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Multi-Criteria Approach to Support Decisions to Participate in Oil and Gas Tenders

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1 Introduction

Change and hypercompetition are common phenomena in the current market. Companies are constantly bombarded by technology, globalization and the digital revolution, requiring them to pay attention to the transient nature of their environment (Salgado, Aires, & Araújo, 2022).

In this respect, high quality management is necessary to face market challenges. The central element of good management is decision making (Marchisotti, Domingos, & Almeida, 2018), a factor present in the life of individuals, in everyday or business-related situations (Olalekun, Olubunmi, Samson, & Oluwatoyin, 2021; Ugoani, 2018).

Decision making is directly linked to the performance of an organization, a critical aspect for its survival and success (Olalekun et al., 2021; Beaver & Jennings, 2005). Decision processes are the bridge between the strategic aims of an organization and their reach, stimulating positive actions to achieve goals being the primary objective (Olalekun et al., 2021).

In addition, decision making is characterized by a growing set of mutually conflicting alternatives and criteria (Araújo & De Almeida, 2009) in a complex multidimensional process that becomes difficult for many managers (Shimizu, Park, & Hong, 2011), who need to develop and assess multiple alternatives for taking action with the information and skills at their disposal (Olalekun et al., 2021).

In this regard, service providing companies that participate in tender processes deal daily with the decision to participate or not in the process (making a bid or not) (Lesniak, Kubek, Plebankiewickz, Zima, & Belniak, 2018; Li, Zhang, Chen, & Martek, 2020). Deciding whether or not to explore an opportunity is complex and involves multiple factors, such as project demands, organizational capacity, the tender itself etc (Lesniak et al., 2018; Biruk, Jaskowski, & Czarnigowska, 2017; Shash, 1993).

Decision making in this process is crucial, directly impacting the success of an organization and may cause irreparable damage if not done properly (Lesniak et al., 2018; Biruk et al., 2017; Li et al., 2020). Given the multiple issues involved in this problem, Multi-Criteria Decision Making (MCDM) is an appropriate methodology to help decision making in this context.

In order to improve the efficiency of the decision process, decrease uncertainties and support the decision maker while considering multiple factors, MCDM has frequently been used for tender decision making (Lesniak et al., 2018).

However, no studies have been carried out using MCDM methods for decisions to participate in tenders from the standpoint of a company contracted by the Brazilian oil and gas industry. Despite being an activity characterized by multiple risks and uncertainties (Araújo & De Almeida, 2009), studies using MCDM focus on the contracting company (Araújo & De Almeida, 2009; Gonçalo & Morais, 2018) or problems related to the production chain (Brito & De Almeida, 2009; Mota, De Almeida, & Alencar, 2009).

In addition, Brazil is one of the major oil and gas producers in the world (Alves de Moura, Racy, Vartanian, & Silva, 2020), attracting significant investments due to its geographic potential (Cintra & Simões, 2020). The sector accounts for 13% of the GDP, generates thousands of jobs and attracts billions of dollars in investments (ANP, 2018).

Thus, based on the above, the aim of this study is to propose a multi-criteria model to support decisions to participate in tenders in the Brazilian oil and gas industry. The rest of the article is structured as follows: first, a literature review on MCDM for decisions to participate in tenders is presented; next, the method of the study is described; the results, discussion and sensitivity analysis are then presented; and finally, conclusions are drawn and the main contributions summarized.

2 Multi-Criteria Decision-Making (MCDM) for Decisions to Participate in Tenders

A tender involves inviting bids/proposals to participate in (or execute) a project. There are two possible viewpoints in this process: (i) that of the contracting party and; (ii) that of the contracted company (or service provider). In the former, the best proposal and best company to execute the project is selected. A few of the studies carried out in this area are mentioned below.

Wang, Tsai, Ho, Nguyen and Huang (2020) aimed to help in the selection of companies and materials for a Vietnam oil industry project. The authors assessed the efficiency of each service provider using a combination of the Analytic Hierarchy Process (AHP), Supply Chain Operation Reference (SCOR) and Data Envelopment Analysis (DEA).

Gonçalo and Morais (2018) also conducted a study from the perspective of the contracting party in selecting service providers for a Brazilian oil company. The results of the Preference Ranking Organisation Method for Enrichment Evaluation (PROMETHEE) II rank the companies that provide the services the organization is seeking.

