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UTILIZATION OF MULTI-CRITERIA DECISION ANALYSIS (MCDA) IN SELECTING CONTRACT TYPES FOR GEOTHERMAL EXPLORATION DRILLING PROJECT IN INDONESIA

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ABSTRACT

One of the important factors is achieving a successful drilling campaign is by having proper drilling contracts that is fitting with the current company's organizational capability. This leads to the question on which type of contract is the best for a certain drilling project, especially in the exploration phase in Indonesia. This issue is currently on the rise in geothermal industry in Indonesia due to Government of Indonesia's effort to achieve 7,200 MWe geothermal plant installed capacity in 2025. However, there is no absolute answer to that question as the decision making to choose the drilling contract type is usually involving more than one criterion. Therefore, it is necessary to use decision-maker's preferences to differentiate between alternatives.

Several drilling contract type for geothermal exploration project in Indonesia that is commonly known are discrete contract, integrated project management contract (IPM), and semi-IPM where usually the selection of contracts is primarily based on the organizational capability company has at the time. However, based on literature reviews, there are several other ways for drilling contract types that do not really fit into the three categories mentioned previously and might improve the drilling performance.

This paper discusses the application of Multi-Criteria Decision Analysis (MCDA) in assisting the decision-making process in drilling contract type selection. MCDA is considered as one of complex decision-making (DM) tool involving both quantitative and qualitative factors. It has been widely applied in various fields such as; energy and environment, business, economy and production.
The study initiated by defining clear objectives of drilling contract. Several drilling contract scenarios or alternatives are then identified to be examined where most of scenarios are developed based on published literature related to case in Indonesia. Sensitivity analysis is conducted to test whether conclusions are sensitive to changes in the model.

BACKGROUND

Indonesia, as one of the countries with the greatest potential for geothermal energy in the world, faces various challenges in utilizing this energy source. Since the first geothermal power plant was installed on the Kamojang field in 1930, Indonesia until the end of 2018 has only managed to use less than 7%, namely 1948.5 MW, of its total potential geothermal energy that is estimated at 28.5 GW (EBTKE, 2018). *Figure 1* shows the history and target of geothermal energy development in Indonesia.

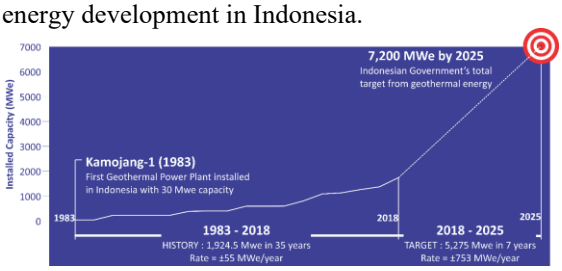


Figure 1: History and 2025 target of Indonesia geothermal development

Many studies have discussed various challenges in developing geothermal energy in Indonesia, where the high resource risk in the exploration phase is considered one of the main challenges (IGA, 2014; Darma, et al., 2010; Ngugi, 2014; Purba, Adityatama, Umam, & Muhammad, 2019). The level of risk is high due to the uncertainty of the existence of economic resources in the subsurface combined with the high upfront drilling cost, which makes investors think more carefully before investing.

Moreover, managing a high-cost geothermal drilling project might become more complex in the exploration phase due to shortage of personnel. It is realistic to view that a geothermal company most likely still has not yet fully establish a team to run a drilling campaign in that early stage of project. In

order to address this issue, the geothermal company need to choose the most suitable drilling contract type since it precedes the performance of work and governs the operator-contractor relationship (Williams, Schaffner, & Co, 1989). By choosing the right type of contract to its current situation, a geothermal company may expect to successfully manage the drilling risk and complete the exploration phase in a timely manner that eventually could accelerate the development of geothermal energy in Indonesia.

Consequently, the decision maker will need a reliable decision-making tool to assist him or her in choosing the type of drilling contract that is appropriate in accordance with the project characteristics and capabilities of the team that will manage the project. It is very natural if the decision maker wants the type of contract that can produce wells with the smallest possible risk, cost and effort. But then again, decision makers will find that getting the ideal conditions in accordance with it is often unrealistic so that compromise is needed on several criteria to still produce the most optimum decision in achieving the objectives related to the type of drilling contract to be used.

RESEARCH OBJECTIVES AND QUESTIONS

This study aims to investigate whether Multi-Criteria Decision Analysis (MCDA), a decision-making (DM) tool, is applicable to assists the decision maker in selecting drilling contract type for geothermal exploration project in Indonesia.
To achieve the objective, this study explores several questions as follow:

1. What are the key activities in a geothermal drilling project?
2. What kind of drilling contract types available in the market?
3. What kind of DM tool is available to select the right type of drilling contract for geothermal exploration project?
4. Are there any previous work or publication exercising MCDA in selecting drilling contract?
5. What are the objectives of decision maker in a contract type selection?
6. Is MCDA tool relevant to assist decision maker in selecting drilling contract type for geothermal exploration project?
7. What is the limitation of application of MCDA in this case?

