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DESIGNING A FRAMEWORK FOR SUBCONTRACTOR'S SELECTION IN CONSTRUCTION PROJECTS USING AN MCDM MODEL

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Research paper

Abstract: *The difficulties discovered in selecting subcontractors via a simple method of bid price as the main factor along with an initial screening of subcontractor properties impressed us to look at a little beyond the existing trend and offer a coherent procedure for this purpose. Despite this, we know that the main factor in outsourcing a project is a bid price and this is in full agreement with the existing circumstances of subcontractor selection in Iran, but the objective of this research was integrating all criteria with the same importance for selecting a subcontractor. The questionnaire was used for collecting initial data of research to pass through the Analytic Hierarchy Process (AHP) and Multi-Criteria Decision-Making (MCDM) model of Simple Additive Weighting (SAW). The findings showed the priority in subcontractors' selection as Hejrat Manesh Izeh (1), Khesht Sazan Karoun (2), Yeganeh saze omid (3), Sakht karan Moongasht (4), Darya Sanat Khavarmianeh (5), Omran mehragane Yosef (6) respectively. The present study offered a coherent procedure to select the subcontractor regardless of the bid price importance and integrating all interfering criteria in the same importance.*

Keywords: *Subcontractor, Construction projects, MCDM, Model*

1. Introduction

The construction industry is a well-developing and thriving industry in the world. The industry encompasses a huge budget of nations to implement road and building projects. The maintenance, lack of rework, use of innovative techniques comprised main aspects of advances in the construction industry. The aspects ensure the durability of construction projects with regard to the fact that this industry surrounds complex endeavors with a huge outlay and costs. That is why this industry

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expanded and included excellent opportunities for business and commerce. The government construction budget was around two billion two hundred and sixty-one million dollars for Khuzestan province in 2019. The Ahwaz municipality construction budget allocated around 91,058,000 USD. It has been spent a huge budget for other provinces too. We are reporting the budget associated with Khuzestan province because of project location in Iran. Nowadays, Iran is under the pressure of heavy sanctions that resulted in a recession of construction projects, but it will move towards progress levels by providing budget. To construct the projects, lots of private and semi-private companies participate in Iran. The procedure of contractor and subcontractor selection has been based on the bid price, and technical and professional experiences of companies (Jafari and Hassanpour, 2014).

Outsourcing construction projects to contractors and subcontractors is a common rule in lots of nations. The successful implementation of construction projects depends on solutions defined by in-charge organizations. The responsibility of the contractor is very weighting in comparison to the subcontractor. Actually, the subcontractor plays the second role in the implementation of a project, as suppliers of materials, manpower, equipment, tools, or assigns lots of specialists in this regard (Kumaraswamy and Matthews, 2000). The use of MCDM models in lots of projects containing various scales and vague dimensions to make a clear decision has been widely expanded. The influencing parameters make the designer, constructor and engineers to select the best choice among a series of items. To solve and hold back this kind of difficulty, a large number of models that are called MCDM models have been introduced. The circumstances of application and use of models are explained by Kahraman (2008), Zavadskas, and Turskis (2011), as the famous scientists in this regard, in a variety of studies. The selection of the best subcontractor, quality control, risk assessment, crisis management, reasons for delays in the project schedule, identification of causes of delay, value engineering also underwent MCDM systems and sensitivity analysis in terms of comparison of different models to make a decision by lots of studies. By the present study, we used an MCDM model to select the subcontractor for the project.

The subcontractors hold a prominent role with regard to the first contractor or firsthand contractor in such a way to be its effect around 70-90% of the total value of the project (Hinze and Tracey, 1994). Its role is ensuring the project well-implementation in parallel with a contractor role. The firsthand contractor takes the highest responsibility in the project development stage as a supervisor who involves upper hand supervisors from ruling organizations. The subcontractor is introduced to the project when the contractor has got financial support difficulties or encountered a peak in project construction, etc. So, hiring the subcontractor performs an especial task and influences the project performance and its completion. The selection of subcontractor came through some complex pathways such as the relationship with the firsthand contractor, relationship with the main supervisor of project or employer, selection based on financial ability, equipment and facilities ability, and selection by bids and beneficiary purposes and lots of other options and definitions (Clough et al., 2015).

