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# Client and consultant perspectives of prequalification criteria

## Abstract

A crucial task in contractor prequalification is to establish a set of decision criteria through which the capabilities of contractors are measured and judged. However, in the UK, there are no nationwide standards or guidelines governing the selection of decision criteria for contractor prequalification. The decision criteria are usually established by individual clients on an *ad hoc* basis. This paper investigates the divergence of decision criteria used by different client and consultant organisations in contractor prequalification through a large empirical survey conducted in the UK. The results indicate that there are significant differences in the selection and use of decision criteria for prequalification.

*Keywords:* Contractor prequalification, decision criteria, discriminant analysis

## 1. Introduction

Most client organisations in the UK (and many other countries) adopt a selective approach to inviting tenders for construction contracts. This helps to minimise the amount of abortive tendering, and associated overhead costs, of contractors. It also provides an opportunity for clients to assess the ability, competency and capability of potential contractors to satisfactorily carry out the contract work. A common form of this assessment process is contractor prequalification, which seeks to identify a number of contractors who are each financially sound and technically capable and with whom the client could enter into a contract [1]. This involves measuring and judging potential contractors in accordance with a set of decision criteria or, as they have become known, Prequalification Criteria (PQC).

To do this can be quite arduous, for both the contractors and clients, in identifying, gathering and analysing the required information. The European Union's (EU) public procurement legislation, for example, requires decision criteria to be clearly and unequivocally established and conveyed to tenderers. It has been shown, however, that contractor PQC have been established by clients on an *ad hoc* basis in attempt to reflect their specific objectives and project requirements. As a result, since standards for tenderer selection vary, contractors are assessed differently by different clients. A recent UK study found over 90% of the clients surveyed currently used their own, idiosyncratic, decision criteria in practice [2].

To avoid the unnecessary opportunity costs involved, Latham [3] recommended the rationalisation of prequalification within the UK construction industry, and the Contractor Management Information System [4] attempts to do this. However, despite several studies into contractor PQC [5-8], an accepted nationwide standard has yet to be developed. The inability to accommodate the specific interests and requirements of clients is the major obstacle to standardisation [2].

This paper reports on a study that investigated the divergence of PQC adopted by different types of organisations. This involved a postal questionnaire survey of 192 client/consultant organisations in the UK. The respondents were asked to rate the importance of thirty five predetermined PQC. These PQC were established as a result of previous research undertaken

by the authors [9, 10] and knowledge acquired from 12 clients and consultants in the UK [2]. The subsequent analysis revealed significant divergences between different types of organisations.

## **2. Possible factors affecting criteria selection**

Contractor prequalification has been adopted by many types of client and the decision criteria used and the importance attributed to them vary between clients. Two factors that are likely to influence the choice of criteria have been identified. These are client objectives [11] and decision maker perceptions [2].

### *2.1 Client objectives*

Client objectives not only affect the selection of PQC but also the relative importance attached to the PQC [12]. It is conventional to group clients into two broad categories - public and private. Public sector clients, including governmental organisations and public utility companies, are accountable to the general public. Their PQC are more stringent and well defined to eliminate any imprudent inclusion, or unlawful rejection, of contractors. Public sector (and to some extent, private sector) clients are also bound by government policies, such as employment, training, health and safety and racial discrimination, and they are obliged to reflect these policies in their PQC.

Private clients do not have to demonstrate public accountability to the same extent as public clients. Instead, their objectives are related to shareholder and commercial benefits associated with profit generation. Most private clients have greater flexibility in determining their PQC than their public counterparts. This allows them to select suitable criteria to meet their organisational objectives.

### *2.2 Decision maker perceptions*

The discipline and training of decision makers affects the selection of PQC [12]. An architect may be more interested in contractors' technical and managerial capabilities, while a quantity surveyor may focus on their financial soundness. Clients also vary in their attitude to, and perception of, risk. This can affect the level of importance placed on the PQC used.

Differences in perception may also exist between client and consultant. Poor communications can result in consultants selecting PQC that are not well aligned to their clients' needs.

## **3. Questionnaire survey**

A postal questionnaire survey was carried out to uncover the general trends and patterns of decision criteria being used by clients and consultants in the UK. This was preceded by a pilot study in which participants were asked to consider the layout, order, complexity [13], intelligibility [14] and length of the questionnaire [15]. The comments received from this pilot study focused on the intelligibility of the questions and modifications were incorporated into the final version of questionnaire (see Appendix A). In the main study, respondents were

asked to rate the importance of thirty five predetermined PQC by ticking a box against a numerical scale of zero to five, zero being not important and five being the most important. A brief description of the PQC examined is shown in Appendix B.

Six categories of organisations were identified as having experience in contractor prequalification. These were private and public clients, and architectural, civil engineering, quantity surveying and project management practices. A target sample of these organisations was selected randomly from the relevant directories [16-20]. The sample represented a cross section of organisations of different sizes and backgrounds. For instance, the public sector client group covered borough, city and county councils and central government bodies, and the private sector client group included the privatised utility companies, developers, insurance companies, and educational institutions.

A total of 500 questionnaires were distributed to the target sample on 24th June 1994 and 192 (38.4%) completed questionnaires were received. The highest response rate was received from the public sector (56 responses); whilst 19 private sector clients returned their questionnaires. Twenty six architectural, 36 civil engineering, 22 quantity surveying and 33 project management firms also responded. Although there were twice as many responses received from public clients than were received from private sector clients, this was to some extent balanced by the number of consultant firms representing private clients' interests. Of the total 192 respondents, 49% represented the interest of private clients and 51% represented the interest of public clients.

