

IDENTIFICATION OF CONTRACTOR PREQUALIFICATION CRITERIA USDED IN TIANJIN ROADWAY ADMINISTRATION BUREAU, CHINA

INTRODUCTION

General

The construction industry is characterized by cost and duration overrun, serious problems in quality standards and safety measures, an increased number of claims, counterclaims and litigation in some senses. The decisions an owner must make at the beginning of construction program often set the patterns of success or failure for the entire project. One of these decisions and maybe the most important and crucial challenge is the selection of the contractor to execute the project according to the prepared plans and specifications. If that contractor is a qualified contractor, the potential problems will be minimized and the project will be completed according to the owner's expectations. On the other hand, if that contractor is not qualified by experience, skill, and responsibility, and does not have the necessary financial averages to execute the project, the outcome will be disappointing. Various problems may be encountered in the execution of project, which may include project delay, poor quality, cost overruns, construction disputes and claims, and many more. Therefore, the right choice of contractors is crucial for the success of construction projects.

In public sector, the tender price is the main criterion for selecting the contractor. Generally a contract will be awarded to the bidder who offers the lowest bid price in an open competitive bidding. The lowest bid award system is very common in the public sector in china and other countries, since the public sector is bound by public accountability and must demonstrate that the best value for money has been achieved. The straightforward selection of the lowest bidder is based on the assumption that the specification used clearly defines the product that will be delivered. It assumes that all contractors are the same and it is therefore best to choose the lowest cost alternative (Palaneeswaran, 1999). However, it is becoming more and more aware of the fact that selection of a contractor based on tender price alone is quite risky and

may lead to the failure of the project in terms of time delay and poor quality standards. Russel and Jaselskis (1992) found that the amount of the contractor prequalification is related to the probability of contractor failure.

As a safeguard and complement, contractor prequalification assessment serves as a key control measures in the lowest bid award system. The contractor prequalification will contribute significantly to assurance bidding participation of only qualified contractor with satisfactorily capability and prevention of contractor default.

Statement of Problem

The construction industry has contributed around seven percent of the Gross Domestic Product (GDP) in China yearly according to the data provided by State Statistics Bureau of China (SSBC). It plays a quite important role in the high speed development of Chinese economy.

The Chinese construction industry was formerly known for its low efficiency and effectiveness. To improve efficiency and effectiveness in construction industry, the Chinese government has been actively introducing competitive bidding approaches by setting up a series of laws and regulations since 1981.

In Article 18 of the Law of Inviting and Submitting of Bids of People's Republic of China (LISB), it is stated that a tenderer may, in accordance with the need of a project subject to tender, demand the intended bidders to provide documentary evidences related to their qualifications and information on their business performance in his tender announcement or invitations for submission of bids, and shall examine the qualifications of the intended bidders; and if the State has the provisions on the qualifications of bidders, such provisions shall govern. A tenderer may not restrict or exclude any intended bidder with unreasonable requirements and may not apply discrimination treatment to any intended bidder.

As a fact, contractor prequalification decision-making involves a wide range of criteria that often consists of both qualitative and subjective information. However, the area of contractor prequalification has received a minimal amount of attention after enforcement of the LISB. The current tendering procedure lacks a consistent approach that clearly defines all the steps and aspects of the contractor prequalification. The current practice of the contractor prequalification of highway engineering works is performed subjectively based on the experience of the tendering committee formed for each project. There is no nation-wide contractor prequalification standard or guidelines that could be uniformly followed by Roadway Administration Bureau of China. In some instances, the contractor is not well convinced by the outcome.

On the other hand, various surety systems, such as performance bond and payment bond, have developed in different counties to protect against failure of contractor to complete a signed contract. However, the surety system is not popularly adopted in Chinese construction industry, and only applied in large projects and some foreign investing projects. So far there is no registered surety company in China; bank usually functions as the surety company. Presently, only bid bond or cash deposit for bidding is required and other surety system is seldom adopted, and the clients can not be protected well in case of contractor failure in current tendering system.

In order to protect the public fund and prevent contractor failure, it is necessary to develop prequalification standards to improve the efficiency and effectiveness of the public procurement systems in highway engineering works.

Objectives of Research

The main objectives of this research were as follows:

(1) To determine a list of prequalification criteria in selecting contractors in Tianjin Roadway Administration Bureau, China and evaluate their relative importance.

(2) To investigate the different opinions of the relative importance and applicability of these criteria between public client and contractor.

Scope of Research

The area of this research focused on the contractor prequalification applied in highway construction projects in Tianjin, China. Currently, various Provincial Roadway Administration Bureau (PRAB) and Municipal Roadway Administration Bureau (MRAB) are responsible for overall management of highway projects located in their territory. The survey was conducted in two groups:

(1) Public clients from Tianjin Roadway Administration Bureau of (TRAB), China

(2) Construction contractors who participated in highway engineering projects in Tianjin, China

LITERATURE REVIEW

Contractor Prequalification

Definition of Contractor Prequalification

In an open bidding system, contractors often go through a prequalification stage to be able to submit a tender on a particular project. This prequalification stage is one of the earliest stages of the tendering process and is also the focus of this study. Basically, the qualification process selects based on their qualifications and allows them to move to the next stage of tender preparation and submission.

The successful execution of contracts for large buildings, civil engineering, supply and installation, turnkey, and design and build projects requires that contracts be awarded only to firms, or combinations of firms, that are suitably experienced in the type of work and construction technology involved, that are financially and managerially sound, and that can provide all the equipment required in a timely manner. The assessment by an implementing agency of the suitability of firms to carry out a particular contract prior to being invited to submit a bid is a process called prequalification. (World Bank)

Russell and Skibniewski (1990) stated “prequalification is a screening process used to determine a candidate’s competence or ability to meet the specific requirements for the performance of a task. In the construction industry, prequalifying a contractor involves screening by a project owner, according to a given set of criteria, to determine the contractor’s competence to participate in a project bid.”

Prequalification is a process that identifies the contractors that are believed incapable of completing the project on budget, on time, and according to the specifications, and prevents them from submitting a tender.

The prequalification process reduces the large number of prospective contractors to those who have demonstrated their ability to perform consistently with acceptable standards of quality and reliability. If properly used, prequalification can reduce the risk of poor contractor performance.

Purpose of Contractor Prequalification

The principal purpose of contractor prequalification is to help owners avoid constructor failure by ensuring that constructors participating in the bidding process have adequate experience and expertise to perform the work that the project under consideration entails (Russell, 1996).

Properly designed prequalification procedures have the following objectives:

- (1) Assure that contractors willing to participate in the bidding process will be competent, responsible, and experienced, with adequate resources to complete the job.
- (2) Eliminate contractors with limited financial resources, over-loaded, and / or inadequate or overly inexperienced organizations.
- (3) Maximize competition among qualified contractors.

Benefits and Shortcomings of Contractor Prequalification

World Bank (2002) has stated the benefits as follows:

- (1) The process enables prospective bidders, who may be insufficiently qualified on their own, to avoid the expense of bidding. Conversely it is an incentive for these potential bidders to form a joint venture that may give them a better chance of success;

(2) After being prequalified, well-qualified firms will price their bids with the knowledge that they are competing against other qualified bidders meeting realistic minimum competence criteria; the assurance that inadequately qualified competitors will be excluded from submitting unrealistic low bids thus encourages leading contractors to bid;

(3) Prequalification enables Borrowers to assess the interest from qualified firms generated by the contract and, in the event that only a limited number of applications are received, to make any necessary adjustments in the procurement process (including, in particular, the special conditions of contract—sharing of risk, payment terms, liquidated damages, or completion times, which may be perceived as onerous by potential bidders);

(4) It helps to expose potential conflicts of interest by identifying contractors who may have a business association with consultants to the project;

(5) It reduces the amount of work and time involved by employers in evaluating bids from unqualified contractors;

(6) It encourages local firms to form joint ventures with other local or international firms, thereby benefiting from their resources and experience;

(7) It enables the employer to assess the likelihood of contractors' eligibility for domestic bidder price preference in borrowing countries where this is applicable;

(8) It reduces significantly, if not eliminates, problems of rejection associated with low-priced bids submitted by bidders of doubtful capability; and

(9) It gives some indication of an employer's ability to manage an important, early procurement function.

On the negative side, prequalification has some potential disadvantages:

(1) It may increase procurement lead time, although this can be minimized by good procurement scheduling, e.g., undertaking the prequalification process while bidding documents are being prepared;

(2) It is required to review all prequalification applications, whereas postqualification requires the review of the qualifications of, normally, only one (the lowest evaluated) bidder;

(3) The element of subjective judgment required by evaluators when applying the prequalification criteria to a number of applicants, and the discretionary rights reserved to the employer, provide opportunities for externally influenced deviations from the expected high standards of ethics and impartiality in prequalifying applicants.

Russell (1996) identified a list of benefits and shortcomings result from contractor prequalification process. Examples of benefits and drawbacks associated with this prequalification process for both owners and contractors are summarized in Table 1.

Prequalification versus Postqualification

Prequalification is the process of screening candidates prior to issuing the complete project plans and specifications that contractors need to prepare a bid. By comparison, post qualification permits any contractors to obtain project plans and specifications and prepare an estimate. Owners who utilize postqualification wait until they have received the contractor's bids, and then evaluate the qualifications of the lowest bidder only. If an owner finds that the low bid contractor is unqualified, then the next bidder receives similar analysis. Evaluating each low bidder until finding a qualified one can cause delays and may lead to expensive schedule-stymieing litigation (Russell, 1996).

Table 1 The benefits and Drawbacks of Contractor Prequalification

Owner	Contractor
Benefits	
<ol style="list-style-type: none"> 1. Identifies contractors who will submit a bid or proposal. 2. Provides an opportunity to screen out contractors who do not have sufficient qualifications and/or experience to execute contract 3. Reveals a contractor who has a large backlog of current work that may reduce resources/capacity available for new projects. 4. Minimizes the probability of contractor default or delays. 5. Establishes organized, professional conduct as precedent for the climate of project's execution. 	<ol style="list-style-type: none"> 1. Contractors are assured that bids will maintain a realistic relationship to sound engineering and construction practices and economic conditions. Thus, unqualified contractors are prevented from introducing uncertainty into bidding process. 2. The contractor benefits from the reduction of competition in bidding process for a specific project 3. Spares most bidders expense of preparing the estimate or proposal and embarrassment of disqualification. 4. Protects contractor from being awarded projects they are incapable of performing.
Drawbacks	
<ol style="list-style-type: none"> 1. The cost of developing, implementing, and evaluating objective contractor prequalification criteria and evaluating contractor. 2. The difficulty of developing quantifiable criteria that are applicable for a given project circumstance that allows owner to make accurate, sound, and consistent decisions. 	<ol style="list-style-type: none"> 1. The potential for biased or erroneous denial of admission into bidding process. 2. The expenditure of resources on promotion and public relations to secure an opportunity to participate in bidding process. (The opportunity to increase reputation may be a benefit.)

Table 1 (Cont'd)

Owner	Contractor
Drawbacks	
<p>3. The difficulty of formalizing the decision-developing process to make objective and sound decisions, without introducing subjective judgment and biases.</p> <p>4. The potential for qualified contractors to choose not to participate.</p> <p>5. High levels of competition may cause contractors to make bids at or near cost to keep organization viable. Thus, a reduced number of bidders and restricted competition can result in a higher project markup for the contractor. Therefore, owner may incur a higher project cost.</p>	<p>3. The limitation of growth potential as the result of diminished opportunity to expand into new areas in which the contractor does not have an established track record.</p>

Source: Russell (1996)

Prequalification Procedure

Russell and Skibnewski (1988) developed a generic logic which is used in the contractor prequalification process in the United States of America (USA). The general flow diagram of contractor prequalification is shown in Figure 1.

The Federations of European International Contractors (EIC) and the International Federation of Consulting Engineers (FIDIC) presented the main stage of the prequalification procedure of tendering along with its steps in Table 2.

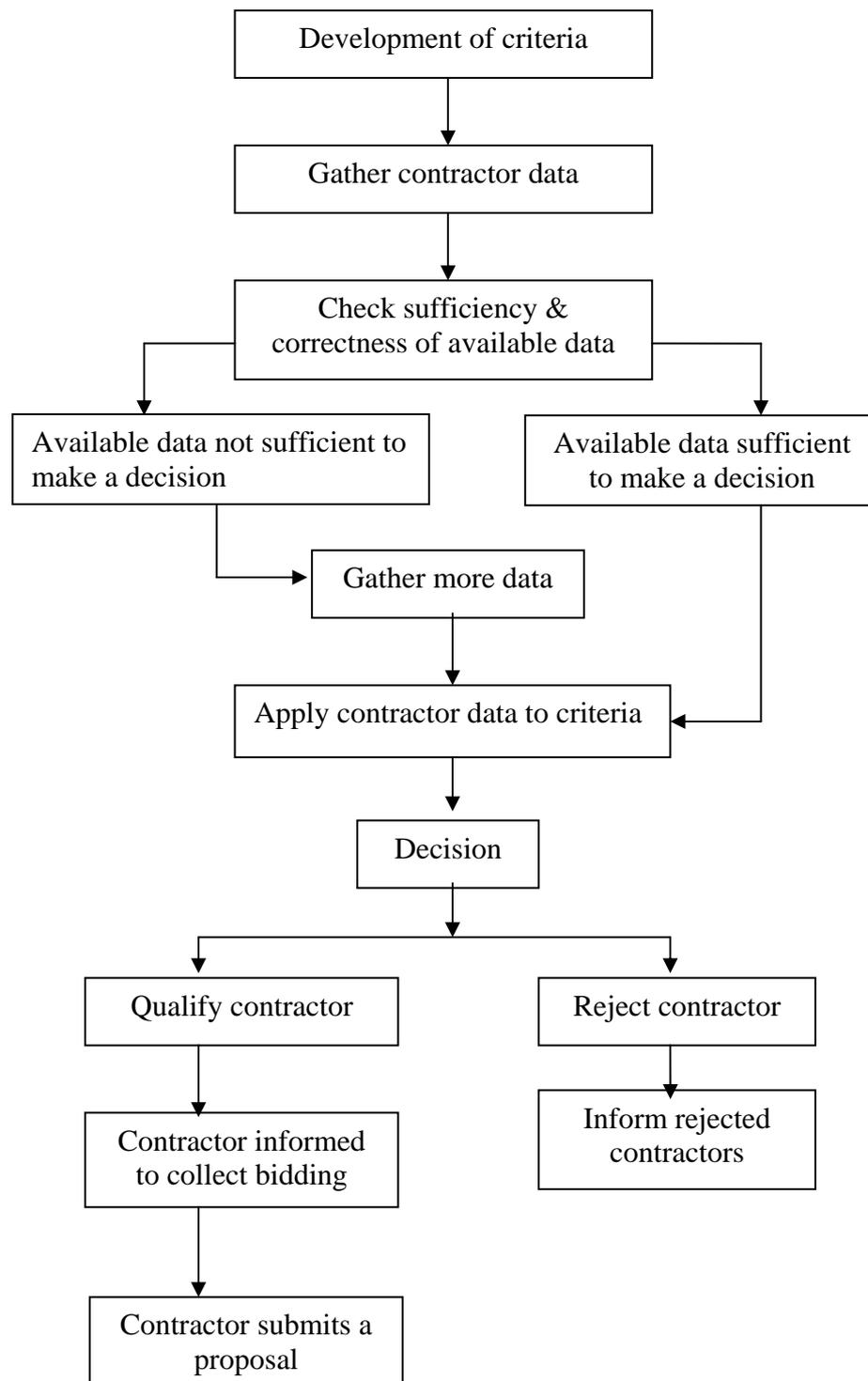


Figure 1 Flow Diagram of Contractor Prequalification Process

Source: Russell and Skibnewski (1988)

Table 2 Prequalification of Contractors

Description	Employer/Engineer	Contractor
1. Invitation to contractors to prequalify	Place prequalification advertisement in press, embassies, etc. as appropriate stating: <ul style="list-style-type: none"> ● Employer & engineer ● Outline of project (scope, location, and program) ● Enquiry issue & tender submission dates ● Instruction for applying prequalification ● Submission date for contractors ● Prequalification data 	
2. Issue and submission of prequalification documents	Issue prequalification instruction & questionnaires requesting from each company/joint venture: <ul style="list-style-type: none"> ● Organization and structure ● Experience in the intended type of work and the country ● Resources: managerial, technical, labor, plant ● Financial statements 	1. Request prequalification documents 2. Respond to questionnaires on companies and if appropriate joint venture
	Acknowledge receipt	

Table 2 (Cont'd)

Description	Employer/Engineer	Contractor
3. Analysis of prequalification data and selection & notification of list of selected tenderers	Analyze prequalification data: <ul style="list-style-type: none"> ● Company/Joint venture structure ● Experience ● Resources ● Financial stability ● General stability 	
	Select companies /Joint ventures for inclusion in list of tenders	Acknowledge receipt
	Notify all contractors / Joint Ventures of the list of selected tenders	Confirm intention to submit valid tender

Source: FIDIC (1988)

Merna and Smith (1990) illustrated the component of a typical prequalification procedure used in the United Kingdom (UK) as shown in Figure 2.

