



International Journal of Multidisciplinary Research and Growth Evaluation.

Multi-Criteria Decision Modeling for Supplier Selection in Aviation, Oil & Gas, and Construction

Samir Ali Syed

Department of Procurement and Supply Chain, Chartered Procurement and Supply Chain Management (CharProSCM) Team, Riyadh, Saudi Arabia

* Corresponding Author: Samir Ali Syed

Article Info

ISSN (Online): 2582-7138

Impact Factor (RSIF): 8.04

Volume: 07

Issue: 02

March-April 2026

Received: 19-02-2026

Accepted: 17-03-2026

Published: 15-04-2026

Page No: 619-627

Abstract

Background: The supplier selection process in high-risk industries is extremely important to ensure suppliers are chosen to fulfil the requirements of safety and compliance, and to mitigate any potential reputational damage. Poor supplier selection can lead to just such an occurrence, as demonstrated by some of the previous high-profile cases we examine. Supplier evaluation in high-risk industries such as aviation, oil & gas, and construction is challenging due to the inherent complexity and uncertainty associated with each supplier, and therefore requires a methodical and transparent approach in providing decision support for the selection of suppliers to do business with.

Methods: In this study a systematic review of the existing literature, along with a comparative analytical methodology, is used to evaluate the current use of multi-criteria decision-making techniques used for supplier selection in these three industries. The study includes an analysis of common established supplier evaluation techniques (e.g. Analytic Hierarchy Process (AHP), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), VIKOR, ELECTRE, PROMETHEE and hybrid and fuzzy-based extensions), all of which focus on addressing uncertainty and incomplete data. We then conclude the study by developing a methodology to evaluate carefully selected supplier evaluation criteria, weighting those criteria based on the criteria identified, and developing an integrated conceptual framework (including sensitivity analysis) that demonstrates the effects of varying the evaluation criteria on the outcome of the evaluation process.

Results: The results show that there is no one MCDM method that works best for choosing suppliers in high-risk industrial settings. The appropriateness of a method depends on how complicated the decision is, how much data is available, how uncertain things are, and the goals of the organization. When choosing aviation suppliers, regulatory certification, safety compliance, and traceability are the most important factors. When choosing oil and gas suppliers, operational risk management, environmental compliance, and reliability are the most important factors. When choosing construction suppliers, cost efficiency, schedule adherence, and delivery performance are the most important factors. Hybrid and fuzzy MCDM models show that they are better at dealing with qualitative criteria and decision-making situations that are not clear.

Conclusion: The study finds that MCDM frameworks that are specific to a situation and can change are necessary for choosing suppliers in high-risk industries. The suggested integrated framework makes decisions more clear and strong, which helps to ensure fair procurement results. Future research ought to investigate the amalgamation of machine learning, real-time data analytics, and digital twin technologies to enhance MCDM-based supplier selection systems.

DOI: <https://doi.org/10.54660/IJMRGE.2026.7.2.619-627>

Keywords: Multi-Criteria Decision Making (MCDM), Supplier Selection, AHP, TOPSIS, Aviation Supply Chain, Oil & Gas Procurement, Construction Vendor Evaluation, Fuzzy Logic, Supply Chain Risk Management

1. Introduction

1.1. Strategic Role of Supplier Selection

Supplier selection is a foundational aspect of strategic supply chains, especially in high-tech, highly regulated industries with potentially severe consequences for non-delivery of services (e.g., aviation, oil and gas, and construction). For example, the

procurement of a product used for an aircraft flight is not just a transactional decision, but rather a long-term strategic decision that could have long-term implications on operational continuity, safety, and company reputation^[1, 2]. Due to the interconnectedness of global supply chains, suppliers are increasingly interdependent with clients and vice versa; supplier evaluation is a multifactorial decision-making process with significant consequences for mission success^[3].

Unlike conventional manufacturers, the above-mentioned industries face unique combinations of technical, regulatory and environmental pressure when sourcing. Regulatory bodies such as the Federal Aviation Administration (FAA) and the European Union Aviation Safety Agency (EASA) have imposed strict airworthiness and certification requirements for all aviation supply chains^[4]. Likewise, the oil and gas industry continues to face commodity market volatility along with two additional challenges: 1) operations occurring in geographically remote environments and 2) the presence of numerous complex frameworks of environmental liability; both of these factors can complicate supplier sourcing decisions^[5]. Construction is unique in that projects often include custom-designed deliverables that may be produced by many tiers of subcontractors; therefore, it is important for a construction manager to take an integrated approach to supplier qualification that balances cost, schedule and quality of deliverables^[6]. The magnitude of these sourcing decisions cannot be supported by intuition and/or a single dimension method of evaluation.

1.2. Risks of Poor Supplier Decisions

It is well known that choosing the wrong supplier in these fields can have serious effects. In aviation, the use of unapproved or counterfeit parts has resulted in catastrophic failures with attendant loss of life, regulatory sanctions, and reputational damage^[7]. Poor contractor performance, not enough technical capability assessments, and not enough environmental due diligence have all been blamed for the failure of major oil and gas infrastructure projects^[8]. In construction, delays caused by suppliers and poor material quality are two of the main reasons why projects go over budget. This costs hundreds of billions of dollars around the world every year^[9].