The mean importance ratings of the PQC, both overall and divided into the six categories of organisations is summarised in Table 1. The ten PQC that are regarded as being the most important, are in descending order: overall include contractors' performance; fraudulent activity; financial stability; management capability; stability of firm; competitiveness; progress of work; standard of quality; failed contract; and relationship with client. The ten least important PQC overall include the numbers of previous bids, amount of subcontracting works, length of time in business, location, method of procurement, specialised trade, form of contract, working capital, relationship with subcontractor, and level of technology. Table 2 shows the top ten most important PQC by each type of organisation. While most of the top PQC of the consultants are the same as those of the clients, there are some apparently significant differences. For instance, clients considered "health and safety" as an important PQC (ranked 8th and 6th by private and public sector clients respectively), whilst the consultants ranked it only between 16th to 24th most important. Another example of that is "failed contract" (6th and 4th for private and public sector clients respectively), with architectural, quantity surveying and project management firms ranking it 13th, 16th and 19th, respectively.

Conversely, "relationship with the client", "integrity", and "reputation" were recognised by the consultant firms as highly important PQC. This is in contrast with the client firms, who rated these PQC of rather less importance "15th, 19th and 23rd for governmental firms and 13th, 19th and 28th for private firms).

#### **4. Discriminant analysis**

The mean and ranked ratings of responses only depict differences between individual decision criteria. To identify overall differences and similarities among the six groups of

organisations (i.e. public and private clients, and architectural, civil engineering, quantity surveying and project management firms), a discriminant analysis<sup>1</sup> was employed. Since the objective of the study was to distinguish among the groups of organisations, it was necessary to select a collection of variables that measure characteristics on which the groups are expected to differ.

For discriminant analysis, these variables must also be measured at the interval or ratio level of measurement. The 35 predetermined decision criteria in the questionnaire were selected as the discriminant variables in this study. The results are discussed below.

#### *4.1 Significant functions*

The product of discriminant analysis is the canonical discriminant functions. A canonical discriminant function is a linear combination of the discriminating variables that are formed to satisfy certain conditions. Despite each discriminant function having its own discriminating power, some of these are trivial solutions in a mathematical sense and may lack statistical significance. To determine how many functions are significant for the discrimination, the eigenvalues and Wilks' lambda have to be examined.

As a general rule, the larger the eigenvalue is, the more the groups are separated on that function. The results shown in Table 3 indicate that Function 1 is the most powerful discriminant with an eigenvalue of 1.262. Function 2 has an eigenvalue of 0.780, which provides the next greatest discrimination power. The eigenvalue of Function 3 is 0.501; the third greatest discrimination power. The functions with least discriminating power are Functions 4 and 5 which have the eigenvalues of 0.380 and 0.255 respectively. The percentage of variance allows us to compare the relative magnitudes to determine the total discriminating power each function has. As shown in Table 3, Function 1 contains 39.7% of the total discriminating power in this system of equations. The cumulative percentage of Functions 1 and 2 accounts for 64.3% of the total discriminating power. The first eigenvalue is 1.6, 2.5 and 3.3 times greater than the eigenvalues of Functions 2, 3 and 4, respectively. The difference between the eigenvalues of Functions 1 and 5 is 5.0 times, which suggests that Function 5 is a very weak discriminant.

Another way to judge the substantive utility of a discriminant function is by examining the canonical correlation coefficient. This coefficient is a measure of association that summarises the degree of relatedness between the groups and the discriminant function. A zero value denotes no relationship at all, while large numbers represent increasing degrees of association, with 1.0 being the maximum. A high coefficient for Function 1 (0.747) indicates that a strong relationship exists between the groups and Function 1. Function 5 has a rather

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<sup>1</sup> Discriminant analysis is a broad term that refers to several closely related statistical activities, including those used for interpreting the group differences and those employed to classify cases into groups [21]. The group differences are established on the basis of some set of characteristics. The characteristics used to distinguish among the groups are called discriminating variables. For the purpose of classification, one or more mathematical equations are derived from the analysis. These equations are called discriminant functions, which combine the group characteristics in a way that will allow one to identify the group that a case most closely reassembles.

low value (0.451), which indicates a weak association, as surmised from the percentage of variance.

Wilks' lambda is a multivariate measure of group differences over several discriminating variables. Values of Wilks' lambda that are near zero denote high discrimination. As lambda increases toward its maximum value of 1.0, it is reporting progressively less discrimination. When Wilks' lambda equals 1.0, there are no differences at all. The results of Table 4 confirm that Function 1 has the highest discriminating power, with the value of Wilks' lambda equals to 0.096. It is necessary to investigate whether enough residual discrimination remains to justify the derivation of the second and third functions, etc. Wilks' lambda values for Functions 2 and 3 are 0.216 and 0.385 respectively, which are still small. Removing the third function depletes the discriminating information further, so that lambda becomes 0.578. This value is high, indicating that the remaining information about group differences may not be worth pursuing.

Wilks' lambda can be converted into a test of significance. The significance level of 0.001 (Table 4) means that we would get a chi-square this large or larger only one time out of a thousand samples when there were actually no differences between the centroid. This confirms that the first function is statistically significant. After deriving the first function, it is necessary to check if the remaining discrimination functions are significant. According to Table 4, the chi-square is smaller, and the significant level is 0.121 (Function 2), and this result can still be considered as significant. However, the significant level of 0.541 suggests that it would not be necessary to derive the third functions since all significant information about the group differences had already been absorbed. The implication is that Functions 1 and 2 can represent all of the observed differences between the groups.