Nowadays, company managers forced to comply with existing rules and take enough responsibility in better performing duties. On the other hand, the competition between stockholders and employers caused the definition of strict rules to improve their efficiency in the constructive processes. Following a certain

strategy is an important task to promote efficiency and performance (Lingard et al., 2017). Therefore, selecting the subcontractor is a good strategy to confer part of work to third parties with new breath in proceeding the task. However, the very important task is associated with circumstances of subcontractor selection in the defeat of successful proceeding the project. The subcontractor selection can experience lots of difficulties in terms of incomplete and biased, and lacking consideration to time, cost, and quality and safety standards from subcontractor and contractor sides.

Improper selection of subcontractors leads to delay, defeat, losing time, rework, and other kinds of project crises. Therefore, lots of cases and factors interfere with the right selection of subcontractors. The current research study attempting to select the subcontractor depends on the main criteria in a practical project that is being constructed in Iran now. The experts in completing the project were the consultants and executive managers, project engineers, and supervisors. The ranking and weighing systems were chosen to prioritize the options and alternatives and finally, the right decision was made for selecting the relevant subcontractor.

Many studies show the procedure to select subcontractors in construction projects, and some of them have defined conceptual frameworks, but in Iran, Khuzestan province, additional research is needed to be approached to choose subcontractors in the construction industry through the MCDM model. Since uncertainty always exists, one is always somewhere in the middle, somewhere between the extremes, etc. MCDM is concerned with structuring and solving decision and planning problems involving multiple criteria. The purpose is to support decision-makers who are facing such problems and decision-maker preference facilitates project development. The specific objectives of current research are stated below.

- Investigating the general subcontractor selection methods from existing literature.
- Conducting the questionnaire-based survey with Iranian construction experts to identify the significance of essential criteria in subcontractor selection.
- Evaluating the subcontractor competence and performance, based on the questionnaire to obtain the capacity of each subcontractor.
- Applying the MCDM model to select the best subcontractors in the construction industry by keeping the existing situations.

Generally, the present research objectives encompassed (1) important criteria selection, (2) subcontractor selection, (3) weighing and ranking alternatives, (4) subcontractor competence evaluation.

In Iran, due to the lack of a defined framework to select a subcontractor according to the existing situation in terms of the subcontractor's financial capacity, ownership of equipment for the project, compliance with administrative instructions and the subcontractor’s managerial capacity, this study considering the same importance of factors for tendering the construction projects has formulated important criteria in this regard. On the other hand, lots of companies participate in attracting the project, and in Iran, the project is assigned at the lowest bid price, regardless of other important factors involved in an apparent situation. Therefore,

questionnaires were designed with the cooperation of experts involved in the tendering of the project to solve the existing problem.

First, the authors tried to do a relevant literature review for the research and collect appropriate studies, then the criteria were chosen regarding the location of project and workplace conditions. Then, questionnaires were designed and distributed among experts to determine the main criteria of subcontractor selection and prequalification assay, and the results were presented in Tables. In the subcontractor competence assay, a questionnaire was distributed among the subcontractors to know the inventory list of each company, which included various parameters, such as 18 factors related to the equipment and devices required for the construction of the project. The other items consisted of various factors, most of which were associated to managerial aspects such as company's professional work experience records in implementing previous projects, professional experience of prominent staff, project purpose achievements, planning and managing ability, experience in similar contracts, HSE guidelines observation, expert workforces along with the bid price offered by each company to obtain the project. The questionnaires were analyzed according to different criteria and the results were further analyzed in tables and excel sheets according to the methodology. In the end, the weight and ranking systems used led to the selection of the best option.