These failure modes highlight the necessity for organized, evidence-based supplier evaluation methodologies that comprehensively assess various aspects of supplier performance. In these high-stakes situations, single-criterion methods like picking the lowest-cost bidder don't work. It is not only desirable but also operationally necessary to combine safety, quality, technical capability, financial stability, and sustainability into a single evaluation framework^[1, 3].

2. Overview of Multi-Criteria Decision Modeling

2.1. Concept and Principles of MCDM in Supply Chain Management

MCDM is the umbrella term for a series of analytical techniques developed to aid decision-makers evaluate alternative options utilizing multiple often conflicted evaluation criteria^[12]. MCDM within Supply Chain

Management acts as a means for structuring how to evaluate complex multi-dimensional Supplier data into an actionable ranking or recommendation. MCDM is based on theoretical foundations of operations research, decision theory and systems engineering, and has been extensively utilized in procurement decision-making across many different industry settings^[13].

The fundamental concept behind all MCDM methodologies is taking an overall complicated decision making process and breaking, or decomposing it down into manageable pieces, or components - which include developing an appropriate set of decision-making criteria; weighting the decision criteria to represent their respective importance; evaluating each of the alternative suppliers against each of the decision criteria; and aggregating each evaluation into a single performance score or ranking^[12]. This orderly/decomposed approach to decision making allows (among other things) transparency/reproducibility and stakeholder involvement throughout the decision-making process, both of which are especially important to regulated industries where procurement decisions can be reviewed and evaluated by regulatory agencies.

2.2. Traditional vs. Multi-Criteria Supplier Evaluation Approaches

Traditional methods for evaluating suppliers often use single-criterion or weighted scoring models that don't have the analytical rigor needed for procurement environments that are very complicated. Price-based selection is easy to manage, but it doesn't take into account lifecycle costs, risk exposure, or qualitative performance dimensions^[2]. Weighted scoring matrices, though an enhancement, are vulnerable to arbitrary weight allocation and fail to encapsulate trade-offs and compensatory relationships among criteria^[11].

MCDM frameworks, on the other hand, offer theoretically sound methods for weighing criteria, evaluating alternatives, and combining results. They allow for the systematic analysis of both quantitative data (like on-time delivery rates and defect frequencies) and qualitative assessments (like management culture and innovation capacity) within a single framework^[13]. In addition, advanced MCDM techniques have ways to model preferences, show uncertainty, and do sensitivity analysis, which makes them much stronger than traditional MCDM techniques.

2.3. Handling Qualitative and Quantitative Decision Factors

A unique difficulty in supplier evaluation is the presence of both hard quantitative metrics and soft qualitative judgments. You can measure and verify financial stability, delivery performance, and defect rates. On the other hand, it's hard to put numbers on things like supplier responsiveness, corporate social responsibility, and the potential for innovation^[14]. MCDM frameworks address this heterogeneity through various mechanisms: the employment of linguistic variables and fuzzy set theory to encode qualitative evaluations; normalization procedures that make disparate data comparable; and aggregation operators that consolidate various types of evidence into composite scores^[15].

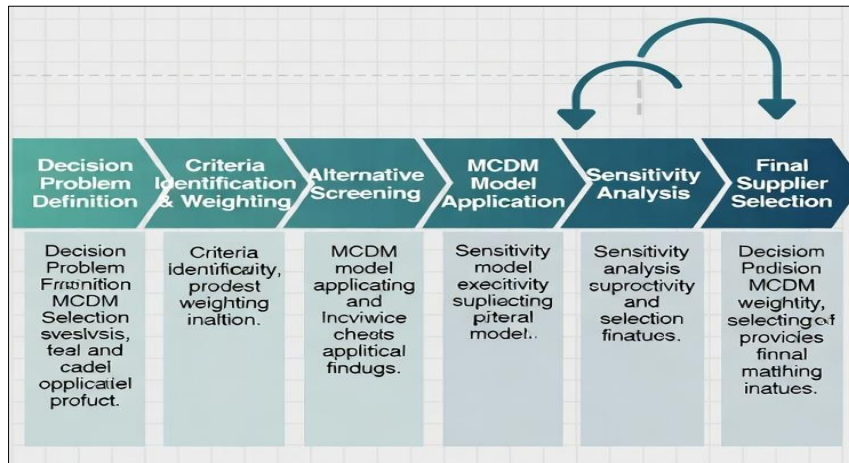


Fig 1: Conceptual framework illustrating the integrated MCDM-based supplier selection process across aviation, oil & gas, and construction sectors

3. MCDM Techniques for Supplier Selection

3.1. Analytic Hierarchy Process (AHP)

Saaty's Analytic Hierarchy Process (AHP) is one of the most recognized MCDM techniques used for supplier selection. AHP converts the decision-making problem into a hierarchical structure that includes the overall goal, evaluation criteria, sub-criteria, and a list of candidate alternatives. Each level of the hierarchy supports pairwise comparisons between each decision option, which are expressed on a 9-point scale to provide a numerical ratio of how one option is preferred over another. The priorities established through these comparisons are used to calculate the weighting of each criterion and candidate, leading to a global priority ranking for all alternatives.

