Selecting a Technical Service Provider Using the Analytic Hierarchy Process

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ABSTRACT

The selection of a suitable technical service provider in the oil and gas industry can be a lengthy process. To expedite the procurement process, the analytic hierarchy process (AHP) method is proposed as a means of identifying the best technical service provider to develop a field development plan (FDP) for Field X. In the analysis of technical service providers using the AHP model, the Technical Capability and Project Deliverability criteria received the highest overall weights of 0.270 and 0.244, respectively, while the Reliability of the Company and Technology Transfer criteria had lower weights of 0.067 and 0.069, respectively. The Cost criterion had the third highest weight, and the Track Record of Performance criterion the fourth highest in terms of importance: their weights were 0.188 and 0.162, respectively. Provider 5 and Provider 1 had the highest and the second highest overall weights, which were 0.2895 and 0.2546 respectively, while Provider 2 had the lowest overall weight, 0.1246. Based on the use of the AHP method, Provider 5 was selected as the provider to conduct the work of developing an FDP for Field X.

Key Words: analytic hierarchy process, goal, criteria, alternative, field development plan

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1. INTRODUCTION

Oil prices are at a high level and are expected to remain so over the next few years. In fact, oil prices have increased steadily from early 2005 to the present time. Although world economic growth has slowed during the last few years, the price of oil has been hovering around $100 U.S. per barrel for the last several months. With an economic recovery expected in the coming years, the price of oil may range between $90 and $110 U.S. per barrel. After hitting a peak around 1996, oil production declined and has continued to decline up to the present time. Production performance, as a source of revenue to a company, has fallen in most of the major oilfields, and routine optimization has not been able to stop the decline in production. Given the current situation, the government is asking oil companies to look for ways to boost production as high as possible to fill the gap. If no major study is undertaken to comprehensively assess the potential of Field X (a specific field in the area of oil and gas exploration) and recommend alternative optimization methods, production will continue to decline, and Field X faces abandonment sometime in the coming years. This means that the company will not achieve its objective of increasing oil production, and its overall performance will decline (Riyadi, 2010). A comprehensive study to evaluate Field X is therefore a must.

The potential of the field is there, as current recovery is about 34% (Riyadi, 2010) and more oil can be recovered. A number of optimization works using primary recovery methods have already been conducted, and the next step is to go beyond the use of primary recovery methods. This requires the involvement of a number of specialists, such as geologists, geophysicists, petrophysicists, geomodellers, reservoir simulation engineers with an EOR (enhanced oil recovery) background, production technologists, drilling engineers, completion engineers, facility engineers, and project economists. The next questions are how to gather these personnel, and is there any in house expertise available to do the work within the committed time frame?

From a current assessment at the corporate level, existing staff do not have the requisite expertise. Some recruitment processes have been conducted, but suitable candidates could not be found. Given the situation, the company's managing director has decided to outsource the work pertaining to Field X to a technical service provider. The company must therefore develop a process for identifying and selecting a qualified and suitable technical service provider capable of undertaking and completing the work.

2. METHODOLOGY

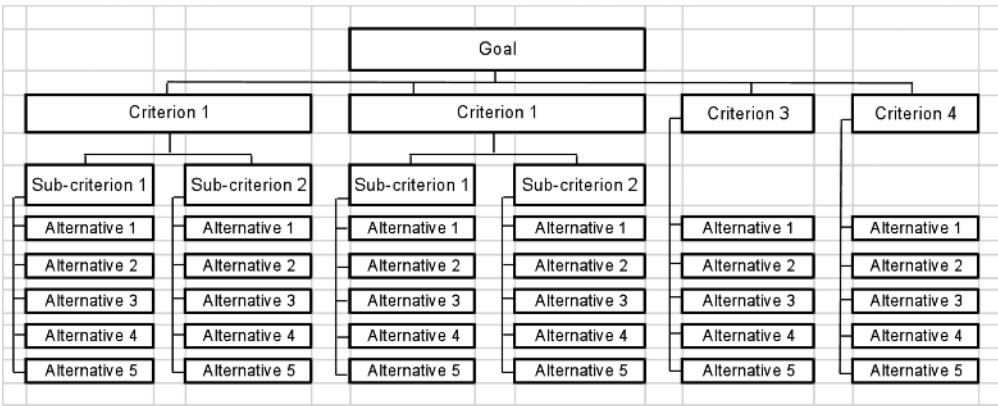
2.1 Analytic Hierarchy Process (AHP) Method

The selection of the technical service provider was done using the analytic hierarchy process (AHP). This method has been applied in many other areas, such as accounting, conflict analysis, energy, finance, healthcare, marketing, portfolio management, R & D management, risk analysis, technology, and so on (Zahedi, 1986; Vaidya and Kumar, 2006; Sipahi and Timor, 2010).