## **5. Perceptions of client and consultant**

The canonical discriminant functions derived can be used in understanding and interpreting the group differences. This is done by examining the positions of the group centroids and studying the relationships between the individual variables and the functions.

### *5.1 A spatial interpretation*

To understand the relationship between a group and the discriminant functions, the position of the group should be identified, and this can be carried out by computing its centroid. A group centroid is an imaginary point representing the group's mean on each of the variables. Since each centroid represents the typical position for its group, the differences among the groups in relation to a particular discriminant function can be identified.

Since there are only two discriminant functions, the location of group centroids can be represented in a territorial map. Figure 1 provides the territorial map of the six organisational groups. The horizontal dimension represents Function 1 while the vertical dimension represents Function 2. The asterisks denote the six group centroids, and the numbers symbolise territories of cases from the groups.

Visual inspection of the territorial map confirms that the centroids are well separated and

there is no obvious overlap of the individual cases. When examining the relationships between the group centroids and Function 1, the centroids of the private and public clients are on the positive side of the scale whereas the consultant firms (including the architectural, civil engineering, quantity surveying and project management firms) are located on the negative side of the scale. This provides a clear indication of differences in the perceptions of the clients and the consultants on the importance of the PQC used. An obvious difference can be found between the group of government organisations (+1.742) and the group of quantity surveying firms (-1.576) as they are at the opposite ends of the continuum (refer to Table 5).

An examination of the relationships between the groups and Function 2 shows that private developers and project management firms are on the positive side of the scale, while government organisations, architectural and civil engineering firms are on the negative scale. The prequalification objectives and requirements are therefore different between private and public sector clients. The centroid of the quantity surveying group lies around zero (-0.086) indicating that it is somewhat neutral to Function 2. The magnitudes of the private (+1.731) and civil engineering (-1.391) groups are also well separated (refer to Table 5).

### *5.2 Discriminant function coefficients*

The magnitudes of the discriminant function coefficients help identify the variables that contribute most to the differences in that function. The larger the magnitude of the standardised coefficients, the greater is that variable's discriminatory contribution. For Function 1, 'financial stability' (+0.675) and 'capacity of work'(0.548) contribute most to the difference (Table 6). Clients consider the financial capabilities of the contractors to be the most relatively important factor to the project success. 'Management capabilities' (-0.531) and 'fraudulent activities' (0.497) are next in the rank order. These are followed by the 'type of project' (-0.431), 'specialised trade' (+0.421) and 'size of project' (+0.416). 'Health and safety' (+0.411) also contributes significantly to the differences. The perceptions of clients and consultants are significantly different in these decision criteria.

For Function 2, the most significant divergence appears in 'form of contract' (+0.671), 'claims and contractual disputes' (-0.661). 'Length of time in business' (-0.489), 'method of procurement'(+0.481), 'financial stability' (+0.454), 'relationship with consultant'(-0.444) and 'progress of work' (-0.417) have relatively high standardised coefficients. So each makes a similar contribution to the discriminant function on this dimension.

## **6. Differences between private and public clients**

Since the consultant firms in the sample have their own perceptions on the selection and importance of certain decision criteria, in order to eliminate their effects on the analysis, they were excluded when the differences between the private and public clients were examined. A further discriminant analysis was conducted between the private and public client groups only.

The eigenvalue for the function was 6.069 with a canonical correlation coefficient of 0.927, representing a high degree of association between the groups and the discriminant function. Wilks' lambda was 0.141, which is similar to that of Function 2 of the previous analysis. A significant level of 0.141 confirms that there are some differences between the private and

public groups. The standardised canonical discriminant function coefficients (Table 7) indicate that the 'form of contract' (+5.070), 'management capabilities' (+3.859), 'progress of work' (-3.551), 'relationship with client' (-3.141) and 'response to instruction' (-3.031) are the discriminating variables that contribute most to the differences.

### *6.1 Accuracy of classification*

To establish the accuracy of the discriminant analysis classification procedure, the classification matrix was examined. The classification matrix is derived by taking the known cases and applying the classification rules on them. The proportion of cases correctly classified indicates the accuracy of the procedure and indirectly confirms the degrees of group separation. The magnitude of this percentage should be judged in relation to the expected percentage of correct classifications if assignments were made randomly. Since there are only two groups, there is a 50% expectation of correct predictions by pure random assignment. As shown in Table 8, 65.9% of public sector clients have been correctly classified, and 72.6% accuracy for the private client. In total, 69.4% of the original grouped cases are correctly classified.

## **7. Conclusions**

This paper describes a UK postal questionnaire survey of 192 client/consultant firms' views on the importance of 35 PQC. The results show that there are significant differences (more than would be expected by chance alone) between the client and consultant firms involved. The PQC that contribute most to the differences include financial stability, capacity of work, management capabilities, fraudulent activities, type of project, specialised trade, size of project, and health and safety. The consultants either underestimated or overestimated the importance of certain decision criteria relative to the clients' importance rating. This misalignment of perceptions suggests the need for an increased emphasis on consultants identifying the client's objectives clearly before a set of PQC is established for contractor prequalification.

Significant differences also exist between public and private sector clients. Form of contract, management capabilities, progress of work, relationship with client, and response to instructions are the PQC that contribute most to the differences between the private and public clients.

