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Abstract: Supplier selection decision as a strategic decision level impacts on overall success of organisations. This fact is highlighted in the oil and gas industry. To choose the best suppliers for the O&G industry, this research presents the three multi-criteria decision-making (MCDM) techniques: analytic hierarchy process (AHP), stepwise weight assessment ratio analysis (SWARA), and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). In the first phase, we delved into the literature of O&G industry to extract the most important and significant factors affecting supplier selection decisions. Then, the three MCDM methodologies are used to optimise supplier selection decisions through conducting a real case study in Oman. The study concludes by proposing some efficient managerial implications through the achieved results.

Keywords: multi-criteria decision-making; MCDM techniques; oil and gas industry; supplier selection; analytic hierarchy process; AHP; SWARA; TOPSIS.

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1 Introduction

The frequency and amount of outsourcing has increased dramatically over the last 20 years in various industrial and commercial projects. A diverse set of suppliers and contractors frequently offer various products and services, especially for oil and gas

(O&G)-related projects. The ecosystems in which O&G businesses operate are constantly changing and complicated, and they frequently face difficulties, particularly in the matter of demand and supply. Taking into consideration the level of crude oil price at unprecedented levels, procurement is crucial to the enormous O&G sector. O&G, the two key factors in the energy sector and the key sources of fuel to the globe, have a big effect on the world economic growth. Natural gas and oil have a history of being related, mostly as a result of production or the upstream stage of business.

Building strong supplier relationships is essential for long-term business success. Supplier relationship management (SRM) thrives on a foundation of effective supplier selection. By carefully choosing the right partners, companies can foster collaboration, ensure quality and performance, and manage risks through well-defined SRM strategies (Kamran, 2012). Selecting suppliers goes beyond simply picking the cheapest option. As Goh (2018) highlights, supplier selection in the O&G industry is crucial for minimising purchasing risks, maximising overall value, and forging lasting partnerships. This process involves evaluating existing suppliers to identify cost-saving opportunities and improvement areas, while also compiling a shortlist of the best potential vendors in the market. Ultimately, the goal is to establish a mutually beneficial relationship with a reliable supplier who offers the best value for money. However, when additional factors beyond cost come into play, selecting the right supplier becomes a multi-criteria decision problem.

This research focuses on enhancing supplier selection decisions in the O&G sector using multi-criteria decision-making (MCDM) techniques. The suggested methods are specifically applicable to Oman's O&G companies. According to International Trade Administration (2022), the O&G sector has been the backbone of Oman's economy since 1967, contributing significantly to national revenue. Petroleum Development Oman (PDO), a state-owned company, is the leading O&G entity, while Occidental Petroleum is the second-largest operator and the most prominent foreign investor. OQ and OQ Exploration and Production (OQ EP), OQ Group plays a key role in driving Oman's energy sector forward, supporting economic diversification and sustainability initiatives. On the other hand, OQ Exploration & Production (OQEP, n.d.) is a leading upstream oil and gas company in Oman, focusing on the exploration, development, and production of hydrocarbons. As a major player in the country's upstream sector, OQEP is actively involved in expanding Oman's oil and gas reserves while optimising production efficiency and sustainability.

Several other key players contribute to Oman's O&G landscape. BP Oman holds a contract for engineering and construction services in Khazzan and Ghazeer gas assets. Oman Oil Marketing Company (SAOG) dominates the local fuel retail market with over 300 service stations, focusing on network expansion and renewable energy diversification. Additionally, Eni Oman, in collaboration with Oman Oil Company Exploration and Production (OOCEP), holds a significant stake in exploration projects, further strengthening the industry. With increasing investments in natural gas reserves and alternative energy sources, Oman's O&G sector is expected to remain a key driver of economic growth (Times of Oman, 2023).

Therefore, the concept presented here can apply to initiatives in the global O&G sector. The O&G sectors are one of the most complicated and difficult to operate, and choosing the right suppliers is crucial to a project's success. However, there are risks, delays, and cost overruns because the selection of suppliers is frequently subjective and lacks a uniform evaluation mechanism. Therefore, a reliable framework for supplier selection has been developed using the MCDM technique. Despite its potential advantages, the MCDM technique is rarely used in supplier selection, particularly in Oman's O&G sector. This research will explore the factors that affect selection of suppliers in the O&G companies and will test how well the MCDM technique identifies the best suppliers. The study also intends to analyse why the MCDM approach has not been adopted in Oman's O&G industry and offer suggestions to overcome obstacles and promote the usage of the MCDM technique for supplier selection.

The following sections of this research are arranged and organised as follows. The research's scientific foundation, supplier selection procedures, and additional information from the literature are addressed in the next section. The research methods are discussed in Section 3. In Section 4, the results and a brief overview of the findings are presented. Finally, Section 5 presents a conclusion and a recommendation for future research directions.

2 Literature review

Supplier selection plays a crucial role in supply chain management, directly impacting operational efficiency, cost reduction, and overall business performance. The O&G industry, characterised by high complexity and stringent quality requirements, demands a strategic approach to supplier selection and evaluation. This literature review explores various aspects of supplier selection, including its process, key selection criteria, significance in the O&G sector, and the different methodologies applied in decision-making.

2.1 Supply selection and evaluation process

The selection and evaluation of suppliers has been widely studied in supply chain management literature. Supplier selection is a strategic decision aimed at reducing procurement risks, optimising cost efficiency, and ensuring long-term relationships with reliable vendors (Narayanan and Jinesh, 2018; Goodarzi et al., 2022; Vaka, 2024). The process involves identifying potential suppliers, assessing their capabilities, and selecting the most suitable ones based on predefined criteria. Research by Adebayo et al. (2024) highlights the importance of supplier assessment in ensuring that all potential suppliers meet technical, financial, and commercial requirements.

Haleem et al. (2021) define supplier evaluation as a structured approach for assessing supplier performance over a specified period. Yazdani et al. (2022) emphasise the importance of process-related theories, supplier evaluation models, and selection methodologies in streamlining supplier selection. Several studies have proposed structured selection processes, including the recognition of supplier selection needs, identification of supply sources, shortlisting potential suppliers, evaluation, and final selection (Ferreira and Silva, 2022; Saputro et al., 2022; Strag, 2023).