In regard to selecting industrial suppliers, AHP's major strength lies in its ability to extract and conceptualize expert opinion in a systematically and logically consistent manner. The consistency ratio (CR) is an indicator of the logical consistency of the pairwise comparisons made in the AHP process, allowing for the identification and correction of inconsistencies in judgment. Numerous AHP applications have been developed in MRO supplier selection^[4], oil and gas contractor assessment^[5], and construction subcontractor qualification^[6]. In a large number of cases, AHP has demonstrated a superior level of performance when compared to the unstructured methods used for evaluating suppliers. Its principal weakness is that the method can be subject to rank reversal when new alternatives are added to the problem, and the computational complexity grows exponentially with the number of criteria and alternatives used in the methodology.

3.2. TOPSIS

The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), created by Hwang and Yoon^[17], ranks options based on how close they are to a positive ideal solution (PIS) and how far they are from a negative ideal solution (NIS). The method uses normalizing the decision matrix, calculating weighted Euclidean distances, and a relative closeness coefficient as the ranking metric. It is better to choose options with higher closeness coefficients, since they are close to the best performance profile and far from the worst^[17].

TOPSIS is especially good for situations where there are a lot of options and the criteria can be measured objectively. Its ease of computation and intuitive geometric interpretation have made it a popular choice for procurement analytics^[13]. TOPSIS has been used to rank suppliers of drilling equipment in oil and gas vendor assessments based on their technical ability, price, and delivery metrics^[8]. Limitations encompass sensitivity to the employed normalization method and the possibility of rank reversal under specific conditions.

3.3. VIKOR, ELECTRE, and PROMETHEE

The goal of VIŠEMK (the VišeKriterijumska Optimizacija i Kompromisno Rešenje) is to identify a compromise solution with respect to individual regret and the overall utility of the solution, which is closest to the "ideal solution". This VIKOR method does this by introducing a parameter, known as v , reflecting the degree to which the group will be satisfied compared to individual dissatisfaction. Therefore, the method is especially suitable for supplier selection when there are multiple stakeholder groups with conflicting priorities^[18]. The VIKOR method has been successful for evaluating construction contractors, who are commonly faced with trade-offs among cost, schedule and quality^[9].

The ELECTRE method (Elimination and Choice Translating Reality) uses a methodology based on concordance and discordance indices to identify dominant alternatives through the use of an outranking method. Therefore, this method allows for the identification of dominant alternatives without requiring that the alternatives be fully aggregated (or compensated). This non-compensatory characteristic of the ELECTRE method is especially beneficial for safety-critical procurement scenarios (e.g. aviation), where it would be inappropriate to elevate one supplier with an unacceptable level of safety because of their superior cost performance^[4, 19].

The PROMETHEE method (Preference Ranking Organisation Method for Enrichment Evaluations) uses flexible preference functions that quantify the decision-maker's level of sensitivity to the performance differences in terms of generating a net flow score that allows for ranking all alternatives. Also, the PROMETHEE method's graphical representation (GAIA plane) visually represents the trade-offs between alternatives^[20].

3.4. Fuzzy and Hybrid MCDM Models

One significant disadvantage of traditional multi-criteria decision-making (MCDM) procedures is their dependence on definite input values. Moreover, it isn't always possible to measure the exact input values required by an MCDM evaluation process in a complex manufacturing environment. Information may be incomplete, ambiguous, or described using language. In 1965, Lotfi Zadeh first advanced fuzzy set theory to overcome this limitation by allowing for an input's membership degree to measure how well an entity satisfies an evaluation criterion using a set of fuzzy logic. Using fuzzy numbers (triangular or trapezoidal) in place of crisp point values as inputs to AHP, TOPSIS, or VIKOR improves the representation of experts' assessments and provides researchers with more accurate results than using conventional methods.

A hybrid MCDM approach integrates multiple techniques and takes advantage of their strengths within a common decision-making framework. For instance, AHP could be used for criterion weighting while utilizing either TOPSIS or VIKOR to rank the identified alternatives. This type of integrated approach has been successfully applied to many types of manufacturing processes [13, 14]. More advanced hybrid MCDM approaches have added grey system theory, rough set theory, and/or Delphi methods to further enhance the applications of any previous MCDM method to decrease uncertainty. In evaluating suppliers with diverse performance characteristics, Fuzzy AHP combined with TOPSIS is an example of superior performance in evaluating suppliers based on commercial criteria [4, 7] as compared to the use of only one of those two methods.

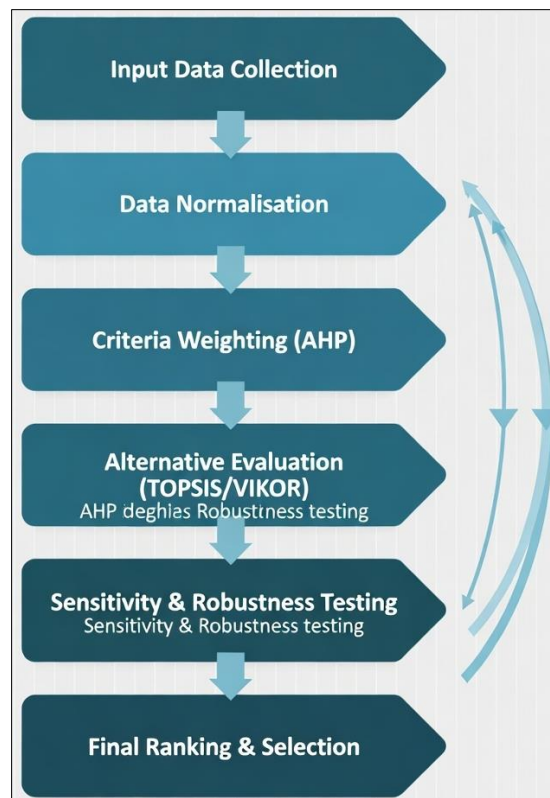


Fig 2: MCDM decision-model workflow illustrating the sequential analytical stages from data collection through normalisation, weighting, ranking, and sensitivity analysis to final supplier selection

