Multi-criteria decision-making model for supplierevaluation and selection in oil and gas companies

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Summary: The purpose of the study is to develop a proposed model for the assessment and selection of suppliers in oil and gas companies using a multi-criteria decision-making approach. The main-criteria and sub-criteria were identified and their relative weights were calculated. At the results the suppliers areclassified according to the relative importance of criteriawhich assist in the establishment of the final supplier evaluating matrix. The "expert choice" software was used to analyse the sensitivity of the model result. The study based on five main criteria and eighteen sub-criteria for the supplier evaluation and selection, in addition to establishes a flexible model that helps in choosing suppliers, taking into account the multiplicity of criteria and differences.
The study recommends that the use of multi-criteria methods in the process of selecting and evaluating suppliers, could contribute to improving the supply chain, developing the decision-making process and increasing performance efficiency in oil and gas companies

Keywords:supplier selection;multi-criteria decision making; main-criteria.
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I-Introduction:

The decision-making process is one of the most important tasks of companies in general. the success or failure of the companies depends on the quality and validity of the decisions taken especially those companies operating in a competitive environment, many companies are using quantitative methods to making decisions more precise and more reliable.

Industrial companies receive all their needs and requirements for production process such as raw materials, equipment, commodities and services, either domestic or foreign suppliers.

Supplier selection is a multiple criteria decision-making (MCDM) problem, which is affected by several conflicting factors (Tahriri, Osma, Ali, & Yusuff, 2008, pp. 201-208).When alternatives are compared on several criteria and their weight aggregated, their ranks can change when alternatives are added or deleted (Saaty, Vargas, & Whitaker, 2009, pp. 121-124),Multi-criteria decision-making approaches propose tens of methods for supplier selection problems, including Analytic Hierarchy Process (AHP).

The Analytical Hierarchy process is one of the most important methods used in the process of making a decision to evaluate and select suppliers, providing a practical framework for solving many problems, an approach to multi-criteria decision-making that enables decision-makers to make effective decisions to solve complex problems by simplifying them. The criteria used to evaluate and select suppliers change from time to time and from industry to another.

The problem of the study can be formulated in the following question: What is the possibility of applying the method of analytic hierarchy process for evaluating and selecting suppliers in oil and gas companies?

The sub-questions that will support this research question are stated below. These questions will aid in answering the research question:

-What are the criteria for evaluating and selecting suppliers in oil and gas companies?

- How to develop a model for supplier evaluation and selection in oil and gas companies?

-How to apply hierarchical analysis process to evaluate suppliers in oil and gas companies?

To answer the question of the research, the following hypotheses have been developed:

-The cost criterion is the most important criterion in the selection and evaluation of suppliers in oil and gas companies.

- oil and gas companies rely on several criteria in evaluating and selecting suppliers.

- The use of the hierarchical analysis process contributes to evaluation and selection of the best supplier in oil and gas companies.

The objective of the study is to develop a proposed model for assessing and selecting suppliers in oil and gas companies, using a multi-criteria decision-making approach.

I.1.literature Review:

Selecting the right supplier can greatly enhance value, cost savings, quality standards. Therefore, the companies should select reliable suppliers, share similar strategic objectives and values that are consistent with the overall strategy of the business.

Numerous criteria for evaluating suppliers can be found in literature and in various publications.

Lima-Junior and Carpinetti (2016) proposed an approach for evaluating performance improvement potentials of suppliers by combining the metrics of the SCOR model with fuzzy TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) approaches. Based on an evaluation in the dimensions cost and delivery performance, suppliers are categorized into four groups that allow deriving directions for action plans to support their continuous improvement.

Furthermore, Dweiri, Kumar, Khan, and Jain (2016)applied an AHP-based decision system in supplier selection in the automotive industry in Pakistan. Suppliers were selected and ranked based on a set of sub-criteria. The results of the ranking showed that the main criteria, in descending order of importance, are price, quality, delivery, and service.

Mohammed Balubaid, Rami Alamoudi (2015) investigated the utility of the AHP for theselectionofcontractors.TheAHPtechniquewasappliedasadecisionsupportmodelwhich enabled clients to recognize the contractors who will provide better satisfied outcomes. The

modelwasputtotestbyutilisingahypotheticalstructurewhichevaluatedsixcriterionsforthe candidatecontractors.Eachcriterionwasevaluatedinrespecttothemainpurposeofselection. For data collection and defining the importance of each criterion. A questionnaire was distributed to experts in the project management field, the criterions were then compared and givenascore,thealternativewiththehighestscoreisconsideredtobethebestcandidate.The model was proved to be effective in selecting the adequate contractor based on other alternatives by implementing the analytical hierarchy process rather than basing the selection process on the lowestbid.

