ESTABLISHING RELATIVE WEIGHTS FOR CONTRACTOR PREQUALIFICATION CRITERIA IN A PRE-QUALIFICATION EVALUATION MODEL

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ABSTRACT: Pre-qualification criteria is a screening methodology to select contractors. Each contractor attribute has its own importance in relation to the others. It is an essential process that the relative importance 'weights' of each selection criteria be identified. Several methodologies are used to identify such weights. A Delphic technique together with Analytical Hierarchy Process (AHP) utilizing pair-wise analysis was used to establish such weights through a structured questionnaire. The established weights will then be used to develop a contractor's pre-qualification model using a hybrid technique by combining a Neural Network and a Genetic Algorithm.

Keywords - Analytical Hierarchy Process, Contractors, Relative importance, Pre-qualification.

1. INTRODUCTION

One of the most important features of any procurement process is the selection of the 'best' contractor to execute a project. This selection is based on evaluating an extensive array of contractor criteria. Each pre-qualification criterion is a different measure of a specific contractors potential to complete a project. Each of these criteria has a relative importance (weight) to others in deciding the overall contractor's ability. The standing list of criteria was identified through previous research and is illustrated in Table 1 (El-Sawalhi et al., 2007). Seven main criteria and thirty one sub-criteria were identified when deciding the contractor pre-qualification for standing list. These criteria were then used to establish the required weights.

Different methods for the determination of relative weights of contractors pre-qualification do exist. Some of these are direct (absolute) ratings, trade-offs, ranking, and regression. These methods are characterized as simple, linear and direct methods. More accurate yet more complex methods are the multi criteria methods i.e. Multi Attribute Utility, Fuzzy Set and Analytical Hierarchy Process (AHP). Among these methods, the AHP rating method is a well known and the most widely used scoring method (Saaty, 2004).

AHP is simple to construct, adaptable to both groups and individuals, encourages compromise and consensus building and does not require inordinate specialization to master and communicate (Munif, 1995). The advantages of AHP lies in its capacity to establish the weights of attributes in a systematic and robust manner and to allow the decision maker to check the consistency of his ranking of relative importance among the involved criteria and re-do such ranking to satisfy the consistency condition (Marzouk and Moselhi, 2003). Mahdi et al. (2002) and Topcu (2004) used AHP as a decision tool for contractor selection. However, both multi attribute utility theory and fuzzy set methods are difficult to apply in practice since their application is sophisticated and needs extensive knowledge, from the decision-maker, of mathematical and probability backgrounds. Therefore, AHP was adopted to enable this analysis.

AHP is a method of multiple criteria decision analysis developed by Saaty (1980). AHP is a general theory of measurement used to derive ratio scales from both discrete and continuous paired comparisons. It allows decision-makers to measure the consistency of their judgments, and furthermore, AHP uses an analytic procedure to process these judgments. Additionally, these judgments can be easily implemented by using user-friendly Expert Choice software (Saaty, 2004). AHP was used to evaluate the criteria weights through pair-wise comparisons. The normalized Eigenvalue of a comparison matrix was used to represent the linguistic evaluation of results.

Table 1. Emergent structure for standing list pre-qualification criteria

Main criteria	**Sub criteria**	**Main criteria**	**Sub criteria**
Financial stability	Credit rating Turnover Bank arrangement Debit ratio Liquidity Profitability	Experience	Type of project Size of project Number of projects Experience in the region Length of time in business
Management and technical ability	Experience of staff Management capability Qualification of staff Past performance Quality performance Company org. Innovate method	Historical non-performance	Company image Skilled manpower Client satisfaction Record of failure Claims & litigation
		Resources	Equipment Number of staff
Quality	Quality control Quality policy Quality assurance	Health and safety	Safety performance Accountability Injury & illness

Some authors (Belton and Gear, 1985; Dyer and Wendel, 1985) had criticized AHP because of the lack of a firm theoretical basis. However, Harker and Vargas (1987) and Perez (1989) proved that AHP is based upon a firm theoretical foundation and examples in the literature and the day-to-day operations of various governmental agencies, corporations and consulting firms illustrates that AHP is a viable, usable decision-making tool (Al Harbi, 2001).