2. Literature review

To conduct present research, we first tried to come through the literature review to understand and identify the criteria and most difficulties recognized in selecting the subcontractors. Also, it was taken into consideration the reasons for the defeat and success of conducted construction projects and a glance view based on weighing and ranking models employed in prioritizing the criteria and alternatives. A study reported the emergence of satisfaction from the employer for the implemented project regardless of the presence of main performance criteria in contractor selection. It was recommended by clients in South Africa and the universal construction industry (Bowen et al., 1997). Russell et al. (1992) applied the effects of 20 decision criteria via Spearman Rank Correlation analysis to find the major influencing criteria on contractor selection. So, it was found a series of major criteria including financial stability, experience, and past performance. A study came through a strong literature review pointing out the inclusion of the contractor's pre-qualification method as one of the main criteria in the tendering process (Holt et al., 1995). The competence screening step has carried out via interview, questionnaire, and various strategic methods with taking account of the global benchmarks in this field, contractors and subcontractors experiences, professionally completed projects, etc. The most important criteria have been detected to be economical soundness, technical ability, management capability, and the health and safety performance of contractors (Hatush and Skitmore, 1997a, b). The study of Doloi (2009) aimed to understand the quality of criteria selected (43 cases) to evaluate the performance of the project via multiple linear regression models. Sacks and Harel (2006) deployed a predictive model for assessing the subcontractor resources via game theory. The successful move of the project joined the relationship between managers and having strong commitments in going ahead. By research, 29 experts participated to demystify the scores of criteria in selecting the suitable sub-contractor via a

questionnaire survey supported by SPSS software analysis (Marzouk et al., 2013). The most important criteria have been realized to be the project price among criteria of quality, cooperation, and technical know-how in subcontractor selection by the multi-nominal model in Singapore (Hartmann, and Tan, 2009). The performance of the sub-contractor has been recognized to be an important point in conducting the objective of the project. The study revealed that 80-90% of Australian building projects outsourced to the subcontractor with regard to the affordability of contractors and consultants to move the project in terms of time, quality, and costs (Hinze and Tracy, 1994). The subcontractors play some prominent roles in project risks and take responsibilities against redeployment, hiring and firing of workers, and financial difficulties. However, reliable subcontractor selection will recede the difficulties experienced by the way. Sari and El-Sayegh (2007) suggested considering a collection of factors through the literature review for distinguishing the right criteria for a certain company among general factors, construction management factors, and general contracting factors. So, they will enable you to figure out the proper matrix of criteria for the construction management at-risk contractor. Akintan and Morledge (2013) assessed the relations between the main contractor and subcontractor based on qualitative and quantitative factors and connections between them via integrated project delivery and the last planner system. In the United Kingdom, the questionnaire was applied to assess a contractor view in terms of particular criteria of construction projects. The data were analyzed using SPSS software and taking into account the lowest-price wins principle (Wong and et al., 2000). In Singapore, industry-based contractors' selection was performed using questionnaires and criteria and alternative choices. Findings manifested to offer the most important criteria for the criterion of contractor professional experience (Singh and Tiong, 2006). In Australia, the questionnaire method was used to assay the relationship among 20 contractors in a selection program. The questionnaire included three main success reasons for the project such as time, quality, and outlay. Findings comprised a set of contributed criteria with identifying the most and least interfering criteria (Hatush and Skitmore, 1998). Kumaraswamy and Matthews (2000) used the questionnaire procedure to select the subcontractor regarding 20-step interviews. So, it showed the subcontractor's thrift by 10% of outlays in tender price and promoting the time and quality performances in the project. Maturana et al. (2007) took the questionnaire procedure to select subcontractors from among 29 cases. The performance was reported by the contractor's experience mostly.