There, however, is a general agreement between the public and private client groups on what comprise the set of key criteria, even though each group rank the individual criteria in the set differently. Amongst the top ten criteria, financial stability, performance, fraudulent activity, stability of firm, failed contract, standard of quality, health and safety, and competitiveness are considered by both private and public clients as the key factors to contractor prequalification.

The discriminant analysis results indicate that a generalised set of decision criteria weightings is unlikely to satisfy both public and private clients. Clients should, therefore, be allowed to weight criteria in line with their organisational objectives. The means and rank orders of government and private groups as shown in Table 1 can provide a basis for establishing or even rationalising the criteria weights for these types of clients. The choice of criteria

weights, however, varies between different types of clients. For instance, the public clients consider progress of work and previous debarment as the key factors while the private clients are more concerned about the contractors' management capabilities and project complexity.

An added advantage of discriminant analysis is the derivation of a discriminant function for the classification of unknown cases. In practice, besides the public and private sector clients, there is also the quasi-governmental client. This type of client is jointly supported by public funding and private investment, and as a result, their organisational objectives might reflect the interest of the public or private sectors. Using the discriminant function as illustrated in Appendix C allows these organisations to identify, based on their own characteristics, the group they most closely resemble. The discriminant function provides an additional tool for the rationalisation of decision criteria for use in contractor prequalification.

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## Appendix A

### Questionnaire

The purpose of this questionnaire is to collect new facts and data for a Science and Engineering Research Council (SERC) funded research project entitled Decision Support System in Tendering Prequalification. The details of the prequalification system used by/ designed for your company/ your clients are the main focus of this study. Simply tick a box (or more than one where appropriate) relating to the questions you can answer "Yes" to, and leave the rest blank. Please put your answer in the space provided if applicable. If you do not deal with any of the project types or client sectors listed below, please leave the whole column blank.

According to the pilot studies, the average time required to answer all the questions in this questionnaire is 10 minutes. I hope it will not take up too much of your valuable time.

If you have any queries about the questions in this questionnaire, please contact me on 061-200 4632. I will be more than happy to assist you in completing this questionnaire or giving you some background to my research work. Thank you very much for your kind cooperation.

#### A. About your tendering system

##### 1. Construction procurement system(s) commonly used.

- a. traditional
- b. design and build
- c. management types
- d. fast track
- e. don't know
- f. others .....

##### 2. Tendering arrangement method(s) commonly used.

- a. single stage selective tendering
- b. two stage selective tendering
- c. open tendering
- d. negotiated tender
- e. others .....

#### B. About your prequalification system

##### 3. What type(s) of work does your company prequalify for?

- a. new building
- b. building services (e.g. electrical, lift, CCTV)
- c. building specialist & nominated subcontractor(NSC) (e.g. asbestos removal)
- d. building maintenance
- e. new civil engineering
- f. civil engineering services (e.g. mechanical & electrical)
- g. civil engineering specialist & nominated subcontract (NSC) (prestress concrete)
- h. civil maintenance
- i. general goods
- j. general services
- k. others .....

##### 4. Why does your firm prequalify?

- a. client's demand
- b. ensure most suitable contractor to be employed
- c. comply with European Community legislation
- d. meet client's objectives
- e. public accountability
- f. standard procedure
- g. it is widely used
- h. don't know
- i. others .....

##### 5. What type of list does your firm normally prequalify for?

- a. a standing list of contractors for projects of certain types and sizes?
- b. an ad-hoc list of contractors for a particular project (including those exceeding the amount of the EC legislation)
- c. others .....

Note: If the answer to question 5 included "a standard list", please carry on. Otherwise go to question 6.

6. How frequently do you review the information of contractors in your standing list?

- a. daily
- b. weekly
- c. monthly
- d. half yearly
- e. yearly
- f. when information is available
- g. not required
- h. don't know
- i. others .....

7. Does your prequalification system follow the quality assurance procedures?

- a. yes
- b. no
- c. don't know

8. Which guideline do you follow in determining the maximum numbers of contractors in the list of tenderers?

- a. NJCC
- b. internal guideline
- c. don't know
- d. no guideline is used
- e. others.....

9. During the prequalification process, do you adopt the same decision criteria, decision rules and evaluation methods for different projects?

- a. yes
- b. no
- c. sometimes, please specify when .....

Note: If your answer to question 9 is "sometimes" or "no", please carry on. Otherwise go to question 11.

10. How do you determine which decision criteria and rules are to be used for different project?

- a. standard internal guidelines for your local office
- b. standard internal guidelines for your whole organisation
- c. according to individual's experience
- d. according to client's requirements/strategies
- e. according to the size, nature & type of project
- f. don't know
- g. others .....
- k. ....
- k. ....

11. What information has to be submitted by the contractors?

- a. the completed questionnaire
- b. method statement
- c. outline programme
- d. safety policy
- e. quality assurance policy
- f. CV of management staff
- g. financial details
- h. site organisation chart
- i. others .....