(1) The initial selection may be based on advertisement and approved prequalified lists, on advertisements and historical records, or solely on the use records and engineering judgment and experience.

(2) Approved lists are independently maintained and updated by many public sector owner organizations. To gain entry to an approved list, a contractor has to apply initially to owner and is then assessed on grounds of financial stability, managerial capacity, organizational structure, technical expertise, and previous record of comparable construction. Record system is compiled from application of contractors who are assessed by owner.

(3) The response to advertisements is often so great that owner are required to narrow down the number of contractors to a short list, which is traditionally one and a half times the

number of contractors to be invited to bid. This process is usually carried out on a subjective, informal basis.

(4) The performance of contractors will be assessed in detail to ascertain the current state of financial, technical, and managerial ability of each contractor.

(5) The final assessment is the step of this procedure to reject or invite the assessed contractor.

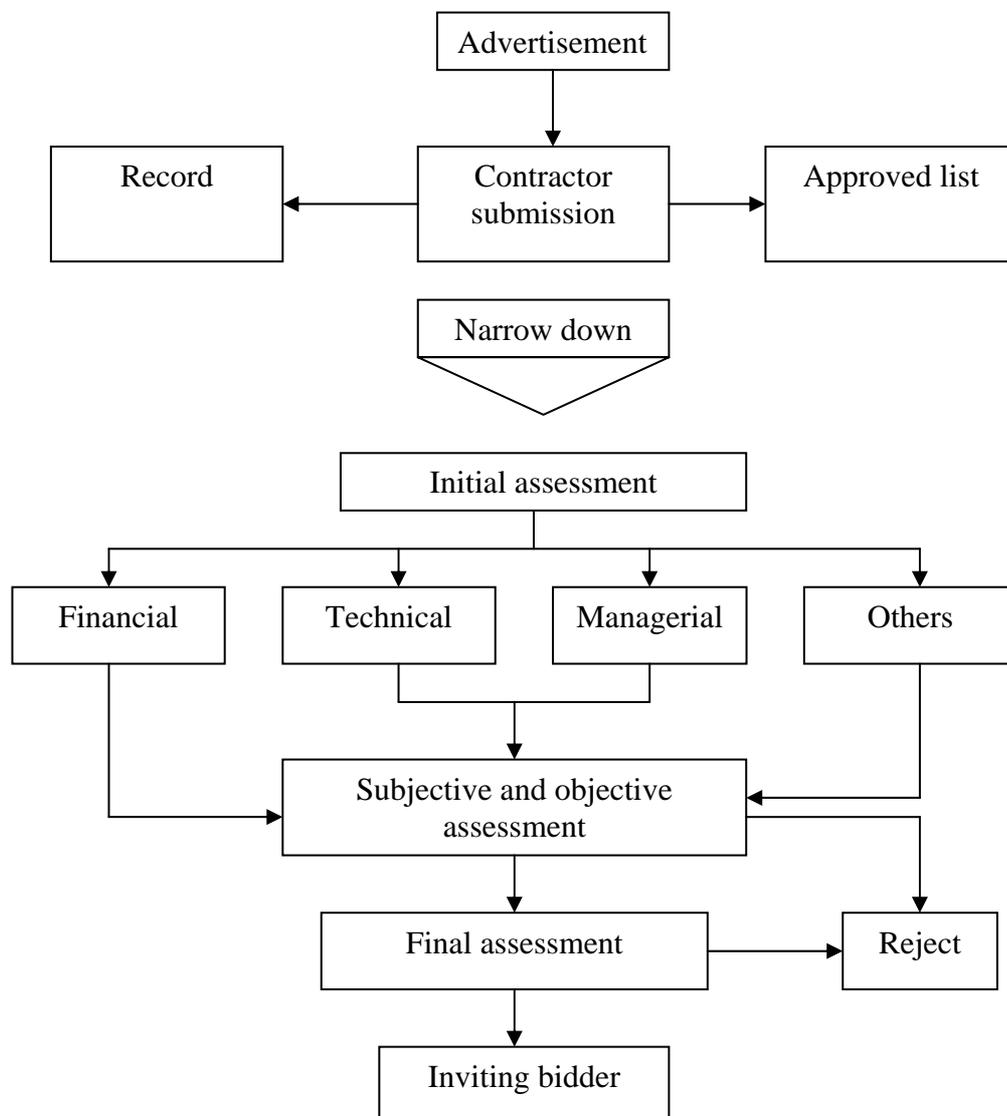


Figure 2 Typical Prequalification Procedures in the U.K.

Source: Merna and Smith (1990)

Prequalification Criteria

Qualification criteria and requirements are to specify the criteria and corresponding requirements that the clients shall use to evaluate the applications and prequalify the applicants. Prequalification criteria vary from model to model and are usually owner specific in every project. Construction researchers have proposed many different criteria for contractor prequalification.

Prequalification Criteria Used in the USA

The contractor's qualification statement recommended by the American Institute of Architects (AIA) and the Associated General Contractors of America (AGCA) includes these prequalification items:

- (1) Company organization (including the name of principals and ownership type);
- (2) A listing of major projects under construction currently;
- (3) A listing of major projects performed in the past 5 years;
- (4) Construction experience of principal individuals;
- (5) Reference both from bank and trade;
- (6) Name of bonding company;
- (7) Statement of financial conditions including latest balance sheet.

Potter and Sanvido (1995) introduced the prequalification in evaluating the qualification of potential design/build project teams used in United States Postal Service (USPS) as follows:

(1) Construction experience;

The USPS requires contractors to submit the following information regarding comparable projects completed or still in progress in the last 5 years: 1) project name, 2) client name, title, address, and phone number, 3) project location, 4) project type, 5) contract type, 6) original contract amount and current or final contract amount, and 7) originally scheduled completion date and currently estimated (or actual) completion date.

(2) Financial stability;

The financial stability of a candidate contractor can be determined by evaluating contractor's financial statement, banking arrangements and bonding capacity.

(3) Firm capacity;

(4) Safety performance.

Three major attributes will be investigated: 1) worker's compensation experience modification rate (EMR), 2) OSHA recordable injury and illness incidence rates, 3) the contractor's safety attitudes and practices.

(5) References evaluation (mainly from previous owners);

(6) Company organization;

(7) Percentage of work performed with own forces;

(8) Project management capability;

To evaluate this criterion, the USPS requires contractor to submit information about: 1) company organization, 2) scheduling, 3) project staffing, 4) percentage of self-performed work, and 5) commitment to TQM.

(9) Percentage of work subcontracted to minority business participation;

(10) Experience in USPS fixed mechanization;

(11) Judgments, claims, and lawsuits;

(12) Suspension or debarment status.

Russell (1990) classified the prequalification criteria used in United States of America in five groups as below:

(1) General information - It concerns both administrative and past information such as references, reputation, and past performance for preliminary screening;

(2) Financial stability - It requires the consideration of credit rating, bank arrangements, bonding capacity, and financial statements;

(3) Status of current work program - It requires the consideration of work under contract and bid backlog;

(4) Technical expertise - It considers the contractor's key management personnel and company as well as project procedures (e.g., project control procedures) to determine whether the contractor has the basic technical knowledge, experience, and understanding of the requirements to execute all tasks associated with the project;

(5) Project specific criteria - It is considered prior to performing prequalification. Location, materials, or time constraints may be sought for owner's requirements.

Prequalification Criteria Used in the U.K.

Holt (1996) grouped widely criteria used in prequalification of contractor in the U.K. in five groups as follows:

(1) Organization criteria;

Adequacy of the organizational structure is another attribute used for the selection process. Organizational structure indicates the level of management commitment for different functions such as quality control and safety. The information required includes an organization chart, the name and address of the company, material supplier, and sub-contractor. The criteria have been broken down into six specific characteristics, which include size of organization, age of organization, image of organization, quality control policy, health and safety and litigation tendency.

(2) Financial criteria;

Financial stability is an important criteria used by a number of owners. Financial stability indicates whether a contractor has the necessary financial resources to execute the project. Some owners use a recent financial statement for evaluation. Others require additional information such as the approximate value of work in hand, the annual value of work, and the name and address of bankers from whom references may be obtained. The criteria have been broken down into three specific characteristics, which include ratio analysis, bank reference and supplier and manufacturer references.

(3) Experience criteria;

A contractor's experience is the most significant attribute for owner to evaluate. Similar projects under taken in terms of type, size, and complexity are reviewed carefully. The level of satisfaction, time of completion, and the percentage of work subcontracted are also considered. There are three key points, which include type of projects completed, size of projects completed and national or local experience.

(4) Management criteria;

Management capability is often considered under the manpower category, while some owners evaluate it separately depending on the project objectives. The prequalification contractor submits the qualification of key management personnel and company for owner evaluation. Four key elements are further analyzed, which include qualification of company owners, qualification of key personnel, key personnel, and years with company.

(5) Performance criteria;

Past performance for working on projects is a measure of contractor's competence whether he is able to handle the present project with its anticipated objective. Failure to complete a contract or contract overruns (time and cost) is asked from owner. This information is an important consideration because failure of project may lead to disputes and claims resulting in unpleasant situation. There are four specific points, which include failure to have completed a contract, schedule overruns, cost overruns and quality of work.

Ng and Skitmore (1999) investigated the divergence of decision criteria used by different client and consultant organization in contractor prequalification through a large empirical survey conducted in the U.K. Thirty-five prequalification criteria have been determined as a result of their preview study and knowledge acquired from professional in the U.K. construction industry. The top ten prequalification criteria that are regarded as being the most important are in descending order:

- (1) Performance of the related completed project;
- (2) Fraudulent activity (History of convictions in professional conduct, default or deceive, non-payment of social security, and non-payment of tax);
- (3) Financial stability (The previous, present and future financial status of the contractor);
- (4) Management capability (Availability of experienced management staffs to monitor and co-ordinate the work);
- (5) Stability of firm (Is the company in the process of bankruptcy proceedings?);
- (6) Competitiveness (The prices of previously received tender compared to the accepted tenders);
- (7) Progress of work (Did the contractor proceed diligently in previous projects?);
- (8) Standard of quality (Quality of workmanship and material in previous projects.);
- (9) 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.);
- (10) Relationship with client (Any adverse relationship with client due to contractor's fault).

From the perspective view of public client, the top ten most important prequalification stated by the government authorities were as follows:

- (1) Financial stability;
- (2) Performance;
- (3) Fraudulent activity;
- (4) Failed contract;
- (5) Stability of firm;
- (6) Progress of work;
- (7) Health and safety (Record of health and safety on previous projects, and availability of health and safety measures.);
- (8) Previous debarment (Contractor has recently been debarred by other clients from tendering, removed from another standing list or rejected by other clients.);
- (9) Competitiveness;
- (10) Standard of quality.

Prequalification Criteria Used in Australia

Palaneeswaran and Kumaraswamy (2001) also examined prequalification practices in Australia. The Construction Industry Development Agency (CIDA), Australia has prescribed mandatory criteria to screen out ineligible or unsuitable applicants as well as additional & reserved criteria to further describe and/or evaluate the applicants' skills and philosophy in order to discriminate them properly. Mandatory prequalification criteria are:

(1) Technical capacity;

The purpose is to enable the company to demonstrate it has the technical capacity to perform the work for which it is seeking prequalification or registration for specific projects. The information required for making this assessment is: past performance and experience, management and administration capability, labor and equipment, subcontractors and consultants.

(2) Financial capacity;

The contractors are required to provide the information to demonstrate level of compliance with minimum requirements of accounting and financial controls and financial strength which include ownership of the company, historical financial information, forecast cash flow, borrowings, work in progress, off balance sheet information.

(3) Quality assurance;

The key elements of the criterion focus on the extent of documentation and implementation of a quality system on Australian quality standards.

(4) Timely performance;

The contractor is required to provide details of past project performance and status of the company's time management systems.

(5) Occupational health and safety;

The purpose is to identify whether the company has a documented occupational health and safety management system.

(6) Human resources management;

The key elements include the human resource management processes, human resource management outcomes, and organizational culture.

(7) Skill formation;

It seeks a declaration that the company is meeting its statutory obligations in relation to training, has a skill formation policy, and is implementing a skill formation strategy.

Claims performance, compliance with legislative requirements and management for continuous improvement are prescribed as additional criteria while research and development facilities and export development are prescribed as reserved criteria.

Prequalification Criteria Used in Saudi Arabia

Abdulaziz and Kamal (1996) have identified the following common criteria that are considered in the prequalification practice in semipublic and private projects in Saudi Arabia:

(1) Contractor's experience;

(2) Financial stability;

(3) Past performance;

(4) Quality performance;

(5) Project management capacity;

(6) Contractor failure records;

(7) Management staff availability;

(8) Contractor capacity.

Prequalification in Turkey

Topcu (2004) also proposed the complete hierarchy of prequalification criteria in Turkey public sector. There are two main criteria at the prequalification stage: “ability to timely complete projects” representing the “time” dimension and “organizational expertise” representing the “quality” dimension. The hierarchy of prequalification criteria is given at Figure 3.

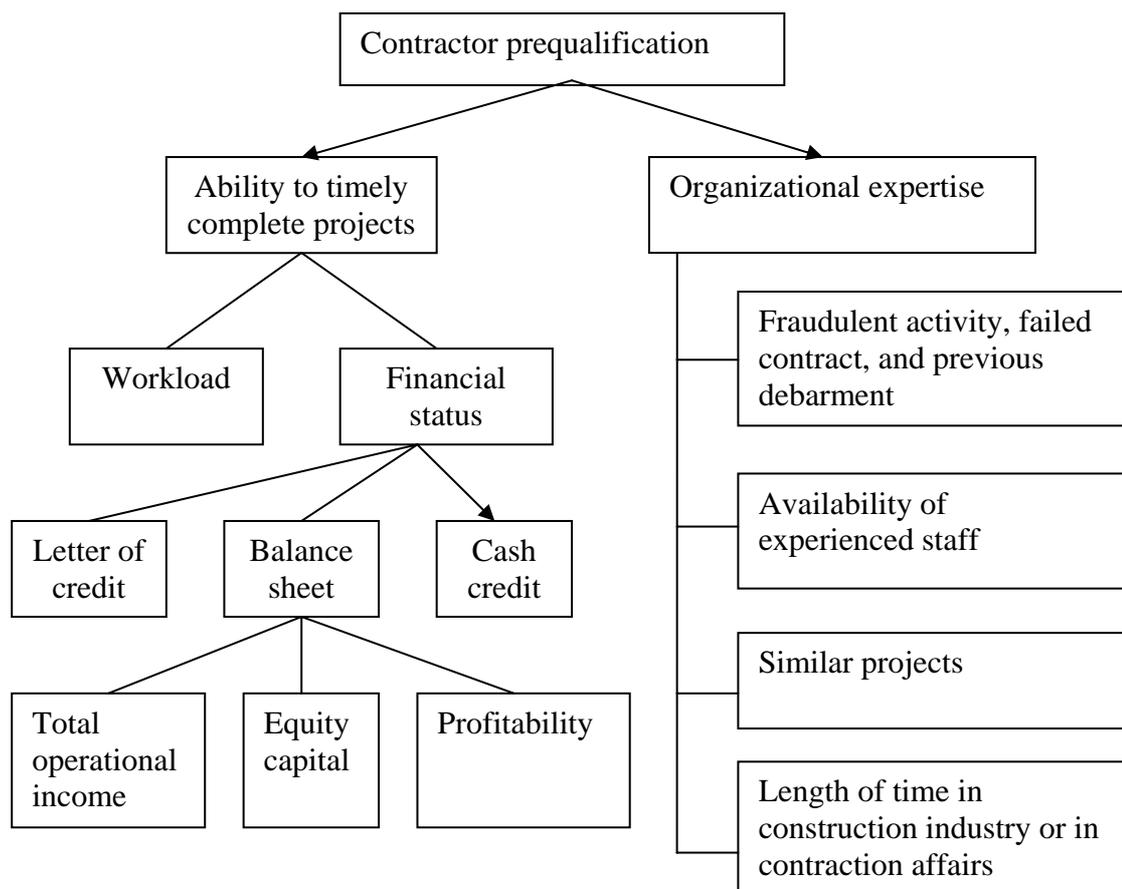


Figure 3 the Complete Hierarchy of Prequalification Criteria in Turkey

Source: Topcu (2004)

Prequalification Criteria Used in Hong Kong

The contractor prequalification used by two major government clients of Hong Kong have been studied by Palaneeswaran and Kumaraswamy (2001).

