, social, environmental, governance, and quality dimensions as the most frequently discussed factors. An initial list of candidate criteria and subcriteria was compiled from the literature and subsequently evaluated through expert interviews. During this screening process, overlapping, redundant, and less relevant indicators were removed, while subcriteria considered critical to the current high-tech industry context were retained. As a result, five criteria and twenty-five subcriteria were selected for the AHP analysis

The implementation of the AHP method in this study consisted of several stages [14]. First, a problem hierarchy was developed to clearly define the decision structure. This hierarchy facilitated the systematic identification and organization of criteria and sub-criteria relevant to supplier selection in the high-end industry.

Second, the criteria and sub-criteria were determined based on a combination of expert interviews and an extensive literature review conducted by the author. As a result, five main criteria and a total of 25 sub-criteria were identified. The five criteria include economic, social, environmental, governance, and quality aspects. Specifically, the economic criterion (E) consists of five sub-criteria, the social criterion (S) includes six sub-criteria, the environmental criterion (L) comprises three sub-criteria, the governance criterion (T) includes six sub-criteria, and the quality criterion (Q) consists of five sub-criteria. A detailed description of each criterion and its corresponding sub-criteria is presented in Table 1.

Table 1. Criteria dan Subcriteria Supplier Selection in *High Tech Industry*

Criteria	Sub Criteria Code	Subcriteria
1. Economy (E)	E1	Competitive pricing compared to the market
	E2	Transparency of cost structure
	E3	Long-term price consistency
	E4	Impact on yield & scrap rate
	E5	Documented export/import process
2. Social (S)	S1	Organizational structure and PIC available
	S2	Competent & responsive technical team
	S3	Troubleshooting support available
	S4	Co-development/customization capability
	S5	Compliance with occupational safety standards
	S6	Environmental & occupational safety compliance (OHS aspects)
3. Environment (L)	L1	RoHS compliance
	L2	MSDS Availability
	L3	Contamination Control Implementation
4. Governance (T)	T1	Clear company name & production location
	T2	Active & valid ISO 9001 certification
	T3	Certificate of Analysis (COA) available for each batch
	T4	Batch/lot traceability system available
	T5	Complete & easily accessible documentation
	T6	Business ethics & anti-corruption policy
5. Quality (Q)	Q1	Complete Material Specifications Documentation
	Q2	Purity Level According to Standards
	Q3	Standard test method
	Q4	Adequate testing laboratory
	Q5	Complete and updated technical data

The next step involved distributing questionnaires to selected experts. The questionnaires were administered to three professionals with expertise in supplier selection within the high-end industry. These experts were chosen based on their relevant experience and professional backgrounds. The profiles of the selected experts are presented in Table 2.

Table 2. Expert Data

No	Name	Position	Experience
1.	Expert A	Senior Purchasing	10 years
2.	Expert B	Purchasing Senior Manager & Lecture	22 years
3.	Expert C	Purchasing Staff	7 years

The selection of three experts was based on the requirements of the AHP methodology, which emphasizes the quality and expertise of decision-makers rather than the size of the sample. The selected experts possessed substantial experience in supplier management within high-tech industries, with professional experience ranging from 7 to 22 years and responsibilities directly related to supplier evaluation and purchasing decisions. Their extensive industry knowledge enabled informed and reliable pairwise comparisons.

Nevertheless, the relatively small number of experts remains a methodological limitation that may affect the generalizability of the findings. Therefore, future studies are encouraged to involve a larger and more diverse panel of experts from various high-tech sectors to validate and refine the proposed framework

The selected experts were asked to evaluate the relative importance of each criterion and sub-criterion using a pairwise comparison approach, which is commonly applied in the AHP method. This approach allows experts to assign scores based on the relative significance of one element compared to another. The pairwise comparison scale used in this study follows the standard AHP scale proposed by Saaty. The detailed scale is presented in Table 3.