Stability of firm	<input type="checkbox"/>	.....									
Financial stability	<input type="checkbox"/>	.....									
Credit rating	<input type="checkbox"/>	.....									
Working capital	<input type="checkbox"/>	.....									
Resources	<input type="checkbox"/>	.....									
Management capability	<input type="checkbox"/>	.....									
Location	<input type="checkbox"/>	.....									
Length of time in business	<input type="checkbox"/>	.....									
Capacity of work	<input type="checkbox"/>	.....									
Cooperative outlook	<input type="checkbox"/>	.....									
Claims and contractual dispute	<input type="checkbox"/>	.....									
Response to instruction	<input type="checkbox"/>	.....									
Relationship with subcontractors	<input type="checkbox"/>	.....									
Relationship with consultant	<input type="checkbox"/>	.....									
Relationship with client	<input type="checkbox"/>	.....									
Progress of work	<input type="checkbox"/>	.....									
Type of project	<input type="checkbox"/>	.....									
Size of project	<input type="checkbox"/>	.....									
Project's complexity	<input type="checkbox"/>	.....									
Level of technology	<input type="checkbox"/>	.....									
Standard of quality	<input type="checkbox"/>	.....									
Specialised trade	<input type="checkbox"/>	.....									
Amount of subcontracting work	<input type="checkbox"/>	.....									
Method of procurement	<input type="checkbox"/>	.....									
Form of contract	<input type="checkbox"/>	.....									
Previous debarment	<input type="checkbox"/>	.....									
Failed contract	<input type="checkbox"/>	.....									
Fraudulent activity	<input type="checkbox"/>	.....									
Competitiveness	<input type="checkbox"/>	.....									
Number of previous bids	<input type="checkbox"/>	.....									
Health and safety	<input type="checkbox"/>	.....									
others .....	<input type="checkbox"/>	.....									
others .....	<input type="checkbox"/>	.....									
others .....	<input type="checkbox"/>	.....									
others .....	<input type="checkbox"/>	.....									
others .....	<input type="checkbox"/>	.....									
others .....	<input type="checkbox"/>	.....									
others .....	<input type="checkbox"/>	.....									

18. What were the ratings in Q.17 based on?

- a. predominant type and size of work requiring contractor prequalification
- b. company's/client's prequalification system
- c. prequalification objectives
- d. personal perception
- e. others .....

*C. About yourself*

19. Your discipline

- a. architect
- b. civil/structural engineer
- c. building services engineer
- d. quantity surveyor
- e. project manager
- f. businessman
- g. others .....

20. How many prequalification exercises have you been actively involved in for each category of work over

the past five years?

- Note: B = building  
 C = civil engineering  
 M = maintenance  
 S = Building services  
 P = specialist

	B	C	M	S	P
a. none	<input type="checkbox"/>				
b. 1-5	<input type="checkbox"/>				
c. 5-10	<input type="checkbox"/>				
d. 10-20	<input type="checkbox"/>				
e. 20-50	<input type="checkbox"/>				
f. more than 50	<input type="checkbox"/>				

21. Main role in prequalification in last 4 years

- a. decision making
- b. planning
- c. evaluation
- d. implementation
- e. advisory
- f. provide information for prequalification
- g. not involved
- h. others .....

*D. About your organisation*

Note: The questions in this section relate to the office that you are physically working in. The answers should not include data from head office, other branches, parent company or subsidiary companies.

22. Type of organisation/practice

- a. public authority
- b. private client/developer
- c. architectural
- d. engineering
- e. quantity surveying
- f project management
- g. contractor
- h. others .....

Note: If your company is a private consultant or contractor, please carry on. Otherwise go to question 24.

23. What is the proportion of work between private and public sector clients?

- (private : public)
- a. 100%: 0%
  - b. 90%:10%
  - c. 80%:20%
  - d. 70%:30%
  - e. 60%:40%
  - f. 50%:50%
  - g. 40%:60%
  - h. 30%:70%
  - i. 20%:80%
  - j. 10%:90%
  - k. 0%:100%

Note: Questions 24 & 25 relate to the project types listed below

24. Number of contract per annum

Note: B=building



## Appendix B

### *Brief description of the PQC analysed*

Performance	The performance of recently completed projects.
Fraudulent activity	History of convictions in professional conduct, default or deceive, non payment of social security, and non payment of tax.
Financial stability	The previous, present and future financial status of the contractor.
Management capability	Availability of experienced management staffs to monitor and coordinate the work.
Stability of firm	Is the company in the process of bankruptcy proceedings?
Competitiveness	The prices of previously received tender compared to the accepted tenders.
Progress of work	Did the contractor proceed diligently in previous projects?
Standard of quality	Quality of workmanship and material in previous projects.
Failed contract	Whether the contractor has failed to complete a contract or recently has his contracts terminated by the client or has prematurely withdrawn from a contract.
Relationship with client	Any adverse relationship with client due to contractor's fault?
Health and safety	Record of health and safety on previous projects, and availability of health and safety measures.
Integrity	Readiness to advise on buildability.
Resources	Availability of sufficient labour and plant for this project.
Project's complexity	Contractor's experience to handle the complexity as required in the present project.
Size of project	Applicants should have carried out works of the values similar to that of the applied price range.
Response to instruction	Did contractor respond to the instruction diligently in previous projects?
Type of project	Applicant should have carried out works of the similar nature.
Previous debarment	Contractor has recently been debarred by other clients from tendering, removed from another standing list or rejected by other clients.
Reputation	Whether the referees would use this contractor again?
Claims and contractual dispute	Record of unjustified claims in previous projects.
Cooperative outlook	Is the contractor likely to cooperate with the client, client's representatives and subcontractors?
Relationship with consultant	Any conflicts between contractor and consultants due to contractor's fault?
Capacity of work	Contractor has too much work at any one time.
Quality assurance & control	Whether the company has obtained or pursuing a quality assurance scheme.
Credit rating	A bank reference obtained from the applicant's bank to prove that the company has a sound financial status to carry out the specified range of work.
Level of technology	Contractor's experience to handle the level of technology as required in the present project.
Relationship with subcontractors	Any adverse relationship with subcontractors due to contractor's fault?
Working capital	Availability of sufficient working capital to finance this project.
Form of contract	Whether the contractor has previous experience with the form of contract used?
Specialised trade	The construction trades that the contractor is specialised in.
Method of procurement	Whether the contractor has previous experience with the method of procurement used?
Location	Location of head office and availability of a local office in the case of an overseas company.
Length of time in business	Length of establishment in construction.
Amount of subcontracting work	Usual subcontracting proportion and which trades are usually subcontracted?
Numbers of previous bids	Rate of returning tenders.