The selection of prequalified contractors in the Works Bureau is carried out in two stages. The first stage is primarily intended to screen out those applicants who are so patently ineligible or unsuitable so as to make further assessment of their applications unnecessary. The second stage assessment comprises a detailed technical evaluation of all applicants who have fulfilled the requirements of the first stage screening. The criteria for first stage assessment include the following where applicable:

(1) Whether the applicant is confirmed within the relevant category or group of works stipulated in the advertisement;

(2) In case of joint ventures, whether each of the joint venture partners satisfy the criteria stipulated in the advertisement;

(3) Whether adequate financial resources are available;

(4) Whether special plant, equipment, workshops, etc. as stipulated for the works will be made available to the contractor.

The criteria for the second assessment include technical aspects of the checking process, including the following where applicable:

(1) Experience in Hong Kong Government contracts in the past five years;

(2) Experience on other local contracts and overseas contracts in the past five years;

(3) Experience of the types or size of buildings etc., or forms of construction involved in the project in the past five years;

(4) Experience, availability and organization of managerial, professional and technical staff;

(5) Availability and details of special plant, equipment, workshops, etc;

(6) A preliminary method statement, quality assurance plan and site safety policy;

(7) Site safety record, including accident records and records of convictions for site safety violations and suspensions arising from regulating actions relating to site safety;

(8) Details of financial resources;

(9) A brief history of all claims, litigation and arbitration proceedings in connection with government building and engineering contracts in which the applicant has been involved in the capacity of the contractor over the last five years;

(10) Past environment performance, including convictions under any of the pollution control ordinances and breaches of environmental protection clauses in any government buildings or engineering contract in which the applicant has been involved;

(11) Record of convictions related to construction offences such as employment of illegal immigrants, site safety, etc.

The qualification criteria followed by Mass Transit Railway Corporation (MTRC) was shown in Figure 4.

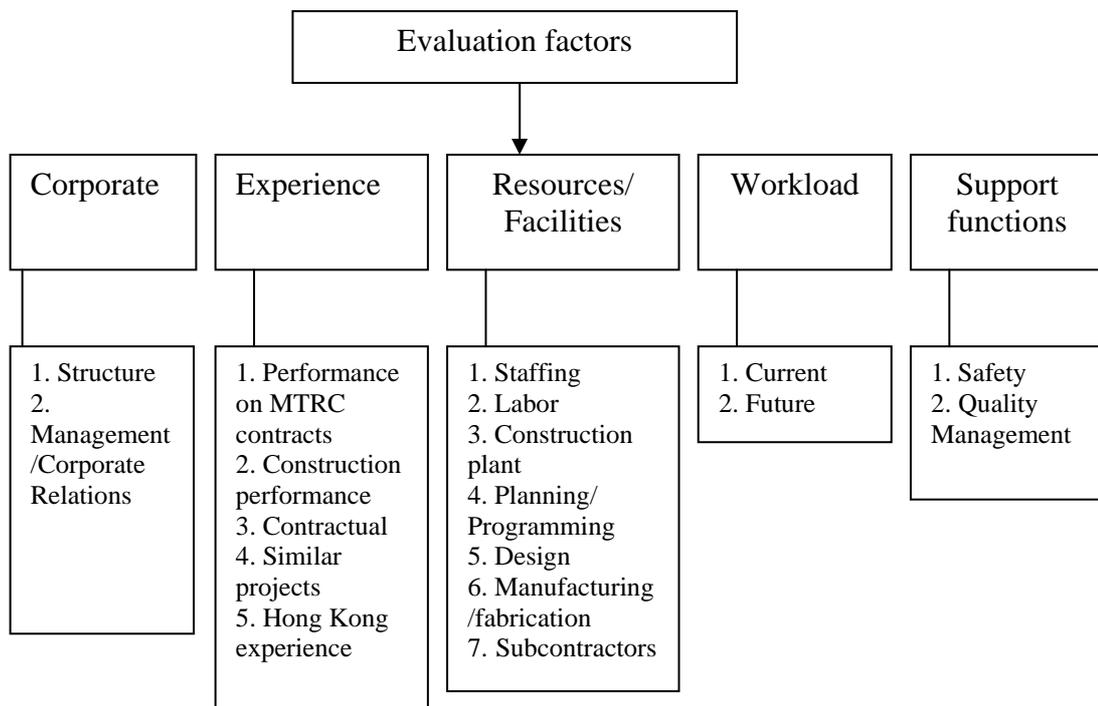


Figure 4 Prequalification Criteria Used by MTRC, Hong Kong

Source: Palaneeswaran and Kumaraswamy (2001)

Prequalification Criteria and Requirements by World Bank (WB) and Asian Development Bank (ADB)

The prequalification is applied widely on projects financed by WB and ADB. The four main qualification criteria used by WB and ADB are:

(1) Eligibility;

The sub-criteria included nationality, conflict of interest, bank ineligibility, government owned entity and United Nations resolution or borrower's country law.

(2) Historical contract non-performance;

The sub-criteria included history of non-performing contracts, failure to sign contract and pending Litigation.

(3) Financial situation;

The sub-criteria included financial performance and average annual construction turnover.

(4) Experience.

The sub-criteria included general construction experience and specific construction experience.

Prequalification Practice in China

Wang (2004) have illustrated the general prequalification process as shown in Figure 5.

Wen (2003) suggested that the prequalification of electricity construction works should include the following criteria:

(1) Contractors' qualification;

(2) Contractors' financial stability;

(3) Contractors' special construction capability;

(4) Contractors' reputation and credibility; and

(5) Contractors' resource.

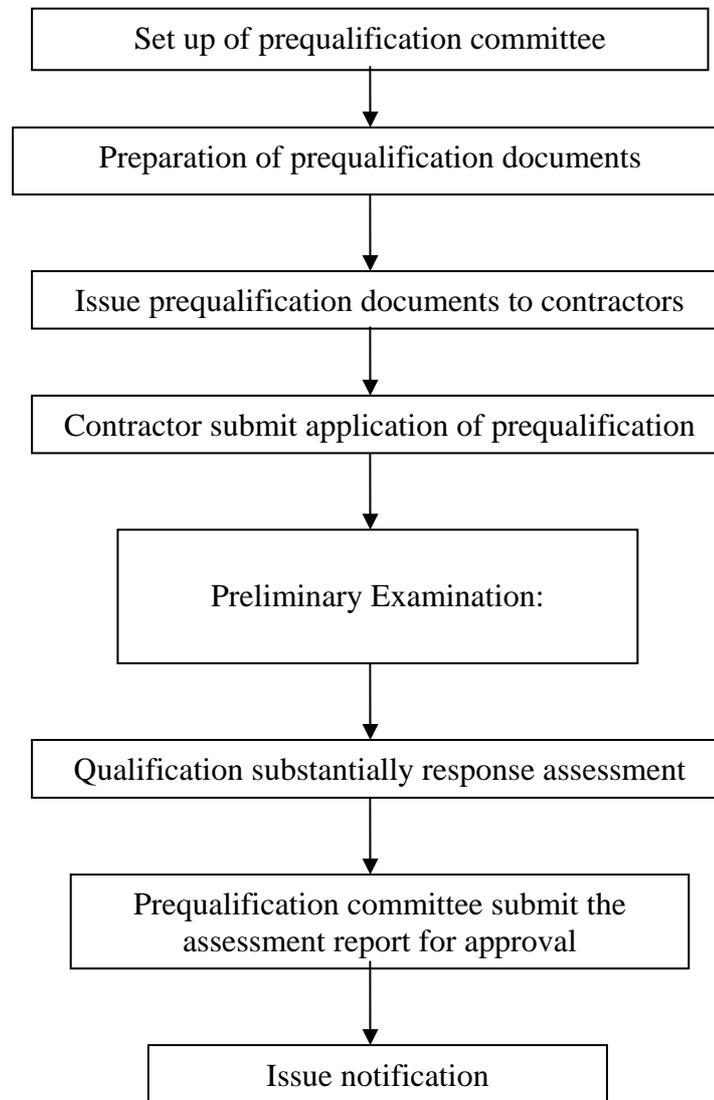


Figure 5 Prequalification Process in China

Source: Wang (2004)

Qian (1999) discussed the following prequalification criteria being used for the one of the hydraulic works construction project – XiaAn Reservoir Project.

(1) The grade of contractor's qualification;

(2) Construction experience in similar projects;

(3) Contractor' equipment;

(4) Key personnel of intended project team; (it further break down into three sub criteria, which included qualification level of project manager, No. of working years for that position and past experience of key personnel on similar projects)

(5) Contractors financial situation for the past three years; (which include the available loan credit and the Balance Sheets audited and certified by a registered accountant and supported by tax returns.)

(6) Contractors past performance and reputation; (which could be evaluated by honor titles earned by the contractor in past five years and quality assessment record of projects completed in past five years.)

(7) Contractors capacity;

(8) Past litigation information.

Cao and Shen (2004) also identified the criteria of prequalification used in hydraulic works as listed below:

(1) The grade of contractor's qualification;

(2) Contractor's past performance;

(3) The financial statement of past two years;

- (4) The qualification level of project manager proposed for the bidding project;
- (5) The construction equipment;
- (6) The human resources assurance;
- (7) The past execution information of construction contract;
- (8) Contractor's similar construction experience.

Prequalification Methods

Russell and Skibniewski (1998) suggested five methods for prequalification of contractors generally used in U.S. as below:

- (1) Dimensional Weighting;

Each criterion or decision parameter and its weight is based on the characteristics of the owner. Once the criteria are established, contractors can be rated with respect to these criteria. A contractor's score is calculated as a weighted sum of ratings over all the criteria. The rank order of score can then be used for contractor prequalification selection.

- (2) Two-Step Prequalification;

Step one entails the employment of a dimension ordering strategy i.e., contractors are qualified or disqualified based on how well they satisfy a number of preliminary screening dimensions. In order for contractors to be eligible to proceed to the second step in the qualification process, they must satisfy the preliminary screening dimensions. The second step utilized the dimensional weighting strategy using more specific criteria to determine the

competitiveness of the contractors. Using this method, it allows rapid elimination of incompetent contractors.

(3) Dimension-wide Strategy;

In this method, owners use a strategy that is based on the selection of the most important dimension and all contractors are evaluated with respect to it. Then they are evaluated on the next most important dimension. At each evaluation step, the contractor is judged on the dimension only. If a contractor fails to meet the owner's objectives at a certain dimension, he is removed from the list of contractors qualified for bid submittal. Some examples of the dimension used in U.S. were length of time in business, financial stability, experience, past performance and safety.

(4) Prequalification Formula;

In this method, owner utilizes a formula in the prequalification selection of contractors. This formula is calculated based on the maximum capability of contractors. Maximum capability is defined as the maximum amount of uncompleted work in progress, which the contractor can have at any one time. The purpose of this method is to reduce discretion. This allows the contractor's capability and circumstances to be compared with minimal danger of bias or oversight, which can have an effect on the final decision.

(5) Subjective Judgment.

In some instance, individuals performing prequalification base their decision on subjective judgment and not on a structured approach. The judgment may be influenced by biases of decision-maker such as previous experience with contractor and by how well the contractor's field staff operated. This process can lead to incorrect decision due to the lack of rational systematic approach.

Review of Construction Industry in China

General

The Chinese construction industry is presently the world's 2nd largest after the USA. The construction industry has maintained a strong level of development in China in recent years and demonstrating a higher growth than that of its Gross National Product. The industry's output value increased 12.06 percent in 2000, 22.91 percent in 2001, 20.6 percent in 2002 and 24.6 percent in 2003. With the steady development of the national economy, the construction industry will continue its momentum of growth in the coming years.

Statistics from the National Statistics Bureau indicated that China's construction industry achieved 818.13 billion Yuan in total output value in 2003, accounting for 7 percent of the nation's gross domestic product (GDP). In the first half of 2004, China's construction industry has completed a production value of 1,009.7 billion Yuan (about 122.24 billion U.S. dollars), up 27.5 percent over the same period of the previous year. Internal estimates indicate China's construction output to increase to about US\$700 billion by 2015, overtaking the U.S. construction market to become world's No. 1.

The contribution of construction to the economy in China is evidenced by the statistical data in the following Table 3.

The Administrative Framework of Construction Industry in China

The regulatory framework involves government agencies and industrial associations and covers procurement policies and procedures, licensing requirements, codes and standards, taxation, credit systems, import and export policies and rules and legislation such as construction law, contract law, and tendering law and so on.

Table 3 GDP Components of China

Year	GDP	Primary Industry	Secondary Industry		Tertiary Industry
			Industry	Construction	
1990	18,547.9	5,017	6,858	859.4	5,813.5
1991	21,617.8	5,288.6	8,087.1	1,015.1	7,227
1992	26,638.1	5,800	10,284.5	1,415	9,138.6
1993	34,634.4	6,882.1	14,143.8	2,284.7	11,323.8
1994	46,759.4	9,457.2	19,359.6	3,012.6	14,930
1995	58,478.1	11,993	24,718.3	3,819.6	17,947.2
1996	67,884.6	13,844.2	29,082.6	4,530.5	20,427.5
1997	74,462.6	14,211.2	32,412.1	4,810.6	23,028.7
1998	78,345.2	14,552.4	33,387.9	5,231.4	25,173.5
1999	82,067.5	14,472	35,087.2	5,470.6	27,037.7
2000	89,468.1	14,628.2	39,047.3	5,888	29,904.6
2001	97,314.8	15,411.8	42,374.6	6,375.4	33,153
2002	105,172	16,117.3	45,975.2	7,005	36,074.8
2003	117,252	17,092.1	53,092.9	8,181.3	38,885.7

Source: State Statistics Bureau, China Statistical Yearbook 2004, China Statistics Press, Beijing, 2004. (Unit: 100 million Yuan)

The administrative framework regulating the construction industry in China is a hierarchical system with roughly four levels: central, provincial, municipal and county.

The Ministry of Construction (MOC) is at the top of the framework and plays a leading role in guiding and administering the industry.

The MOC shares the duties of regulating construction activities throughout the country with the State Development Planning Commission. The State Development Planning Commission

is responsible for making proposals and policies of nation wide fixed capital investment, setting the overall scope and size of fixed capital investment, appraising and approving requests for funding of capital projects. The commission also coordinates the implementation of priority capital projects, and makes regular inspection to ensure that the state's fixed capital investment programme should be implemented as planned.

