

Presenting the Contract Selection Model of Supply Chain Management with Uncertainty Approach and Multi-criteria Decision Making Methods in Gas Company of Khuzestan Province

Esmail Kamaee¹, Mohammad Jalali Varnamkhasti^{2*} , Mojtaba Aghajani³

¹ Department of Industrial Management, Isf.C., Islamic Azad University, Isfahan, Iran

² Department of Mathematics, Isf.C., Islamic Azad University, Isfahan, Iran

³ Department of Management, Mo.C, Islamic Azad University, Mobarakeh, Isfahan, Iran

*Corresponding author: jalali206@iau.ac.ir

Original Research Abstract

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Selecting the appropriate supply chain contract under conditions of uncertainty is a critical and complex challenge, particularly within volatile sectors like the oil and gas industry. This research aims to develop and present a comprehensive, structured model for supply chain management contract selection tailored to the specific needs of the Khuzestan Province Gas Company. The study utilizes a mixed-methods approach, beginning with a qualitative meta-synthesis of existing literature to identify and screen the primary criteria and sub-criteria for contract selection. Subsequently, a hybrid Multi-Criteria Decision-Making (MCDM) model is implemented, using the Decision Making Trial and Evaluation Laboratory (DEMATEL) technique to analyze the causal relationships among criteria, followed by the Analytic Network Process (ANP) to determine the final weights and rankings based on data collected from industry experts. The findings from the DEMATEL analysis reveal a distinct cause-and-effect structure, identifying "Environmental and Social," "Economic and Financial," and "Quality and Innovation" as the foundational causal factors that influence the effect criteria of "Management and Logistics," "Supplier Performance," and "Communication and Collaboration". The final ranking results from the ANP method surprisingly indicate that "Management and Logistics" (weight: 0.529) and "Communication and Collaboration" (weight: 0.406) are the most critical criteria, significantly outweighing "Economic and Financial Factors". This suggests a strategic prioritization of operational stability and partnership quality over purely cost-based considerations. Ultimately, this study provides a practical and defensible framework that transforms a complex decision into a structured process for managers. It proposes a two-stage evaluation system as an actionable solution, where suppliers are first screened by causal criteria and then selected based on high-priority effect criteria.

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Keywords: Supply Chain Management; Contract Selection; Uncertainty Conditions; Supplier Selection; Meta-Synthesis Method

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1. Introduction

The concept of the Supply Chain (SC) began to develop in the 1980s and today plays a very important role in every economy and company. Supply Chain Management (SCM) is a set of approaches that, by efficiently integrating suppliers, manufacturers, and warehouses, ensures the production and distribution of products in the right quantity, to the right location, and at the right time to meet customer needs and minimize intra-system costs [1]. The experience of leading countries and industries has shown that increasing the efficiency and productivity of the supply chain is considered one of the key strategies for improving the business environment and increasing productivity; this becomes doubly important given that supply chain costs sometimes constitute up to 30% of the final product price [2]. In this context, supplier selection, which requires a comprehensive comparison of suppliers using a set of criteria and methods, holds a significant position in procurement management [3].

The oil and gas industry, as one of the most important economic sectors contributing to a country's revenue [4], is heavily dependent on an efficient supply chain. However, today's turbulent and uncertain business environment exposes supply chains to new vulnerabilities [5]. These vulnerabilities and disruptions, a prime example of which was the coronavirus pandemic, can destabilize the entire supply chain [6], and if not adjusted in a timely manner, their consequences can halt supply chain operations, which in turn leads to a loss of revenue [7]. To improve performance, companies outsource some of their functions [8], and consequently, the evaluation and selection of a suitable supplier contract model is an essential step in creating sustainable partnerships in the supply chain [9].

Given the complexities, market dynamics, and common uncertainties in this industry, the need to present an efficient decision-making model with an uncertainty approach and the use of Multi-Criteria Decision-Making (MCDM) methods is inevitable. Multi-Criteria Decision-Making (MCDM) is a field that helps managers make decisions based on multiple and conflicting criteria and is well-suited to the complex nature of organizations. However, many existing models operate deterministically and do not consider the impact of uncertainty in demand, supply, and other factors.

The existing research gaps indicate that there is a perceived shortage of hybrid models that can integrate MCDM methods with uncertainty approaches. Furthermore, most existing research has focused on general industries, and the application of these models in the gas industry, especially in Khuzestan province, has received less attention.

Therefore, the present research strives to cover these gaps by presenting a comprehensive model. This research, by considering an uncertainty approach in supply chain management and contract selection, and using multi-criteria decision-making methods, presents a model for the Khuzestan Province Gas Company. The ultimate goal is to localize the indicators according to the

specific conditions of the oil and gas industry and to present a model that helps improve the functions of the supply chain and ultimately contributes to the sustainable growth and development of this sector in Iran. Such a model can enable the oil and gas industry to sustainably face complex variables and various uncertainties and improve its performance and productivity.