The AHP method structures a multi-criteria decision making (MCDM) problem by developing a decision hierarchy that presents the relationships between the goal, the criteria, the sub-criteria (if any), and the alternatives. Using the AHP method, the following steps were used to select the technical service provider: (1) the goal or objective of the problem was defined; (2) the criteria used to select a technical service provider were defined; (3) alternatives were identified; (4) surveys were conducted using a questionnaire developed for the process, and a conclusion was reached after analysing the results of the survey.

Figure 1 shows the general structure of a decision hierarchy involving four major criteria and five alternatives. Criteria 1 and 2 each have two sub-criteria, while criteria 3 and 4 do not have any sub-criteria.

Figure 1: General structure of a decision hierarchy involving four major criteria and five alternatives



According to Islam (2003), there are four steps to solving an MCDM problem using the AHP method:

Step 1: Decompose the problem at hand and find out the salient factors and elements (criteria, sub-criteria and alternatives) of the problem. Then, construct the linear hierarchy of the problem (see Figure 1).

Step 2: Construct pairwise comparison matrices for all the criteria, sub-criteria (if any), and alternatives.

Step 3: Determine the weights of the criteria, sub-criteria (if any) and alternatives from the pairwise comparison matrices obtained in Step 2 using a suitable weight determination technique.

Step 4: Synthesize all the local sets of weights computed in Step 3 and obtain a set of overall weights for the alternatives.

2.2 Goal and Criteria

As stated previously, the goal of the present work is to select the best technical service provider to produce a field development plan for Field X. The field development plan needs to be completed in 24 months. The FDP's scope of work includes updating the static and dynamic models, conducting enhanced oil recovery (EOR) screening, predicting the performance of EOR alternatives, etc. After defining the goal, the criteria were defined. The following six main criteria were identified for the present work: Project Deliverability (PD), Technical Capability (TC), Reliability of the Company (RB), Track Record of Performance (TRP), Cost (CT), and Technology Transfer (TT).

2.3 Alternatives

The alternatives[1] consisted of the prospective technical service providers, including local, regional, and worldwide players. Five possible service providers are shown in the following table.

No.	Provider Code	Definition
1	Provider 01	International major technical secvice provider
2	Provider 02	Regional technical service provider
3	Provider 03	Regional technical service provider
4	Provider 04	International major technical service provider
5	Provider 05	International technical service provider

2.4 Survey

A survey of the technical service providers was conducted through a questionnaire sent to fifteen high ranking technical officials within the company. The questionnaire consisted of three parts:

Part A – Demographic information.

Part B – Respondents' opinions on the relative importance of the six criteria.

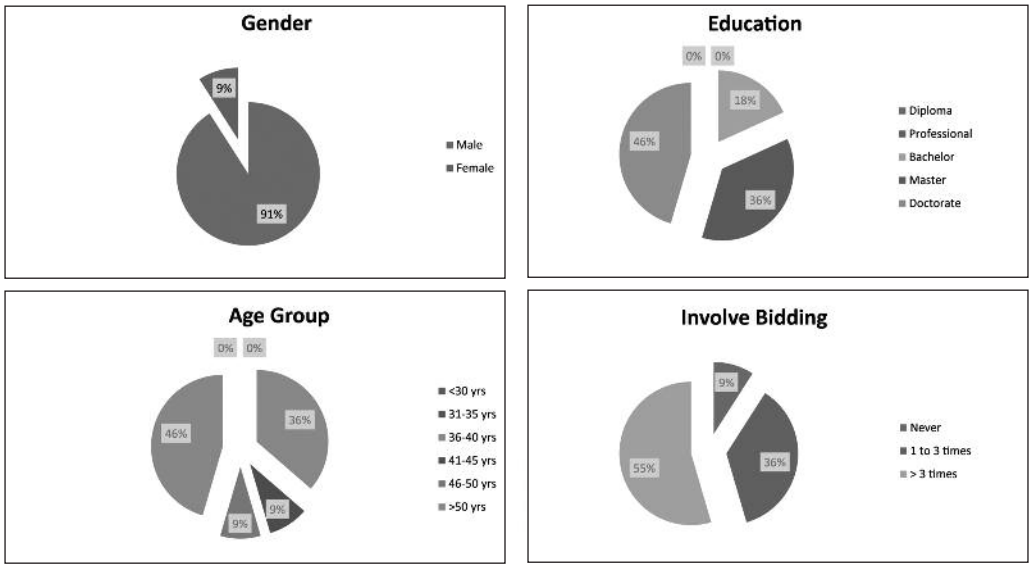
Part C – Respondents' evaluations of the five service providers in a pairwise fashion.

2.5 Survey results

Although 15 questionnaires were sent to selected high ranking technical officials within the company, only 11 completed questionnaires were returned. The demography of the respondents can be seen in Figure 2. In terms of gender, only one respondent was female, while the rest were male.