Strag (2023) introduced a strategic supply management model that incorporates opportunity analysis and data sourcing before selecting suppliers. Tesco, for example, applies the Kraljic matrix analysis to classify suppliers, evaluate their capabilities, and negotiate contracts (Peng, 2022). Alternatively, Yehuala (2023) proposed Fogg's supplier appraisal process model, which, unlike strategic models, focuses on operational evaluations. However, its lack of clarity on implementation limits its effectiveness

(Ongaro and Gatobu, 2024). The best practices suggest integrating on-site appraisals and periodic performance reviews to mitigate risks and enhance supplier relationships.

2.2 Supplier selection criteria

The supplier selection criteria have evolved beyond cost considerations to include multiple dimensions such as quality, reliability, sustainability, and regulatory compliance. Sabri et al. (2022) highlight the role of procurement managers in developing comprehensive selection frameworks that align with organisational objectives. Wu et al. (2021) emphasise the integration of technical and functional specifications in procurement strategies.

Several researchers argue that MCDM approaches are essential in evaluating suppliers beyond cost factors. Khan et al. (2023) and Ecer (2022) assert that organisations must adopt holistic selection criteria encompassing financial stability, technical expertise, innovation, and risk management. The complexity of supplier selection in the O&G sector is further heightened by environmental, social, and political considerations (Liu et al., 2023). Traditionally, suppliers were selected based on price competitiveness, but modern approaches incorporate sustainability, ethical sourcing, and digital capabilities to drive long-term value (Ghosh et al., 2023).

Hao and Demir (2024) advocate for leveraging advanced technologies to enhance supplier selection, suggesting that automation and artificial intelligence (AI) can improve decision-making efficiency. Afrasiabi et al. (2022) further argue that an effective supplier selection process leads to better resource allocation, cost savings, and enhanced risk mitigation. Organisations must maintain flexibility in their criteria to adapt to evolving industry dynamics while fostering sustainable supplier relationships. Taherdoost and Brard (2019) analysed several literatures and gathered the most common criteria. The definition of supplier selection criteria by Taherdoost and Brard (2019) is as depicted in Table 1.

2.3 Importance of supplier selection in the O&G industry

The O&G industry is characterised by high capital investments, stringent regulatory requirements, and complex operational environments, making supplier selection a critical factor in maintaining efficiency and compliance (Yazdi et al., 2022; Okeke, 2021; Capobianco et al., 2021). Fallahpour et al. (2021) examined supplier selection in the Malaysian O&G industry, highlighting the role of robust optimisation strategies in managing uncertainties. The study found that suppliers offering higher value, rather than the lowest cost, were preferred due to the industry's sensitivity to project timelines and risk exposure. Feng et al. (2022) emphasised the importance of integrating environmental, social, and governance (ESG) factors into supplier selection. Sonar et al. (2022) highlighted emerging paradigms such as lean, agile, green, and sustainable procurement models, which are becoming increasingly relevant in O&G operations. Effective supplier selection mitigates risks and enhances competitiveness by ensuring a stable and responsive supply chain.

Table 1 Definition of supplier selection criteria

Criterion	*Definition*
Quality	Consistent excellence in suppliers is determined by their ability to meet and maintain high standards across various aspects of their operations, such as product quality, variety, production capabilities, and continuous improvement efforts. This includes ensuring premium qualities in dimensions, durability, materials, and design, as well as implementing effective quality-control systems and utilising advanced manufacturing equipment and processes.
Delivery	The ability of a supplier to meet established delivery deadlines is influenced by various factors such as lead-time, on-time performance, fill rate, returns management, location, transportation, and incoterms.
Performance history	The success of a supplier can be measured by their financial stability, business achievements, contributions to society, and impact on organisations.
Warranties and claim policies	The absolute authority of the claim policy takes precedence over the express written guarantee when it comes to providing coverage or payment for a covered loss or insurance occurrence. However, the express written guarantee ensures that necessary repairs or replacements for a product will be provided within a specific timeframe.
Production capacity	With its available resources, a supplier has the capability to produce a specific amount of goods or services.
Price	The price criterion encompasses various factors, including the unit price, pricing guidelines, currency exchange rates, taxes, and potential discounts.
Technology and capability	A supplier's access to state-of-the-art technological resources and tools is crucial for advancing their research and development methods and procedures. It enables them to stay at the forefront of innovation and maintain a competitive edge in the market.
Cost	Costs represent the financial assessment of the resources, efforts, materials, and potential drawbacks involved in the production and delivery of a product or service, including the missed opportunities that arise during the process.
Mutual trust and easy communication	The degree of confidence in the supplier's ability to deliver quality work is closely tied to the level of trust between the provider and the buyer. Furthermore, effective communication and transparency in sharing information between the company and the supplier facilitate seamless interaction.

Table 1 Definition of supplier selection criteria (continued)

Criterion	*Definition*
Reputation and position in industry	A product, service, or company’s position and reputation are determined based on its sales performance relative to its competitors in the industry.
Supplier’s profile	Standing, performance history, financial soundness, qualifications, and references of the supplier, in addition to their reputation and supremacy.
Management and organisation	The management group of the supplier needs to be trustworthy and competent to make wise choices.
Repair service	The ability of the provider to repair worn-out, inefficient, or broken items and get them back in working order.
Attitude	The manner in which the supplier contacts them, including their professionalism and assurance.
Risk factor	An asset’s value may be impacted by changes in the risk factor, which includes market prices, interest rates, and currency rates.
Commercial plans and structure	The format provided by the provider outlines business objectives, plans, and infrastructure for accomplishing them, along with arguments for their viability.
Labour relations record	Communication between the supplier’s employees and management.
Geographical location	The geographical location of the service provider.
Reliability	Referrals can be used to assess a supplier’s longevity and dependability (based on customer feedback), financial stability (capex, annual revenue), current and past business associates, personnel and organisational structure, different partnership aspects, and cultural sensitivity.
Service	The features of a provider’s ability to supply items include specialised dimensions, form, pigment, style, and brand delivery; lowest mass for purchases; interaction (response period, knowledge, and language); business proficiency; resilience; and its adaptability to shift.
Product development	The capacity of a supplier to alter the composition or look of an already-existing design in addition to creating a new, remarkable product to close a recently identified gap in the market or customer need.

Pamucar et al. (2023) argued that supplier selection in O&G varies across industries such as healthcare, manufacturing, and energy, each with distinct criteria. Ricardianto et al. (2022) hypothesised that effective supplier selection strategies enhance profitability and operational efficiency by improving product quality and reducing costs. Yazdi et al. (2022) further supported this view, stating that a well-executed supplier selection process lowers production costs and increases overall profitability in the O&G sector. Organisations that adopt comprehensive supplier selection strategies benefit from improved supplier performance, reduced operational disruptions, and enhanced sustainability compliance.