4. Industry-Specific Supplier Selection Criteria

4.1. Aviation: Safety, Certification, and Traceability

Aviation supplier selection is subject to an extremely stringent regulatory and safety framework (including documented proof of compliance with applicable airworthiness standards, AS9100 Quality Management System (QMS) Certification, Parts Manufacturer Approval (PMA) per FAA regulations, and EASA Form One documentation for Aeronautical Component Parts) [4]. The foremost criterion in evaluating suppliers is their ability to demonstrate "traceability," which is the ability to document the origin and chain of custody for every aviation component from its time of manufacturing until it is installed on an aircraft. This requirement is driven by the imperatives of safety and the mandates of aviation regulations,

and thus, it is not negotiable [7].

Key evaluation factors that are used to determine whether a supplier meets the above requirements include the financial stability of the supplier, supplier ability to meet on-time delivery performance requirements, supplier response time in AOG situations, and supplier engineering support capability. As environmental compliance becomes a more important component of supplier evaluations, managing hazardous substances under E.U. REACH regulations is also becoming an increasingly important element. In general, AHP methodology supports the fact that safety compliance and certification always rank highest when applying criteria through AHP methodology, thus reflecting the zero-tolerance regulatory culture that exists in commercial aviation [4].

4.2. Oil & Gas: Operational Risk and Environmental Compliance

Due to the very harsh operational environments where vendors must work, and serious consequences of equipment/supply service failures, oil and gas procurement criteria have been shaped by considerations of operational risk. This means that operational risk management (the principal dimension of evaluation) incorporates an assessment of a vendor's prior performance with regards to blowout prevention, well control, pipeline integrity and hazardous material management. The second most important dimension is risk with respect to environmental compliance; this includes adherence to environmental impact assessment, spill response capabilities, and ESG (Environmental, Social and Governance) reporting.

In addition, technically qualified personnel and certifications of the equipment being used are also considered throughout the entire life cycle of oil and gas procurement - upstream exploration through downstream refining. Of particular concern is the financial viability of the vendor; given the capital intensive nature of oil and gas projects and the cyclicity of commodity markets, there exists substantial financial risk for the vendor during periods of market decline. Additionally, while performance related to sustainable development has historically been considered secondary by many companies within oil and gas industry, it has gained significant importance over recent years due to several high-profile environmental disasters as well as increased awareness regarding the accelerating Energy Transition.

4.3. Construction: Cost Efficiency and Sustainability

Evaluation of construction suppliers is characterised by a greater range of criteria weighting in comparison to both the aviation and oil and gas industries which is indicative of the numerous structural differences between these sectors as well as the degree of commercial competition amongst businesses operating in them. Cost competitiveness continues to be the most important criterion for virtually all procurement opportunities within the construction sector; particularly so in the public sector due to a requirement that all construction procurement occurs with value for money in mind ^[6, 9]. However, there is a gradual, but clear, progression away from using a simple price comparison as the method to evaluate competing supplier bids towards using total cost of

ownership frameworks - which incorporates lifecycle maintenance costs incurred during project delivery, contractor performance with regard to managing variations that are outside the contract documents and risk associated with any contract(s) awarded - in more sophisticated procurement operations within the construction sector.

Delivery performance measures - which includes, but is not limited to, schedule reliability, the lead time required for ordering and receiving materials and the coordination of logistics functions - are additionally very important to construction projects, especially considering how often they occur on critical path schedules. The effective management of quality assurance, environmental impacts (including waste generation and management; carbon footprint; material sourcing and sustainability), and worker safety are the other main evaluation criteria for suppliers within the construction sector ^[6]. Building information modelling (BIM) and digital project management platforms have led to introducing a supplier selection criterion of digital capability as an emerging trend in modern day construction procurement.

4.4. Weighting and Prioritisation Across Industries

An exploration of distinct industries shows systematic differences in the priority of criteria weights due to the unique characteristics of each sector regarding risk and regulatory aspects. Aviation has its primary focus on pre-empting safety risks, due to severe consequences associated with non-compliance to regulations; while Oil & Gas has operational risk management as the main focus of their criteria, in addition to the environmental compliance aspect, given their exposure to catastrophic risks as well as their increased environmental scrutiny. Construction focuses primarily on cost efficiency and delivery performance as the main criteria weighted most heavily due to a highly competitive marketplace and the project schedule being the fundamental driver of project costs.

The systematic differences in priority criteria weighting can have a substantial impact on design of MCDM models, requiring an industry/organisational-context-specific customisation of both the criteria set and weighting structure, rather than a universal criteria framework. Sensitivity assessments of the criterion weightings will assist in determining how robust supplier rankings are to sensitivity of stakeholder preference changes.