## Appendix C

### *Discriminant function*

$$\begin{aligned} DF = & 8.495 + 2.229x_1 - 2.402x_2 - 0.167x_3 + 0.137x_4 - 1.515x_5 - 2.440x_6 + 0.180x_7 - 1.055x_8 + 0.423x_9 \\ & + 4.636x_{10} + 2.151x_{11} - 2.700x_{12} - 0.257x_{13} + 2.336x_{14} - 0.468x_{15} - 4.408x_{16} + 2.285x_{17} + 0.780x_{18} \\ & - 4.065x_{19} - 6.220x_{20} + 2.507x_{21} - 0.369x_{22} - 2.354x_{23} + 0.064x_{24} + 1.376x_{25} - 0.731x_{26} - 0.695x_{27} \\ & - 2.039x_{28} + 3.981x_{29} + 1.434x_{30} + 4.753x_{31} - 1.936x_{32} + 1.246x_{33} - 1.053x_{34} + 1.744x_{35} \end{aligned}$$

where:

DF = discriminant function

x<sub>1</sub> = performance

x<sub>2</sub> = quality assurance and control

x<sub>3</sub> = reputation

x<sub>4</sub> = integrity

x<sub>5</sub> = stability of firm

x<sub>6</sub> = financial stability

x<sub>7</sub> = credit rating

x<sub>8</sub> = working capital

x<sub>9</sub> = resources

x<sub>10</sub> = management capability

x<sub>11</sub> = location

x<sub>12</sub> = length of time in business

x<sub>13</sub> = capacity of work

x<sub>14</sub> = cooperative outlook

x<sub>15</sub> = claims and contractual dispute

x<sub>16</sub> = response to instruction

x<sub>17</sub> = relationship with subcontractors

x<sub>18</sub> = relationship with consultant

x<sub>19</sub> = relationship with client

x<sub>20</sub> = progress of work

x<sub>21</sub> = type of project

x<sub>22</sub> = size of project

x<sub>23</sub> = project's complexity

x<sub>24</sub> = level of technology

x<sub>25</sub> = standard of quality

x<sub>26</sub> = specialised trade

x<sub>27</sub> = amount of subcontracting work

x<sub>28</sub> = method of procurement

x<sub>29</sub> = form of contract

x<sub>30</sub> = previous debarment

x<sub>31</sub> = failed contract

x<sub>32</sub> = fraudulent activity

x<sub>33</sub> = competitiveness

x<sub>34</sub> = number of previous bids

x<sub>35</sub> = health and safety

Table 1  
Importance of PQC

PQC	Mean						
	Overall	Govt.	Private	Arch.	C.E.	Q.S.	P.M.
Performance	4.59	4.60	4.75	4.56	4.59	4.45	4.59
Fraudulent activity	4.39	4.57	4.75	4.50	4.20	4.50	3.97
Financial stability	4.32	4.72	4.75	4.08	4.00	4.00	4.19
Management capability	4.12	3.84	4.44	4.17	3.94	4.48	4.30
Stability of firm	4.10	4.25	4.60	4.04	3.79	4.00	4.10
Competitiveness	4.05	4.11	4.27	3.83	3.97	4.05	4.13
Progress of work	4.03	4.16	4.00	4.08	4.06	3.71	4.00
Standard of quality	4.00	4.04	4.36	4.32	3.76	3.75	3.94
Failed contract	3.96	4.33	4.44	3.77	3.83	3.63	3.61
Relationship with client	3.86	3.80	4.15	3.84	3.78	3.33	4.27
Health and safety	3.77	4.16	4.31	3.68	3.48	3.05	3.70
Integrity	3.77	3.61	3.94	3.96	3.47	3.73	4.09
Resources	3.75	3.56	4.13	3.76	3.76	3.82	3.79
Project's complexity	3.75	3.65	4.33	3.75	3.68	3.85	3.73
Size of project	3.74	3.85	4.25	3.54	3.74	3.81	3.52
Response to instruction	3.74	3.88	4.20	3.76	3.34	3.62	3.78
Type of project	3.70	4.16	4.15	3.50	3.74	3.67	3.70
Previous debarment	3.66	3.43	4.14	3.67	3.47	3.05	3.27
Reputation	3.65	3.43	3.25	3.80	3.65	3.77	3.97
Claims and contractual dispute	3.61	3.85	3.63	3.56	3.35	3.64	3.48
Cooperative outlook	3.60	3.40	4.00	4.00	3.19	3.45	3.88
Relationship with consultant	3.47	3.45	3.33	3.76	3.31	3.38	3.53
Capacity of work	3.44	3.47	3.88	3.32	3.23	3.33	3.52
Quality assurance + control	3.41	3.26	3.75	3.56	3.33	3.05	3.70
Credit rating	3.41	3.78	3.60	3.48	3.00	3.00	3.38
Level of technology	3.28	3.00	3.62	3.35	3.31	3.10	3.59
Relationship with subcontractors	3.15	3.35	3.00	3.52	2.65	2.90	3.28
Working capital	3.12	3.39	3.31	3.08	2.69	2.90	3.22
Form of contract	2.95	2.76	3.63	3.08	2.40	3.00	3.27
Specialised trade	2.92	3.09	2.86	3.27	2.72	2.84	2.77
Method of procurement	2.91	2.60	3.80	3.21	2.25	3.21	3.12
Location	2.85	2.92	3.00	2.64	2.70	2.86	3.00
Length of time in business	2.60	2.48	2.81	2.60	2.67	2.67	2.55
Amount of subcontracting work	2.56	2.61	2.62	2.83	2.19	2.55	2.59
Numbers of previous bids	2.55	2.80	2.29	2.47	2.45	2.40	2.56