It has been used as an algorithm for the selection of sub-contractor pertaining to fuzzy preference relation, from a mathematical point of view containing an example regarding the criteria of reputation, technical capabilities, financial situation, and organizational skills (Ibadov, 2015). AHP was taken into consideration to select the subcontractor via a questionnaire participated by 29 persons with allocating some criteria and alternatives extracted from the literature review in Putrajaya, Malaysia (Manoharan, 2005). Li et al. (2007) accepted the prequalification screening step as a standard procedure in sub-contractor selection. They passed through the step in a tunnel construction project based on a fuzzy approach to prioritize the criteria and alternatives in China. Juan et al. (2009) applied a hybrid approach combining fuzzy set theory and quality function deployment to set up a housing refurbishment contractor selection model with lots of criteria and alternatives. The developed model passed through the sensitivity analysis via another MCDM model such as Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE)

successfully. Araujo, et al. (2015) approached to objectives of his research for contractor selection by paying attention to a set of contractors, resources, and limitations by assigning MCDM models such as group decision and Integer Programming, Delphi, and PROMETHEEGDSS models. In the United Kingdom, utility theory was exploited to contractor selection via MCDM models along with bid price assessment (Hatush and Skitmore, 1998). In India, a questionnaire passed out among project managers to evaluate the contractor based on theoretical methods. In the following step, MCDM models of TOPSIS and Grey-SAW determined the best option considering bids and financial affordability (Puri and Tiwari, 2014). In Hong Kong, a study underpins the framework of a matrix of data for best contractor selection via AHP joined to MCDM models in a variety of scenarios along with a minimum bid (Fong and Choi, 2000). Ng and Luu (2008) proposed a case-based intellectual model for selecting subcontractors. The technical aspect of performing the contract was pointed out to be a point for the decision-making process and developing standards and frameworks of subcontractor selection.

Borujeni and Gitinavard (2017) studied the mining contractor selection problem via a hesitation phase compromise model. The weighing and ranking of alternatives were followed with a sensitivity analysis to promote the accuracy and precision of results. Chiang and et al. (2017) used the AHP to find important aspects in selecting contractors during the bidding phase via identifying the appropriate criteria and embarking the criteria in a hierarchical structure collecting opinions of experts for making a decision matrix. Cheaitou et al. (2019) have done a case study to select the efficient contractor in a public organization via MCDM models and fuzzy logic theory following with data envelopment analysis. So, in terms of the efficient contractors identified in the United Arab Emirates, Mirmousa, and Dehnavi (2016) used MCDM models for the supplier selection purpose in Yazd, Iran. By the way, 43 important criteria were chosen and then around 14 criteria were confirmed for further processing in the questionnaire designed. Further processing was completed by 11 experts and data passed through the decision making systems to rank and weight alternatives. By Morkunaite et al. (2019), contractor selection passed through the quantitative and qualitative criteria, weighing system of AHP and evaluation in the PROMETHEE model. Stević et al. (2020) used Measurement Alternatives and Ranking according to the Compromise Solution (MARCOS) model to select the sustainable supplier for the healthcare industry in Bosnia and Herzegovina. To classify and rank the matrix of 8×21 alternative × criteria, the MARCOS model was assigned along with a sensitivity analysis including rank reversal and findings of other MCDM model.

3. Methodology

3.1. Research design

The survey questionnaire procedure was used to collect the data and literature review and the authors' experiences were taken into account for the right selection of criteria and alternatives. The literature review was also used to select criteria. The present project is a building construction and is currently being developed in Khuzestan, Iran. The present project has included the area of a school to be built and is located in Ahvaz, Khuzestan province, Iran. The main contractor of the project was Shahin Niloofar Jangi Company and all consultants had been recruited based on the

lowest bid price and competitive tender, and coincidentally. The supervision of the project was undertaken by the first contractor and government office of the School Innovation and Equipment Department in Khuzestan, Iran. The Khuzestan province is located in the southwest of Iran, as a neighbor with Iraq and the Persian Gulf, covering an area of 63, 238 km^2. The total built-up area of the building was 2800 m^2. The main structure of the building was structural steelwork and this paper tried to select a subcontractor through a MCDM model. The main contractor, Shahin Niloofar Jangi Company, had been invited to undertake the project with described conditions. The Figure 1 displays the steps undergone by conducted research.