[1] *In this paper, one and two-digit numbering of providers (e.g., Provider 1 and Provider 01) are used interchangeably.*

Figure 2: Demography of the respondents

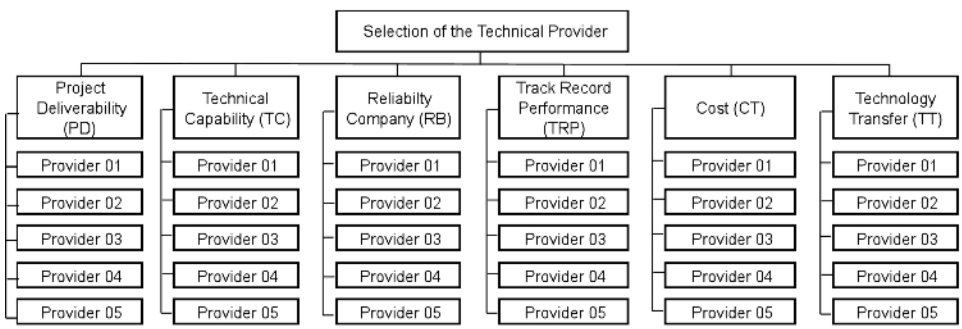


With regard to educational background, a majority of respondents had a doctorate (46%), followed by a master's degree (36%). With respect to age, most respondents were older (above 50) very experienced geoscientists (46%), followed by experienced geoscientists between 36 and 40 years of age (36%). Age group was important, as it had a correlation with the respondents' involvement in bidding exercises: a majority of the respondents (55%) had prior experience in technical bidding activities, having been involved more than three times, while 36% of respondents had been involved in technical bidding activities from one to three times.

3. APPLYING THE AHP

Figure 3 shows the hierarchy of the technical service provider selection problem:

Figure 3: Hierarchy of the technical service provider selection



The next step in applying the AHP was to determine the weight of each criterion. The weights of the criteria were compared using Saaty's pairwise comparison method. To apply pairwise comparison method, a pairwise comparison matrix (PCM) using Saaty's (1/9, 9) ratio scale was constructed for all the criteria. Table 1 shows the interpretation of this scale (Saaty and Vargas, 1982; Saaty, 2008).

Table 1: Saaty's (1/9, 9) ratio scale

Verbal judgment of importance	Numerical rating
Equal importance	1
Equal to moderate importance	2
Moderate importance	3
Moderate to strong importance	4
Strong importance	5
Strong to very strong importance	6
Very strong importance	7
Very strong to extremely strong importance	8
Extreme importance	9

The general form of a PCM is as follows:

	C1	C2	C3	..	Cn
C1	W1/W1	W1/W2	W1/W3	..	W1/Wn
C2	W2/W1	W2/W2	W2/W3	..	W2/Wn
C3	W3/W1	W3/W2	W3/W3		W3/Wn
..	..	..	..	..	..
Cn	Wn/W1	Wn/W2	Wn/W3	..	Wn/Wn

where w1, w2, w3, …, wn are the numerical weights of the criteria C1, C2, C3, …, Cn respectively. According to the interpretation of the (1/9, 9) ratio scale, if the criterion C1 in the above table (for example) is moderate in importance to C2, then w1/w2 = 3. If C1 is strong in importance compared to C3, then w1/w3 = 5. By combining the weight of each criterion with respect to other criteria using Saaty's (1/9, 9) ratio scale, the above table could be filled for each wi/wj where i, j = 1, 2, 3….n.

Verbal judgments pertaining to the importance of the technical service provider selection criteria are provided below:

1). Project deliverability
- => equal to moderate important to technical capability (2)
- => strong important to reliability company (5)
- => moderate to strong to track record performance (4)
- => moderate important to cost (3)
- => strong to very strong important to technology transfer (6)

2). Technical capability
- => strong important to relaibility company (5)
- => moderate to strong important to track record performance (4)
- => moderate important to cost (3)
- => strong to very strong important to relaibility company (6)

3). Reliability company
- => equal to moderate less important to track record performance (1/2)
- => moderate less important to cost (1/3)
- => equal to moderate important to technical technology transfer (2)

4). Track record performance
- => equal to moderate less important to cost (1/2)
- => equal to moderate important to technology transfer (2)

5). Cost
- => moderate to strong important to technology transfer (4)

There are three steps to computing the weight of each criterion using this procedure (Anderson, et al., 2011): (a) sum the values in each column of the PCM; (b) divide each element in the matrix by its column total (this is referred to as the normalized PCM); and (c) compute the average of the elements in each row of the normalized matrix to get the weight of each criteria. Table 2 shows an example of the computation of weights using the row-column normalization procedure for the questionnaire of Respondent #5.