Wood (2016) applied the Fuzzy Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) along with the flexible Entropy method to the problem of selecting service providers to help develop the petroleum industry. Finally, Araújo and De Almeida (2009) used the PROMETHEE II method to select strategic investments in the oil and gas industry of Northeastern Brazil.

From the standpoint of the contracted company (or service provider), the object of the present study, the aim is to select the best project to bid on considering the objectives of the organization. Thus, efforts to win a tender include two main decisions: to make a bid or not, and in the event of a bid, submit an accurate proposal that meets the requirements without underbidding (Lesniak et al., 2018; Li et al., 2020).

The company must answer three important questions: “What needs to be done and under what conditions?”, “Are we able to execute the project?” and “Will the project result in satisfactory profits?” (Biruk et al., 2017). Project attractiveness is also an essential factor for the decision maker. This is defined as project viability, availability of a competent team, resource availability and high return on investment (Mohanty, 1992).

Taking part in projects that are not consistent with the skills and profile of the company may result in losses related to the time invested to prepare the proposal, inexperience and insufficient return on investment (Wanous, Boussabaine, & Lewis, 2000; Biruk et al., 2017). However, the wrong decision to not participate means losing a lucrative contract, not establishing a long-term relationship with new customers and failing to expand and strengthen the business (Biruk et al., 2017).

A number of studies carried out in this area deserve mention, although none involved the Brazilian oil and gas industry. Issa, Mosaad and Hassan (2020) focused on the problem of selecting projects in the construction industry, one of the dimensions to analyze in the decision to participate. In order to help service providers select appropriate new projects, the authors identified critical criteria in the selection decision using a combination of AHP with a fuzzy model for risk assessment in a real case study. The results obtained indicated the best project for the company analyzed to participate in.

In the same context, Davoudabadi, Mousavi, Saparauskas and Gitinavard (2019) used the Interval-Valued Intuitionistic Fuzzy Sets (IVIFSs) model to analyze the project selection problem in the construction industry. Using a case study conducted by Kaya and Kahraman (2011), the authors showed the benefits of the proposed model as a support for decision making amidst inaccurate company information.

Lesniak, Kubek, Plebankiewickz, Zima and Belniak (2018) proposed the use of a hybrid Fuzzy AHP to support the decisions of service providers to participate. A case study in the Polish civil construction industry was used to identify the criteria and usefulness of the model. As a result, the authors found fifteen factors that impacted the decisions of the company analyzed and indicated the best project to participate in.

Cheng, Hsiang, Tsai and Do (2011) proposed a multi-criteria approach for decisions to participate in tenders using the Multi-Criteria Prospect Model for Bid Decision Making (BD-MCPM). Unlike the aforementioned studies, the authors also aimed to help define what profit margin should be used in the proposal. Applying the model to a case study in the construction sector in Vietnam, the authors demonstrated its benefits as a support tool in project selection and profit margin.

Marzouk and Moselhi (2003) combined the Multi-Attribute Utility Theory (MAUT) and AHP to support construction service providers in estimating profit margins for tenders. Using two numerical applications, the authors demonstrated the usefulness of the proposed approach.

Wang, Dzeng and Lu (2007) aimed to help determine the price of proposals submitted by companies participating in tender processes. The authors proposed an integrated approach of a cost model based on simulations and a multi-criteria model in order to consider cost-related uncertainties and the preferences of decision makers. The results obtained demonstrate improvements in the price determination process.

Zafra-Cabeza, Ridao and Camacho (2003) proposed a risk-based approach in conjunction with the AHP method to support decisions to participate in industrial tenders. The results indicate the best proposal and the actions needed to reduce risk.

Finally, Cagno, Caron and Perego (2001) assessed the likelihood of winning tenders from the standpoint of competing companies. With an approach based on the AHP method applied to a real auction, the results showed the capacity of the model to consider multiple criteria and the preferences of decision makers.

3 Method

In order to construct the model, the present study used three phases suggested by De Almeida et al. (2015) (Figure 1), where the first two are presented in this section and the last in the discussion of results.