2.4 Application of MCDM methods in supplier selection

Supplier selection involves multiple methodologies that support decision-making in complex procurement environments. Traditional approaches, such as cost-based selection, are being replaced by more sophisticated techniques, including MCDM, AI, and optimisation models.

MCDM methods have been widely adopted to enhance supplier selection processes across various industries, including healthcare (Yilmaz et al., 2020), mining (Mikaeil et al., 2015; Kamran et al., 2017; Shaffiee Haghshenas et al., 2019), manufacturing (Rezaei et al., 2016), electronics (Shen et al., 2011), mechanics (Zolfani et al., 2013), construction (Ghorabaee et al., 2018), agriculture (Qureshi et al., 2018; Rouyendegh and Savalan, 2022), marketing (Mahdiraji et al., 2019), and human resources (Esangbedo et al., 2021).

The energy sector and O&G industry benefited from MCDM techniques in supplier selection as well. Yazdi et al. (2022) used the stepwise weight assessment ratio analysis (SWARA) and complex proportional assessment (COPRAS) to rank suppliers in O&G industry of Iran. Results show that the method efficiently navigates the complexity of selection of suppliers in the O&G sector and is appropriate for settings with trade embargoes. Madhu et al. (2020) examined the MCDM challenge of identifying the optimal biomass feedstock for optimal pyrolysis to bio-oil conversion. To choose an optimum solution, they suggest a framework that combines many MCDM methodologies and compares the rankings derived from each method. Zhu et al. (2022) mentioned that China faces issues securing its natural gas supply because of its growing reliance on imported natural gas discussed in the research. It implies the need to choose reputable and safe natural gas suppliers. Due to vulnerabilities in its traditional trading lines, Ur Rehman and Ali (2021) explain how China must diversify its energy import routes. This study examined the fuzzy-TOPSIS MCDM technique and cost-benefit analysis (CBA), for ranking oil exporters. Considering the case of supplier selection for renewable energy, the significance of supplier empowerment and selection as a competitive advantage in project portfolios is covered by Masoomi et al. (2022). The case suggests a supplier portfolio management model considering the company's strategy, policies, and purchasing needs.

In conclusion, supplier selection in the O&G industry requires a comprehensive approach integrating structured evaluation processes, MCDM, and emerging technologies. By leveraging these methodologies, organisations can enhance supplier performance, reduce risks, and maintain sustainable procurement practices.

3 Research methodology

This section outlines the methods used to evaluate suppliers. We have selected well-established techniques commonly applied in supplier selection across various industries. MCDM methods serve as analytical tools for assessing and ranking multiple options based on various criteria. These methods are particularly valuable in Oman's O&G industry, where supplier selection requires balancing multiple performance metrics and strategic objectives.

In this study, supplier selection is examined across four distinct contract types established from OQ EP:

a call-off contracts for the supply of miscellaneous specialised fire and safety items

b 5K wellheads

c one-time procurement of materials

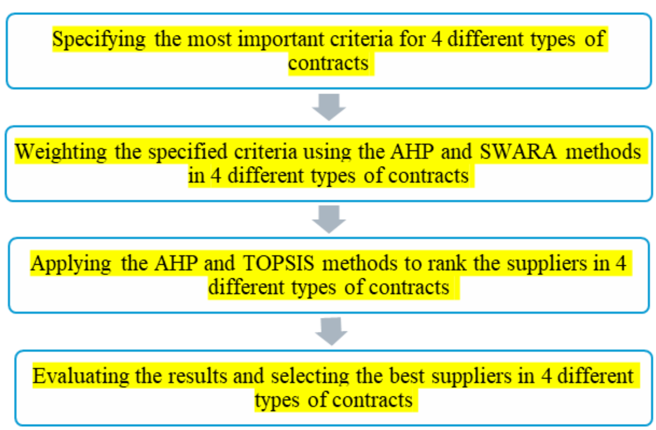
d call-off contracts for service supply (third-party testing services).

Each contract type involves different evaluation criteria.

Two different MCDM-based frameworks are employed to determine the most suitable suppliers. First, the analytic hierarchy process (AHP) is used twice – once to assign weights to the criteria and then again to rank the candidate suppliers. Second, the SWARA method is applied to determine the criteria weights, followed by the TOPSIS to rank the candidate suppliers.

The specific criteria for each contract type are discussed in Section 4. Figure 1 presents the framework of the approach used in this study for supplier selection in the O&G industry.

Figure 1 Diagram for selecting the best suppliers (see online version for colours)



3.1 Analytic hierarchy process

Saaty (1977) developed a comprehensive method for resolving intensive challenges with decision-making. AHP is utilised as a tool for decision-making to combine both qualitative as well as quantitative considerations (Deng et al., 2014).

AHP helps break down a complex decision into simpler parts by organising it into a hierarchy. The steps include:

1 Structuring the criteria into a hierarchy.
2 Conducting pairwise comparisons to assess the relative importance of each criterion.
3 Ensuring the consistency of these judgements with a consistency ratio.
4 Combining the results to create a weighted score for each supplier.

AHP is particularly helpful when you need to consider both qualitative and quantitative factors in evaluating supplier performance.

3.2 Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

Shanian and Savadogo (2006) claim that TOPSIS has a systematic process and is comparatively quick and straightforward. The core tenet of this approach is that the best alternative has been chosen based on what is distant from the non-ideal and closest to the ideal. The whole alternatives are considered to find such ideal and non-ideal solutions.

TOPSIS is based on the idea that the best option should be closest to an ideal solution and farthest from a negative ideal solution. The steps include:

1 Normalising the decision matrix to make the data comparable.
2 Creating weighted normalised decision matrices.
3 Identifying the ideal (best) and negative-ideal (worst) solutions.
4 Calculating how far each option is from these solutions.
5 Ranking the suppliers based on their proximity to the ideal solution (Gao et al., 2019).

TOPSIS is popular because it is easy to compute and provides a clear differentiation between alternatives.

3.3 Stepwise weight assessment ratio analysis

Kersuliene et al. (2010) developed a SWARA method for evaluating and weighting of criteria. SWARA is comparatively easier to use than other MCDM tools. SWARA method has so far found the way to be applied in solving different problems in various areas. SWARA helps determine the weights of criteria based on expert judgement. The steps include:

1 ranking the criteria by importance
2 experts assess the relative importance of each criterion starting from the second most important
3 calculating the comparative importance coefficients
4 adjusting the weights to reflect these evaluations (Alinezhad and Khalili, 2019).