2. Literature Review and Research Background

Every organization provides products to its customers, which are traditionally described as goods or services. While manufacturers like Sony offer tangible goods and companies like Vodafone provide intangible services, in reality, every product is a complex package containing both. For example, Ford, in addition to producing cars, also offers services such as warranties and financial services, and McDonald's restaurants provide a combination of goods (like burgers) and services (like serving food). Therefore, products can be categorized on a spectrum, from predominantly goods (like automobiles) to predominantly services (like insurance and education).

At the heart of every organization lies "operations," which transform various inputs into desired outputs. This process includes the following:

Inputs: Includes raw materials, components, human resources, equipment, information, and financial resources.

Operations: Includes activities such as manufacturing, transportation, sales, and training.

Outputs: The main products include goods and services. This cycle is depicted in the figure below.

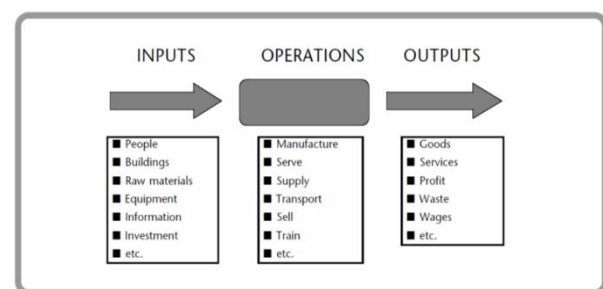


Figure 1: The operation of creating output

The products created by the organization's operations are transferred to customers, forming a cycle of supply and demand in which logistics is responsible for the movement of materials. Logistics is divided into three main parts:

Inbound Logistics: The transfer of materials from suppliers to the organization.

Materials Management: The movement of materials within the organization.

Outbound Logistics: The transfer of materials from the organization to customers.

In reality, organizations do not operate in isolation, and each organization in this cycle plays the role of both a customer (when buying from suppliers) and a supplier

(when selling to others). Most products move through a series of organizations, from initial suppliers to final customers. This sequence of activities and organizations is called the supply chain. Depending on the perspective, this chain is also known by other names such as the value chain [10], procurement channel, or demand chain.

Every product has its own unique supply chain, which can be very long and complex. This chain describes the entire journey of materials "from soil to soil" [11] and can include raw material suppliers, manufacturers, warehouses, wholesalers, retailers, and even recycling processes. The activities within the supply chain are divided into upstream and downstream, as shown in the figure below.

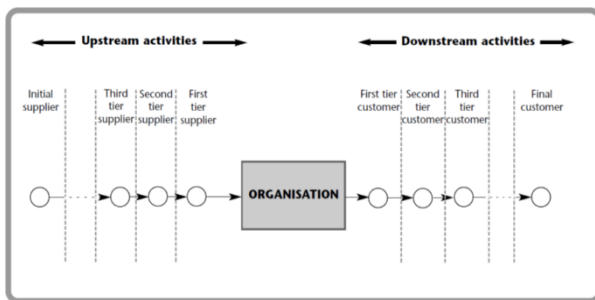


Figure 2: Activities in a supply chain

Upstream Activities: The movement of materials into the organization from various tiers of suppliers (first-tier, second-tier, etc.).

Downstream Activities: The movement of materials out of the organization toward various tiers of customers (first-tier, second-tier, etc.).

Supply Chain Management is based on four fundamental elements: **supply, operations, logistics, and integration**.

Supply: Modern approaches to supply management have moved away from traditional and adversarial strategies (based on a large number of suppliers and short-term contracts) towards a strategic approach. This approach emphasizes reducing the number of suppliers and developing long-term relationships based on strategic partnerships to achieve competitive advantage, higher quality, and better services [12]. One of the key activities in this area is the continuous evaluation of existing and potential suppliers.

Operations: After receiving materials, the elements of internal operations become important for converting them into final products of a specific quality, cost, and volume [13]. Inventory management and control is one of the most important aspects of operations. Companies typically use software systems such as Material Requirements Planning (MRP) and Enterprise Resource Planning (ERP) to manage inventory and share sales and production data with supply chain partners [14].

Logistics: Delivering final products to customers at the right time, quality, and volume requires careful planning and high collaboration [15]. The desired outcome of logistics is to provide better customer service. This is achieved through Customer Relationship Management (CRM) strategies and optimal design of the distribution network [16].

Integration: This element, which is the most difficult part of supply chain management, refers to the coordination of processes among all business partners in the chain. Integration occurs when members of the supply chain cooperate to make key decisions related to procurement, inventory, production, and logistics in a way that maximizes the profit of the entire supply chain. This process requires that supply chain management becomes part of the strategic planning of each member and that goals are set jointly [17].