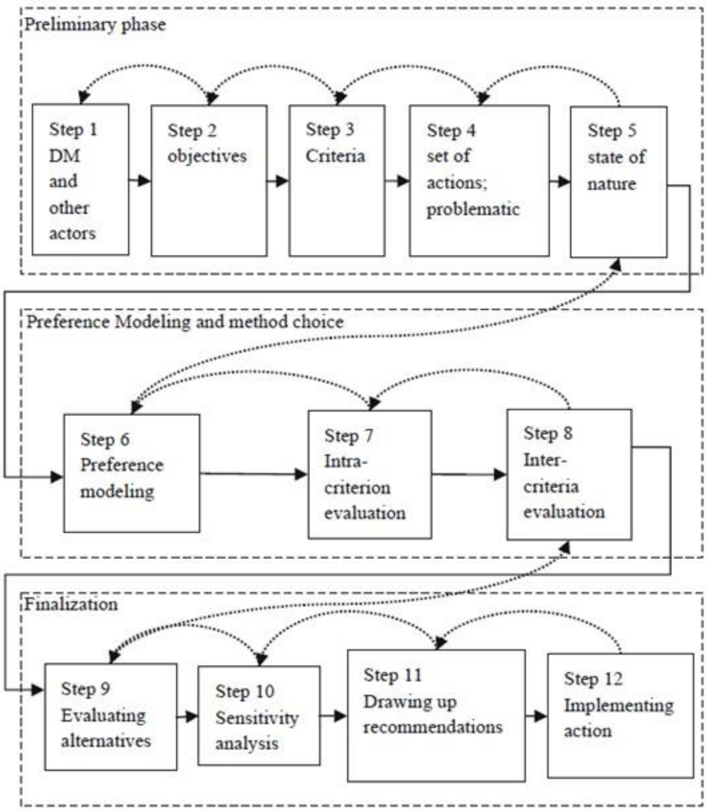

Figure 1. Procedure for resolving an MCDM/A problem
Source: De Almeida et al. (2015)

In the first phase, aimed at proposing a multi-criteria model to support the decisions to participate in Brazilian oil and gas industry tenders, the assessment criteria of each alternative were established based on the literature and the company´s tender documents. The criteria are presented in Table 1.

Table 1. Criteria

Code	Criterion	Description	Source
C_1	Conditions for participating in the tender	Contractual requirements to participate in the tender	Cheng et al. (2011) and Biruk, Jaskowski and Czarnigowska (2017)
C_2	Size of the Project	Extent of the service to be provided: how many employees will be needed? How Much revenue will be generated? Will the service preclude the company from working in other projects?	Cheng et al. (2011), Biruk et al. (2017) and Lesniak et al. (2018)
C_3	Project complexity	Complexity of the services to be provided	Cheng et al. (2011), Cagno et al .(2011) and Lesniak et al (2018)
C_4	Experience with similar projects	Experience of the company in providing the same service	Enshassi, Mohamed and El Kariri (2010), and Biruk et al. (2017)
C_5	Time to prepare the bid	Amount of time available to prepare a bid	Lesniak et al. (2018) and Biruk et al. (2017)

The present study considered six tender documents between November 2021 and May 2022, collected from the Petronect website, one of the main tender platforms in the Brazilian oil and gas industry. Although the tender documents exhibited differences in locality, service provider and contractual procedures, the services involved the same aspects.

A company operating in the Brazilian oil and gas sector for eight years was used for numerical application. Its main activity is providing office services and administrative support, as well as maintaining and repairing oil extraction and prospection equipment. It is headquartered in Rio Grande do Norte, Brazil and has 60 employees.

In order to establish the weight of each criterion, the Swing Weights Procedure (Edwards & Barron, 1994) using the Simple Multi-attribute Rating Technique Exploiting Ranks (SMARTER) method was applied. This approach involves determining weights by systematically comparing the attributes with that considered the least importante (Amaro et al., 2022; Ezell, Lynch, & Hester, 2021). The method is transparent and robust, allowing the inclusion of stakeholder preferences (Amaro et al., 2022; Ezell et al., 2021; Mussoi & Teive, 2021).

For this process, the Rank Order Centroid (ROC) is used, a simple modeling technique to attribute weights that represent decision makers' preferences of the decision makers (Lima & Gomes, 2021; Edwards & Barron, 1994). The ROC consists of establishing a ranking with indices based on the order of attributes and calculating the ROC for each one (Ezell et al., 2021). The technique is expressed by equation 1.

$$W_k\ (ROC) = \frac{1}{n} \sum_{j=k}^{n} \frac{1}{j} \quad (1)$$

where k is the ranking of each criterion;
W_k the calculated weight; and
K the number of criteria/attributes to be ranked.

