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Managerial Evaluation of Construction Contractors in the Selection Process

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Abstract: The construction industry significantly influences the nations' economies. Selecting an eligible contractor in the process of construction management is indispensable to successful completion of a construction project. This research proposes an integrated decision making model for construction contractor selection, along with a method to identify managerial decision criteria. The proposed model shows how the priorities of clients in terms of the managerial dimensions of time, cost, quality and safety can be taken into consideration in the contractor selection process. To identify the most important and efficacious evaluation criteria in each dimension of time, cost, safety, and quality, the incorporation of expert judgments and non-parametric statistical techniques is suggested. In this regard, a survey was conducted, and non-parametric statistical techniques were used for analyzing the outcomes of the survey. The results have also been examined in a case study.

Keywords: construction management, construction contractor qualification, tendering, decision criteria, non-parametric statistics, Analytical Hierarchy Process.

INTRODUCTION

The construction sector significantly contributes to the economy of developed and developing countries. For example, in 2011, the value-added of the construction industry in the United States as a percentage of GDP was about 3.4% [33]. Moreover, this industry provides infruatrusture, utility facilties, and several other amenities for the public. The sensivity of the construction industry, along with its relative complexity and volatility, requires special attention to construction management challenges, one of which is contractor selection. Since contractors play a major role in the success of construction projects, contractor selection is considered to be a critical decision making process within the scope of construction management.

In practice, various procedures such as open, selective, or restricted tendering, prequalification, negotiation, and mixed procedures are used for contractor evaluation and selection. In an open tendering method, any contractor can submit a tender, and after the bid evaluation, the best bidder is selected for the project. When special technology or expertise is required for a construction project, the client may choose selective or restrictive tendering method, and only qualified contractors who can fulfill the project requirements can attend the tendering process.

Prequalification is a screening phase in which the client establishes the project's minimum requirements, and any potential contractors whose capabilities do not meet these requirements would not be considered for the second evaluation phase. In a situation where neither of these methods is applicable, when some special technical or financial conditions are present, or when there is an emergency situation, a negotiation procedure is employed [23, 24, 32]. However, some of the applied procedures are still based on the minimum proposed contract price [13, 21], which is one of the major causes of delays in projects [9, 10, 29, 31].

Although the contractor selection literature is rich and various techniques have been developed, the proposed model in the current study is unique due to its proposed technique and the list of managerial criteria. An integrated decision model, along with a technique for identifying the decision criteria for the evaluation of construction contractors, has been proposed in this study. The developed model shows how priorities of clients in terms of managerial dimensions of time, cost, quality, and safety can be accounted for in the contractor selection process. Due to the various benefits of non-parametric statistics and its widespread application, it is proposed to use it in combination with an expert judgment technique to consider managerial dimensions in the contractor selection process. In this regard, a questionnaire survey was developed and distributed among experts in the Iranian construction contractors to identify the most important contractor selection criteria in each managerial dimension, and the key outcomes of the survey were analyzed based on non-parametric statistical techniques. The applicability of the results has also been examined in a case-study.

LITERATURE REVIEW

Contractor selection requires the assessment of numerous candidates against a set of decision criteria that is usually based on past performance [10]. Contractors' past performance can be documented using project management information systems [30]. Many researchers in this field highlighted a link between a project's success and the contractor selection process [9, 17, 26]. Therefore, the contractor selection process is considered to be a complex and challenging decision. The difficulties of the decision stem from several factors such as uncertainties, lack of information, and complexity in judgments [1, 7, 34].

Due to the importance of the subject, contractor selection has been studied for decades and various methods and tools regarding prequalification, qualification, and evaluation criteria have been proposed. These studies have been categorized in some studies [10] into four types of models, process, criteria, and miscellaneous. According to [10], more than half of the studies focused on contractor selection models. In this section, some of the studies with the most relevance to current research were reviewed.

Regarding prequalification and qualification methods, a Highlight Optimum Legitimate Tender (HOLT) technique has been proposed in the literature [11] as a quantitative multi-attribute based model, which consists of a three tier process. Another multi-approach methods for contractor evaluation and selection is offered in [12]. The proposed methods included bespoke approaches, multi-attribute analysis, multi-attribute utility theory, cluster analysis, multi-regression, fuzzy sets theory, and multivariate discriminate analysis.

The PERT-based methodology [9] is a prequalification and bid evaluation method. Another model for contractor prequalification developed based on cross-sectional surveys in Hong Kong is presented in [24]. This model considers client goals, as well as project level risks and conditions in the analyzing process.