Table 3. Pairwise Scale

Scale	Definition
1	Both criteria are equally important
3	Criteria A is slightly more important than criteria B
5	Criteria A is more important than criteria B
7	Criteria A is slightly more important than criteria B
9	Criteria A is absolutely more important than criteria B
2, 4, 6, 8	Values between two adjacent considerations

The responses obtained from the experts through pairwise comparisons were aggregated and structured into a pairwise comparison matrix, as shown in Table 4.

Table 4. Expert Pairwise Matrics

	T1	T2	T3	Tn
T1	T11	T12	T13	T1n
T2	T21	T22	T23	T2n
T3	T31	T32	T33	T3n
Tn	Tn1	Tn2	Tn3	Tnn

The aggregation of expert judgments was performed using the geometric mean method to combine the pairwise comparison values provided by multiple experts. The geometric mean for each criterion was calculated using Equation (1):

$$\bar{x}_g = \sqrt[n]{k_{1a} * k_{1b} \ldots k_{1n}} \tag{1}$$

$\bar{x}_g$ is the geometric mean of each criteria
n is number of experts
T1a is value of criteria1 for expert A
T1b is value of criteria 1 for expert B

Subsequently, the normalization of expert judgments was performed by dividing each value in a row by the total value of that row for each criterion. This process ensures that all values are transformed into comparable scales.The weight of each criterion and sub-criterion was then determined by calculating the average of the normalized values for each respective criterion or sub-criterion.

To assess the consistency of the pairwise comparison judgments, the maximum eigenvalue (λ_{max}) was calculated. This was obtained by dividing the product of the weights and their corresponding values in each row by the weight of each criterion or sub-criterion.
Next, the Consistency Index (CI) was calculated using Equation (2):

$$CI = \frac{\lambda_{max} - n}{n - 1} \tag{2}$$

where n represents the number of criteria
Finally, the Consistency Ratio (CR) was computed using Equation (3):

$$CR = \frac{CI}{RI} \tag{3}$$

where *RI* denotes the Random Index. A CR value less than or equal to 0.10 indicates that the level of consistency in the pairwise comparison judgments is acceptable, and the results can be considered reliable.

3. Results and Discussion

Based on the determination of the criteria and sub-criteria, an Analytic Hierarchy Process (AHP) structure was constructed to represent the decision hierarchy, as shown in Figure 2. The model consists of five primary criteria: economic (E), social (S), environmental (L), governance (T), and quality (Q), which serve as the foundation for evaluating supplier selection in the high-end industry.