METHOD

The main method used in this study is literature review and group discussion. The study initiated by group discussion to understand the situation and dilemma faced by the decision maker in choosing the right type of drilling contract. defining objectives of the drilling contract. Several drilling contract scenarios or alternatives are then identified to be examined where most of scenarios are developed based on published literature related to case in Indonesia. Sensitivity analysis is conducted to test whether conclusions are sensitive to changes in the model.

RESULTS AND DISCUSSION

Before exercising the application of MCDA in the drilling contract selection process, the authors of this study discussed a scenario that would be used as an example case. The discussion process mainly includes exploration drilling situation and the types of contracts that exist in Indonesia, which are described in the following sections.

Geothermal Exploration drilling in Indonesia

The understanding of the drilling project cycle and the geothermal project cycle is very important for any decision maker to enable him/her to get the most suitable type of contract for the project. Figure 2 shows an illustration of the stages of geothermal energy development projects in Indonesia in accordance with government regulations in Indonesia. In general, geothermal energy development projects in Indonesia are divided into 2 main phases, namely the exploration phase and the development phase (Figure 2).

In the exploration phase the purpose of drilling is to prove the existence of economic geothermal reserves in the sub-surface that have been initially mapped through geology, geochemistry and geophysical (3-G) surveys. Because in this phase the level of uncertainty is still high, generally geothermal companies (developer) will only commit to drill 3-5 wells, depending on the area of interest size. After conducting exploration drilling or test drilling, the developer will conduct well testing and assess the size of the economic reserves that can be developed. Once agreement met between the developer and the government regarding the development plan, the project will continue into the development phase where the number of wells will increase according to the MW target amount.

Regarding the geothermal exploration drilling project in Indonesia, some discussion notes obtained from authors experiences were:

1. The drilling risk is still high due to very minimum sub-surface data. This creates a more challenging situation of the drilling planning stage.
2. In Indonesia, the number of drilling personnel and drilling contractors who have experience in geothermal drilling is far less than oil and gas. This made geothermal developers must compete to get experienced geothermal drilling personnel when the level of certainty in the project is still very high. Umam et al (2018) mentioned how the difference nature of

geothermal to oil and gas drilling requires competency adjustment when personnel from one of the industry migrates to the other.

3. Developing companies that are undergoing an exploration phase on geothermal fields are often new companies in the geothermal industry so they have not gained the trust of the drilling contractors.

Drilling Contract

By definition, Williams, Schaffner, & Co (1989) stated that a contract is a deliberate engagement between competent parties with a lawful consideration or cause to do or not to do a particular thing; and the obligation of a contract is found in the terms in which the contract is expressed. They also mentioned that the key words of any contract are the same, which are: promise, agreement, obligation, performance, and consideration.

Several reasons why a company need to have a correct type of drilling contract are (de Wardt & van Gils, 1994; Isa, Hartono, Jayanto, & Putra, 2017):

1. To produce and maintain cost-effective quality wells
2. To achieve highest safety standard in the process of well construction
3. To comply with local government regulation and with company's policy

In Indonesia drilling industry, both petroleum or geothermal, there has not yet been a standard for drilling contract type or name. However, International Association Drilling Contractor (IADC) has been providing forms or template of several types of drilling contract through their website (IADC, 2018).

In this study, several types of drilling contract that has been found through literature study and authors experiences are summarized as follow:

Based on Contract Type

1. Discrete contract

This is a term that recently used by drilling personnel in Indonesia referring to the most conventional type of drilling contract where the geothermal developer is contracting separately with the rig contractor and every other service company. This kind of approach may create a lot of contract documents, 15-23 in estimate.

2. Integrated contract

This is a term used by drilling personnel in Indonesia in describing the type of contract that brings together several drilling services into a single contract. This is done with the aim of facilitating coordination with drilling service companies because developers only need to communicate with one project coordinator. Companies that become contract leaders can be in the form of drilling rig company or other drilling service companies such as directional drilling, cementing, or other services. This kind of approach is expected to result in less document, 4-5 in estimate.

Based on payment scheme

1. Day rate

This is the conventional method scheme where the drilling rig and service companies are paid based on working days. The unit may be in a form of day rate or another unit rate. This type put the risk more toward on the developer, which force the developer to establish a competent internal drilling team. In Indonesia, companies that use this type are usually companies that have long been in the geothermal industry and have had experience developing geothermal fields (Isa, Hartono, Jayanto, & Putra, 2017).