The main steps that apply to AHP are:

- Modelling the design problem by breaking it down into a hierarchy of interrelated decision elements, decision criteria and sub criteria;
- Developing judgmental preferences for the decision sub criteria for each criterion and judgmental importance of the decision criteria by pair-wise comparisons (Evans and Olsen, 2003).

After the decision problem is modeled in a hierarchical fashion, the decision maker must develop a set of comparison matrices that numerically define the relative preferences of each decision alternative with respect to each criterion and the relative importance of each criterion (Evans and Olson, 2003). The priorities are derived from the matrices of judgment based on the mathematics of the Eigenvector and the corresponding Eigenvalue. The Eigenvector provides priority ordering while the Eigenvalue is a measure of consistency of judgment (Saaty, 1980).

2. DETAILED METHODOLOGY

The research focuses on the main and the sub-criteria for contractor's pre-qualification among the client's construction professionals in the Gaza Strip and West Bank (GSWB) as a developing area. Having previously established a list of qualification criteria (El-Sawalhi et al., 2007), the views of twelve client's construction professionals' were sought to establish pair-wise comparisons. AHP together with a Delphi Technique were used to establish the emerged contractor's pre-qualification weights. This was done via a structured questionnaire to conduct the pair-wise comparison between the pre-qualification criteria. The questionnaire was sent via E-mail to the designated construction professionals to facilitate easier and faster reply and to develop date mining for evaluation of responses. These 12 construction professionals (Managers and Engineers) in the GSWB who are involved in the processing of contractors pre-qualification working with public owners (governmental, non-governmental and non-profit organizations), were selected based on an 'opportunistic sample basis' – picking willing volunteers because of likely workload from Delphic rounds - but checking that the sample did not exhibit any undue bias.

The Delphi Technique of group decision making was utilized to obtain member's responses to the pair-wise relative comparisons for weights of criteria and sub-criteria. The measurement was done by comparing the elements in a pair-wise fashion and assigning a numerical score that expresses a preference between every two elements. A numerical scale from one to nine was used to indicate the relative importance. Using the scale of: (1) Equally preferred; (3) Moderately preferred; (5) Strongly preferred; (7) Very strongly preferred; and (9) Extremely preferred. Intermediate values between each category may be used (Evans and Olson, 2003).

A critical issue with AHP is the consistency judgement specified in the pair-wise comparison matrices. The consistency ratio indicates when it might be desirable to reconsider and revise the original judgement in the comparison matrices. The consistency ratio (CR) was computed in the following manner:

- Multiply each column of the original pair-wise comparison matrix by the relative priority of the decision element corresponding to that column, and sum these" "weighted columns;"
- Divide each element of the weighted column by corresponding priority value of that decision element;
- Average the values computed in step 2; this is denoted as max λ_{max};
- Consistency index (CI);
- Compute the consistency ratio (CR).

In order to provide a measure of the severity of deviation in the consistency of the Eigenvalue (λ_{max}), Saaty (1980) defined a measure of consistency, which is the consistency index (CI) by:

$$CI = \frac{\text{principal eigenvalue} - \text{size of matrix}}{\text{size of matrix} - 1} = \frac{\lambda_{max} - n}{n - 1}$$

The consistency index was compared to a value derived by generating random reciprocal matrices (RI) of the same size to give a consistency ratio (CR) which is meant to have the same interpretation.

$$CR = CI/RI$$

A consistency ratio (CR) of 0.1 or less is considered acceptable and indicates good consistency of the pair-wise comparative judgement. If the consistency ratio is greater than 0.10, then the decision maker should re-examine the pair-wise comparisons (Evans and Olson, 2003; Belton and Stewart, 2003).