The cities at various levels have their own agencies guiding and regulating construction activities within their jurisdictions. They are called "Urban and Rural Development Commission", "Construction Engineering Bureau", or "Construction Industry Administration Bureau" etc. All of them can be called "Construction Commission" for short. A number of central ministries such as the Ministry of Railways have departments performing the same functions.

The MOC, Provincial, City and County Construction Commissions join hands to oversee the construction industry throughout the country. The Provincial, City and County Construction Commissions report to both the People's Governments at the same local level and the MOC through the vertical administrative structure. Each construction commission has under it a quality monitoring and control office to monitor works for compliance with the codes and standards (Lu and Fox, 2001).

The Legal Frameworks of Construction Industry in China

In order to guide and regulate the activities of the construction market, the central, provincial and municipal governments have enacted the Construction Law, Contract Law and Tendering Law, as well as a number of detailed regulations and procedures relating to the qualifications of contractors, soil and site investigators and design institutes, design and construction codes and standards, competitive tendering etc.

China did not have any unified construction law until 1996. The Construction Law was enacted in November 1997 and put into effect in March 1998. The law covers a wide range of issues such as qualifications for entry into the construction industry, procurement and delivery of

works, construction supervision, construction safety, construction quality, legal liability, market regulations and procedures in construction projects. The Construction Law has integrated all existing construction related regulations issued from different sources and will govern all activities in the construction industry, including the issue of permits, procurement and delivery of works, supervision, safety, quality and legal liability (Lu and Fox, 2001).

Construction Contracts

The National People's Congress ratified the Contract law of the People's Republic of China in March 1999. This law governs all the contracts entered into within China's boundaries.

Prior to 1991 there was no standard form of contract in China for construction works. The MOC and the State Industrial and Commercial Administration Bureau jointly prepared a standard form of contract for works of building construction in November 1991, that is, Model conditions of contract for works of building construction (GF-91-0201).

After eight years in use the GF-91-0201 has been modified based on feedback from the users, with reference to other standard national and international conditions of contract such as FIDIC conditions of contract and the requirements of Construction law, Contract law, Tendering law and other laws enacted recently. The revised document, namely Conditions of contract for works of building construction (GF-1999-0201), was published formally in December 1999. The revised edition comprises three parts, namely, Part I-Form of Agreement, Part II-General Conditions and Part III-Conditions of Particular Application (Lu and Fox, 2001).

Contractual Arrangements

Just like in the other parts of the world the contractual arrangements in China fall into three broad categories depending upon the averages of arriving at the contract sum, these are lump sum contract, measurement contract and cost reimbursement contract.

Construction Company in China

The number of construction companies by type of ownership is shown in Table 4.

Table 4 Number of Construction Companies by Type of Ownership

Year	Type of ownership					
	Total	State Owned	Collective Owned	Companies from Hong Kong, Macau, Taiwan.	Foreign Companies	Other Categories
1980	6,604	1,996	4,608			
1985	11,150	3,385	7,765			
1989	13,106	3,927	9,179			
1990	13,327	4,275	9,052			
1995	24,133	7,531	15,348	329	312	613
1996	41,364	9,109	29,044	417	388	2,406
1997	44,017	9,650	29,872	491	454	3,550
1998	45,634	9,458	28,410	629	337	6,800
1999	47,234	9,394	27,197	664	341	9,638
2000	47,518	9,030	24,756	635	319	12,778
2001	45,893	8,264	19,096	622	274	17,637
2002	47,820	7,536	13,177	632	279	26,196
2003	48,688	6,638	10,425	535	287	30,803

Sources: State Statistics Bureau, China Statistical Yearbook 2004, China Statistics Press, Beijing, 2004.

State-owned enterprises in the construction sector are the primary undertakers of the national fixed capital investment programmes. They are mostly highly qualified, both

managerially and technically, well capitalized and equipped. They can be central or local government owned.

Most of the central ministries have their own construction companies to carry out their construction projects, especially the line ministries, such as the MOC, the Ministry of Railways, the Ministry of Metallurgy, the Ministry of Energy, the Ministry of Transport, and the Ministry of Chemical Industry etc. The central ministries have decentralized the control over their construction enterprises since the economic reforms. Many of the enterprises have been given full autonomy and become commercial entities.

The provinces, autonomous regions, municipalities and counties also have their own construction enterprises to undertake their construction projects. The construction companies owned by local governments are normally grouped in one or more corporations that report to the local construction commission. The corporations plan, organize, direct and coordinate the activities of the subordinate companies and other construction or installation associated units.

Collective construction enterprises are found in urban and rural areas. In the urban areas they are under the administration of municipal, borough, district, town governments or community committees. Rural construction brigades are owned and run by townships or villages. They normally undertake housing and other small and/or simple construction works, either for the local community or in other parts of the country.

Starting in 1989, the MOC has successfully issued the regulations on administration on qualifications of construction enterprises, design institutes and supervision agencies. The MOC has evaluated all construction enterprises and classified them into three categories. Basically, the qualification of construction enterprises is classified into the following three categories:

- (1) General Construction Contracting;
- (2) Specialized Discipline Contracting (such as installation works, mechanized

construction works and fitting out and finishing works) and;

(3) Labor Services Sub-Contracting.

General contracting companies normally act as general (main, prime) contractors and represent the majority of the construction enterprises in China. Specialist companies are further sub-classified into several subcategories based upon their specialties, such as excavation, piling, foundation, mechanized construction, equipment and machinery installation, fitting out and finishing, urban utilities and public works.

Each category of qualification above is further classified into different grades (i.e., Special Grade, Grade A, Grade B, etc.), that require the satisfaction of different sets of criteria. The classification is based upon the length of time in the construction business, previous performance, qualifications and percentage of managerial and technical staff, annual outputs, fixed assets and working capital and so on. The significance of such grades is that the scope of permitted projects varies with each grade, so that a construction enterprise can only contract those projects that fall within the grade for which it is qualified.

The projects that a construction enterprise may undertake differ significantly from each other: housing, public buildings, highways, public utilities, power plants, metallurgical facilities, chemical and petrochemical factories, railways, ports and airports and many others. Most of the construction enterprises that used to be under the supervision of industrial ministries are field oriented. The field oriented engineering companies have ceased to restrict their activities to their own sectors and extended their operations to other sectors since reform.

Current Bidding Practice in China

According to the People's Republic of China (PRC) law of inviting and submitting of bids, the following construction projects in the territory of the People's Republic of China, including surveying and prospecting, design, engineering and supervision of such projects as well

as the procurement of major equipment and materials related to the construction of such projects, must be subject to tenders:

(1) Projects such as large-scale infrastructure facilities and public utilities involving the social and public interests and public safety;

(2) Projects which are, completely or partly, invested by the State-owned funds or funded through State financing; and

(3) Projects using loans or aid funds from international organizations and/or foreign governments.

Some construction projects are allowed to exempt from any type of bidding. The prerequisite of these projects are:

(1) It can not be implemented bidding with some special reasons, e.g. the confidential project or the emergency project and so on;

(2) The owner has its own construction force, e.g. the owner itself is construction enterprise, if he wants to construct an office building for his own use, then he can apply to exempt the bidding. After confirmed all the condition including enterprise's business license and professional qualification, it will be permitted.

(3) Designate the big state-owned construction enterprises. In china, the taxation is different for the different ownership enterprise. The taxation of state-owned enterprise is the highest and the profit rate is high too. Most of these companies are big and with rich technological strength. Out the protection policy to state-owned enterprise, for some complicated construction projects, the exempting application is permitted.

(4) The private project or foreign investing project is allowed to exempt bidding.

Bidding Methods

According to the PRC Law of Inviting and Submitting of Bids, Bidding for construction may adopt the following methods:

(1) Public bidding - The unit offering bid invitation publishes public announcement for bidding through newspapers, radio or television and invites unspecified legal persons or other unspecified organizations to submit their bids; A bid announcement shall clearly contain such particulars as the name and address of the bidder, nature of the project subject to bid, quantity, place and time of implementation and methods to acquire the bid documents.

(2) Invitational bidding - The unit offering bid invitation gives out bid invitation letters to three or more enterprises capable of undertaking the project subject to tender and having a good reputation and creditworthiness for submission of bid.

(3) Bid negotiation - With respect to special projects for which neither public bidding nor invitational bidding is appropriate, application shall be made to the department in charge of construction at county or higher level or to a bid institution authorized thereby to conduct bid negotiation upon approval. The number of units participating in the bid negotiation shall not be less than two (including two).

Bidding Procedure

According to the PRC Law of Inviting and Submitting of Bids, bidding for construction shall generally be conducted via the following procedure:

- (1) Organization of a bid committee by the developer;
- (2) Submission of a bidding application to the institution in charge of bidding and tendering. The application letter shall mainly include: qualifications of the bid inviting unit, conditions of the bidding project, the proposed bidding method and requirements of the tendering units;
- (3) Preparation of the bidding documents and pre-tender estimate, which shall be reported to the to the institution in charge of bidding and tendering for approval;
- (4) Publishing of the bidding announcement or sending of the bid invitations;
- (5) Submission of the tender applications by the tendering units;
- (6) Examination of the qualifications of the tendering units and notification of the tender applicants of the examination results;
- (7) Delivery of bid documents, design drawings and technical materials to the qualified tendering units;
- (8) Organization of visits to the construction site by the tendering units and answering of questions regarding the bid documents;
- (9) Organization of a bid appraisal organization and formulation of bid assessment and selection methods;
- (10) Convention of a bid opening meeting and examination of the tendering offers;
- (11) Organization of bid assessment work and decision on the bid winner;

(12) Sending out the bid winning notice; and

(13) Execution of the construction contract between the project developer and the bid winner.

Bid Inviting Document

The main content of documents of inviting for bid generally includes:

(1) Overall introduction to the project: name, address of the project, projects under bidding, project occupation area, floor space and technical requirements, quality standards and site conditions, bidding method and the required project commencement and completion schedule, and requirements regarding the qualifications of the bidding units;

(2) Necessary design drawings and technical materials;

(3) Detailed list of project works;

(4) Construction fund Enterprise's curriculum vitae which show the contractor's payment method and percentage of advanced payment issued by a bank;

(5) Method of supply of major materials (steel, wood, cement, etc.) and equipment; good processing and ordering situation; and method for handling material and equipment price differences;

(6) Construction requirements for special projects and the technical specifications to be adopted;

(7) Requirements regarding the preparation of bid documents and principles of bid assessment and selection;

- (8) Agenda for such activities as tender offering, bid opening, bid assessment and selection;
- (9) "Conditions for the Project Construction Contract" and adjustment requirements;
- (10) The amount of bid bond required, which shall be determined on the basis of the scale of the construction project and shall be a maximum of RMB 1 million.
- (11) Other matters requiring explanation.

Prequalification

The bid inviter of the open bidding may prequalify the bidding applicants according to the provisions of the bid-inviting documents. The documents of the prequalification shall generally include the application format of the prequalification, the notice of applicant, and the qualification documents, performance, technological equipment and financial situation of the enterprise which bidding applicants are required to provide, as well as the resumes, performance, etc certificate materials of projected project executives and main management persons.

In case of excessive bidding applicants who are qualified in the prequalification, the bid inviter may choose no less than 5 bidding applicants who are qualified in the prequalification.

Pre-tender Estimate

According to the PRC Law of Inviting and Submitting of Bids, A pre-bid estimate must be prepared for the bidding invitation of any construction project. The pre-bid estimate shall be prepared by the bid invitation unit on its own or through an entrusted consulting or construction supervising agency approved by the competent construction department as capable of preparing a pre-tender estimate.

The following principles shall be observed in the preparation of a pre-tender estimate:

(1) The volume of construction work shall be determined and the pre-bid estimate shall be prepared in accordance with the designs and relevant materials and bidding documents and with reference to the State-stipulated norm and code for technical and economic standards;

(2) The pre-bid estimate price shall consist of the cost, profit and taxes, which shall generally be limited within the amount of the approved general estimate (or the revised estimate) and the investment of the lump sum contract;

(3) As a price contemplated by the construction developer, the pre-bid estimate price shall seek to comply with actual market changes, and shall be favorable to competition and guarantee the project quality;

(4) The pre-bid price shall take into consideration factors affecting price fluctuation, including labor, materials, number and shift of machinery, etc., as well as the contingency sum, lump sum fee and measure-taking fee. For a project of which excellence is required, relevant fees shall be added;

(5) Only one pre-bid estimate shall be prepared per project.

For a project the price of which is subject to negotiation, its contract price shall be discussed and agreed upon by the parties thereto, and be filed with the institutional body for bidding.

Bidding Document

The bidder shall conscientiously prepare the bidding document as required by the document of inviting for bid. The main content shall contain the following:

(1) Overall descriptions;

(2) The bidding price as calculated per the volume of the construction project and the quantity of consumption of the major materials, including steel, wood and cement. The bidder may submit the bidding price at its sole discretion based on the unified rules for work volume calculation;

(3) The construction plan and the major construction equipment as selected;

(4) The construction method and major technical measures to guarantee the quality, progress and construction safety of the project;

(5) Proposed schedule of commencement and completion and the general schedule;

(6) Confirmation of the major terms and conditions of the contract.

Besides the above mentioned documents, the bidder shall provide the following information to the bid inviting entity:

(1) Enterprise business license and qualification certificate;

(2) History of the enterprise;

(3) Contractor's financial situation;

(4) Number of full-time staff, including the number of technicians and skilled workers, and the average skill levels; a list of main construction equipment and machinery owned by the enterprise;

(5) A list of the major construction projects undertaken over the past three years and the status of the quality;

(6) A list of current construction projects, including those under construction and those which have not yet commenced.

Bidder's Right

As the producer of the architectural product, the construction enterprise shall be entitled to the following rights during the bidding and tendering process:

(1) Any construction enterprise or consortium with the business license and the required certificate of qualifications may participate in the tendering as required in the bidding documents;

(2) The enterprise shall have the right to decide the bid price with reference to its operating conditions and the marketing information available;

(3) The enterprise shall have the right to decide special prices for any project requiring excellent quality;

(4) The enterprise shall have the right to decide whether or not to participate in the bid competition in light of its operating conditions.

Bid Opening

The bid invitation unit shall invite the representatives from the relevant departments to attend the bid opening meeting, publicly announce the methods of bid evaluation and selection, unseal the bidding documents and additional materials, and publicize the main contents and bid price of the bidding document. At bid opening the owner will announce the bidders' names, the bid prices, time for completion, amounts of key materials, such as cement, steel and timber,

construction alternatives and other conditions.

The bidding document shall become invalid if:

- (1) It is not sealed;
- (2) It does not contain the seal or stamp of the bidder and its legal representative or the proxy as authorized by the legal representative;
- (3) It fails to follow the stipulated format, or the contents are incomplete, blurred or illegible;
- (4) It misses the deadline for submission;
- (5) The bidder does not attend the bid opening meeting.

Bid Evaluation and Selection

Bidding evaluation shall be in the charge of the Bidding Evaluation Commission established by the bid inviter by force of law. The Bidding Evaluation Commission shall be composed of the representative of the bid inviting entity and experts in the related technological and economic fields, and the number of committee members shall be an odd number at or above five, of the members, experts in technological and economic fields may not be less than two-thirds of the total members. Experts mentioned in the preceding paragraph shall have worked in the related fields for eight years or longer, have senior academic titles or the same professional level, and they shall be chosen from the name lists of experts provided by relevant departments of the State Council or relevant departments of the people's governments of provinces, autonomous regions and municipalities directly under the Central Government, or from the name list of experts in related fields in the expert bank of the procuring agency; for an ordinary project subject

to bid, the experts may be chosen randomly, and for a special project subject to tender, the experts may be directly chosen by the bid inviting entity.