Table 1: Comparative analysis of principal MCDM methods applied in industrial supplier selection, including application domain, computational characteristics, and recommended use cases

Method	Data Complexity	Computational Effort	Primary Application	Expert Input Needed	Decision Basis
AHP	High	Low	Weight derivation	Moderate	Pairwise comparisons
TOPSIS	Moderate	Moderate	Ranking alternatives	Low	Ideal solution proximity
VIKOR	Moderate	Moderate	Compromise ranking	Low	Maximum group utility
ELECTRE	High	High	Outranking relations	High	Concordance/discordance
PROMETHEE	Moderate	Moderate	Net flow ranking	Moderate	Preference functions
Fuzzy AHP	High	High	Uncertainty handling	High	Triangular fuzzy numbers
Hybrid Models	High	High	Complex multi-stage	High	Integrated frameworks

Table 2: Industry-specific supplier evaluation criteria for aviation, oil & gas, and construction sectors, classified by principal criterion dimensions

Criterion	Aviation	Oil & Gas	Construction
Safety & Compliance	FAA/EASA certification; MRO approvals; AS9100 quality standards	API/ISO safety certifications; HSE performance metrics; OSHA compliance	OHSAS 18001 compliance; site safety records; contractor certification
Technical Capability	Component traceability; OEM authorisation; engineering support	Subsea/upstream expertise; technical workforce capability; equipment reliability	Structural engineering capacity; BIM proficiency; specialist trades
Quality Assurance	Defect rates; non-conformance reporting; inspection audits	Failure mode analysis; corrosion control; quality management systems	Material testing; defect rectification rates; workmanship standards
Delivery Performance	On-time delivery; AOG response; lead time adherence	Just-in-time supply; offshore logistics reliability; inventory management	Project milestone adherence; material procurement timelines; logistics
Cost Competitiveness	Total cost of ownership; warranty provisions; pricing transparency	CAPEX/OPEX optimisation; contract flexibility; cost escalation clauses	Bid competitiveness; value engineering; lifecycle costing
Environmental & Sustainability	Carbon footprint; emissions reduction commitments; waste management	Environmental impact assessments; spill prevention; ESG reporting	LEED/BREEAM alignment; sustainable materials; circular economy practices
Financial Stability	Credit ratings; insurance coverage; bonding capacity	Reserve levels; insurance for blowouts; financial resilience	Surety bonding; payment guarantees; solvency ratios

5. Comparative Analysis and Model Application

5.1. Comparative Strengths and Limitations

A comparison of the major multiple criteria decision making (MCDM) methods shows that there are key trade-offs at the heart of each of the methods including: (1) the level of sophistication of the method (i.e., some methods are mathematically complex and difficult for the average user to understand); (2) the amount of data/analyses it requires (i.e., some methods require an extensive amount; others do not); and (3) the level of interpretive differences (i.e., some methods have multiple interpretations) within the results of using the method. The AHP method works best when there is a need for structured expert elicitation and transparent weight creation. However, with larger numbers of criteria AHP's pairwise comparison approach becomes quite cumbersome, and the potential for an inconsistency bias within larger group decision-making processes exists. In contrast, while the TOPSIS method offers computational efficiency and a theoretically elegant geometric interpretation, the method's conclusions are quite sensitive to how the alternatives are normalised and the composition of the alternatives. In addition, the VIKOR method is of great value for decision-makers seeking to create a consensus in multi-stakeholder procurement environments because of its emphasis on compromise ranking; however, the value of the decision-making process may be numerically compromised due to the subjective nature of determining the value of the compromise parameter (v). Electre offers a non-compensatory outranking approach that essentially aligns well with a safety-critical procurement environment; however, the nature and complexity of Electre's concordance/discordance analyses could make it difficult to communicate the results of the analysis to non-technical procurement participants. Lastly, while PROMETHEE allows for decision-makers to create their own preference function (thus allowing for greater flexibility), the additional level of parameterisation may have the unintended consequence of increasing the cognitive burden on the decision-maker.

5.2. Case-Based Application Across the Three Industries

To conceptualize Fuzzy-AHP for selecting MRO suppliers of a large commercial airline, a panel of experts (including is aware engineers, purchasing agents, and managers) should first establish the criteria hierarchy to evaluate potential

MRO suppliers by using linguistic scales. The ratings assigned from the pairwise comparisons can then be converted into triangular fuzzy numbers before applying them to generate a final crisp rating for each potential MRO supplier; thus creating an even better way to go through the informal process of identifying potential vendors.

Utilizing a hybrid AHP-TOPSIS model for selecting offshore drilling contractors in the oil and gas business can be accomplished by using AHP for determining the relative worth of each of the various selection criteria (HSE performance, technical ability, financial security, and cost effectiveness) as set by the senior operations and purchasing representatives, and then using TOPSIS to rank each contractor based on their performance on these four criteria. This will let the purchaser objectively separate the otherwise qualified contractors from each other based on how they were rated and what their respective rankings were. Using sensitivity analysis allows for changing criteria weights and seeing how that affects the selected contractor.

VIKOR could be used in construction to rate structural steel subcontractors for a big infrastructure project. The method's focus on balancing the most utility for the group with the least regret for each person fits well with the way that large construction projects are procured, where commercial, technical, and sustainability goals must all be met at the same time. A sensitivity analysis of the compromise parameter v would show how stable the ranking is when different assumptions are made about how much weight to give to group vs. individual preferences^[6, 9].