A multi-criteria decision support system for contractor selection is proposed in [32], in which, the Delphi method is used to determine the importance weight of every appraisal criterion.
One of the more notable research studies of this topic is presented in [32] in which a model for construction contractor selection is developed. The model has two main stages: a contractor prequalification stage and a contractor selection stage among the prequalified contractors. According to this work, since high project performance and quality of work are two major objectives for clients, time and quality as two key dimensions are proposed for consideration in the prequalification stage. For the second stage, in addition to dimensions of time and quality, [32] proposed cost to be accounted for as the third dimension.

By using a hybrid model, combining Analytical Hierarchy Process (AHP), Neural Network (NN) and Genetic Algorithm (GA), a pre-qualification model for the contractor selection process in suggested in [7]. Another notable work is presented in [2] in which a web-based sub-contractor evaluation system (WEBSES) is proposed, by which the subcontractors can be evaluated by general contractors based on different criteria. A construction contractor selection technique using SAW_G and TOPSIS Grey techniques is proposed in [35]. In a similar way, a decision support system for selecting a contracting strategy in highway projects is presented in [5].

A study that investigates the factors affecting bid or not-bid decision processes and their relative importance is [4]. According to this study, contractors' attributes significantly affect the assessing process of the relative importance of factors. The study concluded that contractor size, classification, type, and client type were the most important contractors' attributes.

Contractor selection is a multi-criteria decision making process; therefore, decision criteria are the key inputs of the process. 35 prequalification criteria have been determined in [22] as the result of a previous study and knowledge acquired from professionals in the UK construction industry. This study determined the importance of those criteria by conducting a questionnaire survey. This study identified the top ten criteria selected by governmental authorities as being: financial stability, performance, fraudulent activity, contract failure, stability of firm, progress of work, health and safety, previous debarment, competitiveness, and standard of quality. Another relevant work is [34], in which the principal categories for contractor evaluation criteria are determined based on the literature and a conducted survey. According to [34], the most important criteria fall in the categories of managerial and technical skills, reputation and past experience, past performance, and the proposed method of delivery. Based on a survey conducted in Poland [25], the main criteria considered by public clients for contractor evaluation have been classified into five main criteria and 21 sub-criteria. The main criteria established based on literature include: technical ability, reputation, financial standing, management capability, health and safety.

Another example of other studies that categorized the evaluation criteria for contractor selection purposes is [15] in which categories are presented as follows: 1.Financial standing 2.Technical ability 3.Management capability 4.Quality, safety, and senior management 5. Current projects/backlogs.

In the literature, some of the contractor selection studies focused on specific construction work or on the tendering system of a specific country. Examples include [16] with a focus on contractor selection for housing retrofit projects, [3] in which the contractor selection for highway pavements projects was studied, [20] with a focus on Iranian tendering systems, and [36] as well as [32] with a focus on European tendering systems.

PROPOSED CONSTRUCTION CONTRACTOR EVALUATION MODEL

For developing a practical model for construction contractor selection, after conducting a literature review on the related topics, the status-quo of tendering systems in some Iranian oil companies was investigated. For this purpose, a questionnaire was developed and administered. The questionnaire, called Questionnaire 1, contained four parts. The first two parts were designed to investigate the company's prequalification and tendering systems. Parts 3 and 4 are consisted some questions concerning background information of the respondents and the companies in which they were working.

The main purpose of the last two parts was to analyze the results of Parts 1 and 2. Based upon the results of the survey and the literature, a decision model for contractor evaluation and selection is offered (see Fig-1). With dividing the evaluation process into different phases, the proposed model facilitates the decision making process, especially for complex construction projects. Moreover, the model invites clients to put emphasis on evaluations of contractors in each managerial dimension of time, cost, quality, and safety separately. This helps clients to reduce risks of each managerial aspect in association with the project as much as possible.

The proposed model includes four main stages. Due to the diversity of construction contractors in different disciplines, the first step of the model proposes that clients prequalify contractors in a regular manner, and develop a database for potential candidate contractors based on the prequalification. The database might entail contractors' key attributes, such as size, main expertise, financial records, types of projects, in which they have been involved, safety records, and other helpful background information. Moreover, in the database, clients are invited to classify contractors based on their sizes and fields of expertise, which can be based on the Construction Specification Institute (CSI) format [6]. By classifying contractors, clients can save time and effort in updating of the database for new contractor selection assignments.

For the purpose of managerial evaluation of the prequalified contractors in the bidding process, Stage 2 proposes to identify the most important criteria in each dimension of time, cost, quality and safety. The proposed method for developing the criteria in each dimension is described in Section 4.

At the third stage, a project-specific evaluation process is proposed to be implemented, involving only those candidate contractors who, according to the prequalification database, are in the same project category. In other words, to select a contractor for a specific project, tender documents will be sent out only to prequalified contractors whose attributes best fit the project's needs. The evaluation in this phase includes both technical and managerial criteria.