Table 2: Computation of criteria weights using the row-column normalization procedure (for Respondent #5)

	Step a						Step b						Step c
	PD	TC	RB	TRP	CT	TT	PD	TC	RB	TRP	CT	TT	Weight
PD	1.000	0.500	3.000	2.000	2.000	3.000	0.214	0.167	0.176	0.261	0.324	0.209	0.225
TC	2.000	1.000	4.000	2.000	2.000	4.000	0.429	0.333	0.235	0.261	0.324	0.279	0.310
RB	0.333	0.250	1.000	0.333	0.333	0.333	0.071	0.083	0.059	0.043	0.054	0.023	0.056
TRP	0.500	0.500	3.000	1.000	0.500	3.000	0.107	0.167	0.176	0.130	0.081	0.209	0.145
CT	0.500	0.500	3.000	2.000	1.000	3.000	0.107	0.167	0.176	0.261	0.162	0.209	0.180
TT	0.333	0.250	3.000	0.333	0.333	1.000	0.071	0.083	0.176	0.043	0.054	0.070	0.083
	4.667	3.000	17.001	7.667	6.167	14.333	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Legend: PD= Project deliverability, TC= Technical capability, RB= Reliability company, TRP= Track record company, CT= Cost, TT= Technology transfer

3.1 Measuring consistency in decision making judgments

To ensure that the judgments were consistent, the consistency of the responses was measured. There are several steps to calculating the consistency index.

Step a: Multiply the first column of the PCM by the weight of the first criterion. Next, multiply the second column by the weight of the second criterion, and so on. Add the elements across the rows. This gives a weighted sum vector.

Step b: Divide each element of the weighted sum vector by the weights of the criteria. That is, the first element should be divided by the weight of the first criterion, the second element should be divided by the weight of the second criterion, and so on. This division provides the consistency vector.

Step c: Calculate the average of the elements of the consistency vector, which is called "lambda". Lambda is denoted by the symbol λ. In the present case, λ = 6.31.

Cirteria	Step a	Step b
PD	1.45	6.43
TC	1.97	6.34
RB	0.34	6.18
TRP	0.92	6.33
CT	1.16	6.40
TT	0.51	6.16

Step d: Calculate the consistency index (CI) using the following formula:

$$CI = (\lambda - n)/(n-1)$$

$$CI = (6.31-6)/(6-1) = 0.0615$$

The CI provides a measure of departure from consistency. When CI = 0 (meaning that λ = n), the PCM is perfectly consistent and there is no inconsistency in it.

Step e: Calculate the consistency ratio (CR). This is the actual measure of consistency. It is defined as follows:

CR = CI/RI, where RI is the Random Index.

The RI value is taken from a standard table for various sizes of the PCM. The size of PCM in this case is 6, so the RI is equal to 1.24. Therefore, CR can be calculated and is equal to 0.05. The CR is used to determine the extent to which the elements in the PCM are randomly arranged. If the CR value is less than 0.10, the amount of inconsistency present in the PCM is acceptable. In the present case, the CR is less than 0.10 so the amount of inconsistency is acceptable.

The next step is to construct the PCMs for the alternatives with respect to each criterion. Similar to the process encoded in Table 2, the weights for the alternatives with respect to each criterion were computed using the row-column normalization procedure. All the PCMs were dealt with independently. The detailed computations for Respondent #5 can be found in Table 3a).

Table 3a: Computation of weights for the alternatives with respect to each criterion using the row-column normalization procedure (for Respondent #5)

PD-Project delivery

TC	P-1	P-2	P-3	P-4	P-5	P-1	P-2	P-3	P-4	P-5	Weight
Provider 1	1.000	4.000	3.000	1.000	1.000	0.279	0.400	0.353	0.182	0.250	0.293
Provider 2	0.250	1.000	0.500	1.000	0.500	0.070	0.100	0.059	0.182	0.125	0.107
Provider 3	0.333	2.000	1.000	0.500	1.000	0.093	0.200	0.118	0.091	0.250	0.150
Provider 4	1.000	1.000	2.000	1.000	0.500	0.279	0.100	0.235	0.182	0.125	0.184
Provider 5	1.000	2.000	2.000	2.000	1.000	0.279	0.200	0.235	0.364	0.250	0.266
	3.583	10.000	6.500	5.500	4.000	1.000	1.000	1.000	1.000	1.000	1.000

P-1: Provider 1, P-2: Provider 2, etc.

TC-Technical capability

TC	P-1	P-2	P-3	P-4	P-5	P-1	P-2	P-3	P-4	P-5	Weight
Provider 1	1.000	4.100	3.000	2.000	1.000	0.324	0.308	0.400	0.308	0.324	0.333
Provider 2	0.250	1.000	0.500	0.500	0.250	0.081	0.077	0.067	0.077	0.081	0.077
Provider 3	0.333	2.000	1.000	1.000	0.333	0.108	0.154	0.133	0.154	0.108	0.131
Provider 4	0.500	2.000	1.000	1.000	0.500	0.162	0.154	0.133	0.154	0.162	0.153
Provider 5	1.000	4.000	2.000	2.000	1.000	0.324	0.308	0.267	0.308	0.324	0.306
	3.083	13.000	7.500	6.500	3.083	1.000	1.000	1.000	1.000	1.000	1.000