2. Footage

This scheme allows the developer to pay the rig company and service companies based on contractor performance, which is footage drilled. This type put the risk more toward on the rig contractor and drilling service companies, which force the contractors to allocate the risk in their quotation.

3. Turnkey

This is the most uncommon type of drilling contract in Indonesia. The payment scheme is very simple, the contractor will only be paid when the well is delivered as per agreed specification. This is uncommon due to the risk is almost fully absorbed by the contractor, which makes the contractor put a high quotation to the developer to compensate the risk.

Regarding the various types of contracts, the authors discuss the following points:

1. In general, the authors believe that in Indonesia geothermal developers who choose the type of discrete-day rate contract are companies that have high confidence in their internal drilling team capability.
2. For new geothermal companies in Indonesia, there is a tendency to choose the type of integrated-day rate contract, for example SOL (Sarula), SAE (Batu Raden), SGE (Jaboi) and KS Orka (Sorik Marapi and Sokoria).

Decision-making process

Multiple Criteria Decision Analysis (MCDA) is one of the DM tool that has been widely used in many industries, including geothermal industry (Greco, Ehrgott, & Figueira, 2016; Khan, 2019; Cook, Fazeli, & Davidsdottir, 2019). The difference between MCDA and other DM or DA tool such as Financial analysis, Cost-benefit analysis and Cost-effectiveness analysis is it does not require monetized measurements, thus make it more applicable to more complex decision-making situation (Raith, 2018).

When trying to make a good decision, a person must weigh the positives and negatives of each option and consider all the alternatives (WebFinance Inc., 2019). This is also what the decision maker must do when trying to make decision on which type of drilling contract is the best for the project situation that he managed at the time. Some studies (Yadav & Paudel, 2017) describes MCDA as follows:

1. It does not provide the "right" answer
2. It does not provide an objective analysis
3. It does not relieve decision makers of the responsibility of making difficult judgements
4. It assists the decision makers to confidently making a decision by:
    a. Gain a better understanding of the problem faced
    b. Organizing and synthesizing the entire range of information
    c. Integrating objective measurements with value judgements
    d. Making explicit and managing the decision maker's subjectivity
    e. Ensuring that all criteria and decision factors have been taken properly into account

MCDA application in drilling contract selection for geothermal exploration project.

As discussed in Introduction, this study aims to exercise the application of MCDA in assisting the decision-maker in the drilling contract type selection process. As to authors knowledge, so far there has not yet any publication on this kind of MCDA application.

Define Alternatives

The first step of applying this method is to define as many as possible unique alternative ways the decision maker will consider for contracting drilling contractors (Table 1).

Define Objectives and Criteria

The next step is to define objective of the decision. In this study, the objective of this "Getting Suitable Drilling Contract Type" decision analysis is to determine the most optimum alternative for drilling contract that gives minimum cost, minimum risk, minimum effort and maximum peace of mind. Figure 3 shows the value tree and the criteria of the decision analysis.

Based on the value tree, the criteria measurement is described as follow:

1. Cost

a. ***"Cost per well"*** is the cost of wells which includes tangible and intangible costs but does not cover infrastructure costs and the costs of internal drilling teams. In this study a discrete contract with a day rate scheme is used as a baseline where other types of contracts will experience an increase in costs due to handling fees and risk compensation. This cost assumption uses figures from studies that have been carried out by EBTKE (Purwanto et al, 2018) and is expressed in US Dollar. Table 2 shows the cost per well assumptions used in this study. The least the cost the better.

b. ***"Tender/procurement duration"*** is the duration, expressed in month, required to conduct the procurement process in obtaining contract for drilling rig and other drilling services. The duration of contract is correlate directly to the cost. The longer the procurement process the higher the cost of internal drilling personnel, therefore the least the duration the better.

c. ***"Cost of drilling personnel"*** is the total cost that need to be spent to maintain or sustain all of drilling personnel in the geothermal developer organization to run the exploration drilling project. The least the cost of drilling personnel the better. Table 3 shows the assumption used in estimating the cost of drilling personnel of each alternative.

2. Effort

a. **"Number of contract document"** shows the quantity of contract document required as the consequence of the selected alternative. The main component of effort where it expressed "peace of mind" when using the alternative. The least contract document required the least effort from the geothermal developer, which, in this study, is preferable. The assumption used in this study is based on author experiences and on Hartono (2019) paper.

b. ***"Number of contractor reps"*** is the total number of representative sent by the drilling contractors. This number is directly related to number of contracts. The authors

of this study assume that geothermal developer prefers to communicate with less people to avoid confusion and minimize man-hours consumption. The less the number of contractor reps the better.

c. ***"Number of internal drilling personnel"*** shows how many drilling personnel assigned in the project from geothermal developer side that already shown in Table 4 "cost of drilling personnel". It expresses the difficulties geothermal developer must handle in the recruitment process due to limited supply of experienced geothermal drilling personnel in Indonesia. The less drilling personnel required the better.