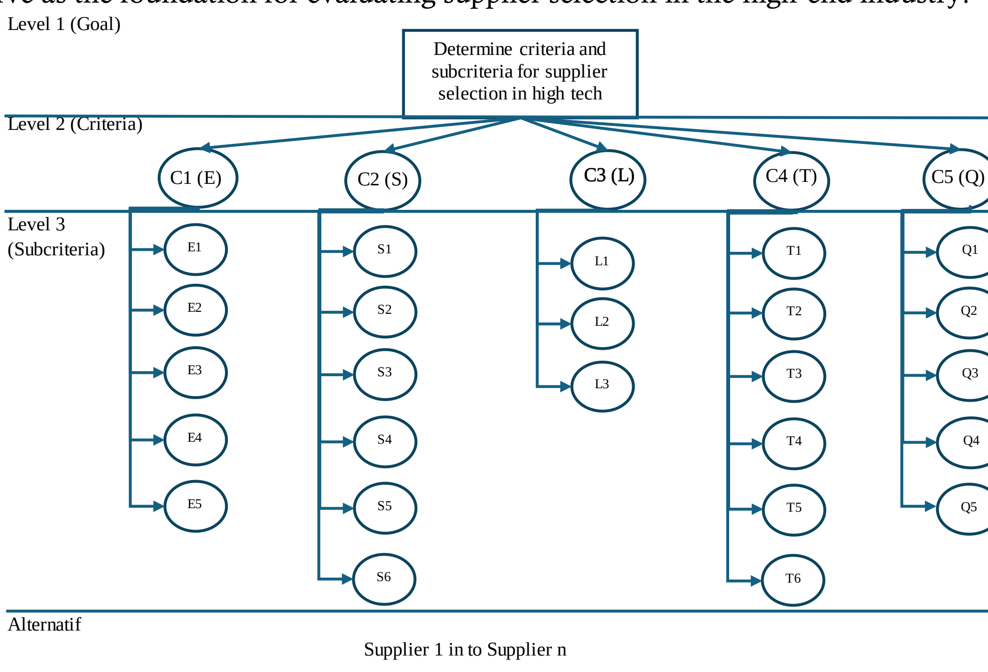

Figure 2. AHP Scheme for High Tech Industry

The results of the questionnaire responses from Experts A, B, and C were aggregated using the geometric mean (GeoMean) method in the AHP framework. The outcomes for each criterion and its sub-criteria are presented in Tables 5–9. For Criterion 1 (Economic), which consists of five sub-criteria, the geometric mean matrix is shown in Table 5. The total values for each sub-criterion are as follows: E1 = 3.971, E2 = 5.142, E3 = 3.029, E4 = 7.059, and E5 = 22.048.

Table 5. Geometric Mean for Criteria 1 (Economy)

	E1	**E2**	**E3**	**E4**	**E5**
E1	1.000	2.080	0.550	1.913	6.649
E2	0.481	1.000	0.894	1.326	5.278
E3	1.817	1.119	1.000	2.596	5.000
E4	0.523	0.754	0.385	1.000	4.481
E5	0.150	0.189	0.200	0.223	1.000

For Criterion 2 (Social), which includes six sub-criteria, the geometric mean results are presented in Table 6. The sum of each sub-criterion is as follows: S1 = 25.776, S2 = 4.056, S3 = 3.399, S4 = 9.147, S5 = 9.240, and S6 = 7.683.

Table 6. Geometric Mean Criteria 2 (Social)

	S1	**S2**	**S3**	**S4**	**S5**	**S6**
S1	1.000	0.168	0.168	0.212	0.523	0.160
S2	5.944	1.000	1.205	3.037	2.061	2.061
S3	5.944	1.587	1.000	2.924	2.924	2.924
S4	4.718	0.329	0.342	1.000	1.145	0.909
S5	1.913	0.485	0.342	0.874	1.000	0.630
S6	6.257	0.485	0.342	1.101	1.587	1.000

For Criterion 3 (Environmental), consisting of three sub-criteria, the results are shown in Table 7. The respective totals are L1 = 1.469, L2 = 5.631, and L3 = 7.838.

Table 7. Geometric Mean Criteria 3 (Environment)

	L1	**L2**	**L3**
L1	1.000	4.309	4.217
L2	0.232	1.000	2.621
L3	0.237	0.322	1.000

For Criterion 4 (Governance), which includes six sub-criteria, the geometric mean matrix is presented in Table 8. The total values are T1 = 15.589, T2 = 3.550, T3 = 12.653, T4 = 5.192, T5 = 11.151, and T6 = 5.285**.**

Table 8. Geometric Mean Criteria 4 (Governance)

	T1	T2	T3	T4	T5	T6
T1	1.000	0.306	0.342	0.281	0.523	0.342
T2	3.271	1.000	3.271	0.894	5.593	2.268
T3	2.924	0.306	1.000	0.329	0.368	0.437
T4	3.557	1.119	3.037	1.000	0.630	0.909
T5	1.913	0.179	2.714	1.587	1.000	0.329
T6	2.924	0.441	2.289	1.101	3.037	1.000

Finally, for Criterion 5 (Quality), which consists of five sub-criteria, the geometric mean results are shown in Table 9. The total values are Q1 = 4.384, Q2 = 3.205, Q3 = 6.265, Q4 = 8.579, and Q5 = 6.883.