Rezaei et al. (2015) proposed a multi-criteria decision-making model based on the best-worstmethod for segmenting and subsequently selecting suppliers for supplier development. The authors used a supplier potential matrix that considers two key dimension of supplierdevelopment, namely supplier capabilities (measured in terms of technical, quality, delivery,intangible, service, financial, sustainable and organizational dimensions) and supplierwillingness to collaborate (measured by the willingness to improve performance, to shareinformation, to rely on each other and to involve in a long-term relationship), which can both be either low or high. Several strategies to improve in either one or both dimensions, such asimproved commitment and collaboration, raising competitive pressure, improved feedback, orknowledge transfer, were discussed.

Dwarik Puri and Sanjay Tizari (2013) introduced methods that consisted of developing quantitative multi-criteria decision-making models for bidding. The study also involved close association with contractors to acquire the data required for the development of the models.
the Analytical Hierarchy Process (AHP) was used to aid clients in the contractor selection in which the process was able to provide a flexible and computer-based method for contractor selection decision.

Amer Ismail Abdallah Al-Hadid study (2012) entitled "setting criteria for selecting the best supplier within the framework of the outsourcing process", the study aims at reviewing the proposals for the outsourcing strategy and criteria for selecting suppliers. In addition, how-to select the best supplier by using the quantitative multi-criteria methods. The survey sample included Asiacell Wireless Communications Company in Ninawa governorate Iraq. the survey was based on personal interviews and field visits to obtain data. the most prominent results of which were the lack of information in the company's management about the subject of the outsourcing operation and the non-adoption of quantitative multi-criteria decision methods in the selection between suppliers. In addition, the organization relies on three criteria for selecting suppliers (lower cost, financial performance and experience).

Tahriri, F. et al. (2008) state that in today's highly competitive environment, an effective supplier selection process is very important to the success of any manufacturing organization. Supplier selection is a multi-criterion problem which includes both qualitative and quantitative factors (criteria). A trade-off between these tangible and intangible factors is essential in selecting the best supplier. Authors further discussed and compared the advantages and disadvantages of different selection methods concerning supplier selection especially the Analytic Hierarchy Process (AHP).

Min, H. (2008) proposes multiple attribute utility theory which can help purchasing professionals to formulate viable sourcing strategies in the changing worldwide marketplace, particularly for international supplier selection. Authors considered the factors including political situations, tariff barriers, cultural and communication barriers, trade regulations and agreements, currency exchange rates, cultural differences, ethical standards, quality standards and so forth.

Maggie and Tummala (2001) formulated an AHP-based model and applied it to a real case study to examine its feasibility in selecting a vendor for a telecommunications system. The use of the proposed model indicates that it can be applied to improve the group decision making in selecting a vendor that satisfies customer specifications. Also, it is found that the decision process is systematic and that using the proposed AHP model can reduce the time taken to select a vendor.

The current study may have the following contribution compared to previous studies:

This research is different from previous studies, including the application and use of the Analysis Hierarchical process, which is one of the most important inputs of multi-criteria decision-making aimed to develop a proposed model for the selection of suppliers in oil and gas companies operating in industrial zone of arzew.

Previous studies had been diversified in the target sectors, there are studies in the construction, automotive industry, furniture and electrical equipment sectors, while this study relates to an important sector of the oil and gas industry in Algeria.

I.2. Supplier selection:

The Supplier selection is the process by which suppliers are reviewed, evaluated, and chosen to become part of the company's supply chain (Sanayei, Mousavi, & Yazdankhah, 2010, pp. 24-30). The selection process is critical for enhancing the company's competitiveness, and requires the assessment of different alternative suppliers based on different criteria (Cipiran.Cristea & Maria.Critea, 2017, pp. 01-09).

Supplier selection is a strategic issue of any business because of the following reasons (Mukherjee, 2017, p. 38):

1. Procurement is considered as value addition process to supply chain.
2. Active supplier involvement can enhance efficiency and effectiveness of supply chain.
3. Short product life cycle and rapid product innovation give more emphasizes on integration of material and information flows, both internally and externally.

A Supplier selection is considered one of the most important component of production management in many oil and gas companies.

I.3.Supplier selection criteria:

Evaluation and selection of suppliers is a typical multiple criteria-decision making (MCDM) problem involving multiple criteria that can be both qualitative and quantitative. These criteriamay vary depending on the type of product being considered and include many judgmental factors.

Various factors have been used as criteria for supplier selection including performance, price, delivery, reputation in the industry, quality, lead-time and product development.

The supplier selection criteria were developed on the basis of a literature review and a series of discussions with expert team. This discussion with the expert team helped us to classify the various criteria of decision-making into five criteria are most suitable. The five criteria include: Price and Costs, Financial status, Logistics, Supplier quality system, Technical capability. These criteria were then divided into various sub-criteria.