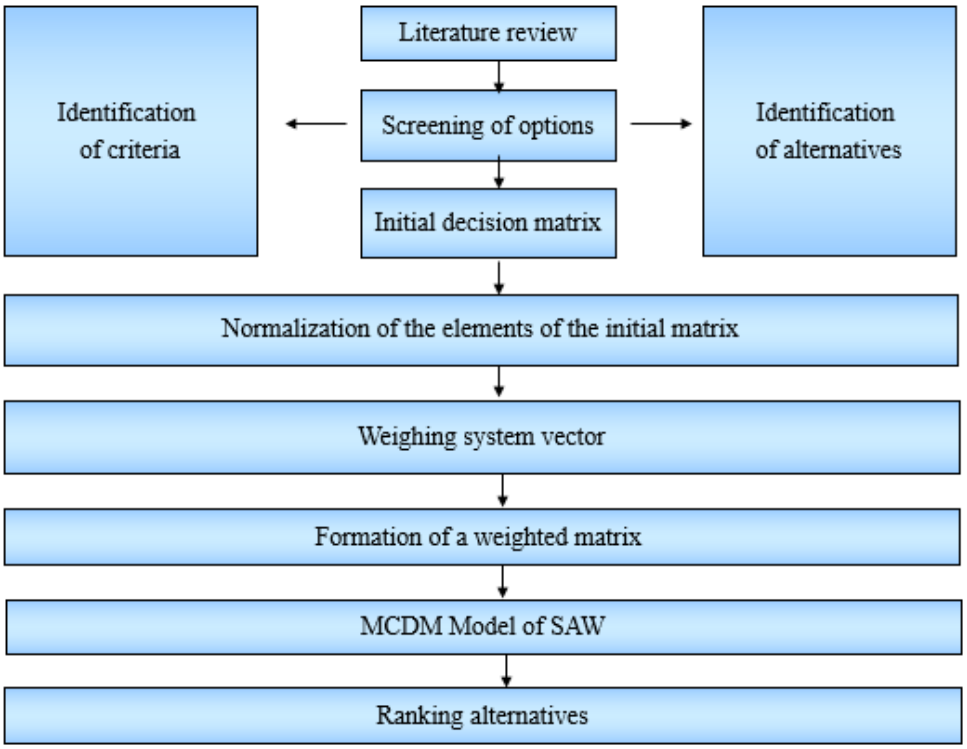

Figure 1. Flowchart of the conducted research

3.2. AHP method

AHP, introduced by Saaty in the 1980s, is a popular MCDM instrument. It consists of a defined mathematical structure built over consistent matrices and associated with Eigenvectors to derive the true weights of compared criteria. Although the AHP technique is more than three-decade-old, its flexibility and robustness keep it in use as a reliable method. The AHP method used in this study is the result of a multiplication of the criteria ($\alpha ij\ I$) with an inverse exponent of criteria numbers ($1/K$) according to Equation 1. Then, the values in columns (Xij) have been divided by the sum of them according to Equation 2.

$$Xij = \left(\prod_{I=1}^{k} \alpha ij\, I\right)^{1/K}, I = 1,2,\dots,K \;\; i,j = 1,2,\dots,n, i \neq j \quad (1)$$

One of the reasons for using the AHP method, which also states the advantages of this weighting method, is the fact that it has the ability to determine the weight of both quantitative and qualitative criteria. It has been introduced as one of the methods with a high degree of reliability because it has a strong theory and is formulated based on obvious principles (Stankovic et al., 2019).

3.3. SAW Model

It is a long time that the SAW model has been used to solve various uncertainties in global world challenges. The model of SAW is one of the simplest methods of MCDM techniques, which can be easily used in ranking the alternatives. To use this method, the decision matrix is normalized by the linear conversion method and then the weighted and normalized values are added together to determine the ranking values of alternatives (subcontractors). Its framework is composed of two simple equations. By Equations 2 and 3, *Xij, R* and *Wj* are the values, ranked, and weighted values respectively. The normalization of the decision matrix was done based on Equation (2) (Hassanpour and Pamucar, 2019). It is needed to explain that *Xij* is the values for the SAW model.

$$\mathrm{Pij} = \frac{\mathrm{Xij}}{\sum_{i=1}^{n} xij} \qquad i = \Gamma, m; \;\; j = \Gamma, n \quad (2)$$

$$\mathrm{R} = \sum (Pij \,.\, Wj) \quad (3)$$

4. Result and discussion

Lots of criteria are interfered with in selecting the best-qualified subcontractors. The criteria were listed in two separate questionnaires and the opinions of Decision Makers (DM) who were holding enough experience and knowledge in this regard were used. The numerical values of 1, 2, 3, 4, 5, 6, and 7 for the criteria encompassed linguistic words as very low, low, slightly low, medium, slightly high, high, and very high in questionnaires respectively. The main criteria used in a separate questionnaire encompass the following according to Table 1.