Table 9. Geometric Mean Criteria 5 (Quality)

	Q1	Q2	Q3	Q4	Q5
Q1	1.000	0.630	1.529	1.357	2.466
Q2	1.587	1.000	2.466	1.710	1.710
Q3	0.654	0.405	1.000	2.924	1.077
Q4	0.737	0.585	0.342	1.000	0.630
Q5	0.405	0.585	0.928	1.587	1.000

After obtaining the geometric mean values of expert judgments for each sub-criterion, a normalization process was conducted to determine the weights of each sub-criterion. The results are presented in Tables 10–14. For Criterion 1 (Economic), as shown in Table 10, sub-criterion E3 (Long-Term Price Consistency) ranked first with a weight of 0.319. The prominence of Long-Term Price Consistency (E3) indicates that decision-makers in high-tech industries place greater emphasis on procurement cost stability than on achieving the lowest short-term purchase price. This finding reflects the operational characteristics of high-tech manufacturing, where production planning, inventory management, and customer commitments often extend over long planning horizons. Frequent fluctuations in supplier prices may increase budgeting uncertainty, disrupt cost control efforts, and negatively affect profit margins. Therefore, a supplier capable of maintaining stable prices over time is often perceived as more valuable than one offering temporarily lower prices.

This result is consistent with the findings of Wu and Weng [15], who reported that supplier evaluation in high-tech industries is strongly influenced by factors that support long-term operational reliability and competitiveness. In technology-driven sectors, firms typically depend on highly specialized materials and components, making supplier stability an important consideration for reducing procurement risk. Similarly, O'Connor et al. [4] emphasized that stable supplier performance contributes significantly to supply chain continuity and sustainable competitive advantage.

The importance of long-term price consistency has become even more evident following recent global supply chain disruptions. Events such as the COVID-19 pandemic, geopolitical tensions, inflationary pressures, and volatility in logistics costs have exposed organizations to considerable procurement uncertainties. Under these conditions, purchasing managers increasingly prioritize suppliers that can provide predictable pricing structures and minimize financial risk over extended periods. Consequently, long-term price stability is viewed not only as an economic consideration but also as a risk mitigation strategy that enhances supply chain resilience.

After E3 was followed by E1 (Cost Structure Transparency) with a weight of 0.281, E2 (Competitive Prices Compared to the Market) with 0.207, E4 (Impact on yield & scrap rate) with 0.149, and E5 (Documented Export/Import Process) with the lowest weight of 0.043. Interestingly, Competitive Pricing Compared to the Market (E2) was ranked below Long-Term Price Consistency (E3). This finding suggests that practitioners are willing to accept slightly higher prices when suppliers can guarantee price predictability, supply continuity, and reduced business uncertainty. Such a preference aligns with contemporary supply chain management literature, which argues that total procurement value should be assessed from a long-term perspective rather than solely through short-term cost minimization. Therefore, the results indicate that supplier selection decisions in high-tech industries are increasingly influenced by strategic considerations related to stability, reliability, and risk management rather than by initial acquisition cost alone.

Table 10. Weight and Rank for Criteria 1

Subcriteria Code	Weighted	Rank
E1	0.281	II
E2	0.207	III
E3	0.319	I
E4	0.149	IV
E5	0.043	V

For Criterion 2 (Social), which consists of six sub-criteria, the ranking results are shown in Table 11. Sub-criterion S3 (Troubleshooting Support Availability) ranked first with a weight of 0.322, followed by S2 (Competent and Responsive Technical Team) with 0.276. The third rank was S6 (Environmental & occupational safety compliance (OHS aspects) with 0.148, followed by S4 with 0.119, S5 (Compliance with Occupational Safety Standards) with 0.097, and S1 (Organizational structure and PIC available) with the lowest weight of 0.038.