To evaluate contractors in the bidding process, it is suggested to identify the relative importance of the managerial and technical dimensions, and the most important criteria in each dimension based on projects' requirements. For determining the weights, a Multi Criteria decision Making (MCDM) technique, such as AHP, can be utilized. MCDM techniques help decision makers consider a broad list of evaluation criteria with different value systems. Moreover, MCDM techniques facilitate debates among decision makers regarding the relative importance of criteria [8].

At the fourth stage, it is suggested that clients evaluate the performance of the selected contractors in the project and update the database of contractors accordingly. This approach encourages the contractors to provide their best possible services in projects because they are aware of the fact that their performances would be monitored which could affect their future positions in the market. This approach cannot be taken unless clients keep track of major changes in the contractors' organizations to ensure the accuracy of their databases.

PROPOSED CRITERIA DEVELOPMENT METHOD

With respect to the importance of the four managerial dimensions of time, cost, quality, and safety in construction projects, clients are proposed to conduct contractors' evaluation in each managerial dimension separately in addition to the technical dimension. The proposed method can provide a higher degree of confidence to project teams so that the result of the contractor selection process better addresses the requirements of a challenging construction environment.

For this purpose, the following steps are suggested:

1. From a list of the primary criteria, the most important ones in each managerial dimension is to be selected by a combination of expert judgment and non-parametric statistical techniques. In this regard, clients' strategic targets and requirements are taken into account for selecting the criteria.
2. Then, it is suggested that for every specific project, the relative importance of the selected criteria in each dimension and the importance weight of each dimension be determined by a MCDM technique and based on projects' requirements. It is obvious that the technical criteria should also be developed and weighted in accordance with projects' targets.

Proposing non-parametric statistics for identifying the most important criteria in each managerial dimension stems from several advantages. For instance, wide ranges of methods can be used and compared for analyzing a set of data; moreover, these tests do not require restrictive assumptions about the population and sample size.

In summary, the proposed evaluation method enables clients to measure the capabilities of contractors and rank them based on not only the needs of the projects at hand, but also according to the strategic objectives of their companies.

Moreover, the proposed method helps clients to significantly reduce the managerial risks of projects due to incapability of contractors.

Step 1 of the proposed criteria development method, identifying the most efficacious criteria, was examined in this research. For this purpose, the following steps were taken.

Determination of the primary criteria

On the basis of the literature, such as the works performed in [37] and [28], and the results of Questionnaire 1, a primary list of criteria was developed (see

Table-1).

Defining the sample size

According to an investigation carried out by the Comprehensive Planning Department of the National Iranian Oil Company (NIOC), it was determined that the population of experts in the Iranian oil industry was following a normal distribution. To determine the required number of samples to determine the required number of respondents to Questionnaire 2, the following two questions had to be answered:

1. Is the statistical population of experts limited or not?
2. Is the variable quantitative or qualitative?

Based on the answers to the above questions, an appropriate formula for determining the number of required respondents had to be selected (see

Table-2). As the number of the experts in NIOC was not indefinite, Equation 1 of

Table-2 was used to determine the sample size:

$$n = \frac{N z_{\alpha/2}{}^2 s^2}{(N-1)d^2 + z_{\alpha/2}{}^2 s^2} \qquad \textbf{Equation 1}$$

In which:

N is the statistical population size which was estimated to be equal to 500 according to the information collected from the Comprehensive Planning Department of NIOC

S is the standard deviation of a pilot study that was conducted to estimate the error magnitude. S was calculated as being 1.5.

$1-\alpha$ is the confidence interval

d is the amount of estimation error calculated using Equation 2:

$$d = \left| \mu - \overline{x} \right| \qquad \textbf{Equation 2}$$

d was assumed to be 0.2 so the sample size was calculated using Equation 3:

$$n = \frac{500*3.84*(1.5^2)}{499*(.2^2)+3.84*(1.5^2)} = 151 \qquad \textbf{Equation 3}$$

Based on the results of the conducted pilot study and by using Equation 1 with an estimation error of 0.2, the number of required respondents was calculated to be 151.

Identifying the importance of criteria in each managerial dimension

After conducting the pilot study and determining the sample size, a questionnaire, called Questionnaire 2, was designed to solicit experts' judgments regarding the key criteria as well as their priority in each four dimensions of time, cost, quality, and safety, as well as the "project as a whole".