SWARA is useful when expert judgement plays a key role, capturing the nuanced understanding of the importance of different criteria (Urosevic et al., 2017).

In the O&G sector of Oman, these MCDM methods enhance the supplier selection process by providing a structured way to consider multiple criteria, both quantitative and qualitative. They improve transparency, consistency, and the overall quality of decision-making, ensuring that the chosen suppliers align with the strategic objectives of the industry.

4 Case study description and results

OQ EP, the focus of our case study, a state-owned energy company in Oman, operates under stringent regulatory frameworks to meet contractual obligations within the O&G sector. Compliance with policies set by the Omani Ministry of Energy and Minerals is crucial to avoid penalties. One of the key regulations requires small and medium-sized enterprises (SMEs) registered in the joint supplier registration system to participate in tenders, ensuring economic participation. However, since not all SMEs follow the same standards, this requirement can sometimes complicate the supplier selection process.

A central policy influencing supplier selection in Oman's O&G sector is in-country value (ICV), which emphasises prioritising local suppliers without compromising cost and quality. The initiative aims to maximise economic benefits by promoting local manufacturing, skill development, and employment. All O&G companies, including OQ EP, must evaluate bidders based on their ICV scores, ensuring that international companies collaborate with local suppliers. The ICV policy has strengthened local business participation, expanded employment opportunities, and increased knowledge transfer in Oman's O&G sector (MEM, 2023).

Beyond ICV, Oman's Procurement and Tendering Policy ensures transparency, equality, and fairness in competition by mandating priority for 'Made in Oman' products. The Oman Investment Authority (OIA) oversees government investments and requires procurement processes to align with Oman Vision 2040 Committee (n.d.) by fostering local workforce growth and industrial capacity-building. These policies enhance domestic production and job creation. However, despite a structured framework, enforcement strategies vary among Omani O&G companies, leading to potential contractual misalignments and disputes. To enhance consistency, decision-makers could benefit from MCDM techniques, which offer systematic evaluation of suppliers based on multiple attributes such as compliance, quality, and delivery performance.

For OQ EP, sustainability and cost-effective supplier evaluation are priorities. The company assesses suppliers based on cost management, quality, delivery timelines, and key performance indicators. Additionally, OQ EP is required to implement capacity development programs during contract execution to strengthen local supplier capabilities over time. MCDM techniques provide an effective framework to improve supplier selection by eliminating ambiguity and increasing rationality in decision-making (Kshanh and Tanaka, 2024). Ensuring compliance while optimising supplier selection remains a strategic challenge, requiring continuous alignment with national economic goals and procurement policies. Table 2 illustrates specifications of experts in O&G industry of Oman that we conducted interviews to complete data source.

As outlined earlier in Section 3 (Figure 1), this study examines supplier selection across four distinct contract types:

a call-off contracts for the supply of miscellaneous specialised fire and safety items (CCSMSFS)

b 5K wellheads (5KW)

c one-time procurement of materials (OTPM)

d call-off contracts for service supply, specifically third-party testing services (CCSS).

Table 2 Experience and position details of interviewees

Position	*Years of experience*	*SC Background*
Sr. procurement and contract specialist	≥ 10 years	Expeditor and senior buyer for many O&G firms in Oman.
Lead-contract and procurement	≥ 10 years	Collaborated on major engineering, procurement and construction (EPC) deals with multiple firms in the supply chain sector while working abroad.
Expert contract engineer	≥ 10 years	Worked in contracting and support roles for various O&G firms.
Manager of procurement division	≥ 20 years	Worked in a variety of O&G fields throughout the SC area.

Table 3 AHP-derived criteria weights for CCSMSFS (pairwise comparison matrix)

	Tech. spec.	*Tech. support*	*Compliance*	*Experience*	*Exp OQ*
Tech. spec.	1.000	4.000	0.200	0.250	0.333
Tech. support	0.250	1.000	0.200	0.250	0.250
Compliance	5.000	5.000	1.000	2.000	2.000
Experience	4.000	4.000	0.500	1.000	3.000
Exp OQ	3.000	5.000	0.500	0.333	1.000

Table 4 AHP-derived criteria weights for CCSMSFS (normalised matrix and priority vector)

	Weights					
	Tech. spec.	*Tech. support*	*Compliance*	*Experience*	*Exp. OQ*	*Priority vector*
Tech. spec.	0.075	0.211	0.083	0.065	0.051	0.097
Tech. support	0.019	0.053	0.083	0.065	0.038	0.052
Compliance	0.377	0.263	0.417	0.522	0.304	0.377
Experience	0.302	0.211	0.208	0.261	0.456	0.287
Exp OQ	0.226	0.263	0.208	0.087	0.152	0.187

Each contract type is evaluated based on different criteria. It is assumed that eight suppliers participate in the tendering process for CCSMSFS and OTPM, while five suppliers compete for 5KW and CCSS. However, this does not imply that the same suppliers compete for each contract; rather, it ensures a uniform evaluation framework.

According to OQ EP, supplier selection for CCSMSFS contracts is based on five key criteria: technical specification, technical support, compliance, experience, and experience within OQ. For 5KW contracts, the four main selection criteria are HSE, technical, support, equipment delivery, compliance, and ICV. OTPM contracts prioritise quality, delivery, compliance, and tenderer experience, while CCSS contracts assess suppliers based on HSE, quality, compliance, tenderer experience, and personnel experience.

Table 5 AHP-derived criteria weights for 5KW (pairwise comparison matrix)

	HSE	*Eq. Del.*	*Tech.*	*Support*	*Compliance*	*ICV*
HSE	1.000	7.000	7.000	7.000	7.000	3.000
Eq. Del.	0.143	1.000	0.333	0.333	0.200	0.200
Tech	0.143	3.000	1.000	3.000	1.000	0.200
Support	0.143	3.000	0.333	1.000	0.333	0.200
Compliance	0.143	5.000	1.000	3.000	1.000	0.200
ICV	0.333	5.000	5.000	5.000	5.000	1.000

Table 6 AHP-derived criteria weights for 5KW (normalised matrix and priority vector)

	Weights						
	HSE	*Eq. Del.*	*Tech.*	*Support*	*Compliance*	*ICV*	*Priority vector*
HSE	0.525	0.292	0.477	0.362	0.482	0.625	0.460
Eq. Del.	0.075	0.042	0.023	0.017	0.014	0.042	0.035
Tech	0.075	0.125	0.068	0.155	0.069	0.042	0.089
Support	0.075	0.125	0.023	0.052	0.023	0.042	0.057
Compliance	0.075	0.208	0.068	0.155	0.069	0.042	0.103
ICV	0.175	0.208	0.341	0.259	0.344	0.208	0.256