Table 2  
Top ten PQC by group of organisation

PQC	Mean	PQC	Mean
(a) Private firms		(b) Governmental firms	
1. Financial stability	4.75	1. Financial stability	4.72
2. Performance	4.75	2. Performance	4.60
3. Fraudulent activity	4.75	3. Fraudulent activity	4.57
4. Stability of firm	4.60	4. Failed contract	4.33
5. Management capability	4.44	5. Stability of firm	4.25
6. Failed contract	4.44	6. Progress of work	4.16
7. Standard of quality	4.36	7. Health and safety	4.16
8. Project's complexity	4.33	8. Previous debarment	4.16
9. Health and safety	4.31	9. Competitiveness	4.11
10. Competitiveness	4.27	10. Standard of quality	4.04
(c) Architectural firms		(d) Engineering firms	
1. Performance	4.56	1. Performance	4.59
2. Fraudulent activity	4.50	2. Fraudulent activity	4.20
3. Standard of quality	4.32	3. Progress of work	4.06
4. Management capability	4.17	4. Financial stability	4.00
5. Financial stability	4.08	5. Competitiveness	3.97
6. Progress of work	4.08	6. Management capability	3.94
7. Stability of firm	4.04	7. Failed contract	3.83
8. Co-operative outlook	4.00	8. Stability of firm	3.79
9. Integrity	3.96	9. Relationship with client	3.78
10. Relationship with client	3.84	10. Standard of quality	3.76
(e) Quantity surveying firms		(f) Project management firms	
1. Fraudulent activity	4.50	1. Performance	4.59
2. Management capability	4.48	2. Management capability	4.34
3. Performance	4.45	3. Relationship with client	4.27
4. Competitiveness	4.05	4. Financial stability	4.19
5. Financial stability	4.00	5. Competitiveness	4.13
6. Stability of firm	4.00	6. Stability of firm	4.10
7. Project's complexity	3.85	7. Integrity	4.09
8. Resources	3.82	8. Progress of work	4.00
9. Size of project	3.81	9. Fraudulent activity	3.97
10. Standard of quality	3.75	10. Reputation	3.97

Table 3  
Eigenvalues of the five discriminant functions

Function	Eigenvalue	% of Variance	Cumulative %	Canonical correlation
1	1.262	39.7	39.7	0.747
2	0.780	24.6	64.3	0.662
3	0.501	15.8	80.1	0.578
4	0.380	11.9	92.0	0.525
5	0.255	8.0	100.0	0.451

Table 4  
Wilk's lambda of the five discriminant functions

Test of functions	Wilks' lambda	Chi-square	df	Significance
1-5	0.096	238.308	175	0.001
2-5	0.216	155.460	136	0.121
3-5	0.385	96.909	99	0.541
4-5	0.578	55.705	64	0.760
5	0.797	23.038	31	0.848

Table 5  
Functions at group centroids

Type of organisation	Function	
	1	2
Government	1.742	-0.257
Private	0.197	1.731
Architectural	0.549	-0.195
Civil engineering	-0.421	-1.391
Quantity surveying	-1.576	-0.086
Project management	0.336	0.718

Table 6  
Standardised canonical discriminant function coefficients

Discriminating variables	Function	
	1	2
Performance	0.124	0.028
Quality assurance and control	0.119	-0.298
Reputation	-0.227	-0.193
Integrity	-0.084	0.030
Stability of firm	0.007	-0.043
Financial stability	0.675	0.454
Credit rating	-0.111	-0.036
Working capital	0.023	0.146
Resources	-0.407	0.007
Management capability	0.531	.196
Location	0.018	0.302
Length of time in business	-0.161	-0.489
Capacity of work	0.548	0.117
Cooperative outlook	-0.302	0.392
Claims and contractual dispute	0.007	-0.661
Response to instruction	0.234	0.114
Relationship with subcontractors	-0.092	0.132
Relationship with consultant	-0.056	-0.444
Relationship with client	0.271	0.091
Progress of work	0.116	-0.417
Type of project	-0.431	0.268
Size of project	0.416	-0.029
Project's complexity	-0.312	0.243
Level of technology	0.106	-0.004
Standard of quality	-0.033	0.278
Specialised trade	0.421	-0.317
Amount of subcontracting work	-0.173	0.021
Method of procurement	-0.043	0.481
Form of contract	-0.021	0.671
Previous debarment	0.110	-0.140
Failed contract	0.389	0.297
Fraudulent activities	-0.497	-0.051
Competitiveness	-0.012	0.117
Number of previous bids	0.337	0.206
Health and safety	0.411	0.094