The DM reached to priority and importance of main subcontractor selection factors as Tender price > Executive Human Resource = Good performance in previous projects > Equipment, tools and machinery ability > Management and planning ability = Experience in similar projects = HSE instructions. According to Table 1, we figured out that the main criterion in outsourcing a project is a bid price and this is in full agreement with the existing circumstances of subcontractor selection in Iran. However, the objective of this research was integrating all criteria with the same importance. It means the bid price is held back and lots of criteria are interfering in subcontractor selection. That is why this research attempted to offer a coherent procedure to be taken into consideration. The criteria taken into account

for conducting this study comprised the below cases in full detail. In Table 2, the full names of criteria are as 400 amp diesel welding motor (C_1), CNC drill (C_2), Rectifier (C_3), H-instrument (C_4), 7-function punch scissors (C_5), Round drill (C_6), Drill Magnet (Magnet) (C_7), 8 ton tower crane (C_8), Powder under welding machine (C_9), Wind compressor 8 times (C_{10}), Fire saw (C_{11}), Diesel generator (C_{12}), 5, 10, 15 ton crane (C_{13}), Truck for cargo transportation (C_{14}), Air capsules (C_{15}), 10 ton jack (C_{16}), Handheld electrode heater (C_{17}), Grinding stone wall machine (C_{18}), other aspects (C_{19}). Also, the remaining symbols are Company (CO), Number of devices and facilities (N), Ownership (O), Score (S), Professional Experience (PE), Professional Experience of Prominent Staff (PEPS), Project purpose achievements (Ppa), Planning and managing ability (Pma), Experience in similar contracts (Esc), HSE guidelines consideration (HSEgc), Expert workforces (Ewf), Bid price (Bp).

In Table 2, lots of various criteria are actually composed of two parts (qualitative and quantitative aspects). The C_1-C_{18} that are the same among companies in three rows of N, O, and S representing the inventory list of each company, which has included various parameters, belong to the equipment and devices required for the construction of the project. The second part included the other items (C_{19}) consisted of various criteria, most of which were associated to the company's professional work experience records in implementing previous projects and the bid price offered by each company to obtain the project, such as PE, PEPS, Ppa, Pma, Esc, HSEgc, Ewf, and Bp. Table 2 was arranged to include all criteria together as the research design of the current study. The data were gone through the normalization step and then the values of the weights were assigned to determine the final weights. The AHP method was used as the weighing system of this study. Its procedure accounts for the values of tables to be multiplied with each other and then reaches to the exponential reverse of numbers. Finally, each number was divided into the sum of amounts released via the exponential reverse of numbers.

Table 3 denotes the values of weights obtained by the AHP and SAW models. According to Table 3, the highest weight was devoted to the criterion of N in both systems of AHP and SAW models because of variations in the number of devices, tools, and equipment applied. Reasonable results appeared by the current research with looking at the values of Bp that were as $ 8055.55, $ 10000, $ 9166.66, $ 6666.66, $ 8333.33, and $ 7500 for the companies of Hejrat Manesh Izeh (1), Khesht Sazan Karoun (2), Yeganeh saze omid (3), Sakht karan Moongasht (4), Darya Sanat Khavarmianeh (5), Omran mehragane Yosef (6) respectively.