Table 1: Fundamental elements of supply chain management

Fundamental Elements of Supply Chain Management	Key factors
Supply	Reducing supply base, supplier alliances, SRM, global sourcing, ethical and sustainable sourcing
Operations	Demand management, CPFR, inventory management, MRP, ERP, lean systems, Six Sigma quality
Logistics	Logistics management, CRM, network design, RFID, global supply chains, sustainability, service response logistics
Integration	Integration barriers, risk and security management, performance measurement, green supply chain

On the other hand, the oil and gas industry has faced instability in recent years due to the sharp decline in oil prices since 2014 [18]. This situation has led to reduced production, financial problems, widespread layoffs, and a decrease in the employment rate in this industry [19]. Fluctuations in supply and demand and low total shareholder return (TSR) compared to other industries have reduced investor confidence [20]. Furthermore, the oil and gas value chain has been affected by disruptive factors such as the emergence of new energy sources (renewable and non-traditional), geopolitical changes, the rise of electric vehicles, and stricter environmental regulations. This industry has also experienced a decline in productivity compared to other heavy-asset industries [21], putting great pressure on companies to reduce costs and increase efficiency.

The Vital Role of Contract Selection in the Gas Supply Chain

Contract selection in the gas industry supply chain is a complex challenge intertwined with inherent uncertainties and the need to balance multiple criteria [22]. The oil and gas industry, a cornerstone of many countries' economies, faces significant fluctuations due to changes in oil prices, geopolitical events, and sanctions [22]. These factors double the need for robust Supply Chain Management (SCM) to mitigate risks and maintain competitive pricing. In this context, supply chain contracts play a fundamental role in managing these dynamics, especially considering that the cost of purchasing raw materials can constitute up to 70% of a

company's total costs [23]. Therefore, selecting the appropriate contract is vital for gas companies to reduce costs and improve efficiency [24].

Contracts serve as the foundation for communication and relationship management between buyers and suppliers, providing the key elements for a stable exchange relationship [25]. These contracts also have a significant impact on managing product flow and the overall performance of the supply chain. Studies have empirically identified the main drivers for companies in selecting supply chain contracts, which include performance, supply chain orientation, and supply chain integration [26].

Integrating Uncertainty Approaches in Contract Selection

Uncertainty is an inherent feature of supply chain operations, especially in the oil and gas sector. Demand fluctuations, lead time variability, price volatility, and geopolitical instabilities all contribute to creating an uncertain environment [27, 28]. Traditional supply chain management models, often based on deterministic assumptions, are inadequate for modern and complex supply chains [27]. To address this challenge, uncertainty theory has emerged as a crucial mathematical framework for analyzing unpredictable phenomena in SCM [29]. This theory helps adapt multi-criteria optimization procedures to situations where reliable probability estimates for random events are not available [30].

Key aspects of uncertainty that are important in contract selection include:

Demand Uncertainty: Demand for gas products can be highly volatile, which affects inventory management and production planning, making flexible contracts desirable.

Supply Uncertainty: Disruptions in the supply of raw materials due to geopolitical issues or infrastructure failures can severely impact operations [31]. Contracts must include mechanisms for risk sharing and mitigation.

Transportation Time Uncertainty: The variability in gas transportation time affects delivery schedules and the overall efficiency of the supply chain [27], requiring contracts that account for potential delays.

Model Uncertainty: The optimization models used for contract design may themselves have errors. More robust approaches can help find solutions that are less sensitive to model assumptions [32].

Furthermore, contract design must consider the financial and capital constraints faced by both suppliers and retailers [33].

Application of Multi-Criteria Decision-Making (MCDM) Methods

Given the multitude of factors involved in contract selection—from cost and quality to reliability and sustainability—Multi-Criteria Decision-Making (MCDM) methods are essential tools [34, 35]. These methods provide structured frameworks for evaluating and selecting the most suitable contract from available options, considering both quantitative and qualitative criteria. Some common MCDM methods used in this

field include:

Analytic Hierarchy Process (AHP): This method helps structure complex decisions into a hierarchy and assign weights to criteria through pairwise comparisons [36, 37]. This method has been extended with concepts like D numbers to manage different types of uncertainty [38].

Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS): This method identifies the best option by finding the one closest to the positive ideal solution and farthest from the negative ideal solution [36, 39].

Fuzzy Set Theory: Since supplier evaluation and selection is often a fuzzy multi-criteria problem [40], fuzzy AHP and fuzzy TOPSIS methods are widely used to deal with ambiguity and uncertainty in decision-making [35, 41, 42, 43].

Best-Worst Method (BWM) and Multi-Objective Optimization on the basis of Ratio Analysis (MULTIMOORA): The BWM method is used to determine criteria weights and is often used in an integrated manner with the MULTIMOORA method for sustainable supplier selection and order allocation [44]. These MCDM approaches are vital for supplier evaluation and selection in the oil and gas industry, where factors like delays in extraction and refining can severely impact operations [45, 46]. They help in selecting suitable suppliers based on multiple quantitative and qualitative criteria, including those related to sustainability [36, 46, 47].

3. Research methodology

In terms of its objective, this is an applied research study that seeks to "present a supply chain management contract selection model with an uncertainty approach and the use of multi-criteria decision-making methods in the Khuzestan Province Gas Company."

Regarding its methodology, this research utilizes a mixed-methods approach (quantitative and qualitative). In the qualitative part, the meta-synthesis method is used to identify indicators from the research literature, and interviews with experts are conducted for a deeper understanding of the subject. In the quantitative part, specialized questionnaires and multi-criteria decision-making (MCDM) techniques have been utilized for data analysis and modeling. The overall research process is depicted in Figure 3.