The ROC method provides more reliable weights than other formulas based on more mathematically complex rankings (Roszkowska, 2020; Lima & Gomes, 2021; Mussoi & Teive, 2021). It is also simpler and more transparent for decision makers to apply, which is essential for complex problems (Mussoi & Teive, 2021) such as decisions to participate in tenders. In addition, the methodology selected is suitable for cases where decision makers cannot accurately specify the weights of the criteria analyzed (De Almeida Filho, Clemente, Morais, & De Almeida 2018).

The Saaty Fundamental Scale (1980) was used to compare the alternatives. This scale is used to construct matrices with the decision makers´ appraisals (Logullo, Bigogno-Costa, Silva, & Belderrain, 2022). Each alternative is assessed and individually compared in relation to each criterion and the other alternatives, in order to determine which are more and less important in relation to the Other (Saaty, 1980; Toloi, Reis, Toloi, Vendrametto, & Cabral, 2022; Logullo et al., 2022). To that end, the author suggests a scale with values ranging from 1 to 9, as shown in Table 2.

Table 2. The Fundamental Scale

Intensity of importance on an absolute scale	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance of one over another	Experience and judgment strongly favor one activity over another
5	Essential or strong importance	Experience and judgment strongly favor one activity over another
7	Very strong importance	An activity is strongly favored and its dominance demonstrated in practice
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between the two adjacente judgments	When compromise is needed

After the first phase, the second phase involved establishing preference modeling and method selection. In this respect, the structure (*P, I*) was defined based on its ability to provide a complete ranking of alternatives. In addition, since one criterion (positive) can be offset by another (negative) in the problem analyzed, R-TOPSIS, an extension of TOPSIS, was the method used.

TOPSIS was presented by Hwang and Yoon (1981) and is characterized primarily by producing robust easy-to-apply results (Behzadian, Otaghsara, Yazdani, & Ignatius, 2012). The method is based on the principle that a given alternative is the closest possible to an ideal point (ideal positive solution), at the same time being as far as possible from the ideal negative solution (anti-ideal point).

However, TOPSIS is one of the most critical methods due to the rank reversal problem (Aires & Ferreira, 2018). Rank reversal, in its most classic conception, is the change in rank of a group of previously ranked alternatives after excluding or including a new alternative irrelevant to the group (Aires & Ferreira, 2018). With a view to obtaining more robust results, Aires and Ferreira (2019) proposed R-TOPSIS. By maintaining a simple application and being immune to rank reversal, the R-TOPSIS model can be expressed in a series of 10 steps:

Step 1: Define a set of alternatives ($A = [a_i]_m$);
Step 2: Define a set of criteria ($C = [c_j]_n$), as well as a subdomain of real numbers $D = [d_j]_{2\,x\,n}$, where $d_j \in \mathbb{R}$, to evaluate the rating of the alternatives, where d_{1j} is the minimum value D_j and d_{2j} the maximum value of D_j;
Step 3: Estimate the performance rating of the alternatives as $X = [x_{ij}]_{m\,x\,n}$;
Step 4: Elicit the criteria weights as $W = [w_j]_n$, where $w_j > 0$ and $\sum_{j=1}^{n} w_j = 1$;
Step 5: Calculate the normalized decision matrix (n_{ij})using *Max* or *Max-Min* as:

Step 5.1: *Max*

$$n_{ij} = \frac{x_{ij}}{d_{2j}}, i = 1,2 \ldots m; j = 1,2, \ldots, n. \quad (2)$$

Step 5.2: *Max-Min*

$$n_{ij} = \frac{x_{ij} - d_{1j}}{d_{2j} - d_{1j}}, i = 1,2 \ldots m; j = 1,2, \ldots, n. \quad (3)$$

Step 6: Calculate the weighted normalized decision matrix (r_{ij}) as:

$$r_{ij} = w_j n_{ij}, i = 1,2, \dots, m; j = 1,2, \dots, n. \quad (4)$$

Step 7: Set the negative (*NIS*) and positive (*PIS*) ideal solutions as:

$$NIS = [r_1^-, \dots, r_n^-], where\ r_j^- = \frac{d_{1j}}{d_{2j}} w_j\ if\ j \in B\ and\ r_1^- = w_j\ if\ j \in C \quad (5)$$

$$PIS = [r_1^+, \dots, r_n^+], where\ r_j^+ = w_j\ if\ j \in B\ and\ r_j^+ = \frac{d_{1j}}{d_{2j}} w_j\ if\ j \in C \quad (6)$$