Table 7 AHP-derived criteria weights for OTPM (pairwise comparison matrix)

	Delivery	*Quality*	*Tenderer exp.*	*Compliance*
Tech. spec.	1.000	0.333	0.333	0.143
Tech. support	3.000	1.000	3.000	0.333
Compliance	3.000	0.333	1.000	0.200
Experience	7.000	3.000	5.000	1.000

Table 8 AHP-derived criteria weights for OTPM (normalised matrix and priority vector)

	Weights				
	Delivery	*Quality*	*Tenderer exp.*	*Compliance*	*Priority vector*
Delivery	0.071	0.071	0.036	0.085	0.066
Quality	0.214	0.214	0.321	0.199	0.237
Tenderer exp.	0.214	0.071	0.107	0.119	0.128
Compliance	0.500	0.643	0.536	0.597	0.569

To determine the most suitable suppliers, two MCDM-based frameworks are employed. First, the AHP method is applied twice – once to determine the weight of each criterion and again to rank the candidate suppliers. Second, the SWARA method is used to assign weights to the criteria, followed by the TOPSIS method to rank the suppliers accordingly.

The detailed calculations for AHP and SWARA, including the assigned weights for each contract type, are presented in Tables 3–14. The overall results from applying these techniques across different contract types are summarised in Table 15, while Figure 2 illustrates the relationships and comparisons of the calculated weights.

Table 9 AHP-derived criteria weights for CCSS (pairwise comparison matrix)

	Compliance	*Tenderer exp.*	*Personnel exp*	*Quality*	*HSSE*
Compliance	1.000	4.000	4.000	3.000	0.111
Tenderer exp.	0.250	1.000	1.000	0.333	0.111
Personnel exp.	0.250	1.000	1.000	0.333	0.111
Quality (comp. rep.)	0.333	3.000	3.000	1.000	0.111
HSSE	9.000	9.000	9.000	9.000	1.000

Table 10 AHP-derived criteria weights for CCSS (normalised matrix and priority vector)

	Weights					
	Compliance	*Tenderer exp.*	*Personnel exp.*	*Quality*	*HSSE*	*Priority vector*
Compliance	0.092	0.222	0.222	0.220	0.077	0.167
Tenderer exp.	0.023	0.056	0.056	0.024	0.077	0.047
Personnel exp.	0.023	0.056	0.056	0.024	0.077	0.047
Quality (comp. rep.)	0.031	0.167	0.167	0.073	0.077	0.103
HSSE	0.831	0.500	0.500	0.659	0.692	0.636

Table 11 SWARA-derived criteria weights for CCSMSFS

Criteria	*Order*	s_j	k_j	q_j	w_j
Compliance	1	1.000		1.000	1.000
Experience	2	2.000	0.280	1.280	0.781
Experience within OQ	3	3.000	0.180	1.180	0.662
Technical specification	4	4.000	0.050	1.050	0.631
Technical support	5	5.000	0.090	1.090	0.578

Note: *s_j: comparative importance of the j^{th} criterion, k_j: coefficient of relative importance, q_j: corrected weight, w_j: final weight.

Table 12 SWARA-derived criteria weights for 5KW

Criteria	*Order*	s_j	k_j	q_j	w_j
HSE	1		1.000	1.000	0.224
ICV	2	0.250	1.250	0.800	0.179
Compliance	3	0.100	1.100	0.727	0.163
Tech	4	0.080	1.080	0.673	0.151
Support	5	0.050	1.050	0.641	0.144
Eq. delivery	6	0.030	1.030	0.623	0.139

Note: *s_j: comparative importance of the j^{th} criterion, k_j: coefficient of relative importance, q_j: corrected weight, w_j: final weight.

Table 13 SWARA-derived criteria weights for OTPM

Criteria	*Order*	s_j*	k_j*	q_j*	w_j*
Compliance	1		1.000	1.000	0.310
Quality	2	0.230	1.230	0.813	0.252
Tenderer exp.	3	0.120	1.120	0.726	0.225
Delivery	4	0.060	1.060	0.685	0.212

Note: *s_j: comparative importance of the j^{th} criterion, k_j: coefficient of relative importance, q_j: corrected weight, w_j: final weight.

Table 14 SWARA-derived criteria weights for CCSS

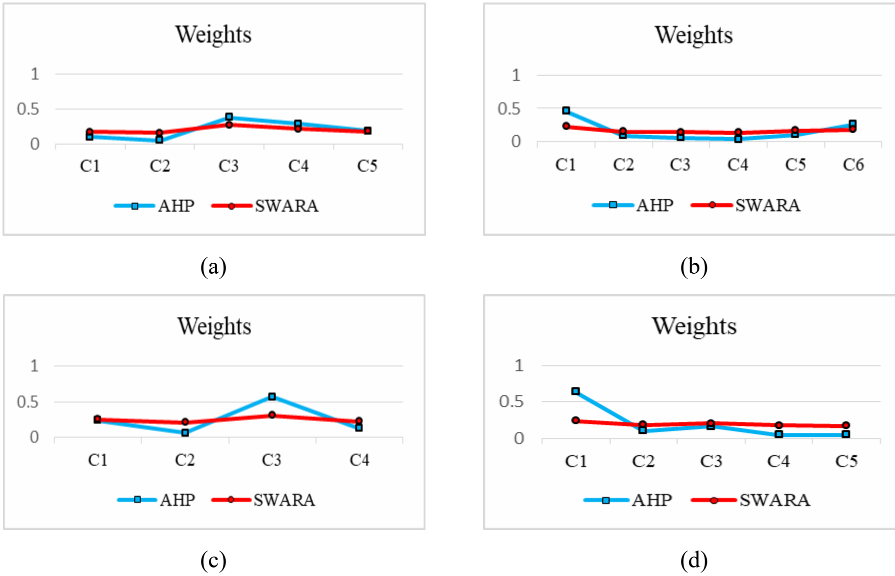
Criteria	*Order*	s_j	k_j	q_j	w_j
HSSE	1		1.000	1.000	0.242
Compliance	2	0.160	1.160	0.862	0.209
Quality (comp. rep.)	3	0.100	1.100	0.784	0.190
Tenderer exp.	4	0.040	1.040	0.754	0.183
Personnel exp.	5	0.040	1.040	0.725	0.176

Note: *s_j: comparative importance of the j^{th} criterion, k_j: coefficient of relative importance, q_j: corrected weight, w_j: final weight.