In this work, the weighted comparisons in having achieved an acceptable CR are processed using Expert Choice software. Expert Choice, developed by Expert Choice, Inc., is available in the local market and simplifies the implementation of the AHP's steps and automates many of its computations (Al-Harbi, 2001). Expert Choice uses the AHP process by arranging the numerous elements of a problem into a hierarchy similar to the structure of an up-side-down family tree (Chavis et al., 1996). This software is a unique product for the analysis of AHP. The software uses the AHP methodology to model a decision problem and evaluate the relative desirability of alternatives. Dr. Saaty (developer of AHP) is co-founder of Expert Choice Inc. There is full confidence in the technical soundness of Expert Choice Pro with respect to the AHP methodology (Fernandez, 2004). The software accommodates hierarchy structuring, pair-wise comparisons, judgment synthesis, measuring consistency and sensitivity analysis (Munaif, 1995).

Each construction professional was requested to compare each pair by identifying to what extent one criterion is more/less important/preferred to another. In the main part of the study, respondents were asked to compare the relative importance of seven main criteria and thirty-one sub-criteria for the standing list of contractor pre-qualification.

The pair-wise matrices were constructed using the AHP method. The Eigenvector of the group represents the weight of each main and sub criteria for establishing the pair-wise evaluation. To achieve consistency, two consecutive Delphi rounds were conducted. In the first round, some of the construction professionals achieved consistent responses for part of the criteria. However, all respondents were requested to re-evaluate the pair-wise matrices to achieve acceptable consistency. Furthermore, the average weights were calculated and the deviation of each participant from the mean value was highlighted. All the participants were requested to re-consider their judgement upon the initial average of suggested weights resulting from the first round.

3. RESULTS AND ANALYSIS

The 12 construction professionals that participated in the survey represented five categories of organizations. These were Ministries, Municipalities, Non-governmental organizations, International organizations and Consultants. The Ministries and Municipalities were considered as the governmental sector and the rest of the organizations/consultants were considered as non-governmental organization. Both governmental and non-governmental client's organizations are accountable to the public. Consultants have such accountability to the public since they represent public clients in selecting the appropriate contractor. Four participants (33%) represented the ministries and municipalities. Four participants (33%) represent the non-government organizations. Another three (25%) represent international organizations and one respondent represents a consulting firm (9%). 100% of participants were previously involved in the pre-qualification process. All participants were Civil Engineers.

3.1 First Round of Pair-Wise Analysis

The twelve-construction professional have filled the pair-wise comparison matrices. An example of evaluator No. 10 results are illustrated in Tables 2 to 4.

The responses of each construction professional were analysed using Expert Choice Pro V9.5 to calculate the consistency ratio (CR) and the weighting vectors of each main and sub-criterion. According to Saaty (1980) the judgement of a construction professional is accepted if CR <= 0.10. The results of the first round of deliberations were presented back to the expert group. The mean values of the Eigenvector comparisons were calculated. The inconsistencies in the results were explained. Discussions were held on the inconsistencies. A few of participants were able to achieve acceptable level of consistency. The results of each evaluator were sent back again to be reconsidered. They were requested also to carefully evaluate the weighted vector compared to other construction professional's results and to the overall average results. All professionals were free to make suitable amendments.

Table 2. Pair-wise matrix for main criteria of standing list

Main criteria	Financial stability	Experience	Management /technical ability	Non-performance history	Resources	Quality management	Health and Safety
Financial stability	1	3	2	7	5	4	6
Experience	1/3	1	1/2	5	3	2	4
Management ability	1/2	2	1	6	4	3	5
Non-performance history	1/7	1/5	1/6	1	1/3	1/4	1/2
Resources	1/5	1/3	1/4	3	1	1/2	2
Quality management	1/4	1/2	1/3	4	2	1	3
Health and safety	1/6	1/4	1/5	2	1/2	1/3	1

(Consistency Ratio (CR) = 0.03)

Table 3. Pair-wise matrix for management and technical ability criteria of standing list

Sub criteria	Company organization	Experience of staff	Qualification of key staff	Project management capability	Past performance	Quality performance	Innovative methods
Company organization	1	5	4	2	7	3	6
Experience of staff	1/5	1	1/2	1/4	3	1/3	2
Qualification of key staff	1/4	2	1	1/3	4	1/2	3
Project management capability	1/2	4	3	1	6	2	5
Past performance	1/7	1/3	1/4	1/6	1	1/4	1/2
Quality performance	1/3	3	2	1/2	4	1	4
Innovative methods	1/6	1/2	1/3	1/5	2	1/4	1