Table 1. The main criteria of subcontractor selection by DM opinion

Main Criteria	Equipment, tools and machinery ability	Good performance in previous projects	Management and planning ability	Experience in similar projects	HSE instructions	Executive Human Resources	Tender price
DM	5	6	3	3	3	6	7

Table 2. The criteria for subcontractor selection

CO/criteria		C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}	C_{18}	C_{19}
	N	3	2	1	1	2	1	1	-	1	1	1	1	1	1	3	-	2	2	-
	O	1	1	0.5	0.5	1	0.5	0.5	-	1	0.5	1	1	0.5	0.5	1	-	1	1	-
	S	1	-	0.5	0.5	1	0.5	0.5	-	1	0.5	1	1	-	0.5	1	-	1	-	-
(1)	PE																			5
	PEPS																			7
	Ppa																			6
	Pma																			1*
	Esc																			3*
	HSEgc																			1*
	Ewf																			4*
	Bp																			1
	N	3	1	4	1	1	2	1	-	-	1	1	2	1	1	1	-	1	1	-
	O	1	1	1	0.5	1	1	0.5	-	-	0.5	1	0.5	0.5	0.5	1	-	1	0.5	-
	S	1	1	1	0.5	-	-	0.5	-	-	0.5	1	0.5	-	0.5	1	-	1	0.5	-
(2)	PE																			5
	PEPS																			6
	Ppa																			6
	Pma																			1*
	Esc																			1*
	HSEgc																			1*

	Ewf																			4.5*
	Bp																			3
	N	2	1	2	1	3	4	2	-	2	1	2	2	1	2	4	-	2	2	-
	O	1	1	0.5	0.5	1	1	0.5	-	1	0.5	1	0.5	0.5	0.5	1	-	0.5	1	-
	S	1	1	0.5	0.5	1	1	0.5	-	1	-	1	0.5	0.5	0.5	1	-	0.5	1	-
(3)	PE																			6
	PEPS																			5
	Ppa																			5
	Pma																			1*
	Esc																			1*
	HSEgc																			1*
	Ewf																			5*
	Bp																			4
	N	1	2	1	1	2	2	2	-	2	2	2	1	1	-	3	-	1	2	-
	O	1	0.5	1	0.5	0.5	0.5	1	-	1	0.5	1	1	0.5	-	1	-	0.5	0.5	-
	S	1	0.5	1	-	0.5	0.5	1	-	-	0.5	1	1	0.5	-	-	-	0.5	0.5	-
(4)	PE																			6
	PEPS																			5
	Ppa																			5
	Pma																			1*
	Esc																			2.5*
	HSEgc																			-
	Ewf																			5.5*
	Bp																			2
	N	1	2	1	3	1	2	2	-	-	2	2	1	1	-	1	-	-	2	-
(5)	O	1	0.5	1	1	0.5	1	1	-	-	0.5	1	1	0.5	-	1	-	-	0.5	-
	S	1	0.	1	-	0.	0.5	1	-	-	0.5	-	-	0.5	-	1	-	-	0.5	-

			5			5														
	PE																			6
	PEPS																			4
	Ppa																			5
	Pma																			1*
	Esc																			2*
	HSEgc																			1*
	Ewf																			6*
	Bp																			5
	N	2	2	2	1	-	2	1	-	1	-	2	1	-	1	2	1	1	2	-
	O	1	1	1	0.5	-	1	0.5	-	0.5	-	1	0.5	-	0.5	1	0.5	0.5	1	-
	S	1	1	-	0.5	-	-	0.5	-	0.5	-	1	0.5	-	0.5	1	0.5	0.5	-	-
	PE																			6
(6)	PEPS																			5
	Ppa																			6
	Pma																			2*
	Esc																			1*
	HSEgc																			0.5*
	Ewf																			6*
	Bp																			6

Ownership=1, Rented=0.5, Full score=1, No score=0, Medium score=0.5

*Sum of scores depends on the number of managers and professional experience

Khesht Sazan Karoun (1), Darya Sanat Khavarmianeh (2), Hejrat Manesh Izeh (3), Yeganeh saze omid (4), Omran mehragane Yosef (5), Sakht karan Moongasht (6)