3. Risk

a. ***"Potential market response"*** is the one of the main components of risk where it expressed "certainty" of successful tender process. The decision-maker from geothermal developer may choose any contract he or she prefers but the remaining question is whether there are any contractors that willing to participate in the tender process. The value of this criterion is using direct rating resulted from authors discussion. Alternative with the highest market response is preferable.

b. ***"Potential dispute"*** expresses the likelihood of dispute between parties involved in the contract as consequences of type of contract selected. Authors of this study believe that discrete type has the lowest possibility of dispute due to each service company contracting directly to the geothermal developer. The lower the likelihood of potential dispute the better. Same as "potential market response" criterion, the "potential dispute" is valued using direct rating in a subjective way by the authors.

c. ***"Overall risk toward geothermal company"*** shows how the alternative put risk to the geothermal developer. Same as the two aforementioned risk criterion, this criterion is valued using direct rating in a subjective way by the authors and is shown in the performance matrix criteria.

Criteria measurement and performance matrix

Based on discussion above a performance matrix of each criteria that can be measured can be developed as shown in Table 2 below.

Table 3 below shows matrix of scores for each criterion which for the quantifiable criteria the value is be derived using the linear function.

Specify the weights for each different criterion

The next step is to define the weights chosen for each criterion. "Cost per well" criterion and "Potential dispute" are given the highest weight in this study due to authors believe in the exploration phase, where uncertainty is still high the geothermal developer prefers to spend minimal investment, avoid conflict with business partners and tends to share risk. Moreover, the developer also wants to have a successful procurement process, which is indicated by market response and procurement duration. That is the reason why "Potential market response" and "Tender/procurement duration" weight ranked the second and third consecutively. The detailed work is shown in Table 4 below.

Overall Score for each alternative

The last step is deriving the overall scores for each of the alternatives for the decision problem given by our value tree. Table 5 and Figure 4 below shows the overall score.

Authors initial expectation is to see the alternative 1-DU to come up as the best decision since it gives the lowest well cost and the lowest potential of contract dispute. However, Figure 4 above shows that the highest score is alternative 2-ISU. It does make sense since alternative 2-ISU cost is not significantly different from alternative 1-DU and still ranked second in term of potential dispute. The winning points of alternative 2-ISU from alternative 1-DU in the "number of contract document" and "number of drilling personnel required".

CONCLUSION

The MCDA method is applicable for selecting drilling contract types in geothermal exploration projects in Indonesia. The author of this study has

applied this method by acting as a decision-maker, which means other decision makers can apply this method by adjusting the value tree, performance matrix and criterion weight according to the available data and their own personal judgment.

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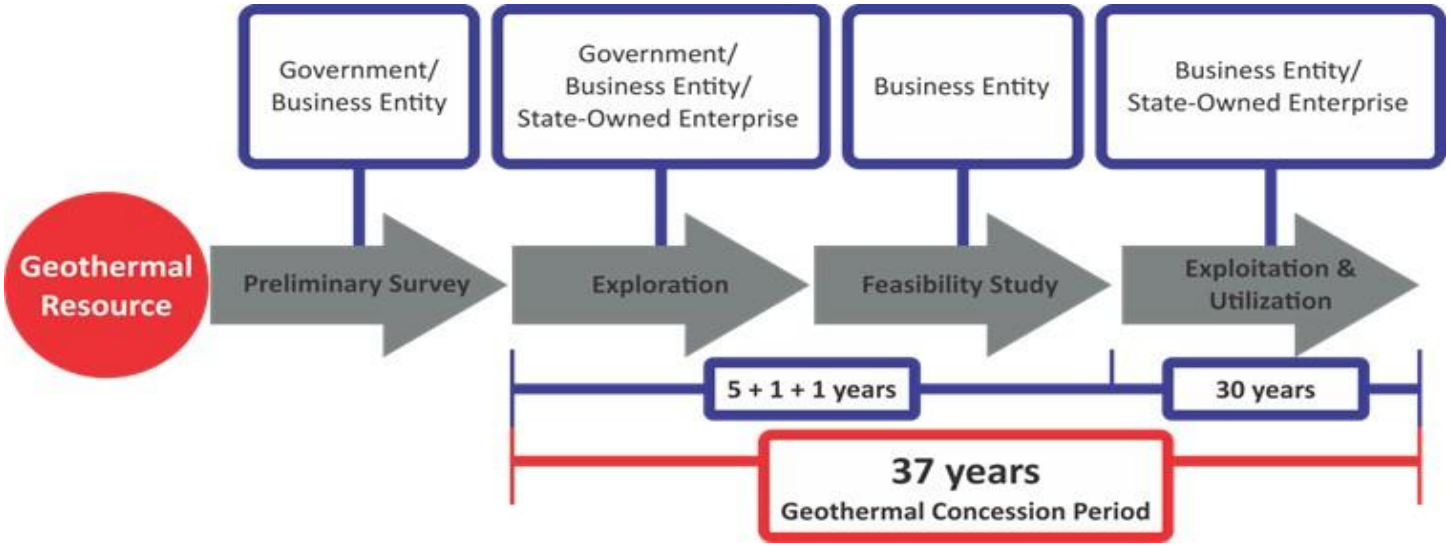