5.3. Sensitivity Analysis and Robustness

Sensitivity analysis plays an essential role in supplier selection through multi-criteria decision analysis (MCDM) as a tool to validate the robustness of rankings that are created by using a range of input parameters (called perturbations) and to determine which criteria are most significant and therefore sensitive to changes in their weights (i.e., based on how much their rankings will change with small changes in weight). There are many different types/techniques for performing sensitivity analyses and they fall into three broad categories: one-at-a-time parameter perturbation (i.e., changing only one criterion weight at a time), scenario analysis (i.e., developing scenarios for combinations of changes to multiple criterion weights), and Monte Carlo

simulation [20, 22]. By demonstrating stable rankings over a range of plausible input configurations, large-scale purchases can improve their credibility as well as help their final selection decisions to be more defensible. Robustness testing should include not just perturbing the weight of the criteria but also perturbing any input(s) that provide the basis for the performance assessment, and

especially where qualitative assessments are subsequently converted to quantitative score values. Suppliers whose rankings are very sensitive to certain input assumptions require that there be further analysis of the subject supplier or its products and may provide the need for increased due diligence on that supplier [14, 22].

Table 3: Comparative analysis and recommended applications of MCDM methods across aviation, oil & gas, and construction supplier selection contexts

MCDM Method	Industry Application	Strengths	Limitations	Recommended Use Case
AHP	Aviation MRO supplier ranking	Systematic weight elicitation	Consistency ratio sensitivity; expert bias possible	Best for criteria weighting in structured environments
TOPSIS	Oil & Gas vendor shortlisting	Geometric simplicity; accommodates quantitative data	Assumes linear utility; rank reversal issues	Effective for large supplier pools with measurable KPIs
VIKOR	Construction contractor evaluation	Balances individual regret and group utility	Subjective v/w parameter selection	Suitable for compromise-seeking across competing objectives
ELECTRE	Multi-sector outranking analysis	Handles incomparability; non-compensatory	Complex interpretation; threshold sensitivity	Useful when strict dominance relations are required
Fuzzy-AHP	Aviation safety-critical procurement	Manages linguistic uncertainty; expert-friendly	Computational intensity; aggregation subjectivity	Ideal for qualitative criteria in high-risk contexts
AHP-TOPSIS Hybrid	Integrated supply chain evaluation	Combines weight derivation with ranking	Compounded error propagation possible	Recommended for multi-industry, multi-criteria frameworks

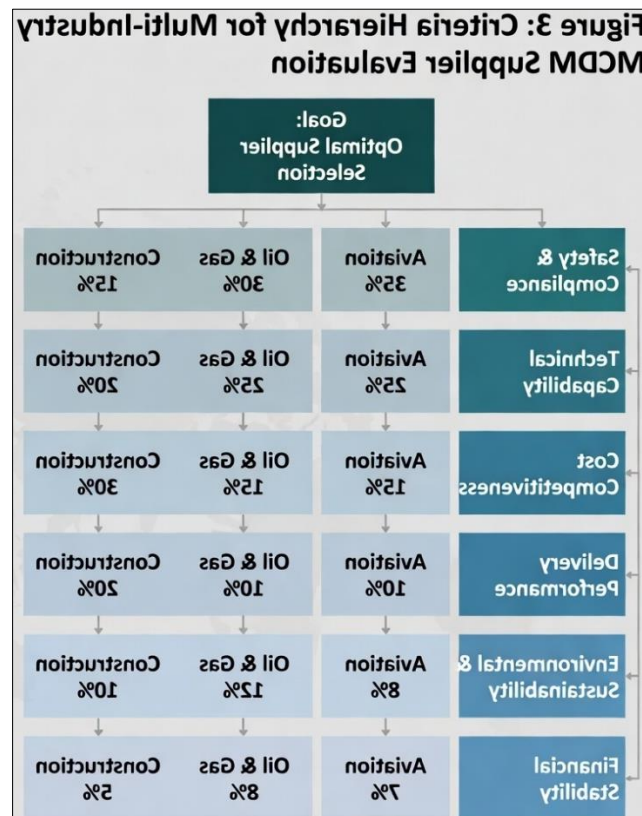


Fig 3: AHP-derived criteria hierarchy and indicative weight distribution for supplier selection across aviation, oil & gas, and construction industries, reflecting sector-specific procurement priorities

6. Managerial and Practical Implications
6.1. Decision Support for Procurement Managers and Policymakers

The outcomes of this review have major ramifications for procurement officials and affected policy-makers across all sectors of the aviation industry, oil & gas sector and construction industry. For procurement executives, this transition from selecting suppliers based primarily on intuition and stakeholder relationships to systematic and evidence-based evaluations of suppliers using the MCDM framework represents a major change. In regulated industries,

such as those mentioned above, there will also be increased assurance that procurement decisions will stand-up to scrutiny from regulators, auditors, or legal proceedings due to the MCDM being a transparent, auditable, and defensible evaluation methodology [3, 11]. Policymakers and standard-setting organizations may consider using MCDM evaluation attributes to create sector-specific supplier qualification standards and incorporate MCDM multi-dimensional criteria into pre-qualification standards. For instance, in aviation, regulatory authorities could use MCDM-influenced supplier evaluation to provide

additional guidance to meet existing airworthiness directives through a structured method for evaluating the overall performance of suppliers above and beyond their compliance with regulatory requirements^[4]. In the construction industry, public sector procurement regulations related to awarding contracts may require that bids meet multi-criteria evaluation requirements to comply with the public sector tender process.