Table 15 Priority weights of supplier selection criteria across contract types using AHP and SWARA

		Weights	
		AHP	*SWARA*
CCSMSFS	Technical specification	0.097	0.173
	Technical support	0.052	0.158
	Compliance	0.377	0.274
	Experience	0.287	0.214
	Experience within OQ	0.187	0.181
5KW	HSE	0.460	0.224
	Technical	0.089	0.151
	Support	0.057	0.144
	Equipment delivery	0.035	0.139
	Compliance	0.103	0.163
	ICV	0.256	0.179
OTPM	Quality	0.237	0.252
	Delivery	0.066	0.212
	Compliance	0.569	0.310
	Tenderer experience	0.128	0.225
CCSS	HSSE	0.636	0.242
	Quality	0.102	0.190
	Compliance	0.167	0.209
	Tenderer experience	0.047	0.183
	Personnel experience	0.047	0.176

Figure 2 Comparison of criterion weights across contract types using AHP and SWARA, (a) CCSMSFS, (b) 5KW, (c) OTPM, (d) CCSS (see online version for colours)



Both AHP and SWARA provide structured approaches for evaluating supplier selection criteria, ensuring consistency in decision-making. While AHP relies on pairwise comparisons to establish priority vectors, SWARA determines weights based on sequential expert judgements. The results of both methods allow for a comprehensive assessment of supplier selection priorities across the different contract types.

Table 15 presents the priority vectors derived from the AHP and SWARA techniques for each contract type:

- *CCSMSFS:* the highest priority criteria were *compliance (0.377)* and *experience (0.287), followed by experience within OQ (0.187), technical specification (0.097), and technical support (0.052).*
- *5KW: HSE (0.460)* emerged as the most critical factor, followed by *ICV (0.256)*, *compliance (0.103)*, *technical (0.089)*, *support (0.057)*, and *equipment delivery (0.035)*.
- *OTPM: compliance (0.569)* was the highest priority, followed by *quality (0.237)*, *tenderer experience (0.128)*, and *delivery (0.066)*.
- *CCSS: HSE (0.636)* was the dominant factor, followed by *compliance (0.167)*, *quality (0.103)*, *tenderer experience (0.047)*, and *personnel experience (0.047)*.

Moving to the SWARA method, the weights of each criterion were determined in descending order based on their relative importance within each contract type. The assigned weights were as follows:

- *CCSMSFS: Compliance (0.274)* ranked highest, followed by *experience (0.214)*, *experience within OQ (0.181)*, *technical specification (0.173)*, and *technical support (0.158)*.

- *5KW: HSE* (0.224) was the most influential criterion, followed by *ICV (0.179)*, *compliance (0.163), technical (0.151), support (0.144)*, and *equipment delivery (0.139)*.
- *OTPM: Compliance (0.310)* was the most critical factor, followed by *quality (0.252), tenderer experience (0.225)*, and *delivery (0.212)*.
- *CCSS: HSE (0.242)* was identified as the top priority, followed by *compliance (0.209), quality (0.190), tenderer experience (0.183)*, and *personnel experience (0.176)*.

These results highlight the varying priorities across different contract types, emphasising the distinct evaluation criteria that influence supplier selection.

For *CCSMSFS*, the most influential criterion under AHP is *compliance* (0.377), followed by *experience* (0.287). SWARA assigns the highest importance to *compliance* (0.274) and *experience* (0.214). Both methods highlight compliance and experience as key factors, but SWARA also assigns higher importance to *technical specification* and *technical support* compared to AHP.

In the *5KW contract*, AHP prioritises *HSE* with a significant weight of 0.460, indicating a strong emphasis on safety in this contract type. *ICV* is also crucial (0.256). Meanwhile, SWARA assigns a lower weight to *HSE* (0.224), placing more emphasis on *compliance* (0.163) and *technical support* (0.144). The differences suggest that AHP gives absolute dominance to HSE, while SWARA provides a more balanced weight distribution.

Table 16 Supplier rankings for CCSMSFS contracts based on AHP

Weights	*0.097*	*0.052*	*0.377*	*0.287*	*0.187*		
Suppliers	*Technical specification*	*Technical support*	*Compliance*	*Experience*	*Experience within OQ*	*Score*	*Rank*
S1	0.306	0.175	0.292	0.144	0.087	0.206	1
S2	0.118	0.040	0.079	0.046	0.087	0.073	6
S3	0.157	0.275	0.121	0.137	0.194	0.150	3
S4	0.070	0.137	0.048	0.376	0.178	0.173	2
S5	0.111	0.096	0.093	0.054	0.033	0.073	7
S6	0.108	0.093	0.087	0.048	0.036	0.068	8
S7	0.071	0.093	0.095	0.071	0.210	0.107	5
S8	0.058	0.091	0.184	0.124	0.175	0.148	4

Table 17 Supplier rankings for 5kW contracts based on AHP

Weights	*0.460*	*0.035*	*0.089*	*0.057*	*0.103*	*0.256*		
Suppliers	*HSE*	*Equipment del.*	*Technical*	*Support*	*Compliance*	*ICV*	*Score*	*Rank*
S1	0.469	0.541	0.482	0.552	0.252	0.145	0.372	1
S2	0.167	0.163	0.277	0.088	0.096	0.083	0.143	4
S3	0.160	0.127	0.109	0.222	0.288	0.445	0.244	2
S4	0.138	0.133	0.107	0.093	0.288	0.256	0.178	3
S5	0.066	0.037	0.025	0.044	0.076	0.072	0.063	5

Table 18 Supplier rankings for OTPM contracts based on AHP

Weights	*0.066*	*0.237*	*0.128*	*0.569*		
Suppliers	*Delivery*	*Quality*	*Tenderer exp.*	*Compliance*	*Score*	*Rank*
S1	0.142	0.138	0.133	0.139	0.138	1
S2	0.142	0.138	0.133	0.139	0.138	2
S3	0.142	0.138	0.133	0.139	0.138	3
S4	0.139	0.138	0.133	0.139	0.138	4
S5	0.139	0.138	0.133	0.139	0.138	5
S6	0.132	0.138	0.133	0.139	0.137	7
S7	0.135	0.138	0.133	0.139	0.138	6
S8	0.029	0.034	0.067	0.139	0.098	8