I. 4. Supplier selection process:

Supplier Selection Problem (SSP) consists of analysing and measuring the performance of a set of suppliers in order to rank and select them to improve the competitiveness of the entire supply system. Many conflicting factors should be taken into account in the analysis, both qualitative and quantitative. Several approaches and methodologies have been developed to cope with this problem. However, while the number of proposals is growing, there is little empirical evidence of the practical usefulness of such tools in the supplier selection corporate practice. (De Boer, Labro, & Morlacchi, 2001, pp. 75-89)

Supplier selection process consists of four stages: problem definition, formulation of attributes, qualification of potential suppliers and the final selection of best suppliers.

I.5. Multi-Criteria Decision Making:

The Multi-Criteria Decision-Making is a structured framework for analysing decision problems characterised by complex multiple objectives and criteria. (Guitouni & Martel, 1998, pp. 501-521).

Multi-criteria decision-making models are suitable for assessment and decision-making for the best alternative options in order to select the ideal criteria.

And we can say that Multi-criteria decision-making methods helps to make decisions under a set of criteria and determine an optimal solution for all criteria, which includes a set of variables,

whether quantitative or qualitative variables, where some criteria can be considered for maximization and others for minimization or both.

There are two basic approaches to MCDM problems: Multiple AttributeDecision Making (MADM) and Multiple Objective Decision Making (MODM).The MADM approach requires that the selection be made among decisionalternatives described by their attributes. It assumes that the problem haspredetermined number of decision alternatives. In the MODM approach, itassumes that the decision alternatives are not given. Instead, MODMprovides a mathematical framework for designing a set of decisionalternatives. Once identifying the decision alternatives, each alternative isjudged by how close it satisfies the objective(Malczwski, 1999, p. 81).

I. 6. Multi-Criteria Decision-Making process:

A Multi-Criteria Decision Making (MCDM) process typically defines objectives, chooses the criteria to measure the objectives, specifies alternatives, transforms the criterion scales into commensurable units, assigns weights to the criteria that reflect their relative importanceselectsand applies a mathematical algorithm for ranking and choosing an alternative(Jayanath & Gamini, 2009, pp. 2536-2548), the MCDM process consists of several steps that include:

1. Define multi-criteria problem and objectives explicitly.
2. List and describe alternatives for meeting objectives or goals.
3. Define criteria/attributes/performance indicators to measure performance of alternatives.
4. Carry out studies to gather data and evaluate criteria.
5. Prepare a decision matrix by arranging alternatives against criteria.
6. Elicit criteria subjective or objective weights for criteria.
7. Rank alternatives and communicate results with interest groups.
8. Decision-makers make decisions with input of interest group and get MCDM results.

II– Methods and Materials:

The firstobjective of this research is to identify the main criteria for selecting suppliers which should be taken into account by the oil and gas companies**,** the second objective of this research is using these main criteria and analysis hierarchical process (AHP) with the aim of developing Supplier Selection Model (SSM) to solve the supplier selection problem.

II.1. Population and Sample:

An empirical study was designed to evaluate the supplier selection process. The populations of the study are the oil and gascompanies in the industrial zone of arzew, using a sample of 70 managers at different levels the population included Three (3) companies.

The questionnaire was distributed through the researcher personally and by mail in English & Arabic, after distribution (70) questionnaires of the study sample, a total of (58) answered questionnaires were retrieved (8) were invalid and (50) answered questionnaires were valid for study.

II. 2.Data collection:

Two sources of data collection were used: primary and secondary data.
Primary Data: Data was collected by extensive survey by questionnaire.
Secondary Data: data was collected from different sources such as journals, working papers, researches, thesis, articles, worldwide Web and Algerian Petroleum Companies.

II. 3. Application of Analytic Hierarchy Process (AHP):

The AHP is applied in the questionnaire survey retrieved to set the objectives of the study then to choose the criteria for the particular goal.

The study adopted four alternatives for purpose of pairwise comparisons and trade-off.

The expert selection software was used to calculate criteria priorities and to calculate the local priority of alternatives. After calculating their global priority, the supplier was selected with the highest priority.

AHP uses a mathematical process to handle subjective judgements of an individual or a group in a decision-making process. It consists of four steps: (1) establishing the hierarchy of criteria and alternatives, (2) making pair-wise comparisons of the criteria and estimating the weights of the criteria and the relative performance values of the alternatives with respect to each criterion, (3) aggregating the weights and performance values for alternative priority, (4) checking the consistency of the judgements to verify the result (Lee & Zaili, 2018, pp. 9-11).

Step 1: Establish the hierarchy of criteria and alternatives Hierarchy is the base of AHP. In order to conduct an AHP study, a hierarchy of clear criteria and alternatives need to be constructed. Figure (1) (see Appendices)shows an example of hierarchy with defined criteria and alternatives

Step 2: Make a pair-wise comparison decision matrix (M).