This process begins with the identification and development of criteria. Then, the internal and external relationships between them are examined using the DEMATEL and ANP techniques. Finally, this leads to the final ranking and evaluation using specialized software.

First Stage: Identifying Criteria through Meta-synthesis

The foundation of any decision-making model is the identification of correct and comprehensive criteria. In this research, the meta-synthesis method was used for the initial extraction and screening of criteria and sub-criteria affecting contract selection. Meta-synthesis is an emerging qualitative method that involves the

systematic interpretation of the results of previous studies to arrive at a new explanation of a common phenomenon [48].

The meta-synthesis process in this study included the following steps:

1. **Defining the Research Questions:** The main research question was: "What environmental, organizational, and individual factors influence the selection of a supply chain management contract with an uncertainty approach?"
2. **Systematic Literature Review:** A systematic search was conducted using Persian and English keywords such as "contract selection," "supply chain management," and "uncertainty."
3. **Selecting Suitable Articles:** The search was performed in reputable Persian databases (such as SID and Magiran) and English databases (such as Springer, ScienceDirect, Emerald) within the time frame of 1395 to 1403 in the Persian calendar (2016 to 2024 AD). At this stage, only articles published in journals were selected.
4. **Extracting and Analyzing Results:** After screening for duplicate and irrelevant articles, concepts and codes related to contract selection criteria were extracted. The final output of this stage was a comprehensive list of criteria and sub-criteria presented in the research by Komaee et al. (2025) [49]. This list formed the basis for designing the research variables and data collection tools in the subsequent stages.

Second Stage: Statistical Population and Data Collection

The statistical population for this research includes senior managers and experts from the Khuzestan Province Gas Company who are active in fields related to the supply chain, contracts, and planning. Given the limited size of the population, a purposive (expert-based) sampling method was used. For this purpose, a group of experts with at least a master's degree and 15 years of relevant work experience was selected. This research utilized two expert groups to complete the questionnaires:

- A group of 5 senior managers and experts to complete the DEMATEL questionnaire.
- A group of 21 specialists and stakeholders to complete the Analytic Network Process questionnaire.

The primary method for data collection was Field Research, and the following tools were used:

1. **Library Studies and Meta-synthesis:** To perform the initial identification of criteria (as described in the first stage).

2. **Questionnaires:** Two specialized questionnaires were designed based on the variables extracted from the meta-synthesis stage.
 - **DEMATEL Questionnaire:** To identify the cause-and-effect relationships and the degree of influence among the main criteria.
 - **Analytic Network Process (ANP) Questionnaire:** To conduct pairwise comparisons and determine the final weights of criteria and sub-criteria, considering the dependencies between them.
3. **Interviews:** To gain a deeper understanding of perspectives and to qualitatively validate the results.
4. **Documentary Analysis:** To analyze contracts and internal company reports.

Third Stage: Data Analysis Method

To analyze the collected quantitative and qualitative data, a hybrid approach based on multi-criteria decision-making (MCDM) was used. This approach helps organizations manage the complexities of contract selection [50, 51]. The analysis stages are as follows:

1. **Causal Relationship Analysis with the DEMATEL Technique:** The data from the DEMATEL questionnaire were analyzed using Excel software. The output of this stage was a network relationship map, which shows which criteria are influential (causal) and which are influenced (effect). This map forms the input structure for the ANP model.
2. **Weighting and Ranking with the Analytic Network Process (ANP):** The ANP method, which is a generalized form of AHP, is suitable for situations where dependencies and feedback exist among criteria. Unlike AHP, this method doesn't require a hierarchical structure and calculates indirect interactions [52]. The ANP questionnaire data were entered into Super Decisions software. After forming the supermatrices and reaching the limit supermatrix, the final weights for each of the criteria and sub-criteria were calculated.

Finally, a Meta-Analysis of the modeling results was employed to interpret the internal relationships of the criteria, compare the results with managerial assumptions, and extract practical patterns for optimizing future contracts at the Khuzestan Province Gas Company.

4. Result and discussion

This section presents the results obtained from the analysis of data collected from experts. As stated in the methodology section, the DEMATEL method was first used to identify the structure of causal relationships among the contract selection criteria and sub-criteria. The goal of this analysis is to understand which criteria play the role of a cause (influential) and which play the role of an effect (dependent) in the decision-making system.

