

EXTENDED ABSTRACT

Marcos Model for Ranking Civil Project Contractors

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1. Introduction

There are many factors that need to be considered when rating and selecting contractors. One of the most important tasks of employers is to rank and choose the right contractor. Choosing an inappropriate contractor will result in delays, poor quality, increased costs and even bankruptcy. A good contractor should be able to meet the needs of the organization and perform the project in unforeseen limited resources and time. Choosing the right contractor and setting the appropriate criteria for decision-making will have the greatest impact on the project's producer and employer. From an exploitative perspective choosing a non-specialized contractor will reduce the quality of work and harmful effects on the environment. From the employer's perspective choosing a contractor who is not able to perform the project causes delays in the project and increases the cost. The best possible performance in project management is to choose an optimal contractor given the resource constraints on tenders. That with the use of process analytical hierarchy process, analytic, along with to select the contractor (DSC-CONT) is proposed: that allows the combination of the demands of the stakeholders, be opposite to. the transparency of the decision, and the stability of the decision-making process will increase and, in fact, a scientific approach, with the potential high for the application issues a decision similar to that in which the decisions of the stable, is required. Evaluating and selecting the resource capabilities of contracting companies, which is the most important problem of large companies and large companies in the oil and gas industry when buying material resources. However, there are not enough comprehensive tools to evaluate the choice of suppliers in a particular industry. The criteria identify the main include: price, politics, flexibility, price, payment terms, quality product, capacity availability, production facilities, free., the level of free functionality, the speed of the delivery industry. Finally, according to the selected criteria, word ford is also the best supplier. Previous experience shows that the current system for selecting and ranking contractors is using outdated decision models, as it has limitations such as long and difficult to perform calculations and high uncertainty in the results obtained. So the aim of this study is to present a new Marcos decision model for ranking construction project contractors. Ranking of contractors using the Multi-Criteria Decision-Making Method The Marcos model, also recorded in 2020. So far, it has received less attention from researchers and has removed a significant part of these limitations. This model is simpler and more accurate than other decision-making methods and is very useful and important for ranking contractors. In the regulations for the referral of work to contractors approved in 1381, which are communicated to consultants and contractors. How to choose contractors include: 1-First Call 2-invitation to evaluate the executive capacity of the work 3-examination of the executive capacity of the work and preparation of a list of selected contractors for the invitation to tender 4-holding a tender and selecting a contractor. Despite the measures introduced in the rules

and regulations of the organization, there are still many problems for selecting contractors in construction projects, including large delays, poor quality work or poor execution, lawsuits brought by employers and contractors, increased costs, lack of proper management practices such as cost reduction methods and project management approach, constant changes in decision-making and price proposals, the final criteria for selecting contractors can be mentioned. Given the methods available for ranking contractors, we see that it is still difficult to choose the right contractor for construction projects. So the innovation of this research is to present the Marcos model to improve the ranking of construction project contractors. The study also searches for articles and research related to the topic, identifies metrics and interviews with experts, and then examines the impact of these metrics. the Shannon entropy method was used to weigh the metrics.

2. Methodology

2.1. Marcos model

The Marcos model is one of the new multi-criteria decision-making methods that will be introduced in 2020. This method is also done to rank options the steps of this method are stated below (Stević et al., 2020).

2.2. Shannon's entropy method

Shannon entropy is one of the important methods in information theory. This method is used in this research to determine the weight of the criteria (Soleimani et al., 2011).