Table 11. Weight and Rank for Criteria 2

Subcriteria Code	Weighted	Rank
S1	0.038	VI
S2	0.276	II
S3	0.322	I
S4	0.119	IV
S5	0.097	V
S6	0.148	III

For Criterion 3 (Environmental), Table 12 indicates that L1 (RoHS Compliance) ranked first with a dominant weight of 0.661, followed by L2 (MSDS Availability) with 0.223, and L3 (Contamination Control Implementation) with 0.115.

Table 12. Weight and Rank for Criteria 3

Subcriteria Code	Weighted	Rank
L1	0.661	I
L2	0.223	II
L3	0.115	III

For Criterion 4 (Governance), Table 13 shows that T2 (Active & valid ISO 9001 certification) ranked first with a weight of 0.312. This was followed by T4 (Batch/Lot Traceability System) with 0.204, T6 (Business Ethics and Anti-Corruption Policy) with 0.196, T5 (Complete and Accessible Documentation) with 0.141, T3 (Certificate of Analysis Availability) with 0.089, and T1 (Clear company name & production location) with 0.058.

Table 13. Weight and Rank for Criteria 4

Subcriteria Code	Weighted	Rank
T1	0.058	VI
T2	0.312	I
T3	0.089	V
T4	0.204	II
T5	0.141	IV
T6	0.196	III

For Criterion 5 (Quality), the results in Table 14 indicate that Q2 (Purity Level According to Standards) ranked first with a weight of 0.303, followed by Q1 (Complete Material Specifications Documentation) with 0.237, Q3 (Standard Test Methods) with 0.187, Q5 (Complete and updated technical data) with 0.151, and Q4 (Adequate Testing Laboratory) with the lowest weight of 0.123.

Table 14. Weight and Rank for Criteria 5

Subcriteria Code	Weighted	Rank
Q1	0.237	II
Q2	0.303	I
Q3	0.187	III
Q4	0.123	V
Q5	0.151	IV

Furthermore, the overall weighting results for the five main criteria are presented in Table 15. The Economic criterion (E) ranked first with the highest weight of 0.490, indicating its dominant importance in supplier selection. The Quality criterion (Q) ranked second with a weight of 0.253, followed by Environmental (L) with 0.109, Governance (T) with 0.083, and Social (S) with the lowest weight of 0.064.

Table 15. Weight and Rank for Criteria

Subcriteria Code	Weighted	Rank
E	0.490	I
S	0.064	V
T	0.083	IV
L	0.109	III
Q	0.253	II

The overall ranking obtained in this study, namely Economy (0.490) > Quality (0.253) > Environment (0.109) > Governance (0.083) > Social (0.064), is generally consistent with findings reported in previous supplier selection studies using MCDM and AHP approaches. Many studies have found that economic and quality-related criteria remain the dominant considerations because supplier performance directly affects production costs, operational efficiency, product reliability, and customer satisfaction. Wu and Weng [15], for example, reported that cost, quality, and delivery-related factors are consistently prioritized in high-tech supply chains, reflecting the operational pressures faced by technology-oriented manufacturers. Likewise, the comprehensive review conducted by Chakraborty et al. [5] concluded that economic and quality dimensions continue to receive the highest attention across various supplier selection models despite the growing incorporation of sustainability considerations.

An interesting finding of this study is the relatively low ranking of the Environmental (0.109) and Governance (0.083) criteria, despite the growing emphasis on sustainability, green supply chains, and responsible sourcing in contemporary supply chain management literature. At first glance, these results appear to contradict the theoretical developments discussed in previous studies, which advocate the integration of environmental and governance considerations into supplier selection processes [1],[23]. However, this discrepancy can be explained by the difference between strategic sustainability objectives promoted in academic literature and the operational realities faced by practitioners in high-tech industries

This finding reflects the increasing importance of sustainability requirements, regulatory compliance, traceability, and certification systems in modern supply chains. Recent studies have highlighted that environmental performance is no longer treated as an optional consideration but has become an important component of supplier evaluation due to stricter regulations and stakeholder expectations. Similarly, governance-related aspects such as ISO certification, transparency, ethical business conduct, and traceability contribute to supply chain resilience and risk mitigation. These findings are aligned with the sustainability-oriented supplier selection literature reviewed by Karakoc et al. [1] and the supply chain sustainability framework discussed by Negri et al. [23], which emphasize the growing role of environmental and governance dimensions in supplier assessment.