For rating the effect of the criteria on each dimension, the following rating scale was used in Questionnaire 2:

Score 0: It does not have any effect.
Score 1: It has a low effect.
Score 2: It has a low-moderate effect.
Score 3: It has a moderate effect.
Score 4: It has a moderate-strong effect.
Score 5: It has a strong effect

Analyzing the results

For analyzing the results of Questionnaire 2, non-parametric statistical techniques including Binomial test, Freidman test, Principal Component test, and Cluster analysis test were used**.**

Binomial test

In this research, the binomial test was used to define the most important criteria in each dimension of time, cost, quality, and safety. By using the test, those criteria whose importance was greater than 3 for more than 60% of the respondents at the confidence level of 95% were accepted as the most effective criteria in each dimension. The results are shown in Table-3 through Table-6. The test can be depicted as expressed in Equation 4.

$$\begin{cases} H_0 : P \leq 0.6 \\ H_1 : P > 0.6 \end{cases} \qquad \textbf{Equation 4}$$

Freidman test

This test was used to rank and sort the most important criteria chosen by the Binomial test. The main assumption of the Freidman test was that each observation (questionnaire response) on each variable (criterion) was independent from other observations. The results are shown in a separate column of Table 3 through Table-6. The results of this test may help clients in identifying the importance weight of the criteria.

Principal component analysis

Under certain circumstances, it might be challenging for clients to deal with multidimensional datasets in the evaluation of a large number of contractors, or clients who believe that there are correlations between dimensions; therefore, it might be difficult for them to decide the relative importance of all the dimensions in their projects. One helpful method for reducing the dimensions of datasets is the principal component analysis (PCA). In cases, where decision-makers believe that there are correlations between dimensions, PCA helps them consider the small number of uncorrelated components which account for a meaningful amount of variance in the primary dataset [19]. The new components of PCA are linear combinations of the original data.

Table-7 shows the results of PCA conducted in this research by IBM SPSS Statistics software. The eigenvalues indicates the amounts of components' variances in the original dimensions. By dividing the eigenvalues by the total variance, the proportion of the variance of each component can be calculated. One of the most-widely used methods to determine which components can be ignored is the Kaiser criterion, based on which, only the components with eigenvalues greater than one will be retained, and the rest will be ignored. Based on this method, component 1 with the variance of 2.504, accounted for 62.61% of the total variance; and component 2 with the variance of 1.093 accounted for 27.31% of the total variance will be retained. Therefore, components 1 and 2 can replace the original four dimensions with the loss of approximately 10% information. As it can be seen in Table-8 (component matrix) and Fig-2 (component loading plot), the first component is loaded positively and highly on the variables V1 (time), V2 (cost), V3 (quality), and the second component is loaded positively and highly on variable V4 (safety). For each new component, the importance values are calculated

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by multiplying the standardized variables' values (standardized importance of each criterion in each dimension) by the component coefficients (Table 9).