3. Results and discussion

3.1. Ideal and anti-ideal values of the decision matrix

Using the relation (1) and (2) ideal option (AI) and anti-ideal (AAI) In fact, the ideal value (AI) is equal to the highest value of each criteria column and the anti-ideal (AAI) is the lowest value of each criteria column in the decision matrix presented in Table 1.

$$AI = \max_i a_{ij} \text{ if } j \in B \text{ and } \min_i a_{ij} \text{ if } j \in C \quad (1)$$

$$AAI = \min_i a_{ij} \text{ if } j \in B \text{ and } \max_i a_{ij} \text{ if } j \in C \quad (2)$$

Table 1. Ideal and anti-ideal values of the decision matrix

C8	C7	C6	C5	C4	C3	C2	C1	Row
2	2	2	2	3	1	1	70	AAI
3	3	4	3	5	3	3	130	A1
3	2	5	4	4	5	2	150	A2
4	5	4	2	3	4	1	90	A3
2	5	3	3	3	2	3	85	A4
4	4	4	2	5	5	1	115	A5
3	3	2	5	5	2	2	110	A6
5	5	3	4	4	4	3	125	A7
4	3	3	5	3	3	3	95	A8
3	2	4	3	5	1	1	130	A9
4	2	3	2	4	3	3	70	A10
5	5	5	5	5	5	3	150	AI

3.2. Weighting criteria using the Shannon entropy method

The weights of the criteria are also calculated using the Shannon entropy method. To obtain the entropy according to the equation (3) and the value of the degree of deviation using the equation (4) and finally the value of the weight of each criterion has been calculated according to the equation (5), the results of which are shown in Table 2.

$$E_j = -K \sum_{i=1}^m P_{ij} \times \ln P_{ij} \quad (3)$$

$$d_j = 1 - E_j \quad (4)$$

$$W_j = \frac{d_j}{\sum_{j=1}^n d_j} \quad (5)$$

Table 2. Weight of criteria obtained through Shannon entropy

W_j	d_j	E_j	Criteria
0.1163	0.1090	0.8909	purse
0.1325	0.1242	0.8757	price
0.1333	0.1250	0.8749	Enforcement and equipment
0.1132	0.1061	0.8938	Technical power and planning
0.1343	0.1259	0.8740	Work Experience
0.1179	0.1105	0.8894	Key project staff
0.1342	0.1258	0.8741	Specialized certificate
0.1179	0.1105	0.8894	Experience

As you can see in Table 2, The criteria for good track record and specialized certification have the highest weight and first and second priorities with values of 0.1343 and 0.1342 respectively. After that, the executive capacity and equipment weighing 0.1333 had the third priority, which is a sign of the higher importance of the criteria of good track record, specialized certification and executive capacity and equipment for the selection of the main contractor.

3.3. Calculate the degree of ideal and anti -ideal utility of the final score and ratings of contractors using Marcos model

To check the degree of desirability of options in the Marcos model, according to relations (6) and (7), the degree of ideal (K_i^+) and anti-ideal (K_i^-) desirability of options is also calculated. The highest value of the anti-ideal coefficient (K_i^-) is 2.1708 and the highest value of the ideal coefficient (K_i^+) is 0.8572, which corresponds to (A7) of the seventh contractor. The lowest value of anti-ideal coefficient (K_i^-) is 1.4797 and the lowest value of ideal coefficient (K_i^+) is 0.5843 for (A9) of the ninth contractor. The value of the coefficient S_i , which is the sum of the values of each row in the weighted matrix. The value of S_i coefficient for anti-ideal (AAI), 0.3948 was obtained. The highest value of S_i coefficient of 0.8572 is related to (A7) of the seventh contractor. Its results are presented in Table 3.

$$K_i^+ = \frac{S_i}{S_{ai}} \quad (6)$$

$$K_i^- = \frac{S_i}{S_{aai}} \quad (7)$$

$$S_i = \sum_{j=1}^n V_{ij} \quad (8)$$

$$f(K_i) = \frac{K_i^+ + K_i^-}{1 + \frac{1-f(K_i^+)}{f(K_i^+)} + \frac{1-f(K_i^-)}{f(K_i^-)}} \quad (9)$$

$$f(K_i^-) = \frac{K_i^+}{K_i^+ + K_i^-} \quad (10)$$

$$f(K_i^+) = \frac{K_i^-}{K_i^+ + K_i^-} \quad (11)$$

Table 3. Calculate the degree of ideal and anti-ideal utility of the final score and ratings of contractors using Marcos model