A pair-wise comparison matrix (M) is constructed for all the criteria (Eq. (1)) *a* in the matrix represents a quantified judgement on a pair of criteria (e.g. a12 represents the importance of Criterial 1(C1) over Criterial 2 (C2)). A scale of "1" to "9" is adopted to conduct non-quantitative pair-wise comparisons of two elements. Judgements are given verbally as indicated in Table (1)before corresponding score is allocated.

$$M=\begin{array}{c} \begin{matrix} C_1 & C_2 & C_3 \ldots Ci \ldots. & Cn \end{matrix} \\ \begin{matrix} C_1 \\ C_2 \\ C_3 \\ Cj \\ C_n \end{matrix} \begin{bmatrix} a_{11} & a_{21} & a_{31} \ldots a_{i1} & \ldots a_{n1} \\ a_{12} & a_{22} & a_{32} \ldots a_{i2} & \ldots a_{n2} \\ a_{13} & a_{23} & a_{33} \ldots a_{i3} & \ldots a_{n3} \\ a_{1j} & a_{2j} & a_{3j} \ldots a_{ij} & \ldots a_{nj} \\ a_{1n} & a_{2n} & a_{3n} \ldots a_{in} & \ldots a_{nn} \end{bmatrix} \end{array} \quad (1)$$

Step 3: Normalize the decision matrix and calculate the priorities of this matrix to obtain the weights of criteria w_1, w_2, . . . and w_n.

In order to calculate the weight of each criterion, the comparison matrix has to be normalized. This can be done by summing each set of column values; then each value is divided by its corresponding summed value. The relative weight of the kth criteria is obtained through averaging the values of the kth row in the matrix. This can be presented by using Eq. (2).

$$W_k = \frac{1}{n}\sum_{i=1}^{n} \frac{d_{kj}}{\sum_{i=1}^{n} a_{ij}} \quad , \; k = (1,2,3, \ldots n) \qquad (2)$$

where, aij is the entry of row i and column j in a comparison matrix of order n and w_k is the weight of a specific criterion k in the pair-wise comparison matrix.

Step 4: Check consistency of the judgements to verify the result, in order to derive meaningful weights, a minimal consistency is required and a test must be done. The consistency of the comparisonmatrix is tracked by a Consistency Ratio (CR). CR index in AHP is used in order to maintain consistency in decision making of the responders. CR can be defined as follows:

$$CR = \frac{CI}{RI} \qquad (3)$$

Values for RI are as presented in Table 2.

CI is the consistency index and RI is the random index. CI can be defined as follows:

$$CI = \frac{\lambda_{max} - n}{n-1} \qquad (4)$$

where λ_{max} defined as the maximum eigenvalue can be approximately calculated in Eq (5):

$$\lambda_{max} = \frac{\sum_{j=1}^{n} \frac{\sum_{k=1}^{n} w_k \ a_{ik}}{w_j}}{n} \qquad j = (1,2,3\ldots n),\ k = (1,2,\ldots n) \qquad (5)$$

where w_j and w_k are the weights of criteria obtained in Step 2.

According to Saaty, CR should be equal or less than to 10% to be acceptable. Higher CR value indicates the need of adjustment of the judgements.

The rating for each alternative against each criterion can be obtained by following a similar procedure. The decision alternatives can then be priorities by using the weighted average rating (Saaty T. , 1995, pp. 81-126).

II. 4. Expert Choice Software:

Expert Choice (EC) is software to implement multi-criterion decision making (MCDM) using the weighting-ranking approach, the particular variant implemented is a proprietary, patented one developed by Thomas L. Saaty in the 1970s and called the "Analytic Hierarchy Process" (AHP).

The AHP is a powerful and comprehensive methodology designed to facilitate sound decision making by using both empirical data as well as subjective judgments of the decision-makers

Following are the steps used in AHP and Expert Choice (Barfod, 2014, p. 9):

1. Brainstorm and structure a decision problem as a hierarchical model.
2. Set the type and mode of pair-wise comparisons or data grid functions.
3. Group enable the model.
4. Import data to Expert Choice from external databases.
5. If applicable, pair-wise compare the alternatives for their preference with respect to the objectives, or assess them using one of the following: ratings or step functions, utility curves, or entering priorities directly.
6. Pair-wise compare the objectives and sub-objectives for their importance to the decision.
7. Synthesize to determine the best alternative.
8. Perform sensitivity analysis.
9. Export data to external databases.
10. To perform resource allocations using Expert Choice's 'Resource Aligner' to optimize alternative.
11. projects subject to budgetary and other constraints.

Expert choice can easily support more complex hierarchies containing sub-objectives, scenarios or uncertainties and player. Another variation like the ratings approach can be used to evaluate a large number of alternatives.