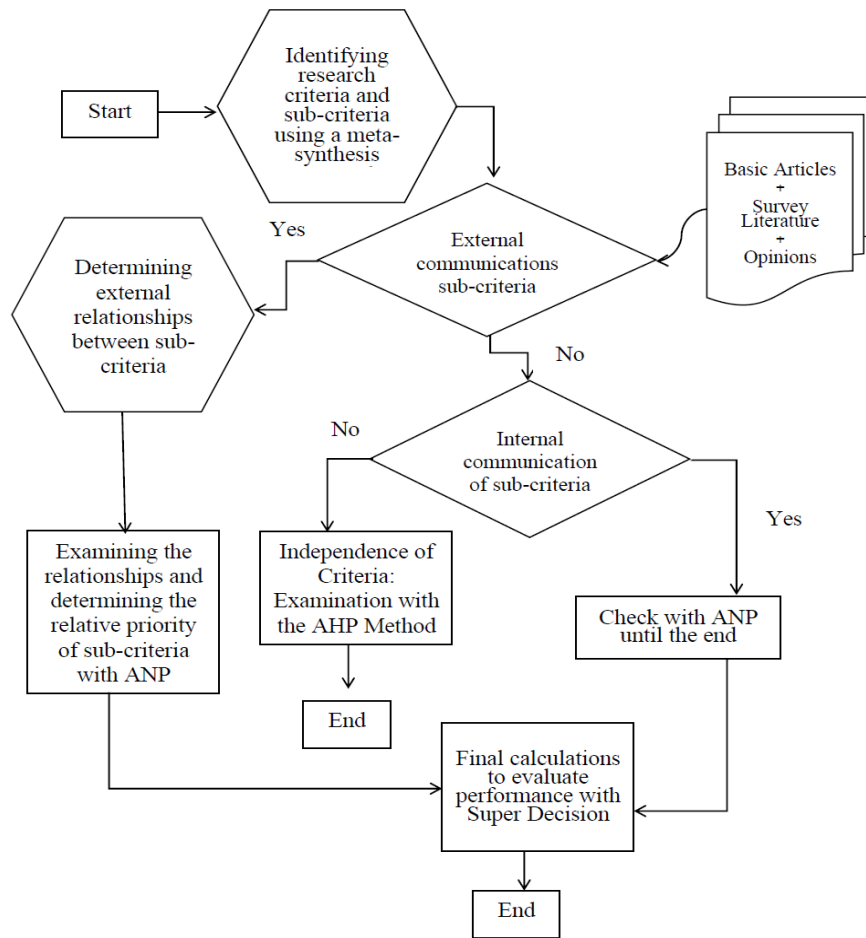


Figure 3: General Research Process

Table 2: Identified Criteria and Sub-criteria [49]

Criteria	Sub-Criteria
Economic and Financial Factors	Costs
	Supplier Financial Stability
	Production Capacity
	Inventory Management
	Productivity and Efficiency
Quality and Innovation	Quality
	Research and Development (R&D)
	Technology and Innovation
	Quality Certificates
	Robustness
Supplier Performance and Social Responsibility	Supplier Reputation
	Social Responsibility
	Commitment to Continuous Improvement
	Environmental Sustainability
	Safety Management
Management and Logistics	Delivery Time
	Flexibility
	Logistics and Transportation
	Reverse Logistics
	Risk and Uncertainty Management
Communication and Collaboration	Level of relationships and cooperation
	Customer satisfaction
	Advertising and its effectiveness
	Geographical location
Environmental and Social	Green Product Design and Packaging
	Green Supply Chain Management
	Environmental Certification Compliance

4.1. Causal Relationship Analysis of Main Criteria

After gathering expert opinions and forming the average matrix, the (R+J) values, representing the importance, and the (R-J) values, representing the degree of influence, were calculated for each of the six main criteria. The results of these calculations divide the criteria into two distinct groups: causal and effect. The influence and dependence levels of the criteria are presented in Table 3.

Table 3: The influence and dependence levels of the criteria

	A	B	C	D	E	F
R+J	3.91	3.84	4.01	3.69	2.97	1.76
R-J	0.98	0.48	-0.51	-0.62	-0.33	1.32

Causal Criteria Group (Influential)

This group includes criteria with a positive R-J value, which act as driving and foundational factors in the decision-making system. The analysis showed that three criteria fall into this group:

1. Environmental and Social (F): This criterion, by achieving the highest R-J value (equal to 1.3207), was identified as the strongest causal factor in the model. This finding indicates that in the current conditions, attention to environmental requirements and social responsibilities is a driving and fundamental factor that strongly influences other dimensions of decision-making.
2. Economic and Financial Factors (A): This criterion, with an R-J value of 0.981, was ranked as the second most influential factor. This result signifies that financial and economic considerations are still considered one of the main and influential pillars in the contract selection process.
3. Quality and Innovation (B): This criterion also falls into the causal group with a positive R-J value (equal to 0.4897), but its intensity of influence is less than the previous two criteria.

Effect Criteria Group (Dependent)

This group includes criteria with a negative R-J value. These criteria are more influenced by the causal group criteria than they are influential, and in a way, they are the outputs or consequences of broader decisions.

1. Management and Logistics (D): This criterion, by achieving the lowest R-J value (equal to -0.6213), was identified as the most dependent factor in the model. This means that the company's logistical performance is a result and function of decisions made in the economic, environmental, and quality domains.
2. Supplier Performance and Social Responsibility (C): This criterion, with an R-J value of -0.5187, is another effect factor, indicating that a supplier's performance is heavily influenced by the financial, innovative, and environmental approaches governing the contract.

3. Communication and Collaboration (E): This criterion also falls into the effect group with an R-J value of -0.3307, showing that the level of effective collaboration in the supply chain is a consequence of other foundational factors.