Government/
Business Entity
Government/
Business Entity/
State-Owned Enterprise
Business Entity
Business Entity/
State-Owned Enterprise
Geothermal
Resource
Preliminary Survey
Exploration
Feasibility Study
Exploitation &
Utilization
5 + 1 + 1 years
30 years
37 years
Geothermal Concession Period

Figure 2.

Table 1

No	Alternative Name	Contract type	Alternative description
1	**1-DU**	Discrete + Unit Rate	• the conventional contract type where the geothermal company has contract with rig company and all other drilling services. • there will be more than **20 contract documents**: list attached • the compensation scheme will use **unit rate or day rate** since it almost impossible to apply footage scheme with 20 different parties, which makes more risk toward the geothermal company.
2	**2-ISU**	Integrated service + Unit Rate	• Recently in Indonesia geothermal drilling community, this type often called Bundled service or Semi-IPM contract. • in this alternative, rig contract is separated from other services contract, where all of the drilling services is integrated into a single contract document. • There will be **5 contract documents**: Rig contract, integrated services contract, equipment inspection contract, casing purchase contract and wellhead purchase contract • the compensation scheme is using **day rate** which makes more risk toward the geothermal company.
3	**3-ISF**	Integrated service + Footage	• Recently in Indonesia geothermal drilling community, this type often called Bundled service or Semi-IPM contract. • in this alternative, rig contract is separated from other services contract, where all of the drilling services is integrated into a single contract document. • There will be **4 contract documents**: Rig contract, integrated services contract, casing purchase contract and wellhead purchase contract • the compensation scheme is using **footage** which makes more risk toward the rig and service company.

4	**4-SubU Rig**	Sub contracted + Unit Rate (Rig as leader)	• Recently in Indonesia geothermal drilling community, this type often called IPM contract. • in this alternative, **rig act as the leader** and subcontracting other services such as directional drilling, cementing, wireline logging, etc. • There will be **4 contract documents**: Rig/IPM contract, equipment inspection contract, casing purchase contract and wellhead purchase contract • the compensation scheme is using **day rate** which makes more risk toward the geothermal company
5	**5-SubU SC**	Sub contracted + Unit Rate (Service company as leader)	• Recently in Indonesia geothermal drilling community, this type often called IPM contract. • in this alternative, **service company act as the leader** and subcontracting other services such as directional drilling, cementing, wireline logging, etc. • There will be **4 contract documents**: IPM contract, equipment inspection contract, casing purchase contract and wellhead purchase contract • the compensation scheme is using **day rate** which makes more risk toward the geothermal company.
6	**6-SubF Rig**	Sub contracted + Footage (Rig as leader)	• Recently in Indonesia geothermal drilling community, this type often called IPM contract. • in this alternative, **rig act as the leader** and subcontracting other services such as directional drilling, cementing, wireline logging, etc. • There will be **3 contract documents**: Rig/IPM contract, casing purchase contract and wellhead purchase contract • the compensation scheme is using **footage** which makes more risk toward the IPM company/drilling contractor.
7	**7-SubF SC**	Sub contracted + Footage (Service company as leader)	• Recently in Indonesia geothermal drilling community, this type often called IPM contract. Sometimes it can also be interpreted as a turnkey contract. • in this alternative, **service company act as the leader** and subcontracting other services such as directional drilling, cementing, wireline logging, etc. • There will be **4 contract documents**: IPM contract, equipment inspection contract, casing purchase contract and wellhead purchase contract • the compensation scheme is using **footage** which makes more risk toward the IPM company/drilling contractor.