III- Results and discussion:

a- structural hierarchy:

The proposed model is used to rank potential suppliers of oil and gas companies in industrial zone of Arzew in Algeria,

This study uses the analytic hierarchy process (AHP) to select best supplier in petroleum companies.

The analytic hierarchy process (AHP) has four stages. The first stage in this study to determine criteria through literature studies, the second stage is an interview with experts, the third

stage conducted a questionnaire to assess the importance of these criteria and sub-criteria selected, the fourth calculate weights and consistency tests using expert choice software to get the final synthesis value and the decision-making hierarchy model.

for selection best supplier, there are five criteria (Price and Costs, Financial status, Logistics, Supplier quality system, Technical capability), each of criteria has several Sub-criteria. The hierarchy is shown in Table (1) (see Appendices).

b- Calculation of the pairwise comparison matrix for main-criteria:

After determining main criteria and sub-criteria, pairwise comparisons were performed systematically to include all the variations of criteria relationships. In order to obtain weight rating of each criteria, the assessment that has been obtained from the respondents of questionnaire was averaged using the Expert choice software. Figure (1) shows theweighting results of the questionnaire for main criteria.

the results analysis of the questionnaire shows the successor failure in oil and gas projects related to the following criteria: Technical capability, price and cost, financial status criterion, logistics and supplier quality system.

In Figure (1)it can be seen that Technical capability criterion is the most important because it has the highest value of (0.459), followed by the price and cost criterion (0.227), financial status criterion with (0.196), logistics criterion (0.073) and supplier quality system criterion with relative weight (0.046).

The results of data analysis have showed that (price and cost, financial status, logistics, supplier quality system and technical capability) are the most important criteria for supplier assessment and selection in oil and gas companies.

These criteria are described as follows:

-Technical capability:

The company select suppliers with high technical capabilities to ensures continuity of the production process, improved supply chain performance and reduced production disruption risk.

The ability of suppliers to acquire new technologies and technical resources for the research and development and applying the process.

-Price and cost:

The supplier ensures the supply of materials, raw materials, commodities at reasonable prices and low costs.

The price and cost including: material cost, shipping cost, supplier management costs and Discount, the right supplier selection could significantly reduce enterprise costs and improve competitiveness

- Financial status:

The objective of the financial appraisal in the supplier selection process is to analyse a supplier’s financial position and determine the level of risk which would threat the company in regard to the contract requirement and value, criticality and the nature of the market.

- Logistics:

Supplier's ability to meet specified delivery schedules that include lead time, on-time performance, fill rate, return management, location and transportation, in addition to meet quality specifications consistently which include quality features (materials, dimensions, design, durability), variety, quality of production (production lines,Machinery manufacturing techniques), quality system, continuous improvement.

-supplier quality system:

The supplier quality system is a set of activities to improve supply chain performance. Such activities include measuring and tracking the cost of supplier quality, using performance based

score cards to measure supplier performance, conducting supplier audits and establishing effective communication with suppliers for aim of achieving customer satisfaction.

Oil and gas companies consider to selecting and assessing suppliers is a strategic objective, where the process of selecting suppliers plays an important role in enhancing the efficiency of the supply chain this relationship is one of the indicators of success or failure of the company as the supplier has a direct influence on the objectives and activities of the oil and gas companies.

c-Calculation of the pairwise comparison matrix for sub-criteria:

After weighting the criteria obtained, the next step is to calculate the pairwise comparison matrix of the sub-criteria as in Table (2) (see Appendices)

In table (2) (see Appendices) for cost and price main-criterion the Discount sub-criterion has the highest relative importance value of (0.13), followed by material cost sub-criterion with a value of (0.05), and shipping cost sub-criterion of (0.03), finally the supplier management costs sub-criterion of relative importance (0.01).

as regards to the main-criterion of financial status, the sub-criterion of assets and capital has the greatest value of (0,13), followed by a financial stability criterion with a value of (0.07).

With regard to the main logistical criterion, the quality sub-criterion was found to have the highest importance value of (0,04), the reliability sub-criterion with a relative importance of (0,2), the flexibility sub-criterion with a value of (0.01), finally the delivery time sub-criterion of relative importance (0.005).

As for the main criterion supplier quality system,the sub-criterion quality of production insurance has a highest relative importance of (0.02) followed by the sub-criteriaInspection an experimentation with a relative importance of (0.01) then sub-criteria staff quality with a relative importance of (0.006) and finally the sub-criteria Management commitment with a value of (0.005).

Finally, for the main criterion of technical capability, the sub-criterion technical cooperationhas greatest relative importance (0.21), followed by the sub-criterion equipment with a value of (0.17), sub-criterion manufacturing (0.06)and finally the sub-criterion organization culture of relative importance (0.02).

d- Calculation of the pairwise comparison matrix for alternatives:

The next step in the pair-wise comparison is comparing each pair of alternatives (suppliers) with respect to each criteria and sub-criteria then comparing the four suppliers.