Step 8: Calculate the distances of each alternative *i* in relation to the ideal solutions as:

$$S_i^+ = \sqrt{\sum_{j=1}^{n} \left(r_{ij} - r_j^+\right)^2}, i = 1,2, \dots, m. \quad (7)$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} \left(r_{ij} - r_j^-\right)^2}, i = 1,2, \dots, m. \quad (8)$$

Step 9: Calculate the closeness coefficient of the alternatives (CC_i) as:

$$CC_i = \frac{S_i^-}{S_i^+ + S_i^-} \quad (9)$$

Step 10: Arrange the alternatives in descending order. The highest (CC_i) value indicates the best performance in relation to the evaluation criteria.

Finally, results and discussion section present the finalization phase, where the alternatives are assessed by applying the decision model. In this phase, sensitivity analysis is also con-ducted and recommendations are made.

4 Results and Discussion

To present the results, first the weights are established. The administrator, the main decision maker regarding the tender, was consulted. This individual analyzes the tender platforms, collects documents and assesses their feasibility. The ranking established with the weights of each criterion using SMARTER and ROC is presented in Table 3.

Table 3. Weights

Position	Criteria	Weights
1º	C_4	0.457
2º	C_3	0.257
3º	C_2	0.157
4º	C_1	0.090
5º	C_5	0.040

Next, the same individual compared the alternatives using the Saaty Scale (1980), creating the matrices presented in Tables 4, 5, 6, 7 and 8.

Table 4. Saaty Scale Matrix for C_1

	A_1	A_2	A_3	A_4	A_5	A_6	Média
A_1	1	5	5	3	9	7	5
A_2	0.2	1	1	0.11	1	1	0.71
A_3	0.2	1	1	0.14	5	3	1.72
A_4	0.33	9	7	1	5	5	4.55
A_5	0.11	1	0.2	0.2	1	3	0.91
A_6	0.14	1	0.33	0.2	0.33	1	0.5

Table 5. Saaty Scale Matrix for C_2

	A_1	A_2	A_3	A_4	A_5	A_6	Média
A_1	1	9	7	1	9	5	5.33
A_2	0.11	1	0.33	0.2	1	0.33	0.49
A_3	0.14	3	1	0.2	3	1	1.39
A_4	1	5	5	1	3	3	3
A_5	0.11	1	0.33	0.33	1	5	1.29
A_6	0.2	3	1	0.33	0.2	1	0.95

Table 6. Saaty Scale Matrix for C_3

	A_1	A_2	A_3	A_4	A_5	A_6	Média
A_1	1	9	5	3	9	7	5.66
A_2	0.11	1	3	0.14	1	0.33	0.93
A_3	0.2	0.33	1	0.2	1	0.33	0.51
A_4	0.33	7	5	1	3	3	3.22
A_5	0.11	1	1	0.33	1	9	2.07
A_6	0.14	3	3	0.33	0.11	1	1.26

Table 7. Saaty Scale Matrix for C_4

	A_1	A_2	A_3	A_4	A_5	A_6	Média
A_1	1	3	1	9	9	7	5
A_2	0.33	1	0.33	1	0.2	1	0.64
A_3	1	3	1	3	5	3	2.66
A_4	0.11	1	0.33	1	0.33	1	0.62
A_5	0.11	5	0.2	3	1	5	2.38
A_6	0.14	1	0.33	1	0.2	1	0.61

Table 8. Saaty Scale Matrix for C_5

	A_1	A_2	A_3	A_4	A_5	A_6	Média
A_1	1	7	5	1	9	5	4.66
A_2	0.14	1	1	0.2	1	1	0.72
A_3	0.2	1	1	0.33	1	3	1.08
A_4	1	5	3	1	3	5	3
A_5	0.11	1	1	0.33	1	1	0.74
A_6	0.2	1	0.33	0.2	1	1	0.62

The resulting Decision Matrix is presented in Table 9.