(Consistency Ratio (CR) = 0.03)

Table 4. Pair-wise matrix for financial stability criteria of standing list

Sub criteria	Credit rating	Turnover history	Bank arrangement	Liquidity	Debit ratio	Profitability ratio
Credit rating	1	2	6	4	5	3
Turnover history	1/2	1	5	3	4	2
Bank arrangement	1/6	1/5	1	1/3	1/2	1/4
Liquidity	1/4	1/3	3	1	2	1/2
Debit ratio	1/5	1/4	2	1/2	1	1/3
Profitability ratio	1/3	1/2	4	2	3	1

(Consistency Ratio CR) = 0.02)

3.2 The Second Round of The Survey

The results of the second Delphi round are illustrated in Tables 5 to 8. All participants were able to achieve an acceptable degree of consistency within the second round. Some participants were re-contacted to re-consider improving slightly deviated results for individual criteria that showed specific deviation from the 'average'. The CR for all results was recalculated together with weight vector of each criterion.

Table 5 illustrates the main criteria weights identified by the twelve evaluators. The financial stability was regarded as the highest weighted criteria (25%) while the management ability (20%) was the second. The lowest weight (5%) was given to the health and safety criteria.

In Table 6, the weights for sub-criteria for financial stability and management and technical ability are identified. For financial sub-criteria, the credit rating was regarded the first (23%) and the liquidity was weighted the second (22%). Both bank arrangement and profitability were equally weighted (16%). The lowest weight (8%) was given to the debit ratio. Experience of staff, qualifications of key staff and management capability were equally weighted (18%) by evaluators for management and technical ability criteria. The lowest weight (8%) was given to the innovative methods sub-criterion.

Table 7 illustrates the weights for experience and historical non-performance criteria. For the experience criteria, it is noticeable that the size of project was highly evaluated (28%) by the construction professionals. The type of project was weighted close to the size of project (27%). Both factors represent 55% of the experience weight. The company image was highly weighted (33%) and the second weight 22% was given to skilled man-power. Record of failure (15%) and Claims & litigation (13%) were closely weighted. For resources criteria (Table 8), the equipment weight was 57% and the Number of staff weight was 43%. Quality control was the highest weighted (41%) sub-criteria while safety performance (49%) was the highest weighted criteria for safety.

3.3 Final Weights of Each Criterion

To find the final weight of each sub-criterion, the results of the weighting vector for standing criteria list was arranged in Table 9. The main criteria weighting vectors (1) are multiplied by the corresponding sub-criteria weighting vectors (2) to obtain the total criteria weight (3). The total criteria weight was adjusted to have a rounded percentage in (4) which represent the final weight of each criterion. The ten highest weighted sub-criteria for standing list were: credit rating; liquidity; size of project; type of project; equipment; quality control; bank arrangement; profitability; company image; and number of staff. These weights will subsequently be used to evaluate the contractor's attributes that will be fed into a hybrid model for contractor pre-qualification that combining the use of Neural Networks and Genetic Algorithms.

4. CONCLUSIONS

The AHP together with the Delphi Technique were utilized to establish weights for contractor’s pre-qualification criteria. Twelve construction professionals participated in establishing such weights. Two Delphic rounds were conducted to achieve consistent responses. The results are the

final weights of contractor pre-qualification criteria that will be used to evaluate the contractor attributes and consequently these evaluations will be fed to the model for contractor pre-qualification as inputs.

This work is important since it creates an explicit quantification approach to evaluate the subjective perceptions of decision-makers in GSWB. This approach could be extended to create a decision-making 'expert' system to improve the probability of selecting contractors capable of achieving the client objectives.

5. REFERENCES

Al-Harbi, K. (2001) *Application of the AHP in project management*, International Journal of Project Management, 19, pp19-22.

Belton V.A. and Gear T (1985) *The legitimacy of rank reversal- a comment*, Omega, 13(3), pp143-53.