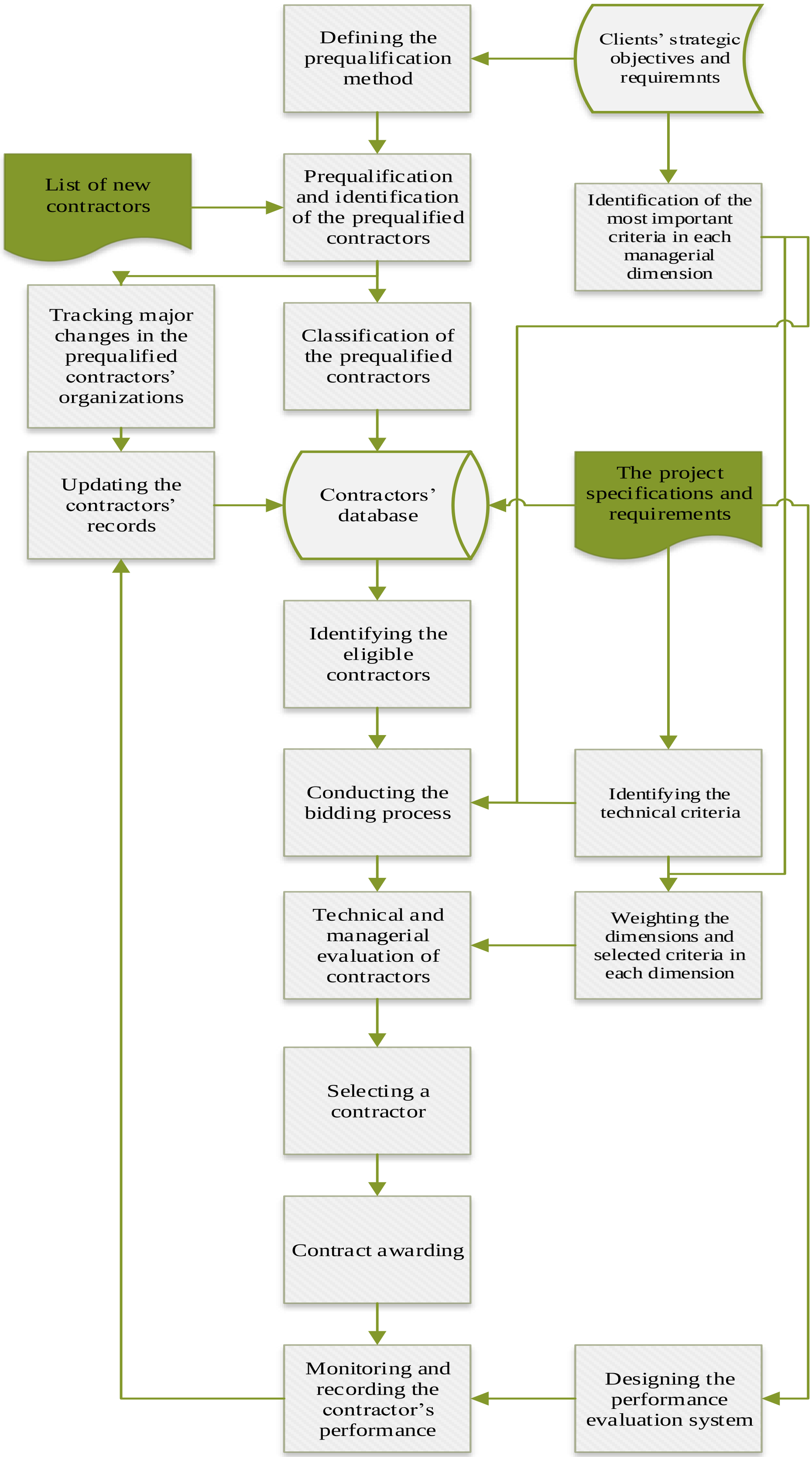

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Fig-1: Proposed model for construction contractors' evaluation and selection

Table-1: Primary list of contractor selection criteria

No.	Criteria
1	Contractor's previous experiences in construction projects (in the same discipline of the project)
2	Contractor's previous experiences in different disciplines of construction projects
3	Previous experiences in the location of the project
4	Experience of the contractor in other project environments (other than construction)
5	Quality certificates of works performed
6	Good performance in previous projects
7	Qualified certificates in any tendering system
8	The number of ongoing projects of the contractor
9	Bid price
10	Proposed time schedule
11	Subcontracting plan
12	Work loading
13	Proposed project organizational chart
14	Project management qualification/experience
15	Qualification/experience of construction personnel
16	Qualification/experience of quality personnel
17	Qualification/experience of project planning and control personnel
18	Quantities, conditions & ownership of equipment (owned equipment status)
19	Ability in project site mobilization
20	Proposed technical specifications and executive plan
21	Quality management and assurance system
22	Quality control plan
23	Environment policy and management plan
24	Contractor's proposed financial insurances for the project
25	The annual financial turnovers in the last three years
26	Contractor's total current assets
27	The average of projects' prices for the last three finished projects
28	The average of work quantities in the last three projects
29	The percentage of subcontracted work quantities
30	Previous backgrounds in claims
31	The average schedule deviation of the last three projects
32	The cumulative score: the allowed monetary amount of works that contractor can handle simultaneously
33	Current capacity: equals to the cumulative score minus the current monetary amount of works-in-hand of the contractor
34	The contractor's main office location
35	Contractor's plan of material usage
36	Proposed plan for using local resources
37	Forecasted monthly construction cost
38	Construction technologies and methods
39	Previous backgrounds in receiving and logging the client's quality approvals
40	Qualification/experience of safety, health and environmental personnel
41	Past health and safety performance
42	Health and safety plan for handling heavy items
43	Documentation system
44	Project manager's ability in communication and negotiation
45	Availability of work delivery procedure to the client

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Table-2: Formulas for selecting the sample's size

Variable	Statistical Population	Formula for selecting the sample's size
Quantitative	Unlimited	$n = \frac{Z_{\frac{\alpha}{2}}^{2}.S^{2}}{d^{2}}$
	Limited	$n = \frac{N.Z_{\frac{\alpha}{2}}^{2}.S^{2}}{d^{2}(N-1)+Z_{\frac{\alpha}{2}}^{2}.S^{2}}$
Qualitative	Unlimited	$n = \frac{Z_{\frac{\alpha}{2}}^{2}.p.q}{d^{2}}$
	Limited	$n = \frac{N.Z_{\frac{\alpha}{2}}^{2}.p.q}{d^{2}(N-1)+Z_{\frac{\alpha}{2}}^{2}.p.q}$

Table-3: Accepted criteria based on the Binomial test with the Friedman ranking in the "time" dimension

No	Criteria	P-Value	Mean Rank (Friedman)
1	Qualification/experience of construction personnel	0.0000	36.20
2	Project management qualification/experience	0.0011	35.10
3	Contractor's previous experiences in construction projects (in the same discipline of the project)	0.0000	35.08
4	Construction technologies and methods	0.0001	34.08
5	Quantities, conditions & ownership of equipment (owned equipment status)	0.0210	32.75
6	Qualification/experience of project planning and control personnel	0.0058	31.27
7	Bid price	0.0058	31.23
8	Proposed time schedule	0.0210	31.05