Rank	$f(K_i)$	$f(K_i^+)$	$f(K_i^-)$	K_i^+	K_i^-	S_i	Option
-	-	-	-	-	-	0.3948	AAI
3	0.6772	0.2830	0.7169	0.7529	1.9067	0.7529	A1
2	0.7002	0.2830	0.7169	0.7785	1.9716	0.7785	A2
7	0.5983	0.2830	0.7169	0.6652	1.6847	0.6652	A3
8	0.5869	0.2830	0.7169	0.6525	1.6526	0.6525	A4
5	0.6564	0.2830	0.7169	0.7298	1.8481	0.7298	A5
6	0.6054	0.2830	0.7169	0.6731	1.7046	0.6731	A6
1	0.7710	0.2830	0.7169	0.8572	2.1708	0.8572	A7
4	0.6604	0.2830	0.7169	0.7342	1.8594	0.7342	A8
10	0.5255	0.2830	0.7169	0.5843	1.4797	0.5843	A9
9	0.5666	0.2830	0.7169	0.6300	1.5954	0.6300	A10
-	-	-	-	-	-	1	AI

According to Table 3, the anti-ideal utility function $f(K_i^-)$ and the ideal function $f(K_i^+)$ according to relations (10) and (11) have values of 0.7169 and 0.2830, respectively. Determining the optimal performance of the options, $f(K_i)$ and the final ranking of the Marcos model has been obtained using equation (9). An option that has the most favorable performance has the best rating. The results of the final ranking of the contractors show that (A7), (A2), (A1), with the values of 0.7710, 0.7002, 0.6772 respectively, the seventh contractor is ranked first and the second and first contractors are ranked second and third. are located (A10) the 10th contractor and (A9) the 9th contractor with values of 0.5666 and 0.5255 were ranked ninth and tenth, respectively.

4. Conclusions

Given the key role of contractors in the success of projects, it is actually one of the concerns of employers to choose the best contractor among other competent contractors. Therefore, due to the different criteria in selecting contractors, the use of traditional and conventional methods has not been effective and the need to use new decision-making methods, including multi-criteria decision-making methods, can be effective. So the goal of this study is to present a new Marcos model for ranking contractors. Identifying the criteria for selecting contractors is the most effective step in selecting contractors. Because it can also play a vital role in choosing the best contractor, so that failure to correctly identify these criteria can lead to the selection of the wrong contractor and even the failure of the project. So project managers should focus on this by taking into account the views of experts and specialists and using their previous experiences. The problems caused by the selection of contractors in construction projects include: inefficiency and inadequacy of project metrics, lack of proper management practices such as cost reduction methods and project management approach and continuous changes in decision-making. In this study, the weight of the criteria was first calculated using the Shannon entropy method. The criteria for good track record, specialized certification and executive capacity and equipment with weights of 0.1343, 0.1342 and 0.1333 are ranked first to third respectively. With the highest weight and the most important criteria The degree of desirability of the options, the highest value of the anti-ideal coefficient (K_i^-) is 2.1708 and the highest value of the ideal coefficient (K_i^+) is 0.8572, which is related to the seventh contractor. The lowest value of anti-ideal coefficient (K_i^-) is 1.4797 and the lowest value of ideal coefficient (K_i^+) is 0.5843 for the ninth contractor. The value of S_i coefficient for anti-ideal (AAI), 0.3948 was obtained. The highest value of S_i coefficient is 0.8572 for the seventh contractor. Determining the optimal performance of the options, $f(K_i)$ and the final ranking using the Marcos model, in fact, the option with the highest optimal performance has the best rating. The results of the final ranking of the contractors show that the seventh contractor is in the first place with a value of 0.7710, the second contractor is in the second place with a value of 0.7002, and the first contractor is in the third place with a value of 0.6772. The 10th contractor and the 9th contractor with the values of 0.5666 and 0.5255 were ranked ninth and tenth, respectively. Ranking using the new Marcos method is much more accurate and simpler than other decision-making methods. Therefore, it is suggested to use the Marcos model for other contractor rating projects in future researches.