Table 9. Decision matrix

Alternatives	Criteria				
	C_1	C_2	C_3	C_4	C_5
A_1	5	5.33	5.66	5	4.66
A_2	0.71	0.49	0.93	0.64	0.72
A_3	1.72	1.39	0.51	2.66	1.08
A_4	4.55	3	3.22	0.62	3
A_5	0.91	1.29	2.07	2.38	0.74
A_6	0.5	0.95	1.26	0.61	0.62

Based on the decision matrix presented in Table 9, R-TOPSIS was applied after the domain was stablished. To that end, the maximum and minimum values of the Saaty Fundamental Scale (1980) were used, since they represent the extremes of the scale applied.

Next, the other steps of the method were carried out, considering the weights presented in Table 3. The final result is presented in Table 10 in terms of DPIS, DNIS, CC and ranking order.

Table 10. Final Result

Alternatives	DPIS	DNIS	Closeness Coefficient	Position
A_1	0.2375	0.2579	0.5205	1
A_3	0.4319	0.0860	0.1660	2
A_5	0.4220	0.0766	0.1536	3
A_4	0.4711	0.0833	0.1503	4
A_6	0.5086	0.0218	0.0411	5
A_2	0.5133	0.0206	0.0387	6

The following result was obtained: A_1 is considered the best alternative for the company´s tender participation, followed by A_3, A_5, A_4, A_6 and A_2. This finding can be explained by several factors.

Alternative A_1 obtained the best performance in all the criteria, the highest weight in the model being C_4 – Experience with Similar Projects. Experience is typically a crucial factor to consider for both contracting and contracted companies (Oo, Lim, & Runerson, 2022; Lesniak et al., 2018; Alptekin, 2018; Aznar, Pellicer, Davis, & Ballesteros-Pérez, 2017; Sonmez & Sozgen, 2017).

Despite initially being considered an isolated subjective element, the explicit or implicit experience takes several factors into account, such as risks, the company´s internal conditions and those of the project itself (Wang, Dzeng, & Lu, 2007; Dulaima & Shan, 2002; Chua & Li, 2000). The contracted company´s decision makers generally rely on their experience as a factor that provides confidence in a new project, which justifies the preference for alternatives that involve similar experiences (Lesniak et al., 2018; Biruk et al., 2017).

The alternative ranked second (A_3) exhibited the second-best performance in the Experience criterion. However, the disadvantage of the criterion with the second highest weight in the model (C_3 – Project Complexity) explains its ranking. Complexity can be defined as the characteristics of a project that hinder its understanding, management and control, even when information is available (Romero, Lara, & Villalobos; 2021; Butt, Arshi, Rao, & Tewari, 2020).

Highly complex projects may exceed an organization´s capacity, leading to high risk that makes the project inviable (Wang et al., 2007; Dao, Kermanshachi, Shane, Anderson, & Hare, 2017). The more complex the project, the greater the likelihood of challenges to achieving objectives, negatively influencing the management and performance of the organization (Dao et al., 2017). Thus, less complex projects are favored over other alternatives.

Although the organization's experience facilitates preparing a bid (Lesniak et al., 2018), in the context of companies that survive from tenders, time is a critical factor that must be skillfully managed (Biruk et al., 2017). Thus, the time available to prepare a bid should be realistic and sufficient in practice (Lesniak et al., 2018), considering that this element incurs organizational costs and efforts (Arslan, Tuncan, Birgonul, & Dikmen 2006).

Alternative A_4 was ranked fourth due to disadvantages in terms of company experience, bid preparation time and project size. The last item is one of the main factors considered in decisions to participate in tenders (Wang, Tsai, Ho, Nguyen, & Huang, 2020; Jarkas, 2013) and the criterion with the third highest weight in the model.

Project attractiveness is linked to its size (King & Mercer, 1985; Jarkas, 2013; Wang et al., 2020; Oo et al., 2022), given the significant impact of this element on profit and mark-up (Jarkas, 2013; Wang et al., 2020; Oo et al., 2022). Thus, contracted companies will avoid contracts that exceed the organization´s capacity (Oo et al., 2022; Male & Stocks, 1991).

Ranked fifth is A_6, which stands out for its critical negative performance in terms of the conditions required to participate in tenders, performing worse than the other alternatives in this criterion. Wang et al. (2020), Lesniak et al. (2018), Jarkas (2013), Wanous, Boussabaine and Lewis (2000) and Shash (1993) underscore the importance given by both the contracting and contracted company to the conditions required for tender participation. The decisions to participate are directly impacted by variables related to contract conditions (Sonmez & Sozgen, 2017).