Previous studies have shown that although organizations increasingly recognize the importance of environmental sustainability, economic and operational factors often remain the primary drivers of supplier selection decisions. Karakoc et al. [1] reported that sustainability-related criteria are frequently incorporated into supplier evaluation frameworks; nevertheless, cost competitiveness, product quality, and delivery performance continue to receive the highest weights in many MCDM applications. Similarly, Chakraborty et al. [5] concluded that economic and quality dimensions consistently dominate supplier selection studies across various industries, while environmental criteria are often treated as supplementary requirements rather than decisive selection factors

One possible explanation is that environmental compliance is frequently regarded as a mandatory threshold rather than a differentiating factor. In many high-tech industries, suppliers are already expected to comply with regulations such as RoHS requirements, hazardous material restrictions, and environmental management standards. Consequently, once suppliers meet these minimum requirements, decision-makers tend to focus on factors that provide more direct operational and financial benefits, such as price stability, quality performance, and technical capability. This perspective may explain why environmental criteria received a lower priority weight despite their recognized importance.

A similar situation applies to governance-related factors. Although governance elements such as ISO certification, traceability systems, documentation quality, and ethical business practices are increasingly promoted as mechanisms for improving transparency and supply chain resilience, practitioners often perceive them as supporting requirements rather than immediate performance drivers. As a result, governance tends to receive lower relative weights compared with criteria that directly affect production continuity, product quality, and cost efficiency.

Furthermore, the findings may reflect the current stage of sustainability maturity among practitioners. Negri et al. [23] argued that the integration of sustainability and resilience into supply chain decision-making remains an evolving process, and organizations frequently face trade-offs between short-term operational objectives and long-term sustainability goals. In practice, purchasing professionals are often evaluated based on cost reduction, quality improvement, and supplier performance targets, which naturally increases the importance of economic and quality criteria. Therefore, while environmental and governance considerations are widely acknowledged in theory and corporate sustainability strategies, their influence on day-to-day supplier selection decisions may remain relatively limited

These findings do not indicate that environmental and governance aspects are unimportant. Rather, they suggest that high-tech industry practitioners continue to prioritize criteria with more immediate and measurable impacts on operational performance. The observed gap between theoretical sustainability trends and practitioner preferences highlights an important challenge for future supply chain management research and practice: how to better integrate environmental and governance objectives into operational supplier selection decisions without compromising competitiveness, quality, and cost efficiency.

Other criteria is social criteria. The relatively low ranking of social criteria is also consistent with observations from previous MCDM studies, where social factors are frequently considered supportive rather than primary decision drivers. While occupational health and safety, organizational capability, and collaboration remain important, experts often perceive these factors as having a less immediate impact on operational performance than economic and quality considerations. Nevertheless, recent sustainability literature suggests that social responsibility contributes significantly to long-term supplier reliability, stakeholder trust, and supply chain resilience. Therefore, although the current ranking places social aspects in the last position, organizations should continue to incorporate them into supplier evaluation frameworks to achieve a more balanced and sustainable decision-making process.

Nevertheless, the relatively low weighting of social criteria may present certain risks. Excessive emphasis on economic and operational considerations could lead organizations to underestimate the long-term importance of supplier workforce welfare, occupational health and safety, labor rights, stakeholder relationships, and collaborative innovation. Such an approach may reduce supply chain resilience and negatively affect sustainability performance.