There are two predominant bid evaluation methods used in the China construction industry. One is so-called lowest bid quotation method after assessment; another is called overall comprehensive evaluation method. Lowest bid quotation after assessment is also named as rational lowest quotation method. The winning bidder according to this evaluation method is the bidder which is able to satisfy the substantial requirements set in the bid inviting documents and to have the lowest bid price quotation upon assessment, with the exception of the bid price quotation which is below cost. On the other hand, through the overall comprehensive evaluation method, the winning bidder according to this evaluation method is the bidder which is able to satisfy the maximum various comprehensive assessment standards set in the tender documents. A general overall evaluation will be conducted of the bid price, term of construction, quantity of consumption of major materials, construction plan, actual quality records and the reputation of the bidder. The bidder with the maximum score based on the overall evaluation will be awarded the construction contract.

Basically, a two-stage evaluation process will be applied to either method, the first stage is technology-bidding document evaluation, and the second stage is business bidding document evaluation. These two bidding documents should be submitted separately.

Technology-bidding document evaluation stage: The technology-bidding document is evaluated by specialists which the bidder's name or any related information about bidder is not allowed to appear. It mainly evaluates the bidders on the phases of construction quality, period, construction management plan and other technical measures. Every member of bid evaluation group should make written opinion and cast their votes, the bidder which the vote is not over half will be eliminated through competition.

The difference between the Lowest Bid Quotation Method and Overall Comprehensive Evaluation Method is that only the successful bidders after passing the first stage can enter into

the second stage competition to win the bid if the Lowest Bid Quotation Method is utilized, on the other hand, each bidder could enter into the second stage but with a different score if the Overall Comprehensive Evaluation Method is applied.

Business-bidding evaluation stage: The main activities during business bidding evaluation stage are to evaluate the quotation price, which includes the checking the bid price, verifying the computation of quotation, analysis the rationality of composed price, comparing and analyzing with the base price.

Bid Time Limitation

The period from the bid opening or the commencement of the bid negotiation to the final bid selection shall be no more than 10 days for a small-scale project, and no more than 30 days for a large-scale project. Such period may be properly extended under special circumstances.

After the successful bidder is selected, the bid invitation unit shall send out the bid award notification within 7 days, with copies to each unsuccessful bidder and submission to the institutional body. Unsuccessful bidders shall return the bidding documents and relevant materials within 7 days upon receipt of notification, and the bid invitation unit shall refund the bidder the deposit.

Thirty days after the tender award notification is sent out, the successful bidder and the construction developer shall execute the project contract on the basis of the bidding documents and the book of tender.

Review of Tianjin Roadway Administration Bureau (TRAB)

Introduction

In order to strengthen the status of Tianjin as the one of the metropolitans of China, promote economic development and improve living quality of the residents, Tianjin has seen skyrocket development in the transportation infrastructures. The urban roadway increases at the speed of nearly 3,000,000 square meters year-on-year, achieving a relatively high density of the road network. By the end of 2005, Tianjin has 2447km urban roadways and 1,982 bridges of all kinds including 215 interchanges and 279 flyovers for pedestrians. The total length of roadway reaches about 10168km, among which 517 km expressways, 1469km first level and second level highway, resulting in the highway density being 85.31 km per 100 square km.

Tianjin Roadway Administration Bureau (TRAB) was set up in April 1991, and it's in charge of the administration of communicational basic establishments. TRAB is responsible for the unified management for the construction and maintenance of transportation infrastructures such as urban roadways (including suburban roadways) and bridges. Acting as an executive body of municipal government, TRAB manages the urban roadway (including suburban roadway) and transportation in a comprehensive manner. Its major responsibilities are:

(1) Following out and carrying out the law, rules and regulations of communicational basic establishments; investigating and studying out the annual plan of the construction and maintenance of communicational basic establishments;

(2) Taking charge of the specific management of road administration; taking charge of the security management of Tianjin roadway crossing;

(3) Taking charge of the engine fee collecting, management of road charge;

(4) Taking charge of the security management of road, bridge and relating facilities; taking charge of the supervising of road construction, maintenance, bidding and tendering;

(5) Participating in preventing and rescue from disaster;

(6) Undertaking other affairs of Tianjin government and Tianjin Municipal Committee of Communication.

Organization Structure

There are 2,625 staffs in Tianjin Roadway Administration Bureau, 11 inner departments, 4 directly under enterprises, and 8 suburban road administration branches. The 11 departments are General office, integrated planning department, road construction department, urban road maintenance department, road maintenance department, road management department, finance department, human resource department, Communist Party Committee office department, discipline committee, legal system department. The 4 directly under enterprises are: Roadway engineering co., ltd, Roadway engineering design institute, Roadway quality supervision station, Roadway engineering consultant co., ltd.

The organization structure is shown in Figure 6.

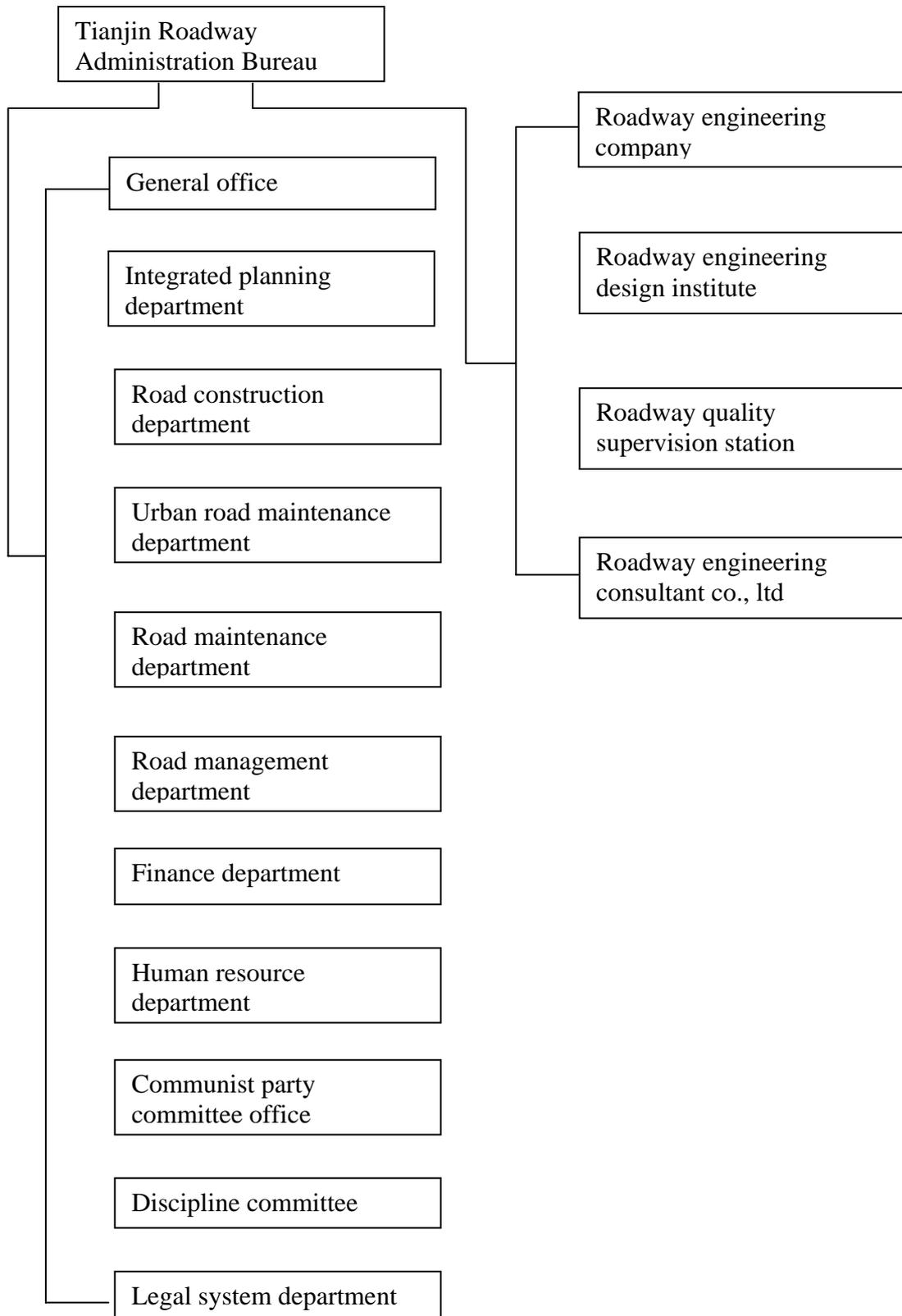


Figure 6 Organization Chart of TRAB

MATERIALS AND METHODS

The research procedure was shown in Figure 7.

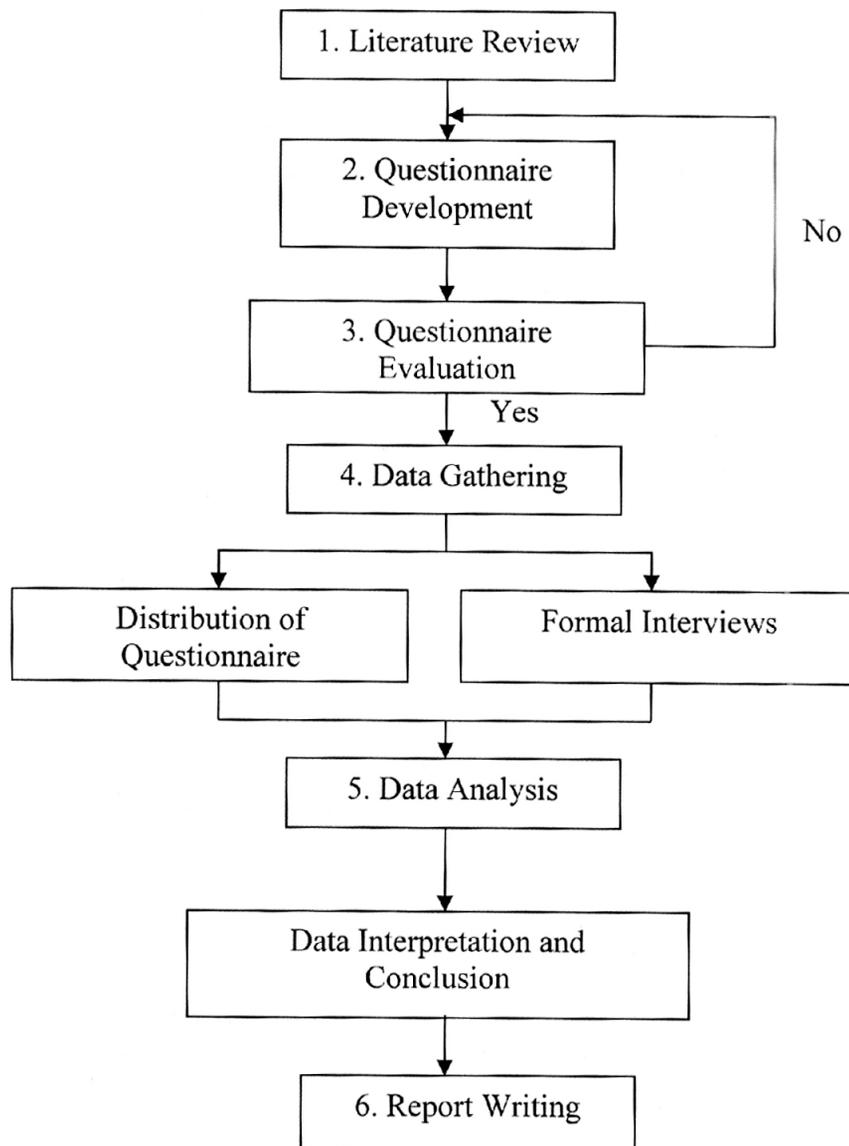


Figure 7 Flow Diagram of Research Procedure

(1) Based on the extensive literature review, a list of possible criteria and sub-criteria of contractor prequalification for Tianjin Roadway Administration Bureau (TRAB) was developed for further exploration through questionnaire survey.

(2) The questionnaire was designed to investigate two groups, owner and contractor. The respondents was requested to rate the importance of predetermined prequalification criteria by ticking a box against a numerical scale of zero to five (zero = not important, and five = the most important).

(3) In order to minimize potential errors, a group of professionals who currently perform contractor prequalification were asked to evaluate the major contents of the questionnaire; the questionnaire was modified as before data gathering.

(4) Generally, the data gathering was achieved through distribution of questionnaires and personal interviews. Since interviews could give more reliable information for a specific question, the interviews were arranged properly. e.g. the questionnaire were sent to the interviewees several days in advance of the interview and the purpose of interview would explain briefly through a phone conversation.

(5) After data collection was finished, the obtained data were analyzed and interpreted through statistical methods. Conclusions were derived from the data discussion and analysis.

(6) Finally, the thesis report was prepared based on the achievements of data collection and data analysis.

DATA ANALYSIS AND RESULTS DISCUSSION

Introduction

Interview and questionnaires survey were chosen as research instrument to collect data necessary for this research. The questionnaire was designed to investigate two groups of organizations, owner and contractor. In order to minimize potential errors, a group of professionals who currently perform contractor prequalification were to evaluate the major contents of the questionnaire. All comments were then incorporated into the modified final questionnaire. The final questionnaire was sent to each respondent under this study with a covering letter, which explained the purpose of this survey (appendix-I). Response data from these questionnaires were analyzed statistically. After preliminary analysis of the data feed back, all of the questionnaires responded could be used for further study.

Sample characteristics

The survey questionnaire were sent to 40 owner personnel in roadway construction department of Tianjin Roadway Administration Bureau (TRAB) and to 40 grade 1 construction firms primarily involved in roadway works. The respondents categorized as the owner (TRAB) responded 39 questionnaires (response rate of 97.5 %) and the contractor responded 35 questionnaires (response rate of 87.5 %). A detailed characteristic summary of questionnaire survey was shown in Table 5.

Moser and Kalton (1971) stated that, if the response rate is less than 30%, the results may be considered subject to non-response bias. However, in this case the response rate was quite high and both of the significant groups could be well represented, therefore the opinions of all sections of the entire population are considered to be adequately reflected.

Table 5 Characteristic Summary of Questionnaire Survey

Organization Type	Survey Source	Total No. of Questionnaire Distributed	No. of Questionnaire Responded	Rate of Response
Owner	Construction Management Department, Tianjin Roadway Administration Bureau, China	40	39	97.5%
Contractor	Grade one Roadway Construction Contractors in Tianjin and nearby Region, China.	40	35	87.5%
Total Sample		80	73	92.5%

Owners' and Contractors' Perception towards Prequalification Criteria

Review

One of the main objectives of this survey was to investigate the criteria and sub-criteria which, the both owners and contractor consider important in prequalification decision as stated earlier, respondents of the owners and contractors group were asked to express their opinion of each criteria and sub-criteria by giving score on a 5 point Likert type scale of 1 to 5, where 1 was “very low” and 5 was “very high”.

Statistical analysis of the survey questionnaire

(a) Average score computation

To each criteria and sub-criteria, the frequency responses on each score were tabulated separately reporting the owners' and contractors' views; and then the average score was then computed by using the following formula:

$$\bar{X} = \frac{x_1 + x_2 + x_3 + \dots + x_n}{n} \quad (1)$$

Where,

\bar{X} = Average score in each criterion

x_i = Scores rated by each respondent

n = Number of respondents (sample size)

(b) Standard deviation of the sample data

In order to evaluate the dispersion in the ratings by the respondents, it is necessary to calculate the standard deviation of the sample data. Walpole and Myers (1985) stated that the standard deviation is a measure of how widely values are dispersed from the average value. Therefore, the lower standard deviation represents the higher accuracy of the data. The following formula is used.

$$Std.Dev = \sqrt{\frac{n \sum x^2 - (\sum x)^2}{n(n-1)}} \quad (2)$$

Where,

x_i = Scores rated by each respondent

n = Number of respondents (sample size)

These average scores were computed for all 11 major criteria and 86 sub-criteria in each case of owners' and contractors' response. Based on the average score, rank ordered lists were derived to obtain insights into the relative importance of the criteria and sub-criteria from owners' and contractors' viewpoints separately.