6.2. Integration with Digital Procurement Systems

Introducing Multi-Criteria Decision Making (MCDM) methods onto digital marketplaces is an important requirement for wide-scale implementation and ongoing use of digital contracting systems. Many ERP systems, Supplier Relationship Management (SRM) systems, and E-Procurement Portals now come with analytical modules that allow purchasers to perform MCDM calculations, normalise supplier performance data across multiple suppliers, and assess the impact of changing conditions on their supplier selection process-- all almost in real-time^[23]. The creation of structured supplier performance data available through the integration of traditional datalogs and digital systems has substantially reduced the burden related to MCDM data collection and has provided continuous assessments of suppliers instead of having one-time assessments.

In addition to these integrated systems, many new technologies have the potential to radically enhance future procurement decision-making capabilities—artificial intelligence (AI), machine learning, and natural language processing, for example. AI-enabled risk models for suppliers can draw both structured and unstructured data from many different areas—including financial filings, regulatory databases, social media, Environment, Social, and Governance reports—and can be processed as normalised risk scores that can serve as dynamic inputs to MCDM frameworks^[23, 24]. At the same time, digital twin technology will create real-time digital representations of entire supply chain networks that can be used to evaluate how supplier selections will perform in hypothetical operational and market scenarios.

6.3. Contribution to Risk Mitigation, Sustainability, and Strategic Sourcing

The use of MCDM to assess suppliers does not only allow firms to be efficient, but it also helps to reduce organisational risk by making visible and quantifiable the vulnerabilities of suppliers. By incorporating financial stability, operational risk and compliance metrics into the supplier evaluation process, organisations can identify suppliers at risk much earlier on, enabling proactive intervention and contingency planning^[11, 14]. The structured evaluation of suppliers using an MCDM framework is particularly attractive now due to the rising number of disruptions to global supply chains driven by geopolitical instability, climate change and pandemic-related events.

Additionally, the explicit inclusion of sustainability criteria in the MCDM supplier evaluation framework is a direct response to the increasing demand from stakeholders for environmental and social performance in all segments of the industrial supply chain^[25]. Giving quantitative weights to environmental compliance, carbon performance and social responsibility through the MCDM framework provides a systematic way to incorporate sustainability into procurement processes without sacrificing analytical rigor. This integration allows organisations to meet their commitments

toward ESG objectives, satisfy their investors/regulatory organisations, and help meet the overall goal of sustainable industrial development^[25, 26].

7. Conclusion

In this paper, the author presents a thorough analytical review of the application of multi-criteria decision-making (MCDM) methods for evaluating suppliers in the three relevant industries: aviation, oil & gas, and construction. These industries inherently possess high levels of operational complexity, large safety and regulatory requirements, and very high risks associated with supplier-related failure.

According to the author, MCDM framework approaches for evaluating suppliers are a significant, evidence-based improvement over the traditional, single-criterion, or qualitative evaluation methods because they provide transparency, reproducibility, and are far more analytically rich than what is necessary to support the strategic importance of supplier selection decisions in these industries.

While an entity can use a better MCDM method, one MCDM method will not be optimal for all decision-makers and all decisions. The analytical strengths and weaknesses of each MCDM method include the following: the analytical hierarchy process (AHP) for structured expert input and weight assignment; the technique for order of preference by similarity to an ideal solution (TOPSIS) for computational efficiency on a significant number of alternatives; the VIKOR method for multi-stakeholder settings to achieve compromise-based rankings; the elimination and choice expressing reality (ELECTRE) method for utility function-based rankings; and the preference ranking organisation method for the evaluation of alternatives (PROMETHEE) method for providing a visually intuitive description of preference structure.

Hybrids and fuzzy extensions of these MCDM methodologies allow for the application of MCDM methods to uncertain decision alternatives in unable to have complete information environments. The choice of MCDM methodology should be carefully considered by the decision-maker based on the structural characteristics of the decision problem, the nature of the data available, and the analytical capabilities of the organisation applying the decision-making framework.

The analysis of specific industries indicates that there is a pattern in the way risk and rules are analyzed. The aviation industry uses safety and ability to find the origin of components when determining what to buy; the oil and gas industry focuses on risk and how the work will affect the environment; and the construction industry looks at the cost to get what is built as well as the ability to deliver it on time. Therefore, MCDM methods must be designed specifically for each industry, rather than using general methods across all industries.

There are several areas of research where further investigation is needed. Empirical evidence of MCDM systems has, for the most part, not been examined in the oil and gas or construction industries with respect to implementations across many organizations over a number of locations around the world. Another area of study is the use of real-time measurement of suppliers' performance and the integration of intelligent prediction tools within the MCDM systems. The creation of industry standard MCDM templates would make it easier for organizations to adopt these systems

and expand their use. Finally, conducting long-term studies comparing MCDM versus traditional purchasing would provide evidence of the validity of MCDM systems and their ability to create value for businesses engaged in any of the three industries mentioned previously.