Recent supply chain management literature has demonstrated that social sustainability issues have become increasingly important in the post-pandemic business environment. Neglecting workplace safety, employee welfare, labor rights protection, and supplier social responsibility may expose firms to reputational damage, operational disruptions, and increased supply chain risks [21,23]. The COVID-19 pandemic highlighted the vulnerability of global supply chains to social-related disruptions, particularly those associated with worker health, labor shortages, and inadequate occupational safety practices. Negri et al. [23] pandemic highlighted the vulnerability of global supplyare strongly interconnected, requiring organizations to consider social dimensions alongside economic and environmental objectives. Similarly, Hezam et al. [21] reported that sustainability risk assessment frameworks increasingly incorporate social indicators because supplier-related social issues can significantly affect supply continuity, stakeholder trust, and long-term organizational performance

Therefore, although social aspects received the lowest priority in this study, they should not be disregarded in supplier evaluation processes. Instead, organizations should adopt a balanced supplier assessment approach that integrates economic, quality, environmental, governance, and social considerations to enhance both sustainability performance and supply chain resilience

The findings also highlight an interesting shift in supplier selection priorities. While traditional supplier evaluation models primarily focus on cost, quality, and delivery performance, the proposed framework incorporates environmental and governance dimensions alongside economic and quality considerations. This integrated perspective reflects the growing importance of sustainability, regulatory compliance, traceability, and ethical business practices in contemporary high-tech industries. Consequently, the framework can support more balanced supplier selection decisions that consider both short-term operational needs and long-term sustainability objectives.

Following the weighting calculations, the Consistency Ratio (CR) was evaluated to assess the consistency of the experts' judgments. This measure is essential to ensure the reliability and validity of the pairwise comparison results in the AHP method [14]. The CR values for each criterion are presented in Table 16. In general, a CR value less than or equal to 0.10 indicates an acceptable level of consistency.

As shown in Table 16, most criteria meet this threshold. The governance criterion produced a consistency ratio of 0.105, which is slightly above the commonly accepted threshold of 0.10. This indicates a minor inconsistency in expert judgments for governance-related factors. Given the marginal deviation from the threshold (0.005), the results were retained for exploratory analysis; however, they should be interpreted with caution. Future studies should conduct a reassessment of pairwise comparisons or involve additional experts to improve judgment consistency.

Table 16. CR Value for Criteria

Criteria	Criteria Name	CR Value
1	Economy	0.035
2	Social	0.047
3	Environment	0.062
4	Governance	0.105
5	Quality	0.057

4. Conclusion

Despite the consistency of the expert judgments, this study is limited by the involvement of only three experts. Although these experts were highly experienced in supplier management, a larger expert panel may provide broader perspectives and improve the robustness of the resulting priorities. Future studies should therefore extend the number and diversity of experts and validate the framework across different high-tech industry contexts

The findings of this study identified five key criteria for supplier selection in the high-tech industry that support sustainability, namely economic, social, environmental, governance, and quality. Each criterion is supported by a set of sub-criteria, including five economic sub-criteria, six social sub-criteria, three environmental sub-criteria, six governance sub-criteria, and five quality sub-criteria. The results indicate that each sub-criterion has a distinct level of importance, as reflected in its respective weight.

Among the five main criteria, the economic criterion was found to have the highest priority, followed by quality and environmental criteria, which ranked second and third, respectively. These findings suggest that economic considerations remain the dominant factor in supplier selection decisions, while quality and environmental aspects also play significant roles in ensuring sustainable supply chain practices.

The results of this study provide a structured framework that can be applied in high-tech industries, such as sensor manufacturing and other advanced technology sectors. By incorporating these criteria and sub-criteria into the supplier evaluation process, companies can achieve more transparent, consistent, and objective decision-making, ultimately supporting the sustainability and competitiveness of their supply chains.

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