RB-Reliability

RB	P-1	P-2	P-3	P-4	P-5	P-1	P-2	P-3	P-4	P-5	Weight
Provider 1	1.000	3.000	3.000	1.000	2.000	0.316	0.333	0.375	0.250	0.400	0.335
Provider 2	0.333	1.000	1.000	0.500	0.500	0.105	0.111	0.125	0.125	0.100	0.113
Provider 3	0.333	1.000	1.000	0.500	0.500	0.105	0.111	0.125	0.125	0.100	0.113
Provider 4	1.000	2.000	2.000	1.000	1.000	0.316	0.222	0.250	0.250	0.200	0.248
Provider 5	0.500	2.000	1.000	1.000	1.000	0.158	0.222	0.125	0.250	0.200	0.191
	3.167	9.000	8.000	4.000	5.000	1.000	1.000	1.000	1.000	1.000	1.000

TRP- Track record performance

TRP	P-1	P-2	P-3	P-4	P-5	P-1	P-2	P-3	P-4	P-5	Weight
Provider 1	1.000	4.000	2.000	2.000	1.000	0.308	0.286	0.267	0.343	0.324	0.305
Provider 2	0.250	1.000	0.500	0.333	0.250	0.077	0.071	0.067	0.057	0.081	0.071
Provider 3	0.500	2.000	1.000	0.500	0.333	0.154	0.143	0.133	0.086	0.108	0.125
Provider 4	0.500	3.000	2.000	1.000	0.500	0.154	0.214	0.267	0.171	0.162	0.194
Provider 5	1.000	4.000	2.000	2.000	1.000	0.308	0.286	0.267	0.343	0.324	0.305
	3.250	14.000	7.500	5.833	3.083	1.000	1.000	1.000	1.000	1.000	1.000

CT-Cost

CT	P-1	P-2	P-3	P-4	P-5	P-1	P-2	P-3	P-4	P-5	Weight
Provider 1	1.000	0.500	0.500	1.000	1.000	0.143	0.143	0.125	0.143	0.125	0.136
Provider 2	2.000	1.000	1.000	2.000	2.000	0.286	0.286	0.250	0.286	0.250	0.271
Provider 3	2.000	1.000	1.000	2.000	3.000	0.286	0.286	0.250	0.286	0.375	0.296
Provider 4	1.000	0.500	0.500	1.000	1.000	0.143	0.143	0.125	0.143	0.125	0.136
Provider 5	1.000	0.500	1.000	1.000	1.000	0.143	0.143	0.250	0.143	0.125	0.161
	7.000	3.500	4.000	7.000	8.000	1.000	1.000	1.000	1.000	1.000	1.000

TT-Technology transfer

TT	P-1	P-2	P-3	P-4	P-5	P-1	P-2	P-3	P-4	P-5	Weight
Provider 1	1.000	0.333	0.333	1.000	0.500	0.100	0.100	0.087	0.143	0.077	0.101
Provider 2	3.000	1.000	1.000	2.000	2.000	0.300	0.300	0.261	0.286	0.308	0.291
Provider 3	3.000	1.000	1.000	2.000	2.000	0.300	0.300	0.261	0.286	0.308	0.291
Provider 4	1.000	0.500	0.500	1.000	1.000	0.100	0.150	0.130	0.143	0.154	0.135
Provider 5	2.000	0.500	1.000	1.000	1.000	0.200	0.150	0.261	0.143	0.154	0.182
	10.000	3.333	3.833	7.000	6.500	1.000	1.000	1.000	1.000	1.000	1.000

Table 3b: Synthesis of the local set of weights for Respondent #5

Criteria / Provider	PD	TC	RB	TRP	CT	TT	Overall Weights
	0.225	0.310	0.056	0.145	0.180	0.083	
Provider 1	0.293	0.333	0.335	0.305	0.136	0.101	0.265
Provider 2	0.107	0.077	0.113	0.071	0.271	0.291	0.138
Provider 3	0.150	0.131	0.113	0.125	0.296	0.291	0.177
Provider 4	0.184	0.153	0.248	0.194	0.136	0.135	0.167
Provider 5	0.266	0.306	0.191	0.305	0.161	0.182	0.254
	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 3b shows the synthesized results used to obtain the global (overall) weights for Respondent #5. The overall weight of each provider was calculated using the following formula:

$$W j = i = 1 n p i \; q i j$$

where p_i, i=1,2,3…,n are the weights of the criteria and q_{ij}, j=1,2,3….,m are the weights of the alternatives 'j' with respect to criterion 'i'. By applying this formula, the global (overall) weight of each alternative was calculated. From Table 3b, the overall weights for Provider 1, Provider 2, Provider 3, Provider 4, and Provider 5 were 0.265, 0.138, 0.177, 0.167, and 0.254, respectively. Therefore, Provider 5 had the highest overall weight among all providers. Note that this decision is based on the data provided by only one respondent.