Table 3.: The values of weights in AHP method and ranks for alternatives

	CO/Criteria	AHP	SAW	Rank
(1)	N	0.48226106	3.954540667	2
	O	0.26102609	1.148514787	
	S	0.25671286	0.872823707	
	PE	0.17857143	0.031887755	
	PEPS	0.25	0.0625	
	Ppa	0.21428571	0.045918367	
	Pma	0.03571429	0.00127551	
	Esc	0.10714286	0.107142857	
	HSEgc	0.03571429	0.00127551	
	Ewf	0.14285714	0.020408163	
	Bp	0.03571429	0.00127551	6.247
(2)	N	0.47499271	3.609944573	5
	O	0.26553607	1.137379511	
	S	0.25947122	0.808685304	
	PE	0.18181818	0.033057851	
	PEPS	0.21818182	0.047603306	
	Ppa	0.21818182	0.047603306	
	Pma	0.03636364	0.001322314	
	Esc	0.03636364	0.001322314	
	HSEgc	0.03636364	0.001322314	
	Ewf	0.16363636	0.02677686	
	Bp	0.10909091	0.011900826	5.727
(3)	N	0.56798939	5.263368325	1
	O	0.21351003	0.754402092	
	S	0.21850059	0.699201876	
	PE	0.21428571	0.045918367	
	PEPS	0.17857143	0.031887755	
	Ppa	0.17857143	0.031887755	
	Pma	0.03571429	0.00127551	
	Esc	0.03571429	0.00127551	
	HSEgc	0.03571429	0.00127551	
	Ewf	0.17857143	0.031887755	
	Bp	0.14285714	0.020408163	6.882
(4)	N	0.53410426	4.495377498	3
	O	0.23698415	0.888690549	
	S	0.2289116	0.648582857	
	PE	0.22222222	0.049382716	
	PEPS	0.18518519	0.034293553	
	Ppa	0.18518519	0.034293553	
	Pma	0.03703704	0.001371742	
	Esc	0.09259259	0.008573388	
	HSEgc	0	0	
	Ewf	0.2037037	0.041495199	
	Bp	0.07407407	0.005486968	6.2
(5)	N	0.51243088	3.751726	6
	O	0.26194853	0.991662	
	S	0.22562059	0.539878	

	PE	0.2	0.04	
	PEPS	0.13333333	0.017777778	
	Ppa	0.16666667	0.027777778	
	Pma	0.03333333	0.001111111	
	Esc	0.06666667	0.004444444	
	HSEgc	0.03333333	0.001111111	
	Ewf	0.2	0.04	
	Bp	0.16666667	0.027777778	5.44
(6)	N	0.51153388	3.83650408	4
	O	0.25576694	0.95912602	
	S	0.23269918	0.83174796	
	PE	0.18461539	0.03408284	
	PEPS	0.15384615	0.023668639	
	Ppa	0.18461539	0.03408284	
	Pma	0.06153846	0.003786982	
	Esc	0.03076923	0.000946746	
	HSEgc	0.01538462	0.000236686	
	Ewf	0.18461539	0.03408284	
	Bp	0.18461539	0.03408284	5.8

5. Conclusion

The challenges posed in subcontractor selection based on the lowest bid price seem to be forgotten by considering and taking into account the same importance for all criteria. By the way, it conducts an easy way for in-charge staff to recede the difficulties, challenges, and argues in subcontractor selection. The SAW model used had a relevant connection for all partitions and released the ranks in a reasonable and discernible way. The findings and procedures of the current study can be taken into consideration across Iran and other nations. It can be concluded that the lowest bid price cannot be a strong decision in holding back the construction crises unless there are lots of interfering criteria in this regard. The sensitivity analysis ignored to verify the implemented method because of variation raised in contents of Table 3 and difficulties in research design based on existing conditions and circumstances in tendering. That is why future research orientation may include lots of criteria and factors despite we took important matters in Iranian projects. The bid price also converted to crisp numbers to rise the precision and accuracy applied in the objective followed. We hopefully declare the civil engineers will extend the procedure and questionnaire designed in the workplace to choose the right subcontractors in future plans.

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