Belton, V. and Stewart, T. (2003) *Multiple criteria decision analysis: an integrated approach*, Kluwer Academic Publishers, UK 2nd ed.

Chavis, B., Lin, T. and Ko, C. (1996) *Using multiple criteria decision support software to teach divisional performance evaluation*, Journal of Acconting and Computers, South-Western College Publishing, <webmaster@swlearning.com>, accessed on 12/11/04.

Dyer, J.S. and Wendel R.E. (1985) *A critique of the analytical hierarchy process*, Working paper 847, 85-4-24, Department of Management, The University of Texas at Austin.

El-Sawalhi, N., Eaton, D., and Rustom, R. (2007) *Contractor pre-qualification model: State-of-The-Art*, International Journal of Project Management, 25 (6), "Accepted to be published in the assigned volume".

Evans, J. and Olson, D. (2003) *Statistics, data analysis, and decision modelling*, Prentice Hall, 2nd ed.

Fernandez, A. (2004) *Pro Version 9.0 for Windows confirms product as an outstanding choice for addressing complex, multi-criteria problems*, <orms@lionhrtpub.com> accessed on 12/11/04.

Harker, P.T. and Vargas L.G. (1987) *The theory of ratio scale estimation: Saaty's analytic hierarchy process*, Management Science, 33(1), pp1383-403.

Mahdi, I.M., Riley M.J., Fereig S.M., Alex A.P. (2002) *A multi-criteria approach to contractor selection*, Engineering, Construction and Architectural Management, 9(1), pp29–37.

Marzouk, M. and Moselhi, O. (2003) *A decision support tool for construction bidding*, Construction Innovation, 3, pp111-124.

Munaif, M. (1995) *Multiple criteria decision making in contractor selection and evaluation of construction bids in Saudi Arabia*, Unpublished Ph.D. thesis, University of Missouri-Rolla.

Perez, J. (1995) *Some comments on Saaty's AHP*, Management Science, 41(6), pp1091-5.

Saaty, T.L. (1980) *The Analytic Hierarchy Process*, McGraw-Hill Co., New York, NY.

Saaty, T.L. (2004) *Mathematical methods of operation research*, Dover Publications Inc., Mineola, New York.

Topcu, Y.I. (2004) *A decision model proposal for construction contractor selection in Turkey*, Building and Environment, 39, pp469–81.

Table 5. Priority weights for main criteria of standing list (2nd round)

Criteria \ Evaluator		E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	Average	S.D.
Main Criteria	Financial Stability	0.29	0.26	0.15	0.23	0.30	0.12	0.29	0.40	0.18	0.35	0.06	0.39	0.25	.11
	Management Ability	0.21	0.14	0.16	0.11	0.21	0.36	0.25	0.10	0.17	0.23	0.22	0.20	0.20	.07
	Experience	0.21	0.27	0.22	0.17	0.25	0.22	0.10	0.10	0.17	0.17	0.25	0.15	0.19	.06
	Non-Performance History	0.14	0.08	0.16	0.33	0.10	0.07	0.07	0.19	0.03	0.03	0.21	0.04	0.12	.09
	Resources	0.09	0.10	0.10	0.09	0.07	0.15	0.05	0.08	0.15	0.07	0.03	0.07	0.09	.03
	Quality Management	0.04	0.09	0.14	0.04	0.05	0.05	0.21	0.08	0.26	0.10	0.12	0.12	0.11	.07
	Health & Safety	0.02	0.06	0.07	0.03	0.02	0.03	0.03	0.05	0.04	0.05	0.11	0.03	0.05	.02
Consistency Ratio (CR) =< 0.10		0.09	0.04	0.04	0.05	0.10	0.09	0.04	0.07	0.08	0.03	0.09	0.09		

Table 6. Priority weights for standing list sub-criteria (2nd round)