In the Figure (2) shows the final results of each supplier. As can be seen, supplier A score of (0.345) is greater than the other three suppliers score such as supplier D (0.337), supplier C (0.192) and supplier B (0.126).

The proposed model is used to rank potential suppliers of oil and gas companies in the industrial zone of Arzew in Algeria.

The main objective is the selection suppliers is to ensure that the different requirements of the company are met in accordance with the specifications and conditions suitable for the company, as the selection of the best supplier leads to:

-**Reducing supply risks:** risks leading to supply interruptions or delays, increased supply costs, lower import quality, or non-compliance by the supplier under the terms of the supply contracts.

-**Performance improvement:** The performance of the supplier is directly reflected in the performance of the company, as a result it effects the contributing factor of company growth and achieving its objectives.

e- Consistency Test:

Form equation (1) et (2) a consistency check for the main criteria of Technical capability, price and cost, financial status, logistics and supplier quality system is computed and shown in table (3).

In table (3) the consistency ratio is less than (0.10)which is an acceptable value according to the analytical hierarchy process.

In Figure (3) (see Appendices) the analysis of performance sensitivity to the decision-makers' judgments of oil and gas companies shows as well how alternatives change according to criteria where the horizontal axis of the criteria, the left vertical axis indicate the relative importance of the criteria and the right vertical axis of the total importance of alternatives.

f-Testing the hypotheses of the study:

-**The first hypothesis:** The cost criterion is the most important criterion in the selection and evaluation of suppliers in oil and gas companies.

To test this hypothesis, the relative importance of the main criteria was calculated by a pairwise comparison matrix. the results in Table (2) indicate that the technical capability criterion is greater relative importance with a Consistency Index (CI) (0.045<0.10) which means rejecting the first hypothesis.this means that the technical capability criterion is the most important criterion in the evaluation and selection suppliers of oil and gas companies.

-**The second hypothesis:** oil and gas companies rely on several criteria in evaluating and selecting suppliers.

The results of the analysis of questionnaires data indicate the validity of the hypothesis that oil and gas companies rely on several criteria in the evaluating and selecting of suppliers as described in Table (2) (see Appendices).

-**The third hypothesis:**The use of the hierarchical analysis process contributes to evaluation and selection of the best supplier in oil and gas companies.

The results indicate the validity of the hypothesis, theanalysis hierarchical process provides significant data and information that can be relied upon in achieving the objectives of oil and gas companies in coordination with the objectives of their suppliers and customers.

The decision-making model is chosen to make the appropriate multi-criteria decision making based on the importance weights given to the criteria by the decision-maker and on the basic of the strategy adopted because the role of the model is enabling the decision maker to analyse, determine criteria, calculate the relative importance and arrange suppliers in short time the choose the best supplier.

IV-Conclusion:

The aim of this study is to select the best supplier by evaluating the structural performance of four different potential suppliers using analytic hierarchical process (AHP) which is a multi-criterion decision-making tool.

A decision model could assist oil and gas companies to select the most appropriate supplier according to the specific of their supply chain. in this study, five criteria were defined to evaluate four potential suppliers.

In this model, the supplier is evaluated on the basic of a number of main criteria and sub-criteria, a total of (5) main criteria and (18) sub-criteria for evaluating and selecting supplier.

The main contribution of the work was the identification of the important criteria for supplier selection process.

After comparing the alternatives (suppliers) with respect to each criteria and sub-criteria then analysing the preference values using the "expert choice" software, the following results were obtained from the following Table (2) (see Appendices) shows the final results and ranking of each supplier. As can be seen, supplier (A) has the highest performance with a valueof (0.345), Supplier (D) in the second order with a value of (0.337), Followed by supplier (C) with a performance value of (0.193), and supplier (B) with the performance value of (0.126), we have reached the following results:

-Determine criteria for the selection and evaluation of suppliers in oil and gas companies, which are cost and price, flexibility, technical capability, financial status,logistics and supplier quality system.
-Calculating the relative importance of main criteria: Technical capability criterion (0.459), then followed by the price and cost criterion (0.227), financial status criterion (0.196), logistics criterion (0.073) and supplier quality system (0.046).
-The main criterion which had the highest relative importance was Technical Capability used for selection and evaluation suppliers in oil and gas companies, the criterion Technical Capability received a relative importance (45.9%).
-The analytic hierarchical process enables decision makers to organize their alternatives and identify the best supplier in short time and in high precision.