Table 19 Supplier rankings for CCSS contracts based on AHP

Weights	*0.167*	*0.047*	*0.047*	*0.103*	*0.636*		
Suppliers	*Compliance*	*Tenderer exp.*	*Personnel exp.*	*Quality*	*HSSE*	*Score*	*Rank*
S1	0.114	0.293	0.330	0.057	0.000	0.054	5
S2	0.293	0.204	0.330	0.455	0.200	0.248	1
S3	0.293	0.193	0.147	0.220	0.200	0.215	2
S4	0.124	0.207	0.147	0.211	0.200	0.186	4
S5	0.343	0.104	0.046	0.057	0.200	0.197	3

Table 20 Supplier rankings for CCSMSFS contracts based on TOPSIS

	Compliance	*Experience*	*Experience within OQ*	*Technical specification*	*Technical support*	*Si+**	*Si-**	*Pi**	*Rank*
S1	0.083	0.069	0.062	0.075	0.061	0.023	0.037	0.610	1
S2	0.110	0.075	0.073	0.059	0.056	0.035	0.020	0.364	6
S3	0.102	0.089	0.056	0.065	0.050	0.030	0.024	0.447	3
S4	0.095	0.075	0.067	0.065	0.061	0.022	0.025	0.532	2
S5	0.095	0.075	0.062	0.054	0.050	0.032	0.017	0.345	7
S6	0.095	0.069	0.062	0.054	0.056	0.035	0.017	0.325	8
S7	0.095	0.075	0.067	0.054	0.050	0.031	0.020	0.389	5
S8	0.097	0.075	0.062	0.059	0.061	0.028	0.020	0.410	4

Note: *Si+: positive ideal solution distance, Si-: negative ideal solution distance, Pi: relative closeness to the ideal solution.

For *OTPM*, *compliance* is the most significant criterion under AHP (0.569), indicating that meeting regulatory requirements is the primary concern in this contract. SWARA also ranks *compliance* as the most critical factor (0.310), but it assigns higher importance to *quality* (0.252) and *tenderer experience* (0.225), suggesting that experience and quality considerations play a more important role when using SWARA.

Finally, in the *CCSS*, *HSSE* is the most critical factor under AHP (0.636), indicating that safety and security measures are paramount in this contract. SWARA, however, provides a lower weight (0.242) to *HSSE* and instead gives more importance to *quality* (0.190) and *compliance* (0.209), suggesting that these elements must also be considered.

Figure 2 illustrates the relationships and differences in the weights obtained using both techniques for each criterion within each contract type.

After determining the criterion weights using AHP and SWARA, the next step is to rank the suppliers (tenderers) based on their performance relative to the criteria. The AHP method utilises computed criterion weights to rank suppliers directly, while the SWARA-derived weights are used in conjunction with the TOPSIS method for ranking. The details of the calculations of supplier rankings across contract types using AHP and TOPSIS are presented in Tables 16–23.

Table 21 Supplier rankings for 5KW contracts based on TOPSIS

	HSE	*Equipment del.*	*Technical*	*Supply*	*Compliance*	*ICV*	*Si+*	*Si-*	*Pi*	*Rank*
S1	0.102	0.076	0.074	0.064	0.064	0.086	0.022	0.057	0.727	1
S2	0.127	0.085	0.074	0.072	0.064	0.061	0.046	0.034	0.429	4
S3	0.089	0.088	0.074	0.077	0.068	0.061	0.025	0.054	0.684	2
S4	0.089	0.085	0.074	0.061	0.063	0.056	0.035	0.047	0.577	3
S5	0.089	0.065	0.067	0.061	0.062	0.037	0.058	0.038	0.398	5

Note: *Si+: positive ideal solution distance, Si-: negative ideal solution distance, Pi: relative closeness to the ideal solution.

Table 22 Supplier rankings for OTPM contracts based on TOPSIS

	Delivery	*Quality*	*Tenderer exp.*	*Compliance*	*Si+*	*Si-*	*Pi*	*Rank*
S1	0.114	0.104	0.101	0.084	0.023	0.066	0.743	1
S2	0.114	0.104	0.101	0.084	0.023	0.066	0.743	2
S3	0.114	0.104	0.101	0.084	0.023	0.066	0.743	3
S4	0.114	0.104	0.076	0.073	0.036	0.051	0.587	4
S5	0.091	0.078	0.061	0.072	0.049	0.049	0.497	5
S6	0.137	0.075	0.061	0.067	0.069	0.013	0.160	8
S7	0.091	0.071	0.061	0.067	0.054	0.047	0.463	6
S8	0.091	0.062	0.058	0.067	0.062	0.046	0.425	7

Note: *Si+: positive ideal solution distance, Si-: negative ideal solution distance, Pi: relative closeness to the ideal solution.

Table 23 Supplier rankings for CCSS contracts based on TOPSIS

	Compliance	*Tenderer exp.*	*Personnel exp.*	*Quality*	*HSSE*	*Si+*	*Si-*	*Pi*	*Rank*
S1	0.103	0.089	0.071	0.069	0.079	0.058	0.057	0.494	4
S2	0.124	0.111	0.106	0.104	0.079	0.041	0.106	0.719	1
S3	0.124	0.111	0.106	0.104	0.079	0.041	0.106	0.719	2
S4	0.083	0.056	0.035	0.048	0.079	0.106	0.041	0.281	5
S5	0.103	0.089	0.085	0.069	0.079	0.051	0.067	0.568	3

Note: *Si+: positive ideal solution distance, Si-: negative ideal solution distance, Pi: relative closeness to the ideal solution.

As can be seen from Table 24, the rankings provide insight into supplier performance based on different evaluation methodologies.

For *CCSMSFS*, AHP ranks supplier 1 (S1) as the top performer, followed by S3 and S8. SWARA-TOPSIS also places S1 at the top, followed by S4 and S3. The consistency of S1 across both methods indicates its robustness as a supplier, while the variations in the next-best suppliers suggest that different criteria weightings impact rankings.

In the *5KW contract*, AHP ranks S1 first, followed by S3 and S4, mirroring the SWARA-TOPSIS rankings for the top three suppliers. However, the fourth and fifth positions differ slightly, indicating that while the top performers remain the same, lower-ranked suppliers vary based on method-specific weightings.

For *OTPM*, AHP assigns the highest rank to S1, followed by S2 and S3, which is consistent with SWARA-TOPSIS. The alignment suggests that the top suppliers for this contract type are less sensitive to methodology differences.

Finally, in the *CCSS*, AHP ranks S2 as the top supplier, followed by S3 and S5, while SWARA-TOPSIS also ranks S2 first but places S3 and S5 in the same order. The consistency in rankings indicates a clear performance hierarchy, reinforcing the reliability of the top suppliers.