Criteria \ Evaluator		E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	Average	S.D.
Financial stability	Credit rating	0.06	0.25	0.34	0.09	0.10	0.38	0.21	0.23	0.42	0.38	0.15	0.17	0.23	.12
	Turnover	0.22	0.18	0.10	0.09	0.16	0.07	0.09	0.24	0.23	0.25	0.05	0.13	0.15	.07
	Bank arrangement	0.13	0.19	0.22	0.04	0.12	0.13	0.45	0.18	0.14	0.04	0.13	0.11	0.16	.11
	Liquidity	0.23	0.25	0.18	0.21	0.25	0.20	0.17	0.26	0.12	0.10	0.23	0.39	0.22	.07
	Debit ratio	0.09	0.07	0.06	0.19	0.08	0.05	0.04	0.03	0.05	0.07	0.18	0.05	0.08	.05
	Profitability	0.27	0.06	0.10	0.38	0.29	0.17	0.04	0.06	0.04	0.16	0.26	0.15	0.16	.11
Consistency Ratio (CR) =< 0.10		0.03	0.07	0.05	0.09	0.05	0.09	0.09	0.08	0.06	0.02	0.08	0.07		
Management and technical ability	Company organization	0.20	0.16	0.06	0.07	0.09	0.07	0.05	0.18	0.04	0.36	0.24	0.15	0.14	.09
	Experience of staff	0.15	0.20	0.30	0.05	0.11	0.27	0.14	0.22	0.15	0.07	0.18	0.26	0.18	.07
	Qualification of key staff	0.14	0.25	0.21	0.13	0.24	0.14	0.14	0.15	0.23	0.10	0.13	0.37	0.18	.07
	Management capability	0.26	0.11	0.17	0.15	0.17	0.26	0.26	0.15	0.16	0.24	0.17	0.06	0.18	.06
	Past performance	0.09	0.10	0.12	0.25	0.22	0.04	0.11	0.05	0.08	0.03	0.19	0.07	0.11	.07
	Quality performance	0.09	0.12	0.08	0.21	0.12	0.10	0.22	0.13	0.22	0.15	0.05	0.06	0.13	.06
	Innovative method	0.07	0.06	0.06	0.14	0.05	0.12	0.08	0.12	0.12	0.05	0.04	0.03	0.08	.03
Consistency Ratio (CR) =< 0.10		0.07	0.03	0.04	0.08	0.07	0.06	0.09	0.09	0.09	0.03	0.08	0.02		

Table 7. Priority weights for standing list sub-criteria (2nd round)

Criteria		Evaluator E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	Average	S.D.
Experience	Size of project	0.25	0.25	0.19	0.25	0.30	0.36	0.10	0.44	0.34	0.42	0.32	0.19	0.28	.10
	Type of project	0.37	0.17	0.28	0.35	0.30	0.31	0.25	0.12	0.31	0.26	0.18	0.35	0.27	.08
	Number of projects	0.16	0.11	0.12	0.18	0.16	0.13	0.13	0.13	0.21	0.16	0.32	0.23	0.17	.06
	Length of time in business	0.12	0.25	0.08	0.16	0.14	0.11	0.22	0.12	0.07	0.10	0.10	0.18	0.14	.05
	Experience in the region	0.10	0.22	0.33	0.06	0.10	0.09	0.30	0.19	0.07	0.06	0.08	0.05	0.14	.10
Consistency Ratio (CR) =< 0.10		0.03	0.02	0.04	0.09	0.09	0.05	0.06	0.08	0.09	0.02	0.07	0.02		
Historical non-performance	Company image	0.34	0.27	0.21	0.04	0.30	0.11	0.25	0.45	0.48	0.42	0.52	0.58	0.33	.16
	Record of failure	0.22	0.11	0.08	0.45	0.26	0.20	0.04	0.12	0.05	0.06	0.13	0.10	0.15	.11
	Claims & litigation	0.22	0.12	0.17	0.23	0.11	0.20	0.06	0.12	0.04	0.10	0.14	0.04	0.13	.06
	Client satisfaction	0.08	0.22	0.21	0.13	0.14	0.07	0.28	0.12	0.30	0.26	0.12	0.13	0.17	.07
	Skilled manpower	0.14	0.29	0.33	0.15	0.19	0.41	0.37	0.19	0.13	0.16	0.09	0.15	0.22	.10
Consistency Ratio (CR) =< 0.10		0.02	0.02	0.06	0.03	0.06	0.08	0.10	0.08	0.07	0.02	0.09	0.05		