This cause-and-effect structure, depicted in Figure 4 and the final relationship graph in Figure 5, shows that optimal decision-making in contract selection must begin with a focus on the driving factors (environment, economy, and quality) to achieve desirable results in the operational areas (logistics, performance, and collaboration).

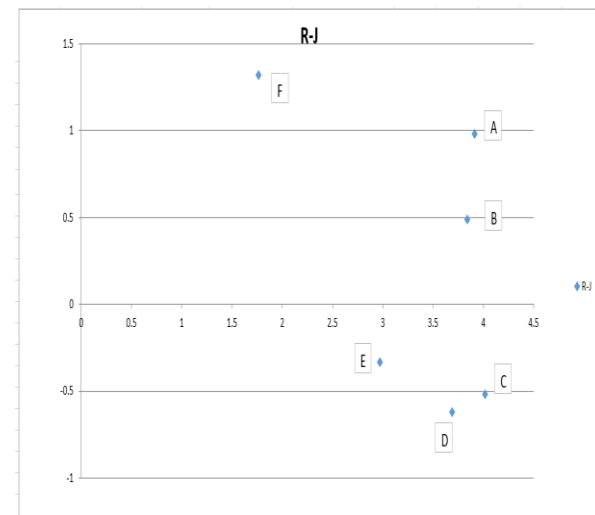


Figure 4: R-J Cause and Effect Diagram of Main Criteria

4.2. Causal Relationship Analysis of Sub-criteria

The DEMATEL analysis was also conducted at the sub-criteria level to gain a more precise understanding of the driving factors and consequences in the model.

Most Important Causal (Influential) Sub-criteria

Based on the results, the most important influential sub-criteria that play a driving role in the entire system are:

- Safety Management (C5): This sub-criterion, achieving the highest R-J score (0.0479), was identified as the most influential sub-criterion. This finding highlights the paramount importance of adhering to safety requirements in the high-risk gas industry and shows that safety is a prerequisite for many other decisions.
- Quality (B1): This sub-criterion ranked second with an R-J score of 0.0466, confirming that the quality of the product or service provided is a fundamental element in shaping other dimensions of the contract.
- Economic Sub-criteria: A set of economic sub-criteria, including Supplier's Financial Stability (A2), Productivity and Efficiency (A5), Costs (A1), Inventory Management (A4), and Production Capacity (A3), all fell into the causal factors group, which confirms the guiding role of economic considerations.

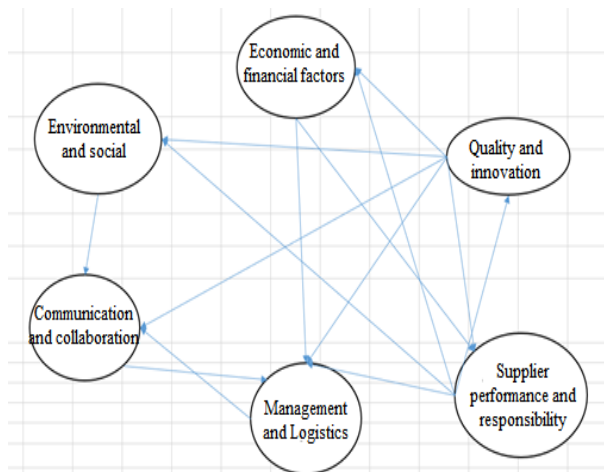


Figure 5: Final Graph of Criteria Relationships

Most Important Effect (Dependent) Sub-criteria

In contrast, the sub-criteria that are mainly the result and consequence of other factors were identified as follows:

- Customer Satisfaction (E2): This sub-criterion, with the lowest R-J score (-0.0399), has the highest dependency in the entire model. This finding indicates that customer satisfaction is a final goal whose achievement indirectly depends on proper performance in the areas of quality, safety, and efficiency.
- Logistics Sub-criteria: Factors such as Logistics and Transportation (D3), Flexibility (D2), and Delivery Time (D1) all fell into the effect group, indicating the operational and consequential nature of logistics performance.
- Innovation and Sustainability Sub-criteria: Interestingly, sub-criteria such as Green Supply Chain Management (F2) and Research and Development (B2) were also categorized in the effect group, which suggests that in this structure, these items were analyzed more as desirable outputs resulting from broad strategic decisions.

After the structure of causal relationships among the criteria was identified through the DEMATEL method, in the second step, the Analytic Network Process (ANP) was used to determine the final weights and priority of each criterion and sub-criterion. The research's network model, which incorporates the identified internal relationships, was designed using Super Decisions software and can be seen in Figure 6.

The calculation process in this method includes forming the initial (unweighted) supermatrix, converting it to a weighted supermatrix, and finally, raising the weighted matrix to a power to achieve the **Limit Supermatrix**, from which the final and stable weights of the system are extracted.

4.3. Final Results and Ranking of Main Criteria

Based on the output of the limit supermatrix, the final weights and rank of each of the six main research criteria were calculated. The complete results are presented in Table 4.