Table 4. Accepted criteria based on the Binomial test with the Friedman ranking in the "cost" dimension

No	Criteria	P-Value	Mean Rank (Friedman)
1	Project management qualification/experience	0.0000	36.60
2	Qualification/experience of construction personnel	0.0000	36.30
3	Bid price	0.0000	34.42
4	Construction technologies and methods	0.0058	33.60
5	Quantities, conditions & ownership of equipment (owned equipment status)	0.0210	32.24

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Table-5: Accepted criteria based on the Binomial test with the Friedman ranking in the "quality" dimension

No	Criteria	P-Value	Mean Rank (Friedman)
1	Qualification/experience of construction personnel	0.0001	37.58
2	Contractor's previous experiences in construction projects (in the same discipline of the project)	0.0001	37.13
3	Quality control plan	0.0019	36.13
4	Qualification/experience of quality personnel	0.0110	35.80
5	Quality management and assurance system	0.0019	35.17
6	Bid price	0.0001	34.00

Table-6:Accepted criteria based on the Binomial test with the Friedman ranking in the "safety" dimension

No	Criteria	P-Value	Mean Rank (Friedman)
1	Qualification/experience of safety, health and environmental personnel	0.0210	37.35
2	Qualification/experience of construction personnel	0.0058	37.32
3	Environment policy and management plan	0.0011	37.30
4	Health and safety plan for handling heavy items	0.0021	37.02
5	Past health and safety performance	0.0390	36.13

Table-7: The results of the principal component analysis (PCA)

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.504	62.612	62.612	2.504	62.612	62.612
2	1.093	27.314	89.926	1.093	27.314	89.926
3	0.314	7.851	97.777	-	-	-
4	0.089	2.223	100.000	-	-	-

Table-8: Component matrix

	Component	
	1	2
V1 (Time dimension)	0.887	-0.404
V2 (Cost dimension)	0.892	-0.359
V3 (Quality dimension)	0.833	0.339
V4 (Safety dimension)	0.478	0.828

Table 9. Component score coefficient matrix

	Component	
	1	2
V1 (Time dimension)	0.354	-0.370
V2 (Cost dimension)	0.356	-0.329
V3 (Quality dimension)	0.333	0.310
V4 (Safety dimension)	0.191	0.758

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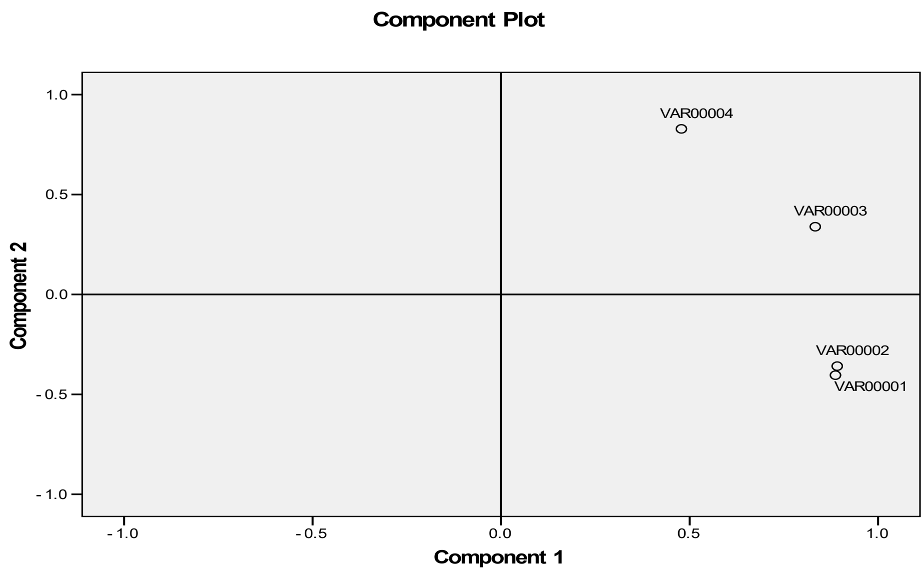

Fig-2: Component loading plot

Cluster analysis

Grouping the primary criteria into homogeneous categories based on their importance in each managerial dimension may help clients in reducing the number of similar criteria or ensuring of contractor evaluation based on different groups of criteria. In this research, cluster analysis was used to classify the primary list of the evaluation criteria based on their importance in each dimension. Since the number of the clusters to be used was unknown, hierarchical clustering was employed (see Fig-3).