8	**8-Turnkey Rig**	Full turnkey (Rig as the leader)	• The drilling of a well for a fixed lump sum price • This type of contract is not common in Indonesia geothermal industry recently. This type of contract sometimes Full IPM with **footage** compensation scheme • The leader can be **rig or any other service company** that has the capability to run the full IPM project where the risk is fully borne by the IPM contractor • Only need **1 contract document**: Turnkey contract
9	**9-Turnkey SC**	Full turnkey (Service company as the leader)	• The drilling of a well for a fixed lump sum price • This type of contract is not common in Indonesia geothermal industry recently. This type of contract sometimes Full IPM with **footage** compensation scheme • The leader can be **rig or any other service company** that has the capability to run the full IPM project where the risk is fully borne by the IPM contractor • Only need **1 contract document**: Turnkey contract

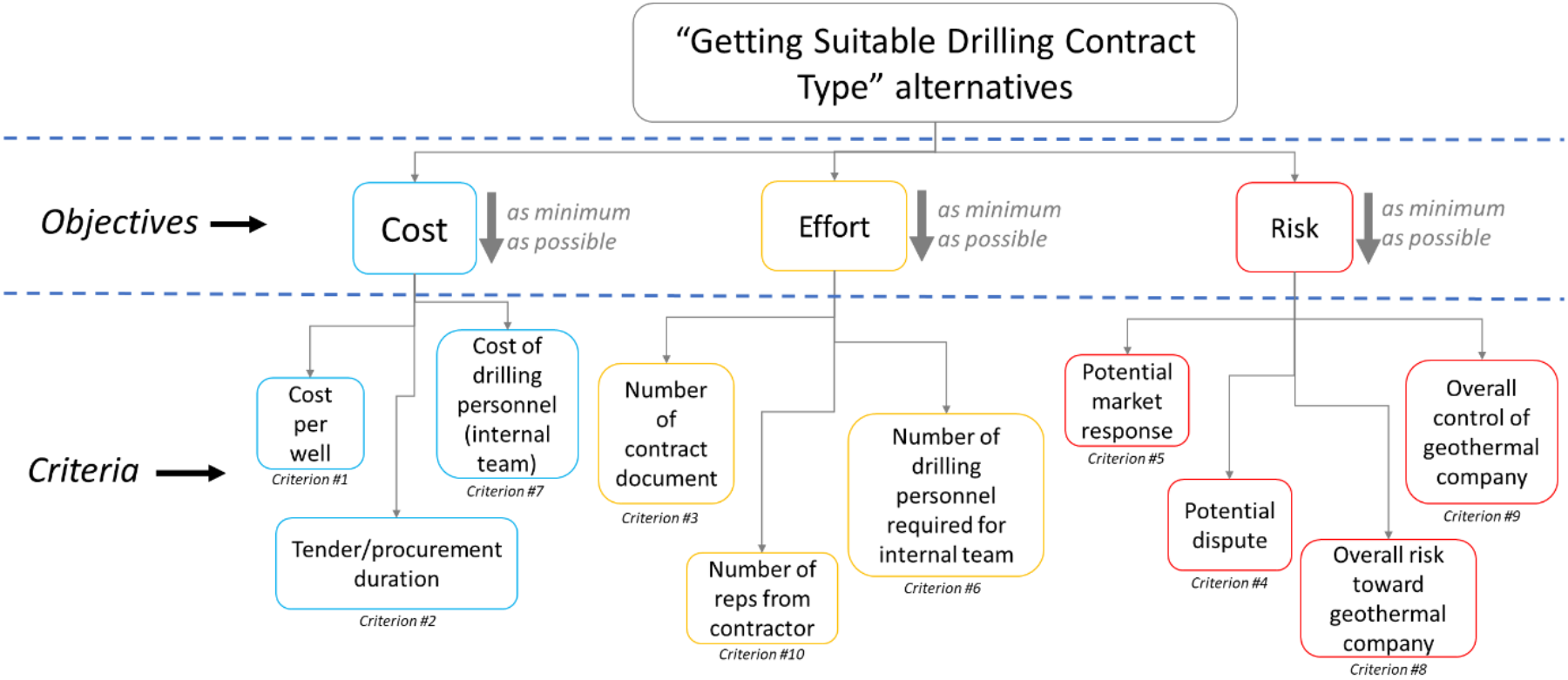

"Getting Suitable Drilling Contract Type" alternatives
Objectives
Cost
as minimum as possible
Effort
as minimum as possible
Risk
as minimum as possible
Criteria
Cost per well
Criterion #1
Cost of drilling personnel (internal team)
Criterion #7
Tender/procurement duration
Criterion #2
Number of contract document
Criterion #3
Number of reps from contractor
Criterion #10
Number of drilling personnel required for internal team
Criterion #6
Potential market response
Criterion #5
Potential dispute
Criterion #4
Overall risk toward geothermal company
Criterion #8
Overall control of geothermal company
Criterion #9

Figure 3.