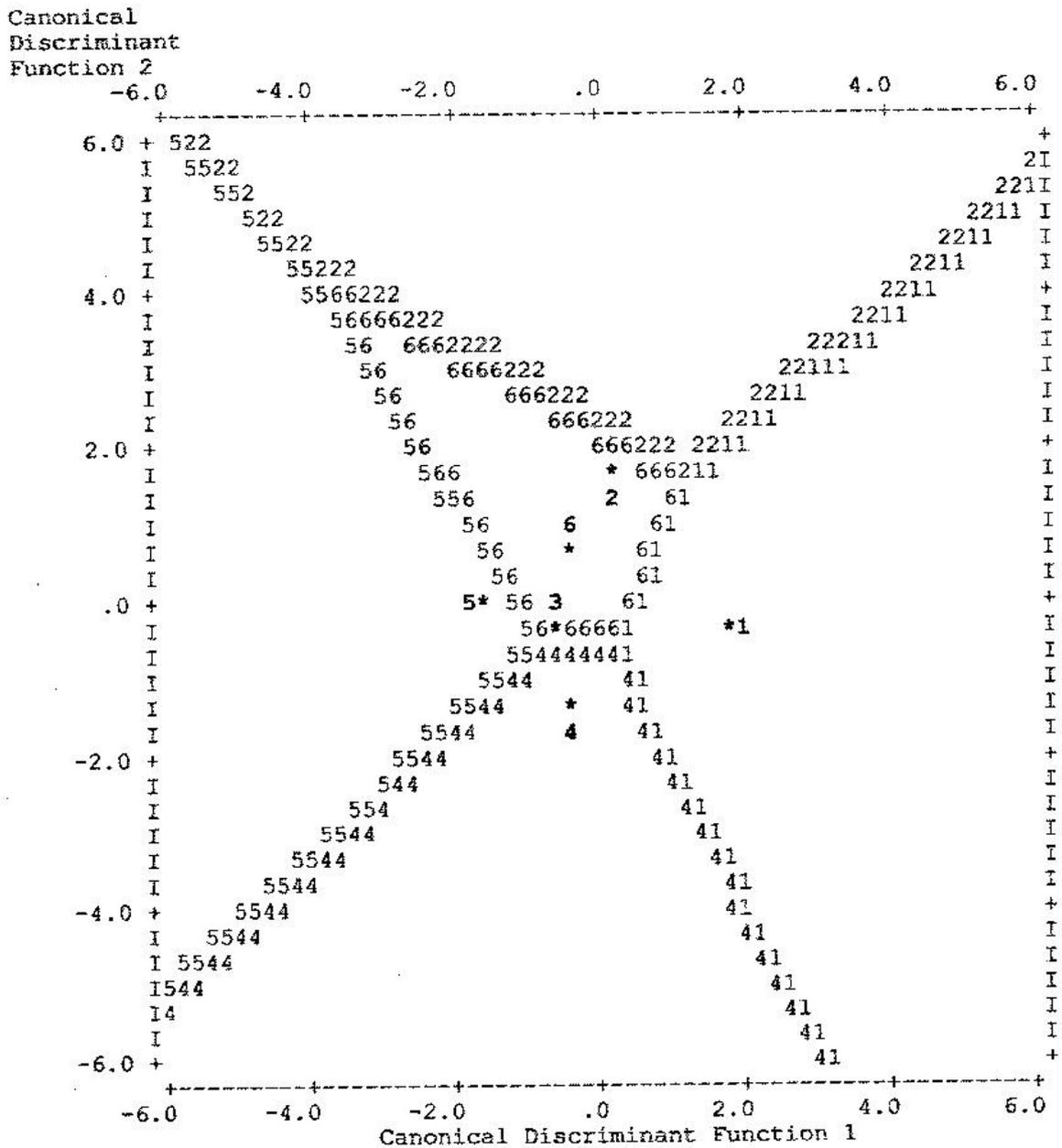
Table 7

Standardised canonical discriminant function coefficients between clients

Discriminating variables	Function 1
Performance	1.100
Quality assurance and control	-2.541
Reputation	-0.161
Integrity	0.122
Stability of firm	-0.946
Financial stability	-1.065
Credit rating	0.225
Working capital	-1.227
Resources	0.277
Management capability	3.859
Location	2.449
Length of time in business	-2.244
Capacity of work	-0.175
Cooperative outlook	2.615
Claims and contractual dispute	0.374
Response to instruction	-3.031
Relationship with subcontractors	2.349
Relationship with consultant	0.730
Relationship with client	-3.141
Progress of work	-3.551
Type of project	2.511
Size of project	-0.364
Project's complexity	-2.212
Level of technology	0.058
Standard of quality	1.291
Specialised trade	-0.923
Amount of subcontracting work	-0.834
Method of procurement	-2.438
Form of contract	5.070
Previous debarment	1.202
Failed contract	2.392
Fraudulent activities	-0.831
Competitiveness`	0.827
Number of previous bids	-1.333
Health and safety	2.115

Table 8  
Classification matrix

	Type of client	Predicted group membership		Total
		Private	Public	
Original %	Private	72.6	27.4	100.0
	Public	34.1	65.9	100.0



Symbols used in territorial map

Symbol	Group	Label
1	1	Government
2	2	Private
3	3	Architectural
4	4	Engineering
5	5	Quantity surveying
6	6	Project Management

\* Indicates a group centroid

Fig. 1. Territorial map of different organisational groups