Next, an average value was developed for each element of a PCM, for both the criteria and the alternatives. The average method used was the geometric mean (geometric average). The geometric mean of a data set $\{a_1, a_2, \ldots, a_n\}$ is obtained using the following formula:

$$\left(\prod_{i=1}^{n} a_i\right)^{1/n} = \sqrt[n]{a_1 a_2 \cdots a_n}.$$

where **a** is the value for each element and **n** is the total number of respondents.

Table 4: Geometric mean of the PCM for the criteria

	PD	TC	RB	TRP	CT	TT	PD	TC	RB	TRP	CT	TT	Weight
PD	1.000	0.906	3.257	1.739	1.426	3.120	0.250	0.249	0.224	0.273	0.254	0.213	0.244
TC	1.104	1.000	3.394	1.739	1.641	4.000	0.275	0.275	0.233	0.273	0.293	0.273	0.270
RB	0.307	0.295	1.000	0.403	0.307	0.855	0.077	0.081	0.069	0.063	0.055	0.058	0.067
TRP	0.575	0.575	2.479	1.000	0.906	2.627	0.144	0.158	0.170	0.157	0.162	0.179	0.162
CT	0.701	0.610	3.257	1.104	1.000	3.045	0.175	0.168	0.224	0.173	0.178	0.208	0.188
TT	0.320	0.250	1.170	0.381	0.328	1.000	0.080	0.069	0.080	0.060	0.059	0.068	0.069
Sum	4.008	3.635	14.557	6.365	5.608	14.648	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Legend: PD= Project deliverability, TC= Technical capability, RB= Reliability company, TRP= Track record company, CT= Cost, TT= Technology transfer

Table 4 shows the average PCM for all the criteria using the geometric mean. The Technical Capability and Project Deliverability criteria had the highest and second

highest overall weight, while the Reliability of the Company criterion had the lowest overall weight. The weights of the alternatives were then calculated for each criterion. Following a similar approach to that used to develop Table 4, each element was calculated using the geometric mean. Table 5a shows the results for the alternatives with respect to each criterion. With respect to Project Deliverability, Provider 5 and Provider 4 had the highest and the second highest weights of 0.329 and 0.291 respectively. Similarly, with respect to the Technical Capability criterion, the same providers had the highest and second highest weights, with values of 0.359 and 0.259, respectively.

Table 5a: Average PCM for the alternatives

PD-Project delivery

PD	Provider 1	Provider 2	Provider 3	Provider 4	Provider 5	Provider 1	Provider 2	Provider 3	Provider 4	Provider 5	Weight
Provider 1	1.000	3.617	2.521	1.811	0.743	0.280	0.312	0.337	0.280	0.245	0.291
Provider 2	0.276	1.000	0.610	0.505	0.300	0.077	0.086	0.081	0.078	0.099	0.084
Provider 3	0.397	1.641	1.000	0.906	0.543	0.111	0.142	0.134	0.140	0.179	0.141
Provider 4	0.552	1.982	1.104	1.000	0.445	0.155	0.171	0.148	0.155	0.147	0.155
Provider 5	1.346	3.337	2.246	2.246	1.000	0.377	0.288	0.300	0.347	0.330	0.329
	3.571	11.577	7.481	6.467	3.031	1.000	1.000	1.000	1.000	1.000	1.000

TC-Technical capability

TC	Provider 1	Provider 2	Provider 3	Provider 4	Provider 5	Provider 1	Provider 2	Provider 3	Provider 4	Provider 5	Weight
Provider 1	1.000	2.784	2.380	1.486	0.635	0.248	0.260	0.316	0.234	0.235	0.259
Provider 2	0.359	1.000	0.673	0.575	0.271	0.089	0.094	0.089	0.091	0.100	0.093
Provider 3	0.420	1.486	1.000	0.906	0.381	0.104	0.139	0.133	0.143	0.141	0.132
Provider 4	0.673	1.739	1.104	1.000	0.420	0.167	0.163	0.147	0.158	0.155	0.158
Provider 5	1.575	3.684	2.380	2.380	1.000	0.391	0.345	0.316	0.375	0.369	0.359
	4.027	10.693	7.536	6.346	2.707	1.000	1.000	1.000	1.000	1.000	1.000

RB- Reliability company

RB	Provider 1	Provider 2	Provider 3	Provider 4	Provider 5	Provider 1	Provider 2	Provider 3	Provider 4	Provider 5	Weight
Provider 1	1.000	2.950	2.784	1.219	1.739	0.323	0.336	0.323	0.300	0.346	0.326
Provider 2	0.339	1.000	0.906	0.552	0.521	0.110	0.114	0.105	0.136	0.104	0.114
Provider 3	0.359	1.104	1.000	0.472	0.552	0.116	0.126	0.116	0.116	0.110	0.117
Provider 4	0.820	1.811	2.119	1.000	1.219	0.265	0.206	0.246	0.246	0.242	0.241
Provider 5	0.575	1.920	1.811	0.820	1.000	0.186	0.219	0.210	0.202	0.199	0.203
	3.094	8.785	8.620	4.063	5.030	1.000	1.000	1.000	1.000	1.000	1.000