Table 2.

			Mark up percentage	*25%*	*25%*	*50%*	*50%*	*75%*	
No	Alternative Name	Contract type	Baseline well cost (standard hole with 2,000m depth)	Handling fee applied by rig	Handling fee applied by service companies	Footage risk compensation applied by rig	Footage risk compensation applied by service companies	Turnkey risk applied by the contractor	Total
1	1-DU	Discrete w/ Unit Rate	$5,860,000	0	0	0	0	0	$5,860,000
2	2-ISU	Integrated service w/ Unit Rate	$5,860,000	0	$487,845	0	0	0	$6,347,845
3	3-ISF	Integrated service w/ Footage	$5,860,000	0	$487,845	$1,552,900.0	$975,690	0	$8,876,435
4	4-SubU Rig	Sub contracted w/ Unit Rate (Rig as leader)	$5,860,000	$487,845	0	0	0	0	$6,347,845
5	5-SubU SC	Sub contracted w/ Unit Rate (Service company as leader)	$5,860,000	0	$776,450	0	0	0	$6,636,450
6	6-SubF Rig	Sub contracted w/ Footage (Rig as leader)	$5,860,000	$487,845	0	$2,930,000	0	0	$9,277,845

7	7-SubF SC	Sub contracted w/ Footage (Service company as leader)	$5,860,000	0	$776,450.0	0	$2,930,000	0	$9,566,450
8	8-Turnkey Rig	Full turnkey (Rig as leader)	$5,860,000	$487,845	0	0	0	$4,395,000	$10,742,845
9	9-Turnkey SC	Full turnkey (Service company as leader)	$5,860,000	0	$776,450.0	0	0	$4,395,000	$11,031,450

Table 3.

		Monthly payment	$ 3,000	$ 3,000	$ 4,000	$ 9,000	$ 14,000	$ 9,800	$ 12,000	$ 12,000		
Alternative name	Estimate tender/procurement duration (months)	Total number of drilling personnel required	Procurement specialist (head count)	Contract Engineer (head count)	Drilling Engineer (head count)	Sr. Drilling Engineer (head count)	Day Drilling Supervisor (head count)	Night Drilling Supervisor (head count)	Drilling Superintendent (head count)	Drilling Manager (head count)	Monthly Cost	Total Cost during the exploration drilling project
1-DU	9	14	2	2	3	1	2	2	1	1	$ 104,600	$ 1,464,400
2-ISU	11	11	1	1	2	1	2	2	1	1	$ 94,600	$ 1,513,600
3-ISF	12	5	1	1	1	1	0	0	0	1	$ 31,000	$ 527,000
4-SubU Rig	16	11	1	1	2	1	2	2	1	1	$ 94,600	$ 1,986,600
5-SubU SC	16	11	1	1	2	1	2	2	1	1	$ 94,600	$ 1,986,600
6-SubF Rig	18	5	1	1	1	1	0	0	0	1	$ 31,000	$ 713,000
7-SubF SC	18	5	1	1	1	1	0	0	0	1	$ 31,000	$ 713,000
8-Turnkey Rig	20	3	1	0	0	1	0	0	0	1	$ 24,000	$ 600,000
9-Turnkey SC	20	3	1	0	0	1	0	0	0	1	$ 24,000	$ 600,000

Table 4.

PERFORMANCE MATRIX	Criterion-1	Criterion-2	Criterion-3	Criterion-4	Criterion-5	Criterion-6	Criterion-7	Criterion-8	Criterion-9	Criterion-10
ALTERNATIVES	**Estimated cost per well**	**Estimate tender/procurement duration**	**Number of contract document**	**Potential dispute**	**Potential market response**	**Number of personnel required from geothermal company**	**Cost of drilling personnel hired by geothermal company**	**Overall risk toward thegeothermal company**	**Overall control of geothermal company on the project**	**Number of project coordinator/reps provided by the contractor**
	USD	*months*	*count*	*direct rating*	*direct rating*	*count*	*USD*	*direct rating*	*direct rating*	*count*
1-DU	5,860,000	9	20	95	95	14	1,464,400	40.0	90.0	8
2-ISU	6,347,845	11	5	75	75	11	1,513,600	40.0	80.0	2
3-ISF	8,876,435	12	4	30	30	5	527,000	70.0	60.0	2
4-SubU Rig	6,347,845	16	4	60	65	11	1,986,600	50.0	50.0	1
5-SubU SC	6,636,450	16	4	65	60	11	1,986,600	50.0	50.0	1
6-SubF Rig	9,277,845	18	3	40	35	5	713,000	60.0	35.0	1
7-SubF SC	9,566,450	18	3	45	40	5	713,000	60.0	35.0	1
8-Turnkey Rig	10,742,845	20	1	10	10	3	600,000	90.0	5.0	1
9-Turnkey SC	11,031,450	20	1	10	10	3	600,000	90.0	5.0	1

Table 5.