The most important findings in this section are:

1. **Management and Logistics (D):** This criterion, with a final weight of 0.52939, was ranked first by a very large margin. This result indicates the vital importance of operational performance, logistical efficiency, delivery time, and flexibility in the contract selection process from the experts' perspective.
2. **Communication and Collaboration (E):** This criterion, with a weight of 0.4061, was identified as the second most important criterion. This emphasizes the importance of stable relationships with suppliers, customer satisfaction, and geographical location.
3. **Supplier Performance (C) and Quality and Innovation (B)** were ranked third and fourth, respectively.
4. **Economic and Financial Factors (A):** This criterion ranked last (sixth) with a very low weight of 0.0079. This result, given the traditional importance of financial criteria in contracts, is unexpected and requires deeper analysis.

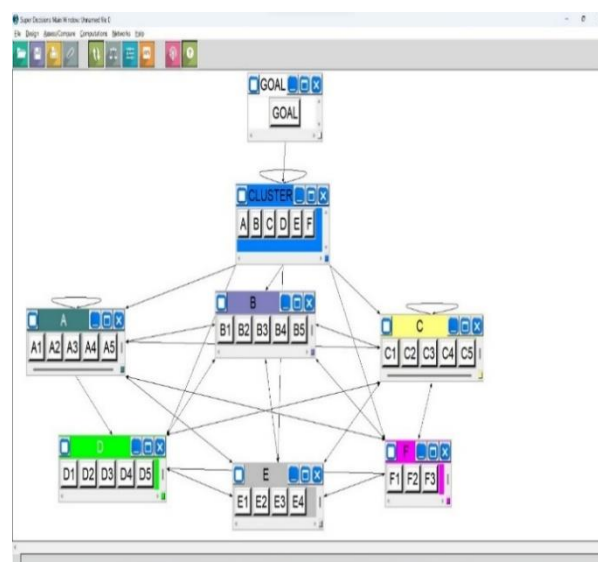


Figure 6: ANP Diagram of the Priority of Indicators and Sub-indicators in Super Decisions Software

Table 4: Final values and ranking of the research criteria

symbol	criteria	value	Rating
A	Economic and Financial Factors	0.0079	6
B	Quality and Innovation	0.02046	4
C	Supplier Performance and Social Responsibility	0.02263	3
D	Management and Logistics	0.52939	1
E	Communication and Collaboration	0.4061	2
F	Environmental and Social	0.01352	5

Analysis of the Main Criteria Prioritization

The low ranking of "Economic and Financial Factors" does not mean it is unimportant; rather, it indicates that within the operational framework of the Khuzestan Province Gas Company, other factors have a higher

priority from the experts' viewpoint. This can be analyzed from several perspectives:

Nature of the Gas Industry: In this industry, the continuity of operations, safety, and service reliability have a higher priority than cost savings. Any delay or defect in supply can lead to safety hazards and massive economic losses; therefore, logistical and communication criteria become strategically important.

Expert Perspective: The participants in this research were mainly operational managers and experts. This group naturally gives more weight to tangible and operational indicators (like delivery time and supplier responsiveness) than to abstract financial criteria.

Standardization of Financial Indicators: From the experts' perspective, financial indicators might be the minimum requirements for entering the competition, with no significant difference among the various options in this area. In contrast, differences in logistical and communication performance were the main distinguishing factor among suppliers.

Organizational Orientation: The high priority of criteria like "customer satisfaction" and "commitment to continuous improvement" could indicate a strategic orientation in the organization towards sustainability and building long-term relationships.

4.4. Final Results and Ranking of Sub-criteria

Analysis at the sub-criteria level provides a more detailed view of the decision-making priorities. The complete results of the ranking for all sub-criteria are provided in Table 5. The most important sub-criteria in the entire model are:

1. Commitment to Continuous Improvement (C3): This sub-criterion ranked first with the highest weight (0.028579), indicating its key role in ensuring the continuity of cooperation and improving service quality.
2. Customer Satisfaction (E2): With a weight of 0.090253, it ranked second, highlighting the importance of a customer-centric view in the supply chain.
3. Green Supply Chain Management (F2): The placement of this sub-criterion in third place (with a weight of 0.012853) shows the growing importance of sustainability and environmental responsibility in contractual decisions.
4. Durability (B5) and Quality (B1) were ranked fourth and fifth, emphasizing the importance of the product's technical capabilities.

In contrast, sub-criteria such as Research and Development (B2) and Technology and Innovation (B3) were ranked at the bottom, which could be a warning sign of decision-makers paying less attention to value-creating and long-term aspects.

Intra-criteria Ranking of Sub-criteria

Analyzing the sub-criteria within each main criterion clarifies the priorities of each section:

- In the Economic Factors (A) criterion, "Productivity

and Efficiency (A5)" was the most important sub-criterion.

- In the Quality and Innovation (B) criterion, "Durability (B5)" had priority over "Quality (B1)".
- In the Supplier Performance (C) criterion, "Commitment to Continuous Improvement (C3)" ranked first by a large margin.
- In the Management and Logistics (D) criterion, the three sub-criteria "Delivery Time (D1)", "Flexibility (D2)", and "Logistics and Transportation (D3)" had very close and high weights.
- In the Communication and Collaboration (E) criterion, "Customer Satisfaction (E2)" alone accounted for more than half of this criterion's weight.