Table 8. Priority weights for resources, quality and H&S criteria

Criteria		Evaluator E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	Average	S.D.
Resources	Equipment	0.67	0.67	0.5	0.25	0.75	0.75	0.50	0.50	0.50	0.75	0.50	0.50	0.57	.15
	Number of staff	0.33	0.33	0.5	0.75	0.25	0.25	0.50	0.50	0.50	0.25	0.50	0.50	0.43	.15
Consistency Ratio (CR) =< 0.10		0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.00	0.00	0.00		
Quality	Quality control	0.49	0.33	0.64	0.40	0.44	0.14	0.25	0.32	0.45	0.55	0.64	0.32	0.41	.15
	Quality policy	0.31	0.33	0.26	0.20	0.17	0.43	0.10	0.26	0.45	0.11	0.26	0.12	0.25	.11
	Quality assurance	0.20	0.34	0.10	0.40	0.39	0.43	0.65	0.41	0.09	0.35	0.10	0.56	0.34	.18
Consistency Ratio (CR) =< 0.10		0.05	0.01	0.00	0.00	0.02	0.00	0.02	0.00	0.00	0.05	0.04	0.02		
Health and safety	Safety performance	0.54	0.55	0.59	0.31	0.44	0.26	0.71	0.47	0.45	0.55	0.64	0.41	0.49	.13
	Accountability	0.30	0.21	0.25	0.11	0.40	0.10	0.23	0.43	0.45	0.11	0.26	0.33	0.27	.12
	Injury & illness	0.16	0.24	0.16	0.58	0.16	0.64	0.06	0.10	0.1	0.34	0.10	0.26	0.24	.18
Consistency Ratio (CR) =< 0.10		0.01	0.02	0.05	0.00	0.01	0.04	0.07	0.01	0.00	0.05	0.04	0.00		

Table 9. Priority weights for pre-qualification criteria for standing list

Criteria		Main criteria Weight (1)	Sub-criteria weight (2)	Total criteria weight (3)	Adjusted weight % (4)
Financial stability	Credit rating	0.25	0.23	0.0575	5.8
	Turnover	0.25	0.15	0.0375	3.7
	Bank arrangement	0.25	0.16	0.0400	4.0
	Liquidity	0.25	0.22	0.0550	5.5
	Debit ratio	0.25	0.08	0.0200	2.0
	Profitability	0.25	0.16	0.0400	4.0
Management and technical ability	Company organization	0.20	0.14	0.0280	2.8
	Experience of staff	0.20	0.18	0.0360	3.6
	Qualification of key staff	0.20	0.18	0.0360	3.6
	Management capability	0.20	0.18	0.0360	3.6
	Past performance	0.20	0.11	0.0220	2.2
	Quality performance	0.20	0.13	0.0260	2.6
	Innovative method	0.20	0.08	0.0160	1.6
Experience	Size of project	0.19	0.28	0.0532	5.3
	Type of project	0.19	0.27	0.0513	5.1
	Number of projects	0.19	0.17	0.0323	3.2
	Length of time in business	0.19	0.14	0.0266	2.7
	Experience in the region	0.19	0.14	0.0266	2.7
Historical non-performance	Company image	0.12	0.33	0.0396	4.0
	Record of failure	0.12	0.15	0.0180	1.8
	Claims & litigation	0.12	0.13	0.0156	1.6
	Client satisfaction	0.12	0.17	0.0204	2.0
	Skilled manpower	0.12	0.22	0.0264	2.6
Resources	Equipment	0.09	0.57	0.0558	5.1
	Number of staff	0.09	0.43	0.0387	3.9
Quality	Quality control	0.11	0.41	0.0451	4.5
	Quality policy	0.11	0.25	0.0275	2.8
	Quality assurance	0.11	0.34	0.0374	3.7
Health and safety	Safety performance	0.05	0.49	0.0245	2.5
	Accountability	0.05	0.27	0.0135	1.3
	Injury & illness	0.05	0.24	0.0120	1.2