MATRIX OF SCORE *[using linear function = 100/(best-worst)*(criterion_value - best)+100]*	**Criterion-1**	**Criterion-2**	**Criterion-3**	**Criterion-4**	**Criterion-5**
ALTERNATIVES	**Estimated cost per well**	**Estimate tender/procurement duration**	**Number of contract document**	**Potential dispute**	**Potential market response**
1-DU	100.0	100.0	0.0	100.0	100.0
2-ISU	90.6	81.8	78.9	76.5	76.5
3-ISF	41.7	72.7	84.2	23.5	23.5
4-SubU Rig	90.6	36.4	84.2	58.8	64.7
5-SubU SC	85.0	36.4	84.2	64.7	58.8
6-SubF Rig	33.9	18.2	89.5	35.3	29.4
7-SubF SC	28.3	18.2	89.5	41.2	35.3
8-Turnkey Rig	5.6	0.0	100.0	0.0	0.0
9-Turnkey SC	0.0	0.0	100.0	0.0	0.0

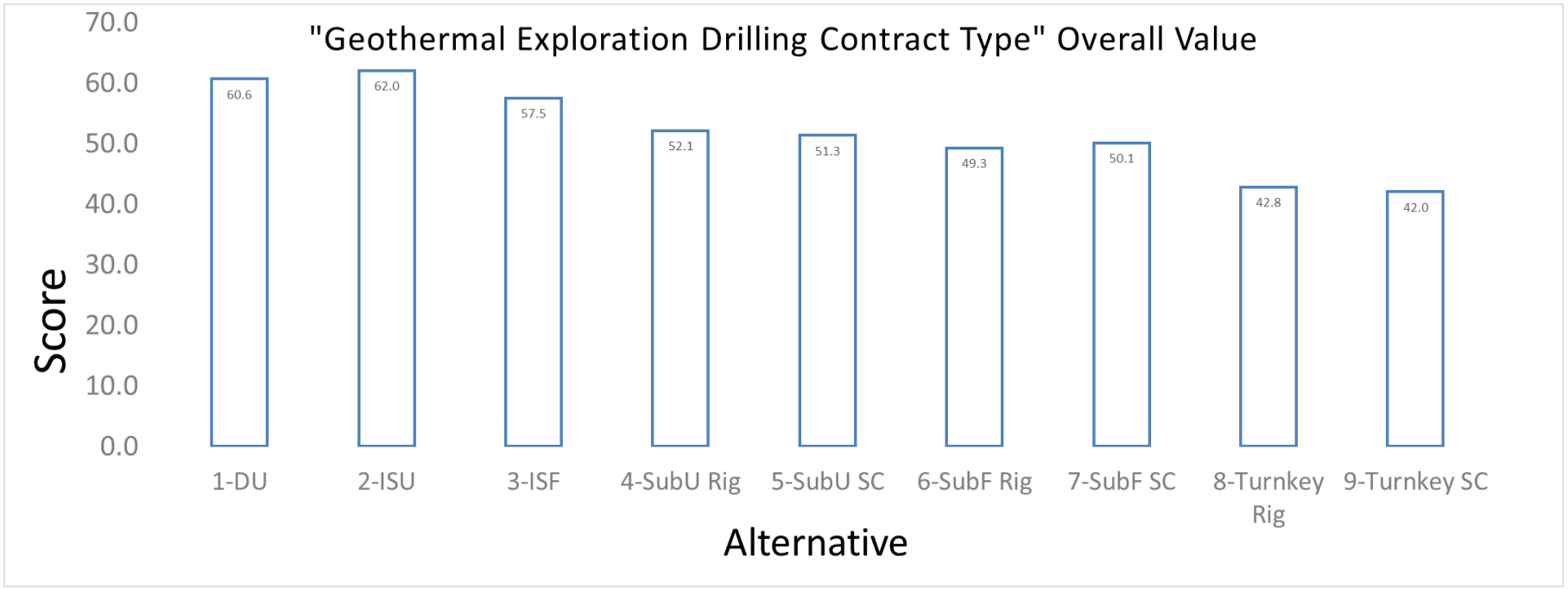

"Geothermal Exploration Drilling Contract Type" Overall Value
Score
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
60.6
62.0
57.5
52.1
51.3
49.3
50.1
42.8
42.0
1-DU
2-ISU
3-ISF
4-SubU Rig
5-SubU SC
6-SubF Rig
7-SubF SC
8-Turnkey Rig
9-Turnkey SC
Alternative

Figure 4.