In the light of the findings of this study, the following is recommended:

- Expand the application of multi-criteria decision making in oil and gas companies to develop the decision-making process and make the right decision to address problems and achieve performance efficiency.
-A particular attention should be paid to staff training in the use of quantitative methods of decision-making in order to improve the quality and efficiency of the decision.
-The need to focus on many criteria that can be adopted in the selection and evaluation of suppliers and not just focus on cost.

- Appendices:

Table (1): judgement scores in AHP

scores	Judgment	Explanation
1	Equally	Two activities contribute equally to the objective.
3	Moderately	Experience and judgment slightly favor one activity over another.
5	Strongly	Experience and judgment strongly favor one activity over another.
7	Very Strongly	An activity is strongly favoured and its dominance demonstrated in practice.
9	Extremely	The evidence favouring one activity over another is of the highest possible order of affirmation.
2,4,6,8	Intermediate values between two adjacent judgments	When compromise is needed.

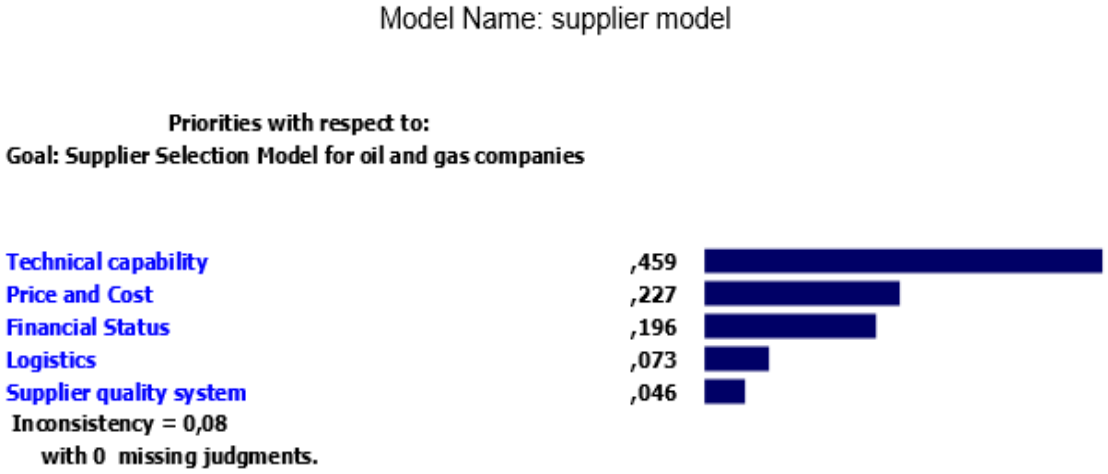
The source: Saaty, T.L. (1980) The Analytic Hierarchy Process. McGraw-Hill, New York.

Table (2): Randomly Generated Consistency Index for different size of matrix

Size	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

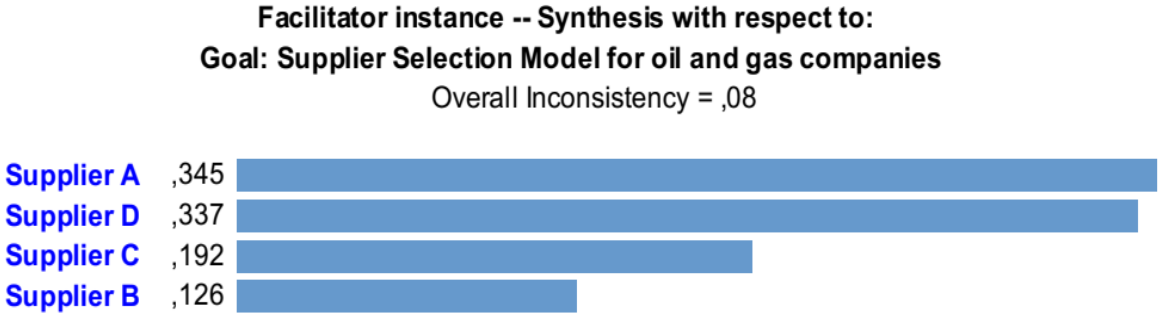
The source: Saaty, T.L. (1980) The Analytic Hierarchy Process. McGraw-Hill, New York.