References

1. Dickson GW. An analysis of vendor selection systems and decisions. *J Purch.* 1966;2(1):5-17.
2. Weber CA, Current JR, Benton WC. Vendor selection criteria and methods. *Eur J Oper Res.* 1991;50(1):2-18.
3. Chai J, Liu JNK, Ngai EWT. Application of decision-making techniques in supplier selection: a systematic review of literature. *Expert Syst Appl.* 2013;40(10):3872-3885.
4. Dožić S. Multi-criteria decision making methods: application in aviation industry. *J Air Transp Manag.* 2019;79:101683.
5. Kordana-Obuch S, Starzec M. Assessment of supplier selection criteria in the oil & gas industry using the AHP method. *Energy Rep.* 2022;8:14326-14337.
6. Marović I, Perić M, Hanak T. A multi-criteria decision support concept for selecting the optimal contractor. *Appl Sci.* 2021;11(4):1660.
7. Zhu Q, Dou Y, Sarkis J. A stakeholder-based assessment framework for green supplier selection with multiple criteria. *Int J Prod Econ.* 2018;196:99-111.
8. Taherdoost H, Brard A. Analyzing the process of supplier selection criteria and methods. *Procedia Manuf.* 2019;32:1024-1034.
9. Plebankiewicz E, Kubek D. Multicriteria selection of the building material supplier using AHP and fuzzy AHP. *J Constr Eng Manag.* 2016;142(1):04015057.
10. Ho W, Xu X, Dey PK. Multi-criteria decision making approaches for supplier evaluation and selection: a literature review. *Eur J Oper Res.* 2010;202(1):16-24.
11. Govindan K, Rajendran S, Sarkis J, Murugesan P. Multi-criteria decision making approaches for green supplier evaluation and selection: a literature review. *J Clean Prod.* 2015;98:66-83.
12. Hwang CL, Masud ASM. Multiple objective decision making—methods and applications. Berlin: Springer; 1979.
13. Stević Ž, Pamučar D, Puška A, Chatterjee P. Sustainable supplier selection in healthcare industries using a new MCDM method: MARCOS. *Comput Ind Eng.* 2020;140:106231.
14. Sarkis J, Dhavale DG. Supplier selection for sustainable operations: a triple-bottom-line approach using a Bayesian framework. *Int J Prod Econ.* 2015;166:177-191.
15. Kahraman C, Cebeci U, Ulukan Z. Multi-criteria supplier selection using fuzzy AHP. *Logist Inf Manag.* 2003;16(6):382-394.
16. Saaty TL. The analytic hierarchy process. New York: McGraw-Hill; 1980.
17. Hwang CL, Yoon K. Multiple attribute decision making: methods and applications. Berlin: Springer; 1981.
18. Opricovic S, Tzeng GH. Compromise solution by MCDM methods: a comparative analysis of VIKOR and TOPSIS. *Eur J Oper Res.* 2004;156(2):445-455.
19. Roy B. Multicriteria methodology for decision aiding. Dordrecht: Kluwer Academic; 1996.
20. Brans JP, Vincke P. A preference ranking organisation method. *Manag Sci.* 1985;31(6):647-656.
21. Zadeh LA. Fuzzy sets. *Inf Control.* 1965;8(3):338-353.
22. Hamurcu M, Eren T. Selection of unmanned aerial vehicles by using multicriteria decision-making for defence. *J Math.* 2020;2020:4308756.
23. Wamba SF, Akter S, Edwards A, Chopin G, Gnanzou D. How “big data” can make big impact: findings from a systematic review and a longitudinal case study. *Int J Prod Econ.* 2015;165:234-246.
24. Rezaei J. Best-worst multi-criteria decision-making method. *Omega.* 2015;53:49-57.
25. Gupta H, Barua MK. Supplier selection among SMEs based on green innovation ability using BWM and fuzzy TOPSIS. *J Clean Prod.* 2017;152:242-258.
26. Ahi P, Searcy C. A comparative literature analysis of definitions for green and sustainable supply chain management. *J Clean Prod.* 2013;52:329-341.
27. Mardani A, Jusoh A, Nor KMD, Khalifah Z, Zakwan N, Valipour A. Multiple criteria decision-making techniques and their applications: a review (2000–2014). *Econ Res.* 2015;28(1):516-571.
28. Yazdani M, Zarate P, Coulibaly A, Zavadskas EK. A group decision-making support system in logistics and supply chain management. *Expert Syst Appl.* 2017;88:376-392.
29. Ghodsypour SH, O'Brien C. A decision support system for supplier selection using integrated AHP and linear programming. *Int J Prod Econ.* 1998;56-57:199-212.
30. Zimmer K, Fröhling M, Schultmann F. Sustainable supplier management: a review of models supporting selection, monitoring and development. *Int J Prod Res.* 2016;54(5):1412-1432.

How to Cite This Article

Syed SA. Multi-criteria decision modeling for supplier selection in aviation, oil & gas, and construction. *Int J Multidiscip Res Growth Eval.* 2026;7(2):619–627. doi:10.54660/IJMRGE.2026.7.2.619-627.

Creative Commons (CC) License

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution NonCommercial-ShareAlike 4.0 International (CC BY-NC-SA 4.0) License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.