Case study

In a case study, the second step of the proposed criteria development method, identifying the relative importance weights of selected criteria based on projects' requirements, was examined. A project with the scope of construction of the oil decks was selected to weigh the selected criteria and evaluate the contractor accordingly. Since the bidding process of the project was already completed, the evaluation was performed based on the selected contractor's bid documents and the contractor's past performance. Through a questionnaire, called Questionnaire 3, the client representatives were asked to identify the relative importance of the selected criteria in each dimension (the identified criteria in Table 3 through Table-6), and to score the selected contractor on each criterion. In order to identify the weight of the criteria, Analytical Hierarchical Process (AHP) method was used. For each of the comparison tables, the inconsistency ratio was checked to ensure it was less than 0.1 [27].

Table-10 through Table-13 depict the weights of the selected criteria and the scores of the contractor in each dimension. As the project duration was six months, and the project ended while this research was still underway, we could observe the contractor's final performance in each managerial dimension.

Table-10: The weights of the selected criteria and the scores of the contractor in the "time" dimension

No.	Criteria	Weight	Score
1	Qualification/experience of construction personnel	0.135	90
2	Project management qualification/experience	0.145	90
3	Contractor's previous experiences in construction projects (in the same discipline of the project)	0.136	90
4	Construction technologies and methods	0.112	80
5	Quantities, conditions & ownership of equipment (owned equipment status)	0.129	80
6	Qualification/experience of project planning and control personnel	0.101	80
7	Bid price	0.148	80
8	Proposed project time schedule	0.090	75

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Based on Table-10, the contractor's overall score in the time dimension was calculated at 83.39. Since many technical and non-technical factors were involved in getting the project completed on time, it is inappropriate to correlate this score directly with the actual time performance of the contractor. It is just worth mentioning that the project had 25% delay.

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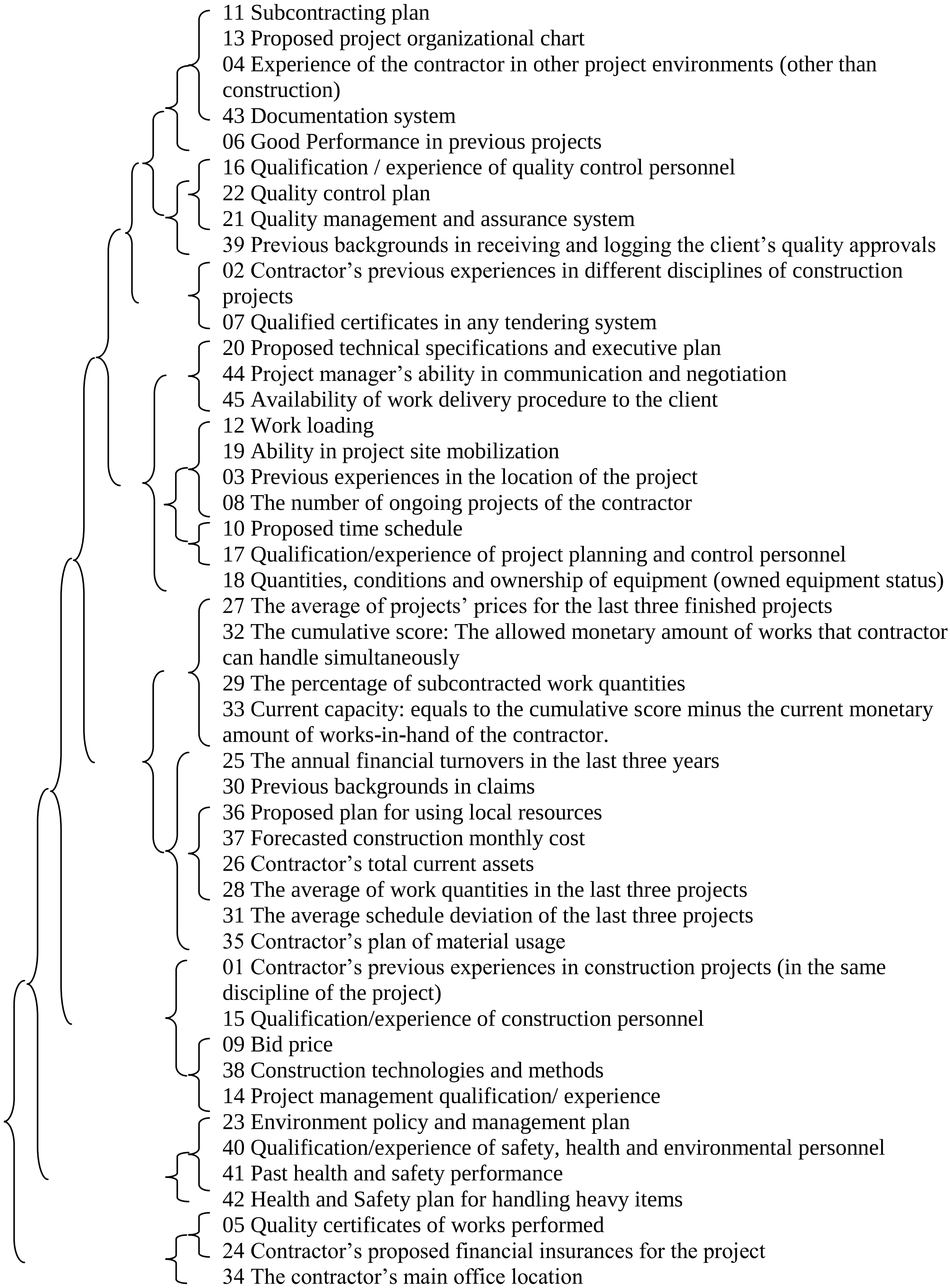