TRP- Track record performance

TRP	Provider 1	Provider 2	Provider 3	Provider 4	Provider 5	Provider 1	Provider 2	Provider 3	Provider 4	Provider 5	Weight
Provider 1	1.000	3.927	2.119	1.811	1.104	0.314	0.312	0.312	0.298	0.325	0.312
Provider 2	0.255	1.000	0.465	0.445	0.305	0.080	0.079	0.068	0.073	0.090	0.078
Provider 3	0.472	2.151	1.000	0.820	0.492	0.148	0.171	0.147	0.135	0.145	0.149
Provider 4	0.552	2.246	1.219	1.000	0.500	0.173	0.178	0.179	0.165	0.147	0.168
Provider 5	0.906	3.281	2.000	2.000	1.000	0.284	0.260	0.294	0.329	0.294	0.292
	3.184	12.605	6.803	6.077	3.401	1.000	1.000	1.000	1.000	1.000	1.000

CT- Cost

CT	Provider 1	Provider 2	Provider 3	Provider 4	Provider 5	Provider 1	Provider 2	Provider 3	Provider 4	Provider 5	Weight
Provider 1	1.000	0.743	0.701	1.104	1.104	0.179	0.161	0.166	0.201	0.202	0.182
Provider 2	1.346	1.000	0.906	1.104	1.170	0.241	0.217	0.214	0.201	0.214	0.217
Provider 3	1.426	1.104	1.000	1.170	1.292	0.255	0.240	0.236	0.213	0.236	0.236
Provider 4	0.906	0.906	0.855	1.000	0.906	0.162	0.197	0.202	0.182	0.166	0.182
Provider 5	0.906	0.855	0.774	1.104	1.000	0.162	0.186	0.183	0.201	0.183	0.183
	5.584	4.608	4.236	5.482	5.471	1.000	1.000	1.000	1.000	1.000	1.000

TT- Technology transfer

TT	Provider 1	Provider 2	Provider 3	Provider 4	Provider 5	Provider 1	Provider 2	Provider 3	Provider 4	Provider 5	Weight
Provider 1	1.000	0.369	0.339	1.104	0.543	0.106	0.100	0.075	0.133	0.112	0.105
Provider 2	2.712	1.000	0.906	2.119	1.346	0.288	0.271	0.200	0.256	0.277	0.258
Provider 3	2.950	1.104	1.000	2.208	1.426	0.313	0.299	0.220	0.267	0.294	0.279
Provider 4	0.906	0.472	0.453	1.000	0.543	0.096	0.128	0.100	0.121	0.112	0.111
Provider 5	1.842	0.743	1.842	1.842	1.000	0.196	0.201	0.406	0.223	0.206	0.246
	9.411	3.688	4.540	8.274	4.858	1.000	1.000	1.000	1.000	1.000	1.000

Table 5b shows the results of the synthesis of the results of previous calculations. Provider 5 and Provider 1 had the highest and the second highest overall weights of 0.2895 and 0.2546, respectively, while Provider 2 had the lowest overall weight of 0.1246.

Table 5b: Global weights of the alternatives

	PD	TC	RB	TRP	CT	TT	Overall Weights
	0.244	0.270	0.067	0.162	0.188	0.069	
Provider 1	0.291	0.259	0.326	0.312	0.182	0.105	0.2546
Provider 2	0.084	0.093	0.114	0.078	0.217	0.258	0.1246
Provider 3	0.141	0.132	0.117	0.149	0.236	0.279	0.1656
Provider 4	0.155	0.158	0.241	0.168	0.182	0.111	0.1657
Provider 5	0.329	0.359	0.203	0.292	0.183	0.246	0.2895
Sum	1.000	1.000	1.000	1.000	1.000	1.000	1.000

4. DISCUSSION

This paper has discussed how the analytic hierarchy process (AHP) might be used to select the best technical service provider to conduct a comprehensive study of Field X and produce a field development plan (FDP). Using the AHP method, the weights of the criteria involved in the selection of provider were determined. Figure 4 shows the weights of the selected criteria.

The Technical Capability and the Project Deliverability criteria show the highest overall weights of 0.270 and 0.244, respectively, while Reliability of the Company and Technology Transfer have low weights of 0.067 and 0.069, respectively. The Cost criterion has the third highest weight, while the Track Record of Performance criterion has the fourth highest weight. The weights for these two criteria are 0.188 and 0.162, respectively.

The Technical Capability criterion is consistent with the reality of the provider's business activities. This criterion determines the quality of the product and drives the accuracy and the comprehensiveness of the technical assessment. It also assesses the uncertainties of the business and mitigates them to reduce risk. On the other hand, the Project Deliverability criterion also reflects the reality of the business. This criterion drives critical issues with respect to a provider's ability to deliver the project according to the project timeline.