Figure (1): Ranking of main-criteria



The source: Expert Choice software data processing result

Figure (2): Supplier's ranking



The source: Expert Choice software data processing results

Table (3): Weights the sub-criteria for supplier selection

Main criteria	λ_{max}	CI	CR	Decision
Technical capability	4.135	0.045	0.05	consistent
price and cost	4.135	0.080	0.09	consistent
financial status	4	0	0	consistent
logistics	4.243	0.081	0.09	consistent
supplier quality system	4.216	0.072	0.08	consistent

The source:Prepared by authors based on the results of the expert choice software

Table (1): main criteria and sub-criteria for supplier selection

Number	Criteria	Number	Sub-criteria
1	Price and Costs (P)	1.1	Material cost
		1.2	Shipping cost
		1.3	Supplier management costs
		1.4	Discount
2	Financial status (F)	2.1	Assets and capital
		2.2	Financial Stability
3	Logistics (L)	3.1	Flexibility
		3.2	Reliability
		3.3	Delivery time
		3.4	Quality
4	Supplier quality system (S)	4.1	Management commitment
		4.2	Quality assurance in production
		4.3	Inspection an experimentation
		4.4	Quality staff
5	Technical capability (T)	5.1	Technical cooperation
		5.2	Equipment
		5.3	Manufacturing
		5.4	Organisation culture

The source: Prepared by researchers from the literature Revie

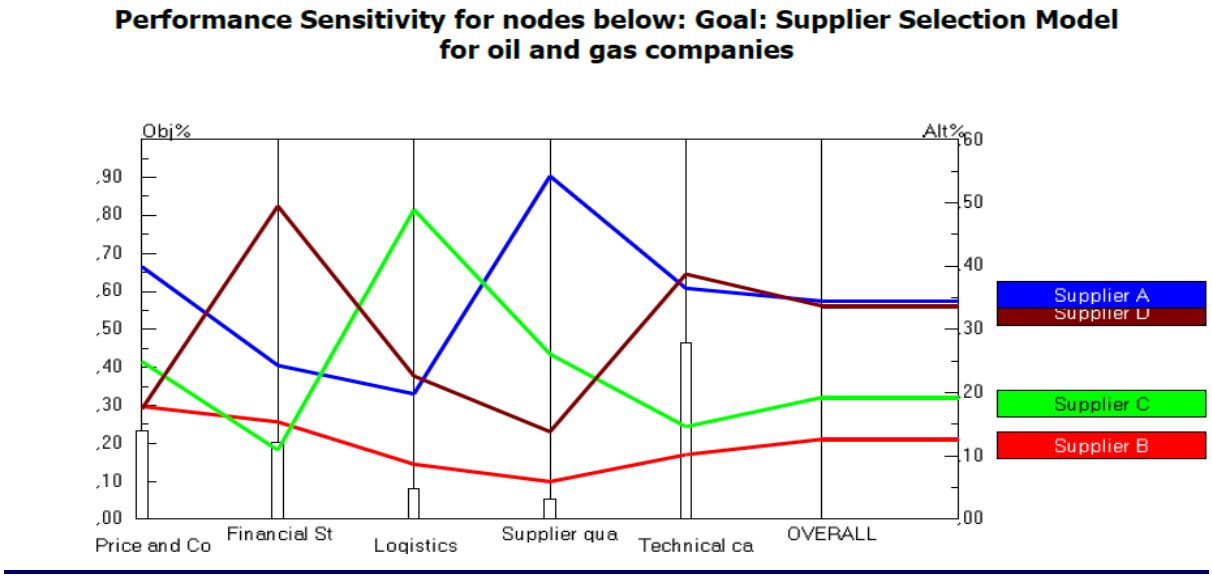
Table (2): The results of comparisons of suppliers with respect the sub-criteria

main criteria	**Weights**	**Sub-Criteria**	**Weights**	**Weights**			
				Supplier A	Supplier B	Supplier C	Supplier D
Price and Costs	0,227	Material cost	0,05	0,007	0,002	0,008	0,001
		Shipping cost	0,03	0,018	0,002	0,003	0,009
		Discount	0,13	0,024	0,029	0,049	0,036
		Supplier management costs	0,01	0,0025	0,003	0,002	0,006
Financial status	0,196	Assets and capital	0,13	0,0314	0,021	0,025	0,051
		Financial Stability	0,07	0,0372	0,004	0,007	0,018
Logistics	0,073	Flexibility	0,01	0,003	0,001	0,002	0,004
		Reliability	0,02	0,012	0,001	0,002	0,006
		Delivery time	0,005	0,001	0,001	0,001	0,002
		Quality	0,04	0,011	0,007	0,009	0,014
Supplier quality system	0,046	Management commitment	0,005	0,001	0,001	0,001	0,002
		Quality assurance in production	0,02	0,013	0,001	0,002	0,006

		Inspection an experimentation	0,01	0,002	0,003	0,002	0,005
		Quality staff	0,006	0,001	0,001	0,002	0,001
Technical capability	0,459	Technical cooperation	0,21	0,070	0,021	0,041	0,082
		Equipment	0,17	0,097	0,010	0,017	0,049
		Manufacturing	0,06	0,011	0,014	0,012	0,032
		Organisation culture	0,02	0,004	0,004	0,007	0,005
			1,00	**0,345**	**0,126**	**0,193**	**0,337**

The source: Expert Choice software data processing result

Figure (3): Performance sensitivity



The source: Expert Choice software data processing results

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