Fig-3: The clustered-criteria

Based on Table-11, the contractor's overall score in the cost dimension was 84.38. It is noteworthy that the contractor completed the project 30% over the last approved budget.

Based on Table-12, the contractor's overall score in the quality dimension was 80.33. The same as the other dimensions, correlating this score with the actual quality performance of the contractor is inappropriate. However, it is noticed that, the contractor had some minor, yet insignificant, reworks and problems concerning the quality of the work.

Based on Table-13, the contractor's overall score in the safety dimension was 69.84. Although it is not wise to correlate this score directly with the actual safety performance of the contractor, it is worth noting that, due to the poor safety controls of the contractor, the job-site fatality rate of the contractor was 1 upon the completion of the project.

Table-11: The weights of the selected criteria and the scores of the contractor in the "cost" dimension

No.	Criteria	Weight	Score
1	Project management qualification/experience	0.230	90
2	Qualification/experience of construction personnel	0.208	90
3	Bid price	0.234	80
4	Construction technologies and methods	0.162	80
5	Quantities, conditions & ownership of equipment (owned equipment status)	0.166	80

Table-12:The weights of the selected criteria and the scores of the contractor in the "quality" dimension

No.	Criteria	Weight	Score
1	Qualification/experience of construction personnel	0.191	90
2	Contractor's previous experiences in construction projects (in the same discipline of the project)	0.176	90
3	Quality control plan	0.132	80
4	Qualification/experience of quality personnel	0.183	80
5	Quality management and assurance system	0.159	60
6	Bid price	0.157	80

Table-13: The weights of the selected criteria and the scores of the contractor in the "safety" dimension

No.	Criteria	weight	Score
1	Qualification/experience of safety, health and environmental personnel	0.189	60
2	Qualification/experience of construction personnel	0.258	90
3	Environment policy and management plan	0.117	60
4	Health and safety plan for handling heavy items	0.228	70
5	Past health and safety performance	0.205	60

CONCLUSION

In this research, by reviewing the literature and investigating the status-quo of tendering systems in some Iranian oil companies, a model was proposed for selecting construction contractors. By having various evaluation phases, the proposed model can be considered as a comprehensive decision-making tool to select the most eligible construction contractor based on the clients' strategies and the needs of projects.

The proposed model entails four main stages for evaluation of contractors. At Stage 1, prequalification was suggested to identify candidate contractors for different types of projects based on contractors' capacities and capabilities.

The second stage proposed to identify the most important criteria in each managerial dimension of time, cost, quality, and safety. For this purpose, it was suggested to use non-parametric statistics incorporation with expert judgment techniques.

At the third stage, evaluation of the prequalified contractors in the corresponding category was proposed for every specific project. In Stage 4, it was suggested that during the project, the contractor should be evaluated, and the performance data should be collected in the developed database. The proposed evaluation process can be more effective than the other tendering systems, because in the proposed method, clients need to periodically evaluate new contractors and update the records of the prequalified contractors. By adopting this approach, clients will always have the list of eligible candidate contractors in each category of their projects.

As the next phase of the research, the proposed method for identifying the most important evaluation criteria in each managerial dimension and weighing them was examined.

Taking four managerial dimensions of time, cost, quality, and safety into account in contractor evaluation processes, along with technical dimension, enables clients to consider their strategies in addition to projects' specific needs in a practical way. Moreover, it helps clients assess contractors' abilities in each of these dimensions separately, which significantly reduces the risks of selecting non-qualified contractors and increases the probability of delivering projects at a higher level of standard.

Although the survey of the research was conducted in the oil industry, the results may be used or customized for other types of projects.

For future research studies, it is proposed that researchers design a database framework for classification of projects as well as the prequalified contractors. They are also suggested to do research on performance evaluation methods of contractors during projects and how the results can be reflected in the developed database.

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