Figure 4: Overall weights of the criteria

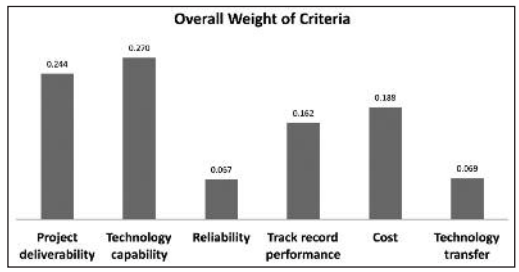
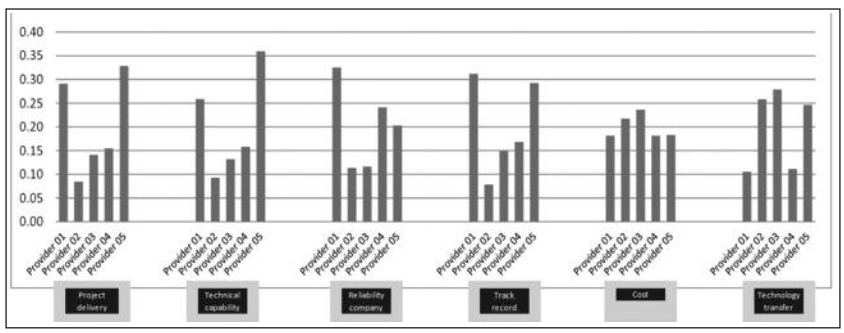


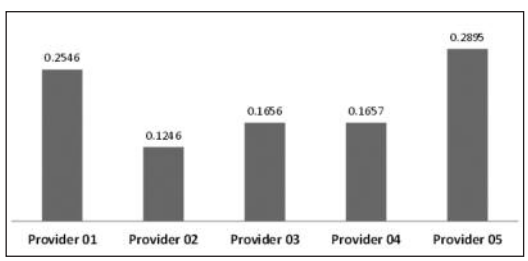
Figure 5 shows the weights of the alternatives with respect to each criterion. Provider 5 and Provider 1 have the highest scores with respect to both Technical Capability and Project Deliverability. These two criteria are essentially determining the higher global (overall) weight.

Figure 5: Weights of the alternatives with respect to each criterion



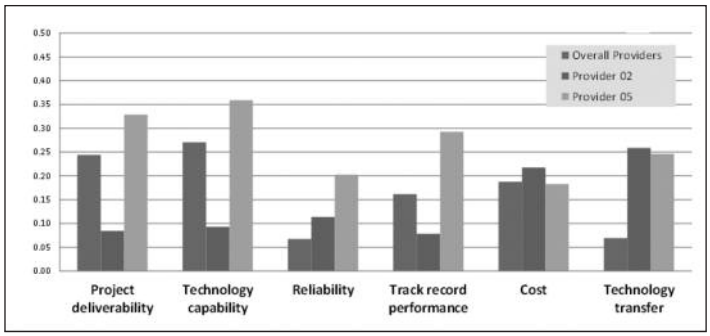
Finally, Figure 6 shows the overall weight for each provider. Provider 5 and Provider 1 have the highest and second highest overall weights of 0.2895 and 0.2546 respectively. As a result, it is recommended that Provider 5 be selected to conduct the study and develop the field development plan (FDP) for Field X. The key to Provider 5 achieving the highest weight (score) lies in the company's high technical capability: the company achieved the highest score for Technical Capability, the criterion that was assigned the highest weight among all the selection criteria. Provider 2 has the lowest overall weight of 0.1246.

Figure 6: Overall weights of the providers



Provider 2 ended up with the lowest overall weight because it had the lowest weight in the three most important criteria: Technical Capability, Project Deliverability, and Track Record of Performance. Figure 7 shows the comparison of overall weights between Provider 2, Provider 5 and the average of all providers.

Figure 7: Overall weights for Provider 2 (lowest weight) and Provider 5 (highest weight) and overall average weight for all providers



5. CONCLUSION AND RECOMMENDATION

The result obtained using the AHP method to select a service provider represents the collective perspective of the expertise within the company. The result could provide direction to management (a bid committee) in selecting the most capable technical services provider. Based on the AHP results, Technical Capability was the most important criterion (0.270) that a technical services provider in the oil and gas industry was required to meet, followed by Project Deliverability (0.244). Provider 5 had the highest global weight (0.290), followed by Provider 1 (0.255). Both providers are established international players in the oil and gas industry. Provider 2, which had the lowest global weight (0.125), is a locally-based technical consulting company. The low score demonstrates that the company needs to improve its Technical Capability and Project Deliverability in order to compete with international players.

As for recommendations, sub-criteria (especially for Technical Capability) could be developed and employed as part of the evaluation of service providers. This would provide additional criteria against which a company's technical competency in geology & geophysics, reservoir, production, drilling, completion and facilities, might be assessed in order to get the best technical consultant and maximize the use of company assets. A sensitivity analysis might also be performed to see the stability of the overall standing of the alternatives.

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