In the Environmental (F) criterion, "Green Supply Chain Management (F2)" was the most important factor.

Table 5: Final values and ranking of the research sub-criteria

symbol	sub-criteria	value	Rating
A1	Costs	0.0019	18
A2	Supplier Financial Stability	0.003	11
A3	Production Capacity	0.0025	15
A4	Inventory Management	0.0023	16
A5	Productivity and Efficiency	0.0031	10
B1	Quality	0.0095	5
B2	Research and Development (R&D)	0.0011	26
B3	Technology and Innovation	0.0011	27
B4	Quality Certificates	0.0061	13
B5	Robustness	0.0114	4
C1	Supplier Reputation	0.0028	23
C2	Social Responsibility	0.0018	25
C3	Commitment to Continuous Improvement	0.0285	1
C4	Environmental Sustainability	0.0023	24
C5	Safety Management	0.0033	21
D1	Delivery Time	0.0737	7
D2	Flexibility	0.0712	8
D3	Logistics and Transportation	0.0707	9
D4	Reverse Logistics	0.0221	22
D5	Risk and Uncertainty Management	0.0348	19
E1	Level of relationships and cooperation	0.0347	14
E2	Customer satisfaction	0.0902	2
E3	Advertising and its effectiveness	0.0268	17
E4	Geographical location	0.0153	20
F1	Green Product Design and Packaging	0.0052	12
F2	Green Supply Chain Management	0.0128	3
F3	Environmental Certification Compliance	0.0071	6

A summary of the final findings showed that:

- A. The complete dominance of operational and executive criteria (Management and Logistics, and Communication and Collaboration) over other criteria indicates a pragmatic and results-oriented approach in the decision-making process.
- B. The high priority of sub-criteria such as customer satisfaction, continuous improvement, and delivery time signifies a customer-oriented and efficiency-driven direction in the final model.
- C. The precedence of environmental criteria over financial criteria is a sign of a gradual shift in decision-making patterns towards sustainability in the supply chain.
- D. The low ranking of criteria related to innovation and research and development could be a warning bell for the need to review the organization's long-term policies to maintain a competitive advantage.

5. Conclusion

The main objective of this research was to present a comprehensive and structured model for selecting supply chain management contracts at the Khuzestan Province Gas Company, considering conditions of uncertainty. To this end, by utilizing a mixed-methods approach, the structure of relationships among the criteria was first analyzed with the DEMATEL technique, and then the final prioritization was performed with the Analytic Network Process (ANP). The DEMATEL structural analysis showed that the "Environmental and Social," "Economic and Financial Factors," and "Quality and Innovation" criteria act as foundational and causal (influential) factors. These driving factors, in turn, affect the "Management and Logistics," "Supplier Performance," and "Communication and Collaboration" criteria, which play an effect (dependent) role. This finding reveals a clear decision-making logic wherein attention to economic and environmental foundations is a prerequisite for achieving optimal logistical and relational performance. The results from the final ranking with the ANP method clearly specified the priorities of decision-makers at the gas company. The most significant finding of this section was the highest importance achieved by the "Management and Logistics" (with a weight of 0.529) and "Communication and Collaboration" (with a weight of 0.406) criteria. This, along with the relatively low rank of the "Economic and Financial Factors" criterion, indicates a strategic approach in the gas industry where operational stability, reduction of executive risks, and long-term relationships with suppliers are prioritized over purely financial considerations. At the sub-criteria level, "Commitment to Continuous Improvement" (C3), "Customer Satisfaction" (E2), and "Green Supply Chain Management" (F2) achieved the highest ranks, emphasizing the importance of dynamism, customer-centricity, and sustainability in selecting business partners. Ultimately, this research successfully achieved all its objectives and presented an integrated model capable of

transforming the complexity and uncertainty inherent in contract selection into a structured, defensible, and practical process for managers. Based on the findings, a key operational solution is proposed: revising the evaluation process and establishing a two-stage system. In the first stage, suppliers are screened based on causal criteria (financial capability and environmental requirements). In the second stage, the final selection is made from among the qualified options based on the highly important effect criteria (logistical capability and quality of collaboration). It is also recommended that top qualitative criteria, such as "commitment to continuous improvement," be converted into measurable key performance indicators (KPIs) within the contracts to ensure their implementation.

Despite its achievements, this research faced limitations, such as its focus on a single case study and the use of opinions from a limited group of experts. Therefore, for future research, it is suggested that this model be developed by applying more advanced uncertainty methods (such as fuzzy logic) and be implemented in other similar companies to evaluate the generalizability of the results.

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Authors Contribution

All the authors have participated sufficiently in the intellectual content, conception and design of this work or the analysis and interpretation of the data (when applicable), as well as writing of the manuscript.

Availability of data and materials

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

Conflict of interests

The author states that there is no conflict of interest.

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