(c) Overall average score

The value to use in ranking all major criteria and sub-criteria is overall average value. To each criteria and sub-criteria, overall average score was computed by considering the viewpoints of both the owners and contractors. A comprehensive rank ordered list was then developed to obtain insights into the overall importance of these factors in the context of the roadway construction industry. The formula is as follow:

$$\text{Overall Average Score} = \frac{(\text{Average Score of Owner} + \text{Average Score of Contractor})}{2} \quad (3)$$

It may be noted from the formula abovementioned, as per the scale chosen for assessment purpose, the higher scores to each criteria and sub-criteria represent its higher importance in prequalification decision-making.

Owners' and Contractors' Viewpoint on Importance of Criteria and Sub-criteria

The respondents from the client and the contractor groups were asked to express their opinion with regard to the level of importance of the listed criteria and sub-criteria in contractor prequalification decision making.

Statistical analysis of the response data from the feed back of the owner and the contractor (average value of each criterion) was done as summarized in Table 6,7, and 8.

Average scores ranking of major criteria rated by owners and contractors

In order to obtain an insight into their opinion on importance and usefulness of the criteria and sub-criteria, a rank ordered list of group of criteria and sub-criteria, based on the average score rated by owners and contractors, was derived as shown in Table 9 and Table 10.

Table 6 Perceived Importance of Prequalification Criteria from Owner's Viewpoint

No.	Major Criteria in Contractor Prequalification	Frequency Responses on 5 Point Scale					Average	Std. Dev.
		1	2	3	4	5		
1	Legal entity status and company profile	0	0	2	13	24	4.56	0.60
2	Financial capacity	0	0	2	17	20	4.46	0.60
3	Construction capacity	0	0	2	15	22	4.51	0.60
4	Construction experience	0	0	0	15	24	4.62	0.49
5	Management capability	0	0	4	11	24	4.51	0.68
6	Plant and equipment	0	2	11	16	10	3.87	0.86
7	Key personnel of project team proposed	0	0	4	20	15	4.28	0.65
8	Past performance and reputation	0	1	2	16	20	4.41	0.72
9	Safety performance	0	1	16	6	16	3.95	0.97
10	Public relationship	1	7	13	14	4	3.33	0.98
11	Litigation history	0	4	13	10	12	3.77	1.01

Table 7 Perceived Importance of Prequalification Criteria from Contractor's Viewpoint

No.	Major Criteria in Contractor Prequalification	Frequency Responses on 5 Point Scale					Average	Std. Dev.
		1	2	3	4	5		
1	Legal entity status and company profile	0	0	2	11	22	4.57	0.61
2	Financial capacity	0	0	1	16	18	4.49	0.56
3	Construction capacity	0	0	3	15	17	4.40	0.65
4	Construction experience	0	1	1	14	19	4.46	0.70
5	Management capability	0	0	2	11	22	4.57	0.61
6	Plant and equipment	0	1	2	12	20	4.46	0.74
7	Key personnel of project team proposed	0	0	1	12	22	4.60	0.55
8	Past performance and reputation	0	1	3	11	20	4.43	0.78
9	Safety performance	0	1	7	11	16	4.20	0.87
10	Public relationship	1	7	9	12	6	3.43	1.09
11	Litigation history	1	2	12	12	8	3.69	0.99

Table 8 Individual and Overall Average Scores by Owners and Contractors

No.	Major Criteria in Contractor Prequalification	Average		Overall Average
		Owner	Contractor	
1	Legal entity status and company profile	4.56	4.57	4.57
2	Financial capacity	4.46	4.49	4.47
3	Construction capacity	4.51	4.40	4.46
4	Construction experience	4.62	4.46	4.54
5	Management capability	4.51	4.57	4.54
6	Plant and equipment	3.87	4.46	4.15
7	Key personnel of project team proposed	4.28	4.60	4.43
8	Past performance and reputation	4.41	4.43	4.42
9	Safety performance	3.95	4.20	4.07
10	Public relationship	3.33	3.43	3.38
11	Litigation history	3.77	3.69	3.73

Table 9 Ranking of Owners' Rating

Major Criteria	Average	Std. Deviation
Construction experience	4.62	0.49
Legal entity status and business profile	4.56	0.60
Construction capacity	4.51	0.60
Management capability	4.51	0.68
Financial capacity	4.46	0.60
Past performance and reputation	4.41	0.72
Key personnel of project team proposed	4.28	0.65
Safety performance	3.95	0.97
Plant and equipment	3.87	0.86
Litigation history	3.77	1.01
Public relationship	3.33	0.98

Table 10 Ranking of Contractors' Rating

Major Criteria	Average	Std. Deviation
Key personnel of project team proposed	4.60	0.55
Legal entity status and business profile	4.57	0.61
Management capability	4.57	0.61
Financial capacity	4.49	0.56
Construction experience	4.46	0.70
Plant and equipment	4.46	0.74
Past performance and reputation	4.43	0.78
Construction capacity	4.40	0.65
Safety performance	4.20	0.87
Litigation history	3.69	0.99
Public relationship	3.43	1.09

Top 5 Major Criteria

From the ranking of average score by owners and contractors, it indicated that the most important major criteria selected by owner include construction experience, legal entity status and business profile, construction capacity, management capability and financial capacity. On the other hand, the most important major criteria selected by contractor include key personnel of project team proposed, legal entity status and business profile, management capability, financial capacity and construction experience. Both owner and contractor choose construction experience, legal entity status and business profile, management capability and financial capacity to be the most important criteria; and the difference is that owners give much more emphasis to construction capacity and contractors give high concern to the key personnel of project team proposed.

Discussion of Major Criteria Ranking Rated by Owner and Contractor

(1) Legal entity status and business profile

Both owners and contractors rated the criterion of legal entity status and business profile as 2nd rank. This is not common comparing with other country practices. However, in the context of Chinese construction industry it is understandable due to the classification of contractors. In china, all registered construction contractors are classified according to their construction abilities and size from grade 1 to grade 4. This classification screens contractors who are not capable of participating in some larger projects beforehand. This averages that contractors who are in grade 2 cannot participate in projects of size 1; so all contractors in grade 2, 3 and 4 are dropped from the qualified short list. During contractor prequalification, contractors must provide evidence of their legal entity and business operation status by providing a copy of official documents such as a Company Registration, qualification grade etc. The preliminary requirement for any types of contractor prequalification will be carried out based on the qualification grade of the contractor on special trade. Necessity of a valid qualification grade license granted from government is a minimum requirement criterion for bidding of public works. The qualification grade license

issued by government administrative agency mirrors the contractor's business status, technical and financial situation. That is why both of the owner and the contractor might have perceived the importance in similar way.

(2) Financial capacity

Contractor rated financial capacity as 4th rank whereas owner rated as 5th rank. The volatility, dynamic nature, and risk associated with the construction industry make the financial stability vital in the analysis process. Schleifer (1990) stated that one frequent reason for which contractors discontinue their business is related to the financial problems. Obviously, if a candidate contractor is not financially stable, this will severely impact his ability to perform the work required for the project. The purpose of this criterion is to ensure that the candidate contractor has the financial capability to handle the exposure to risk that he/she will be taking. Through assessing the financial capacity and soundness of the contractors, the owner will be reassured that the contractor's financial standing in its whole does not have structural weaknesses that may result in financial inability to perform. Furthermore, evaluating the financial capacity of contractor will also give an indication of the scope and value of the work the contractor would be able to undertake. Both owners and contractors realized that financial capacity of contractor is crucial for contractor prequalification.

(3) Construction capacity

It is quite interesting to see that the owner perceived construction capacity as 3rd rank whereas the contractor rated as 8th rank. It seems that there is a clear different point of view regarding construction capacity criterion between the owner and the contractor. The construction capacity is referred to the contractor's general capability in managing construction contracts, which is related to its record of recent experience and to the value of work undertaken. This factor is important to adequately establish the capacity of a contractor's operations and assess his/her ability to assume and subsequently successfully perform the project under consideration. Generally, overall construction capacity of a company may be considered in terms of annual

turnover. It may be judged from value of works which contractor has ever undertaken. Contractor's increasing annual turnover indicates their growth. The owners believe that contractor would not be able to complete works timely if they have heavy workload than their actual capacity. However, the contractors expressed that they are not getting enough works because of intense competition in today's construction industry. This may be the reason that the contractor ranked the construction capacity relatively low compared to the owner did.

(4) Construction experience

The owner rated construction experience as the 1st important criteria of contractor prequalification, whereas the contractor rated as 5th rank. This criterion is an assessment of the past experience of contractor that demonstrates his/her ability to perform the project requirements. Perhaps, the necessity to choose contractor work type who relates with project was viewed as first important issue. This is due to a good indication of future contractor performance is contractor's previous track record of successfully completed projects of similar size and type. Through the construction experience criterion, the owner can ensure that contractors have sufficient knowledge and capability to smoothly execute works. Without experience in similar project, it may cause difficulties to tackle problems in the effective manner. These may result in many undesired outcomes to project such as cost overrun, schedule delay and inferior quality etc. Furthermore, experience is the main method of assessing technical capability of contractor. One of the key considerations in prequalification is to ensure that contractors have adequate knowledge and experience of work of similar nature and complexity, so that the project will not default or suffer problems due to lack of technical capability to execute the work. The more consciousness of the owner on this criterion is most probably due to the fact that they fully realize that it would be difficult to execute work without past experience.

(5) Management capability

The owner rated management capability as 4th rank whereas the contractor rated as 3rd rank. This criterion is an assessment of the ability of the candidate contractor to plan, schedule,

and control of field operations to complete the work associated with the project within time and resource constraints. In labor-intensive construction industry, there are lots of parties being involved, such as numerous suppliers, sub contractors, and large amount of labors. Controlling of those parties is very important and the effective and efficient communication and cooperation is the key parameter to complete project successfully. That is why both of contractor and owner rated this criterion as one of the top 5 criteria.

(6) Plant and equipment

The contractor rated plant and equipment as 6th rank whereas the owner rated as 9th rank. The owner rated plant and equipment lower than the contractor did. The availability of plant and equipment will directly affect to work performance and productivity level. The shortage and poor condition of equipment may cause construction work delay. This is especially true in roadway construction works, which the contractor cannot perform satisfactory without adequate and sufficient number of equipment. Many contractors ever suffer the problems caused by the shortage of equipment. It may be one of the reasons for contractor's higher rating on plant and equipment criterion as compared to the rating by the owner.

(7) Key personnel of project team proposed

On contrary to owner's rating key personnel of project team proposed as 7th rank, it may be quite interesting to see why the contractor gave its top concern to key personnel of project team proposed. In other words, the owners have put less importance on this criterion than the contractors. This result indicated that contractor believe the key personnel of project team proposed is among the most important decision parameter in prequalification. Russell (1991) stated that lack of experience at the management level can be one of the major reasons for project failure. From contractor's point of view, the key personnel of project team are deeply involved in the construction activity's day-to-day running and they have to do with day-to-day management activities on site too. Therefore, the contractor gave highest concern to the key personnel of project team proposed. On the other hand, the owner may have overlooked the influence of key

personnel of project team while rating the criteria, since many government agencies prefer to focus on the entire entity rather than the individual personnel.

(8) Past performance and Reputation

The contractor rated past performance and reputation as 7th rank whereas the owner rated as 6th rank. It indicates that the importance of past performance and reputation in prequalification is moderate. Both the owner and the contractor realized that the performance achieved in the previous projects is the one of the best indicators of overall capability of the contractor. This is exactly true in contractor prequalification practice in many countries. Generally, a contractor's performance in terms of actual quality, cost and schedule achieved against the planned one are well recorded by Chinese government construction administrative agency. And those records will be referred in current projects to assess the contractor's likelihood of completing the project successfully. Keeping in view of this point, the owner might have put more importance on performance and reputation criterion as compared to the contractor.

(9) Safety performance

The contractor rated safety performance as 9th rank, whereas the owner rated as 8th rank. It indicates that the owner is more aware of safety issues than the contractor. Since costs related to construction accidents are directly or indirectly borne by owners, an effective construction contractor's safety procedures results in projects completed with owner costs and time. Therefore, owners give more attention on this criterion and wish to hire contractors with a record of good safety performance. However, both the owner and the contractor realize the consequences of accidents like loss of human life, unnecessary burden of direct and indirect cost during construction and de-motivation to the workers. Nevertheless, the contractor gave less importance on safety issue; they may need to put more attention to the safety criterion.

(10) Public relationship

Both the contractor and the owner rated public relationship as 11th rank. It revealed that both the owner and the contractor put very low importance on public relationship as a prequalification criterion. The ability of the contractor's organization to work compatibly with other project parties, such as the owner, the sub-contractor, the supplier and the consultant, is very important. So, the owner should require a list of previous clients, sub-contractor, supplier and consultant to check this during contractor prequalification. For example, the owner may check whether the contractor is cooperative in the field, whether the contractor has a good credibility and responsibility, whether the contractor follow written instructions faithfully and promptly etc.

(11) Litigation history

Both the contractor and the owner rated litigation history as 10th rank. A corporate tendency for litigation is generally measured by its litigation history. Perhaps a contractor worked for an owner who placed a lot of claims, it should not be held against them. In general, if there are a lot of claims submitted by a contractor and it is repeated occurrence, it may say something about the contractor. Some contractors rely solely on claims and change orders to make a profit on a project, which may not be favorable with an owner. Cost overruns are often associated with litigation tendencies as well. Owners should be on guard against any contractor who habitually resorts to excessive claims, arbitration, and litigation in the execution of contracts. Therefore, the analysis of litigation history of contractors is carried out in most countries. However, the average score of this criterion in Chinese roadway works construction is ranked quite low compared with other criterion. This is because contractors perceived that any litigation will have negative impact in their relation with the owner, especially when the owner is one of the government departments. The contractors prefer to solve those problems through other methods such as discussion and negotiation. They believed that any contractor who has many disputes and claims with owner will be recorded as blacklist by government and they will never get the job from him anymore. Obviously, the owner also realized this situation extensively. It may be one of the reasons behind their lowest rating on litigation criterion. Furthermore, since there is no any effective system of

recording contractor's disputes and claims in China, litigation criteria will not be effective in such circumstances.

Overall Importance of Prequalification Criteria

Development of standard prequalification criteria considering both the owners' and the contractor's viewpoints was one of the main objectives in this study. Based on the average scores rated by owners and contractors, an overall average score on each criteria and sub-criteria was computed by simply taking average of the individual average scores rated by them.

Table 11 Ranking of Overall Average Rating from the Viewpoints of Owners and Contractors

Major Criteria	Average	Std. Deviation
Legal entity status and business profile	4.57	0.60
Construction experience	4.54	0.60
Management capability	4.54	0.65
Contractors financial capacity	4.47	0.58
Construction capacity	4.46	0.62
Key personnel of project team proposed	4.43	0.62
Past performance and reputation	4.42	0.74
Plant and equipment	4.15	0.86
Safety performance	4.07	0.93
Litigation history	3.73	1.00
Public relationship	3.38	1.03

Sub-criteria Ranking Rated by Owners and Contractors

Rank ordered lists of these sub-criteria were then produced as shown in Table 12 and Table 13 to obtain an insight into their relative importance in prequalification decision-making.

The criteria with higher scores are thought to be more important criteria in the context of roadway construction industry, China.