In last place is A_2, which scored lower than the other alternatives in most of the criteria investigated. With a project whose complexity exceeds the organization´s capacity and experience, the size of the alternative is crucial, making it unattractive to the decision makers. Moreover, complexity and size mean longer bid preparation time and difficult project conditions.

4.1 Sensitivity Analysis

Sensitivity analysis was conducted to assess the impact of a 10% more or less variation in criteria weights on the final classification. As a weight increased or decreased, its difference was equally distributed to the rest of the criteria. Table 11 presents the percentage changes in rankings.

Table 11. Sensitivity Analysis

Criterion	-10% of C_1	-10% of C_2	-10% of C_3	-10% of C_4	-10% of C_5	+10% of C_1	+10% of C_2	+10% of C_3	+10% of C_4	+10% of C_5
C_1	0.0810	0.0939	0.0964	0.1014	0.0910	0.0990	0.0860	0.0835	0.0785	0.0890
C_2	0.1592	0.1413	0.1634	0.1684	0.1580	0.1547	0.1727	0.1505	0.1455	0.1560
C_3	0.2592	0.2609	0.2313	0.2684	0.2580	0.2547	0.2530	0.2827	0.2455	0.2560
C_4	0.4592	0.4609	0.4634	0.4113	0.4580	0.4547	0.4530	0.4505	0.5027	0.4560
C_5	0.0422	0.0439	0.0464	0.0514	0.0360	0.0377	0.0360	0.0335	0.0285	0.0440
%	0.00%	0.00%	0.00%	50.00%	0.00%	0.00%	0.00%	33.00%	0.00%	0.00%

In the last line of Table 11 (denominated %) contains the percentages of cases in which the ranking of the alternatives was different as the classification initially presented in Table 10. In general, the rankings obtained showed good stability in response to changes in criterion weights. Only alterations from decreasing criterion C_4 and increasing criterion C_3 resulted in chnges, with coefficients of 50 and 33%, respectively. It is important to note that since these criteria have the highest weight (most critical) in the model, changes due to altered weights are considered natural.

5 Conclusion

Service providing companies that participate in tenders deal daily with the decision to take part or not, a complex and multifactorial process that directly affects the organization´s success (Lesniak et al., 2018; Li et al., 2020; Biruk et al., 2017). In this respect, MCDM shows how an adequate methodology helps the decision-making process by improving decision quality (Lesniak et al., 2018).

Although the decision to participate is crucial and risky (Araújo & De Almeida, 2009), no studies have been conducted on the use of MCDM methods in the decision to take part in tenders from the standpoint of the contracted company in the Brazilian oil and gas sector, an important segment in the country due to its geographic potential (Alves de Moura et al., 2020; Cintra & Simões, 2020; ANP, 2018).

In this scenario, the present study proposes a multi-criteria model to support decisions to participate in tenders put out by Brazilian oil and gas companies. Despite being applicable to any company in the context analyzed, a company located in Rio Grande do Norte state, Brazil was used for numerical application.

The model proposed combined the SMARTER (Edwards & Barron, 1994) and R-TOPSIS (Aires & Ferreira, 2019) methods to respectively establish weights and assess alternatives (tender documents), obtaining reliable results. Thus, the objective was achieved.

With respect to the discussion presented, alternative A_1 ranked first and A_2 last. The experience factor proved to be important for companies in the context analyzed, since this criterion considers several factors, such as internal and external conditions and risks (Wang et al., 2007). In addition, large highly complex projects were unfavorable to decision makers, since they require longer bid preparation times and contain challenging contractual conditions.

In terms of managerial implications, the study may serve as a reference for deciding to participate in tenders in the context proposed, as well as in different organizational sectors. Given that the tender process is critical and difficult for the management of many companies, the proposed model is a useful tool for making decisions with better quality, security and robustness.

In addition, the present study enables the inclusion of several decision makers in the tender process with different preferences, risk perceptions and experiences, since multi-criteria models can incorporate a number of conflicting factors to avoid organizational conflicts while considering all those involved.

Finally, the findings demonstrate the need to assess decisions to participate from the standpoint of the contracted company using methodologies that can encompass the multiple parameters involved in the area. It is important to note that the study does not suggest that this is the only correct model to use, but shows its clarity and reliability.

The study was limited by the difficulty contacting more decision makers for interviews and it is recommended that future studies include new applications in other organizations.

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