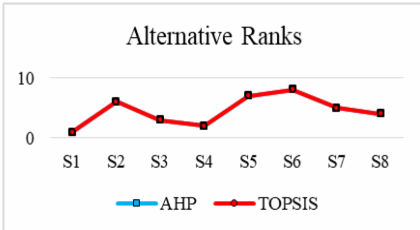
Figure 3 illustrates and compares supplier rankings across contract types based on AHP and TOPSIS.

Table 24 Priority weights of supplier selection criteria across contract types using AHP and SWARA

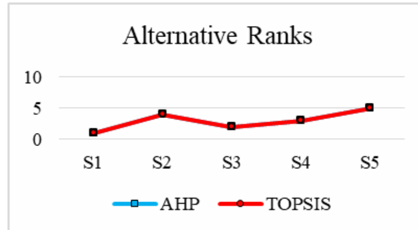
	Rank							
	AHP				*SWARA-TOPSIS*			
	CCSMSFS	*5KW*	*OTPM*	*CCSS*	*CCSMSFS*	*5KW*	*OTPM*	*CCSS*
S1	1	1	1	5	1	1	1	4
S2	6	4	2	1	6	4	2	1
S3	3	2	3	2	3	2	3	2
S4	2	3	4	4	2	3	4	5
S5	7	5	5	3	7	5	5	3
S6	8		7		8		8	
S7	5		6		5		6	
S8	4		8		4		7	

In the O&G sector of Oman, several limitations and rules apply to supplier selection. Oman's Government has put in place strict legislation and regulations to guarantee that only reputable and skilled suppliers are chosen for the country's O&G projects. The minimal technical and commercial standards that suppliers must achieve include performance records, necessary certificates and qualifications, and financial stability. In addition, the government can blacklist or prohibit suppliers and vendors that violate these rules or practice fraud. These restrictions and regulations are designed to guarantee the calibre of goods and services provided to Oman's O&G industry.

Figure 3 Comparison of supplier rankings across contract types using AHP and TOPSIS, (a) CCSMSFS, (b) 5KW, (c) OTPM, (d) CCSS (see online version for colours)



(a)



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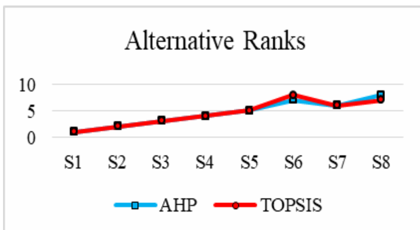

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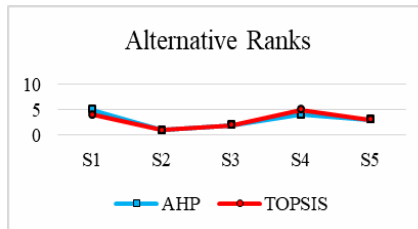

(d)

5 Discussion and conclusions

Effective supplier selection modelling is essential for businesses aiming to optimise their supply chain operations and maintain a competitive advantage, particularly in highly regulated sectors like oil and gas. Supplier selection directly impacts a firm's efficiency, risk management, and cost reduction by improving resource allocation and minimising procurement-related uncertainties. Hence, a structured and hybrid evaluation approach enables businesses to build strategic supplier relationships, enhancing efficiency and long-term competitiveness. This research presented the three MCDM techniques: AHP, SWARA, and TOPSIS. In the first phase, we delved into the literature of oil and gas industry to extract the most important and significant factors affecting supplier selection decisions. Then, the three MCDM methodologies are used to optimise supplier selection decisions through conducting a real case study in Oman. The findings of this study underscore the significance of a structured approach to supplier evaluation, particularly through the application of MCDM techniques.

5.1 Key findings and discussion

The analysis of supplier selection criteria across different contract types using AHP and SWARA highlights how different methodologies assign priority weights, revealing key differences in decision-making approaches. AHP tends to emphasise dominant criteria, while SWARA provides a more balanced distribution of importance. The comparison between the two methods shows that:

- In safety-sensitive contracts such as 5KW and CCSS, *HSE/HSSE* is the most critical factor, reflecting the industry's strong emphasis on safety and regulatory compliance.

However, SWARA suggests a broader evaluation framework by also assigning considerable weight to *compliance*, *quality*, and *experience*.

- For contracts like CCSMSFS and OTPM, *compliance* and *experience* emerge as the most influential criteria, emphasising the need for suppliers to have a strong regulatory and operational track record.
- The *ICV* criterion is applied selectively, indicating that organisational policies and agreements influence their importance.
- The supplier ranking results obtained through AHP and SWARA-TOPSIS show consistency for top-performing suppliers but variations for lower-ranked suppliers, suggesting that hybrid approaches provide a more reliable selection framework.

These findings emphasise the need for a more structured and hybrid approach in supplier selection, ensuring that procurement decisions are data-driven, transparent, and adaptable to specific contract requirements.

5.2 Managerial implications and future directions

The findings highlight key considerations for procurement managers and policymakers to optimise supplier selection:

- Adopting hybrid supplier evaluation models: relying on a single method may introduce bias and overlook critical supplier attributes. Integrating MCDM techniques ensures a balanced and comprehensive supplier assessment.
- Emphasising contract-specific supplier criteria: different contracts prioritise distinct supplier attributes. A customised evaluation framework is essential for making more precise selection decisions.
- Ensuring compliance and supplier experience: since compliance remains a top priority across all contracts, procurement teams must rigorously assess suppliers' adherence to regulations. Industry experience should also be considered in supplier development initiatives.
- Strengthening supplier partnerships: method-specific variations in rankings indicate the need for a diverse, high-quality supplier base to reduce operational risks and avoid over-reliance on a single supplier.
- Leveraging AI, machine learning (ML), and optimisation in supplier selection: AI and ML can enhance supplier evaluation by automating decision-making, identifying patterns, and predicting performance. Integrating AI-driven decision support systems with predictive analytics, optimisation models, and real-time data processing will further improve MCDM methodologies, enhancing supply chain agility and resilience while enabling businesses to adapt to evolving market conditions and regulatory requirements.
- To strengthen procurement policies, the Ministry of Minerals and Energy and the Tender Committee should adopt MCDM techniques instead of relying solely on weighted point methods. This shift will lead to more transparent, flexible, and data-driven decision-making.

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Declarations

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The data used in this study cannot be made publicly available, due to confidentiality restrictions.

The authors declare that they have no conflict of interest.

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