Table 12 Ranking of Sub-criteria from Owners' Viewpoint

Rank	Sub-criteria Group	Average	Std. Deviation
1	Working capital	4.72	0.51
1	Level of qualification of project manager	4.72	0.60
3	Honor titles earned by the contractor	4.69	0.66
4	Legal status of company	4.67	0.58
4	Average annual construction turnover	4.67	0.58
4	No. of similar construction experience	4.67	0.66
7	Safety records	4.64	0.67
8	Qualification grade	4.62	0.59
8	Size of company	4.62	0.63
10	Ownership of equipment	4.59	0.72
10	Quality assessment track record of projects completed	4.59	0.64
10	No. of arbitrations and litigations with clients	4.59	0.59
13	Average construction turnover	4.56	0.60
14	National or local construction experience	4.54	0.72
14	Safety management system	4.54	0.55
16	Qualification of key personnel	4.51	0.72
17	Experience of key personnel	4.49	0.56
17	Past experience of key personnel on similar projects	4.49	0.72
19	Availability, sufficiency and adequacy	4.44	0.72
20	Quality management & assurance system	4.41	0.75
20	Certified by ISO	4.41	0.75
22	No. of working years for that position	4.36	0.58

Table 12 (Cont'd)

Rank	Sub-criteria Group	Average	Std. Deviation
23	The available loan credit	4.31	0.80
23	Schedule management system	4.31	0.80
23	Education of key personnel	4.31	0.61
26	Volume of uncompleted work-on-hand	4.28	0.69
26	Subcontractor management system	4.28	0.65
26	Percentage of self performed work	4.28	0.76
26	Relationship with government agency	4.28	0.76
30	Experience on project specific matters	4.26	0.79
31	Financial bidding capacity	4.23	0.81
32	Ratio analysis	4.21	0.80
32	Magnitude of capital base	4.21	0.70
34	Scope of construction	4.18	0.82
34	Number of failure to complete contract	4.18	0.82
36	Current work load	4.15	0.78
36	Qualification of company owners	4.15	0.67
38	Bank's rating of contractor as a customer	4.13	0.70
38	Implementation of ISO system	4.13	0.86
38	Procurement characteristics (own/lease)	4.13	0.92
41	Cost overrun track record of projects completed	4.10	0.91
42	Causes of arbitration/litigation	4.08	0.81
43	Experience in operating	4.03	0.87
44	Number of years in construction	4.00	0.89
44	Appropriateness of project organization chart	4.00	0.89
44	Schedule track record of projects completed	4.00	0.95

Table 12 (Cont'd)

Rank	Sub-criteria Group	Average	Std. Deviation
44	Results and current status	4.00	0.89
48	Age and operating condition	3.97	0.71
49	Company organizational structure	3.95	0.97
49	Stability of key personnel and staffing	3.95	0.83
49	Maintenance program	3.95	0.76
52	Bank references	3.92	0.74
52	Compliance with specifications and quality standards	3.92	0.84
54	Financial statement	3.87	0.73
54	Relationship with client	3.87	0.98
56	Type of ownership	3.85	0.87
56	Adequacy of professional personnel	3.85	0.81
58	Percentage of sub-contracted work	3.82	0.94
58	Compliance with on-site safety regulations	3.82	0.85
58	Safety tool provision	3.82	0.88
58	Management accountability	3.82	0.82
58	Relationship with supplier	3.82	0.79
63	Trade creditor references	3.79	0.73
63	Implementation of total quality control system	3.79	0.89
63	Attitude towards correcting faulty or incomplete works	3.79	0.86
66	Bid backlog	3.77	0.84
66	Success of previous work	3.77	0.90
68	Bonding capacity	3.74	0.91
68	Relationship with labor	3.74	0.94
68	No. of disputes in the past years	3.74	0.79

Table 12 (Cont'd)

Rank	Sub-criteria Group	Average	Std. Deviation
71	Type of projects completed	3.72	0.94
71	Relationship with sub-contractor	3.72	0.76
73	Size of projects completed	3.69	0.89
73	Relationship with design & consulting firm	3.69	0.80
73	No. of litigations with sub-contractor and/labor	3.69	0.73
76	Project control procedures	3.67	0.87
76	Debarment and fraudulent activity	3.67	0.87
78	Adequacy of skilled technician & labor	3.64	0.90
79	Routine training program	3.59	0.91
80	Co-operation with other project contractors	3.54	1.00
81	Size of organization	3.41	0.91
82	Language and regional experience	3.36	1.18
83	Subsidiaries and associated companies	3.28	1.12
84	Membership of trade/specialist associations	3.23	1.09
85	Head office location	3.21	0.98
86	Associated trade organizations	3.15	0.96

Table 13 Ranking of Sub-criteria from Contractors' Viewpoint

Rank	Sub-criteria Group	Average	Std. Deviation
1	No. of similar construction experience	4.80	0.47
2	Level of qualification of project manager	4.66	0.68
3	Legal status of company	4.63	0.65
3	Quality assessment track record of projects completed	4.63	0.60
5	Qualification grade	4.60	0.60
6	Size of company	4.57	0.85
7	Working capital	4.54	0.70
7	Ownership of equipment	4.54	0.56
7	Honor titles earned by the contractor	4.54	0.66
10	The available loan credit	4.51	0.74
10	Experience of key personnel	4.51	0.85
10	Quality management & assurance system	4.51	0.56
10	Availability, sufficiency and adequacy	4.51	0.56
14	Qualification of company owners	4.49	0.56
15	National or Local construction experience	4.46	0.85
15	Past experience of key personnel on similar projects	4.46	0.78
17	Average annual construction Turnover	4.43	0.78
17	Number of failure to complete contract	4.43	0.56
17	Safety records	4.43	1.01
20	Qualification of key personnel	4.40	0.69
20	Management accountability	4.40	0.74
20	Relationship with government agency	4.40	0.77
23	Schedule management system	4.34	0.87
23	Causes of arbitration/litigation	4.34	0.91

Table 13 (Cont'd)

Rank	Sub-criteria Group	Average	Std. Deviation
25	Safety management system	4.31	0.87
26	Experience on project specific matters	4.29	0.71
26	Experience in operating	4.29	0.71
26	Education of key personnel	4.29	0.79
26	Relationship with client	4.29	0.83
30	Average construction turnover	4.26	0.92
30	Certified by ISO	4.26	1.12
30	Age and operating condition	4.26	0.74
30	Appropriateness of project organization chart	4.26	0.61
30	Relationship with supplier	4.26	0.95
35	Subcontractor management system	4.23	0.69
35	Percentage of self performed work	4.23	0.81
35	Implementation of ISO system	4.23	0.84
38	Magnitude of capital base	4.20	0.93
38	Financial bidding capacity	4.20	0.83
38	Bank's rating of contractor as a customer	4.20	0.76
38	Volume of uncompleted work-on-hand	4.20	0.72
38	Schedule track record of projects completed	4.20	0.76
43	Current work load	4.17	0.86
43	Implementation of total quality control system	4.17	0.86
43	Results and current status	4.17	0.95
46	Type of ownership	4.14	0.73
46	Financial statement	4.14	0.77
46	Bank references	4.14	0.73

Table 13 (Cont'd)

Rank	Sub-criteria Group	Average	Std. Deviation
46	Cost overrun track record of projects completed	4.14	0.81
50	Maintenance program	4.11	0.72
50	Attitude towards correcting faulty or incomplete works	4.11	0.83
50	Compliance with on-site safety regulations	4.11	0.96
53	Ratio analysis	4.09	0.92
53	Scope of construction	4.06	0.76
53	Procurement characteristics (own/lease)	4.06	1.03
53	No. of litigations with sub-contractor and/labor	4.06	0.91
57	Success of previous work	4.03	0.79
57	Adequacy of professional personnel	4.03	0.79
57	Project control procedures	4.03	0.89
57	No. of arbitrations and litigations with clients	4.03	1.15
61	Safety tool provision	4.00	0.73
62	Bonding capacity	3.97	0.95
62	No. of disputes in the past years	3.97	1.12
62	Debarment and fraudulent activity	3.97	0.89
65	Stability of key personnel and staffing	3.94	0.87
65	Relationship with labor	3.94	0.87
67	Company organizational structure	3.91	0.85
67	Adequacy of skilled technician & labor	3.91	0.92
67	Percentage of sub-contracted work	3.91	0.85
67	Relationship with design & consulting firm	3.91	1.01
71	Number of years in construction	3.89	0.80
71	Size of projects completed	3.89	0.80

Table 13 (Cont'd)

Rank	Sub-criteria Group	Average	Std. Deviation
73	Co-operation with other project contractors	3.86	0.81
73	Routine training program	3.86	1.09
75	Trade creditor references	3.83	0.62
75	Type of projects completed	3.83	0.98
77	Compliance with specifications and quality standards	3.80	0.72
78	Language and regional experience	3.77	1.00
79	Size of organization	3.71	0.86
79	Bid backlog	3.71	0.83
79	No. of working years for that position	3.71	0.89
82	Relationship with sub-contractor	3.63	0.81
83	Subsidiaries and associated companies	3.40	1.03
84	Membership of trade/specialist associations	3.37	1.26
85	Head office location	3.34	1.33
86	Associated trade organizations	3.26	0.98

Based on the average scores rated by owners and contractors, an overall average score on sub-criteria was computed by simply taking average of the individual scores rated by them. It is shown in Table 14.

Table 14 Overall Ranking of Sub-criteria from Both Owners' and Contractors' Viewpoint

Rank	Sub-criteria Group	Average	Std. Deviation
1	No. of similar construction experience	4.73	0.58
2	Level of qualification of project manager	4.69	0.64
3	Legal status of company	4.65	0.61
4	Working capital	4.64	0.61
5	Honor titles earned by the contractor	4.62	0.66
6	Qualification grade	4.61	0.59
7	Quality assessment track record of projects completed	4.61	0.62
8	Size of company	4.59	0.74
9	Ownership of equipment	4.57	0.64
10	Average annual construction turnover	4.55	0.69
11	Safety records	4.54	0.85
12	National or Local construction experience	4.50	0.78
13	Experience of key personnel	4.50	0.71
14	Availability, sufficiency and adequacy	4.47	0.65
15	Past experience of key personnel on similar projects	4.47	0.74
16	Qualification of key personnel	4.46	0.71
17	Quality management & assurance system	4.46	0.67
18	Safety management system	4.43	0.72
19	Average construction turnover	4.42	0.78
20	The available loan credit	4.41	0.77
21	Certified by ISO	4.34	0.94
22	Relationship with government agency	4.34	0.76
23	Schedule management system	4.32	0.83
24	No. of arbitrations and litigations with clients	4.32	0.94

Table 14 (Cont'd)

Rank	Sub-criteria Group	Average	Std. Deviation
25	Qualification of company owners	4.31	0.64
26	Education of key personnel	4.30	0.70
27	Number of failure to complete contract	4.30	0.72
28	Experience on project specific matters	4.27	0.75
29	Subcontractor management system	4.26	0.66
30	Percentage of self performed work	4.26	0.78
31	Volume of uncompleted work-on-hand	4.24	0.70
32	Financial bidding capacity	4.22	0.82
33	Magnitude of capital base	4.20	0.81
34	Causes of arbitration/litigation	4.20	0.86
35	Implementation of ISO system	4.18	0.85
36	Bank's rating of contractor as a customer	4.16	0.72
37	Current work load	4.16	0.81
38	Ratio analysis	4.15	0.86
39	Experience in operating	4.15	0.81
40	Scope of construction	4.12	0.79
41	Appropriateness of project organization chart	4.12	0.78
42	Cost overrun track record of projects completed	4.12	0.86
43	Age and operating condition	4.11	0.73
44	Procurement characteristics (own/lease)	4.09	0.97
45	Schedule track record of projects completed	4.09	0.86
46	Management accountability	4.09	0.83
47	Results and current status	4.08	0.92
48	Relationship with client	4.07	0.93

Table 14 (Cont'd)

Rank	Sub-criteria Group	Average	Std. Deviation
49	No. of working years for that position	4.05	0.81
50	Bank references	4.03	0.74
51	Maintenance program	4.03	0.74
52	Relationship with supplier	4.03	0.89
53	Financial statement	4.00	0.76
54	Type of ownership	3.99	0.82
55	Implementation of total quality control system	3.97	0.89
56	Compliance with on-site safety regulations	3.96	0.91
57	Number of years in construction	3.95	0.84
58	Stability of key personnel and staffing	3.95	0.84
59	Attitude towards correcting faulty or incomplete works	3.95	0.86
60	Company organizational structure	3.93	0.91
61	Adequacy of professional personnel	3.93	0.80
62	Safety tool provision	3.91	0.81
63	Success of previous work	3.89	0.85
64	Percentage of sub-contracted work	3.86	0.90
65	Compliance with specifications and quality standards	3.86	0.78
66	No. of litigations with sub-contractor and/labor	3.86	0.83
67	Bonding capacity	3.85	0.93
68	No. of disputes in the past years	3.85	0.96
69	Project control procedures	3.84	0.89
70	Relationship with labor	3.84	0.91
71	Trade creditor references	3.81	0.68
72	Debarment and fraudulent activity	3.81	0.89

Table 14 (Cont'd)

Rank	Sub-criteria Group	Average	Std. Deviation
73	Relationship with design & consulting firm	3.80	0.91
74	Size of projects completed	3.78	0.85
75	Type of projects completed	3.77	0.96
76	Adequacy of skilled technician & labor	3.77	0.91
77	Bid backlog	3.74	0.83
78	Routine training program	3.72	1.00
79	Co-operation with other project contractors	3.69	0.92
80	Relationship with sub-contractor	3.68	0.78
81	Size of organization	3.55	0.89
82	Language and regional experience	3.55	1.11
83	Subsidiaries and associated companies	3.34	1.08
84	Membership of trade/specialist associations	3.30	1.17
85	Head office location	3.27	1.15
86	Associated trade organizations	3.20	0.96

Based on the overall average ranking of sub-criteria from the owner and the contractor, the most important 10-decision parameter is shown in Table 15.

Table 15 Most Important 10 Sub-criteria Based on Overall Average Ranking

Rank	Sub-criteria Group	Average	Std. Deviation
1	No. of similar construction experience	4.73	0.58
2	Level of qualification of project manager	4.69	0.64
3	Legal status of company	4.65	0.61
4	Working capital	4.64	0.61
5	Honor titles earned by the contractor	4.62	0.66
6	Qualification grade	4.61	0.59
7	Quality assessment track record of projects completed	4.61	0.62
8	Size of company	4.59	0.74
9	Ownership of equipment	4.57	0.64
10	Average annual construction turnover	4.55	0.69

As the results show, the owner and the contractor put credence on the same 8 sub-criteria as to be among the most important 10-decision parameter under their individual assessment. The same 8 sub-criteria were as below:

- (1) Working capital;
- (2) Level of qualification of project manager;
- (3) Honor titles earned by the contractor;
- (4) Legal status of company;
- (5) No. of similar construction experience;
- (6) Qualification grade;

(7) Size of company;

(8) Ownership of equipment.

The rest 2 sub-criteria, they considered differently. On the one hand, the owner considered average annual construction turnover, safety records to be the rest 2 among the most important 10 decision parameter. On the other hand the contractor considered the quality assessment track record of projects completed, and the available loan credit to be the rest 2 among the most important 10-decision parameter. This difference is probably due to their different roles played in construction industry and different goals of operation.

Sub-criteria Ranking Within Group

There are 11 groups of sub-criteria. Perception ranking within each major criteria group between owner's view and contractor's view is shown in Table 16. The overall average ranking rated by both owners and contractors is shown in Table 17.

Based on the average score ranking comparison of between the perception of the owner and the contractor regarding the sub-criteria within each major criteria group, there is no much difference towards the importance of sub-criteria. It appears that the owner and the contractor have the same opinion (no difference in average value) to the importance and applications of sub-criteria within each major criteria group. However, it is necessary to use hypothesis testing method to further investigate whether there are any different point of view between owner and contractor.

Table 16 Owner & Contractor Point of View towards Sub-criteria within Group

Rank	Owners' Perception		Contractors' Perception	
	Sub-criteria Group	Ave.	Sub-criteria Group	Ave.
1	Legal entity status and company profile			
1	Legal status of company	4.67	Legal status of company	4.63
2	Qualification grade	4.62	Qualification grade	4.60
3	Scope of construction	4.18	Type of ownership	4.14
4	No. of years in construction	4.00	Scope of construction	4.06
5	Type of ownership	3.85	No. of years in construction	3.89
6	Size of organization	3.41	Size of organization	3.71
7	Subsidiaries and associated companies	3.28	Subsidiaries and associated companies	3.40
8	Membership of trade/specialist associations	3.23	Membership of trade/specialist associations	3.37
9	Head office location	3.21	Head office location	3.34
10	Associated trade organizations	3.15	Associated trade organizations	3.26
2	Financial capacity			
1	Working capital	4.72	Working capital	4.54
2	Average annual construction turnover	4.67	The available loan credit	4.51
3	The available loan credit	4.31	Average annual construction turnover	4.43
4	Financial bidding capacity	4.23	Magnitude of capital base	4.20
5	Ratio analysis	4.21	Financial bidding capacity	4.20
6	Magnitude of capital base	4.21	Bank's rating of contractor as a customer	4.20
7	Bank's rating of contractor as a customer	4.13	Financial statement	4.14

Table 16 (Cont'd)

Rank	Owners' Perception		Contractors' Perception	
	Sub-criteria Group	Ave.	Sub-criteria Group	Ave.
2	Financial capacity			
8	Bank references	3.92	Bank references	4.14
9	Financial statement	3.87	Ratio analysis	4.09
10	Trade creditor references	3.79	Bonding capacity	3.97
11	Bonding capacity	3.74	Trade creditor references	3.83
3	Construction capacity			
1	Size of company	4.62	Size of company	4.57
2	Average construction turnover	4.56	Average construction turnover	4.26
3	Volume of uncompleted work-on-hand	4.28	Volume of uncompleted work-on-hand	4.20
4	Current work load	4.15	Current work load	4.17
5	Bid backlog	3.77	Bid backlog	3.71
4	Construction experience			
1	No. of similar construction experience	4.67	No. of similar construction experience	4.80
2	National or local construction experience	4.54	National or local construction experience	4.46
3	Experience on project specific matters	4.26	Experience on project specific matters	4.29
4	Success of previous work	3.77	Success of previous work	4.03
5	Type of projects completed	3.72	Size of projects completed	3.89
6	Size of projects completed	3.69	Type of projects completed	3.83

Table 16 (Cont'd)

Rank	Owners' Perception		Contractors' Perception	
	Sub-criteria Group	Ave.	Sub-criteria Group	Ave.
5	Management capability			
1	Qualification of key personnel	4.51	Experience of key personnel	4.51
2	Experience of key personnel	4.49	Quality management & assurance system	4.51
3	Quality management & assurance system	4.41	Qualification of company owners	4.49
4	Certified by ISO	4.41	Qualification of key personnel	4.40
5	Schedule management system	4.31	Schedule management system	4.34
6	Subcontractor management system	4.28	Certified by ISO	4.26
7	Percentage of self performed work	4.28	Subcontractor management system	4.23
8	Qualification of company owners	4.15	Percentage of self performed work	4.23
9	Implementation of ISO system	4.13	Implementation of ISO system	4.23
10	Company organizational structure	3.95	Implementation of total quality control system	4.17
11	Stability of key personnel and staffing	3.95	Adequacy of professional personnel	4.03
12	Adequacy of professional personnel	3.85	Project control procedures	4.03
13	Percentage of sub-contracted work	3.82	Stability of key personnel and staffing	3.94

Table 16 (Cont'd)

Rank	Owners' Perception		Contractors' Perception	
	Sub-criteria Group	Ave.	Sub-criteria Group	Ave.
5	Management capability			
14	Implementation of total quality control system	3.79	Company organizational structure	3.91
15	Project control procedures	3.67	Adequacy of skilled technician & labor	3.91
16	Adequacy of skilled technician & labor	3.64	Percentage of sub-contracted work	3.91
17	Routine training program	3.59	Co-operation with other project contractors	3.86
18	Co-operation with other project contractors	3.54	Routine training program	3.86
6	Plant and equipment			
1	Ownership of equipment	4.59	Ownership of equipment	4.54
2	Availability, sufficiency and adequacy	4.44	Availability, sufficiency and adequacy	4.51
3	Procurement characteristics (own/lease)	4.13	Experience in operating	4.29
4	Experience in operating	4.03	Age and operating condition	4.26
5	Age and operating condition	3.97	Maintenance program	4.11
6	Maintenance program	3.95	Procurement characteristics (own/lease)	4.06
7	Key personnel of project team proposed			
1	Level of qualification of project manager	1	Level of qualification of project manager	1

Table 16 (Cont'd)

Rank	Owners' Perception		Contractors' Perception	
	Sub-criteria Group	Ave.	Sub-criteria Group	Ave.
7	Key personnel of project team proposed			
2	Past experience of key personnel on similar projects	2	Past experience of key personnel on similar projects	2
3	No. of working years for that position	4.36	Education of key personnel	4.29
4	Education of key personnel	4.31	Appropriateness of project organization chart	4.26
5	Appropriateness of project organization chart	4.00	Language and regional experience	3.77
6	Language and regional experience	3.36	No. of working years for that position	3.71
8	Past performance and reputation			
1	Honor titles earned by the contractor	4.69	Quality assessment track record of projects completed	4.63
2	Quality assessment track record of projects completed	4.59	Honor titles earned by the contractor	4.54
3	Number of failure to complete contract	4.18	Number of failure to complete contract	4.43
4	Cost overrun track record of projects completed	4.10	Schedule track record of projects completed	4.20
5	Schedule track record of projects completed	4.00	Cost overrun track record of projects completed	4.14
6	Compliance with specifications and quality standards	3.92	Attitude towards correcting faulty or incomplete works	4.11
7	Attitude towards correcting faulty or incomplete works	3.79	Compliance with specifications and quality standards	3.80

Table 16 (Cont'd)

Rank	Owners' Perception		Contractors' Perception	
	Sub-criteria Group	Ave.	Sub-criteria Group	Ave.
9	Safety performance			
1	Safety records	4.64	Safety records	4.43
2	Safety management system	4.54	Safety management system	4.40
3	Compliance with on-site safety regulations	3.82	Compliance with on-site safety regulations	4.31
4	Safety tool provision	3.82	Safety tool provision	4.11
5	Management accountability	3.82	Management accountability	4.00
10	Public relationship			
1	Relationship with government agency	4.28	Relationship with government agency	4.40
2	Relationship with client	3.87	Relationship with client	4.29
3	Relationship with supplier	3.82	Relationship with supplier	4.26
4	Relationship with labor	3.74	Relationship with labor	3.94
5	Relationship with sub-contractor	3.72	Relationship with design & consulting firm	3.91
6	Relationship with design & consulting firm	3.69	Relationship with sub-contractor	3.63
11	Litigation history			
1	No. of arbitrations and litigations with clients	4.59	Causes of arbitration/litigation	4.34

Table 16 (Cont'd)

Rank	Owners' perception		Contractors' perception	
	Sub-criteria Group	Average	Sub-criteria Group	Average
11	Litigation history			
2	Causes of arbitration/litigation	4.08	Results and current status	4.17
3	Results and current status	4.00	No. of litigations with sub-contractor and/labor	4.06
4	No. of disputes in the past years	3.74	No. of arbitrations and litigations with clients	4.03
5	No. of litigations with sub-contractor and/labor	3.69	No. of disputes in the past years	3.97
6	Debarment and fraudulent activity	3.67	Debarment and fraudulent activity	3.97

Table 17 Ranking of Sub-criteria with Individual Major Criteria by All Respondents

Rank	Sub-criteria Group	Average	Std. Deviation
1	Legal entity status and company profile		
1	Legal status of company	4.65	0.61
2	Qualification grade	4.61	0.59
3	Scope of construction	4.12	0.79
4	Type of ownership	3.99	0.82
5	Number of years in construction	3.95	0.84
6	Size of organization	3.55	0.89
7	Subsidiaries and associated companies	3.34	1.08
8	Membership of trade/specialist associations	3.30	1.17
9	Head office location	3.27	1.15
10	Associated trade organizations	3.20	0.96
2	Financial capacity		
1	Working capital	4.64	0.61
2	Average annual construction turnover	4.55	0.69
3	The available loan credit	4.41	0.77
4	Financial bidding capacity	4.22	0.82
5	Magnitude of capital base	4.20	0.81
6	Bank's rating of contractor as a customer	4.16	0.72
7	Ratio analysis	4.15	0.86
8	Bank references	4.03	0.74
9	Financial statement	4.00	0.76
10	Bonding capacity	3.85	0.93
11	Trade creditor references	3.81	0.68
3	Construction capacity		
1	Size of company	4.59	0.74

Table 17 (Cont'd)

Rank	Sub-criteria Group	Average	Std. Deviation
3	Construction capacity		
2	Average construction turnover	4.42	0.78
3	Volume of uncompleted work-on-hand	4.24	0.70
4	Current work load	4.16	0.81
5	Bid backlog	3.74	0.83
4	Construction experience		
1	No. of Similar Construction Experience	4.73	0.58
2	National or local construction experience	4.50	0.78
3	Experience on project specific matters	4.27	0.75
4	Success of previous work	3.89	0.85
5	Size of projects completed	3.78	0.85
6	Type of projects completed	3.77	0.96
5	Management capability		
1	Experience of key personnel	4.50	0.71
2	Qualification of key personnel	4.46	0.71
3	Quality management & assurance system	4.46	0.67
4	Certified by ISO	4.34	0.94
5	Schedule management system	4.32	0.83
6	Qualification of company owners	4.31	0.64
7	Subcontractor management system	4.26	0.66
8	Percentage of self performed work	4.26	0.78
9	Implementation of ISO system	4.18	0.85
10	Implementation of total quality control system	3.97	0.89
11	Stability of key personnel and staffing	3.95	0.84
12	Company organizational structure	3.93	0.91

Table 17 (Cont'd)

Rank	Sub-criteria Group	Average	Std. Deviation
5	Management capability		
13	Adequacy of professional personnel	3.93	0.80
14	Percentage of sub-contracted work	3.86	0.90
15	Project control procedures	3.84	0.89
16	Adequacy of skilled technician & labor	3.77	0.91
17	Routine training program	3.72	1.00
18	Co-operation with other project contractors	3.69	0.92
6	Plant and equipment		
1	Ownership of equipment	4.57	0.64
2	Availability, sufficiency and adequacy	4.47	0.65
3	Experience in operating	4.15	0.81
4	Age and operating condition	4.11	0.73
5	Procurement characteristics (own/lease)	4.09	0.97
6	Maintenance program	4.03	0.74
7	Key personnel of project team proposed		
1	Level of qualification of project manager	4.69	0.64
2	Past experience of key personnel on similar projects	4.47	0.74
3	Education of key personnel	4.30	0.70
4	Appropriateness of project organization chart	4.12	0.78
5	No. of working years for that position	4.05	0.81
6	Language and regional experience	3.55	1.11
8	Past performance and reputation		
1	Honor titles earned by the contractor	4.62	0.66
2	Quality assessment track record of projects completed	4.61	0.62
3	Number of failure to complete contract	4.30	0.72

Table 17 (Cont'd)

Rank	Sub-criteria Group	Average	Std. Deviation
8	Past performance and reputation		
4	Cost overrun track record of projects completed	4.12	0.86
5	Schedule track record of projects completed	4.09	0.86
6	Attitude towards correcting faulty or incomplete works	3.95	0.86
7	Compliance with specifications and quality standards	3.86	0.78
9	Safety performance		
1	Safety records	4.54	0.85
2	Safety management system	4.43	0.72
3	Management accountability	4.09	0.83
4	Compliance with on-site safety regulations	3.96	0.91
5	Safety tool provision	3.91	0.81
10	Public relationship		
1	Relationship with government agency	4.34	0.76
2	Relationship with client	4.07	0.93
3	Relationship with supplier	4.03	0.89
4	Relationship with labor	3.84	0.91
5	Relationship with design & consulting firm	3.80	0.91
6	Relationship with sub-contractor	3.68	0.78
11	Litigation history		
1	No. of arbitrations and litigations with clients	4.32	0.94
2	Causes of arbitration/litigation	4.20	0.86
3	Results and current status	4.08	0.92
4	No. of litigations with sub-contractor and/labor	3.86	0.83
5	No. of disputes in the past years	3.85	0.96
6	Debarment and fraudulent activity	3.81	0.89

Hypothesis Testing to Find the Significance Differences

In order to investigate the significance differences between owner and contractor, a statistical test was performed on two groups to determine if the average impacts are statistically the difference at a specified alpha level.

T-test is a hypothesis testing using t-distribution, a symmetric bell shape distribution. The t test is a useful technique for comparing average values of two sets of numbers. The comparison will provide a statistic for evaluating whether the difference between two averages is statistically significant.

The independent-sample t test is used to compare the averages of one variable for two groups of cases. Depending on the sample size, the independent samples t test could be broken down into large-sample ($n > 30$) and small-sample ($n < 30$) methodologies, using the z or t statistics respectively. However, most statistical software packages including SPSS will use the t -test over the z -test. The reasoning is as follows. Once the sample size gets beyond 30, there isn't that much difference between the z and t . So why not simply report the t ? For, if the sample size is under 30, one would be doing a t -test anyway. This, of course, reduces the amount of computer code.

Define the Hypothesis to Be Tested

A hypothesis is to be set first. The hypothesis being test is called the null hypothesis, and is denoted by H_0 . Any other hypothesis is called the alternative hypothesis, and is denoted by H_1 . It is important to ascertain whether the observed differences in the average scores between the owners and contractors are statistically different. For this the t -test was conducted with the following assumptions:

(1) Both the sample taken from owner and contractor groups are random samples; and both sets of obtained response data are normally distributed;

(2) The owner population and the contractor population have the same variance;

(3) The two samples are independent.

Following null hypothesis and alternative hypothesis were set to facilitate the test:

H_0 : there is no significant difference in the average scores rating between the owners and contractors; H_1 : there is significant difference in the average scores rating between the owners and contractors.

In other words, $H_0: \mu_1 - \mu_2 = 0$ i.e. $H_0: \mu_1 = \mu_2$
 $H_1: \mu_1 - \mu_2 \neq 0$ i.e. $H_1: \mu_1 \neq \mu_2$

Where,

μ_1 : population average of owner's rating

μ_2 : population average of contractor's rating

The test statistic is given by

$$t = \frac{(x_1 - x_2) - (u_1 - u_2)}{\sqrt{s_2 \left(\frac{2}{n_1} + \frac{1}{n_2} \right)}} \quad (4)$$

Where,

$$s^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2} \quad (5)$$

As $\mu_1 - \mu_2 = 0$,

$$t = \frac{(x_1 - x_2)}{\sqrt{s_2 \left(\frac{1}{n_1} + \frac{1}{n_2} \right)}} \quad (6)$$

Where,

n_1 = Number of respondents from owners

n_2 = Number of respondents from contractor

x_1 = Average value of owner's rating

x_2 = Average value of contractor's rating

s_1 = Standard deviation of owner's rating

s_2 = Standard deviation of contractor's rating

(n_1+n_2-2) = Degrees of freedom

Define the Level of Significance (α)

In testing a given hypothesis, the maximum probability with which you would be will to risk, is called the level of significance of the test (Heitzman and Mueller, 1980). The smaller is the chosen significance level, the more restrictive is the test. There is no precise rule in choosing the level of significance. In this study, a level of significance of 0.05 is used because it is generally used in most of the test. The hypothesis H_0 is accepted only if:

$$- t_{0.05/2} \leq t \leq + t_{0.05/2} \quad (7)$$

Where,

$t_{0.05/2}$ = t-value from the t-distribution Table for a significance level 0.025

For the degree of freedom, $(n_1+n_2-2) = (39+35-2) = 72$, $t_{0.05/2} = 1.996$. Thus, we reject H_0 if $t > +1.996$ or $t < -1.996$.

Acceptance of the hypothesis averages that there is no real significant different between owner and contractor attitude and the apparent difference between them is due to the sampling

error. On the other hand, if we reject the hypothesis, we conclude that the difference is significant. In other words, owner and contractor have different point of view.

Significant Test of Different Point of Views in Major Criteria

The results of significant test of different point of view in major criteria are shown in Table 18.

The test results as given in Table 18 shows that there is no significant difference in average ratings of group of criteria between owners and contractors except with plant and equipment criteria and key personnel of project team proposed criteria.

1) Plant and equipment criterion

From the average ranking shown in previous Table 4.5 and Table 4.6, it is found that the contractor rated plant and equipment as 6th rank whereas the owner rated as 9th rank. The owner rated plant and equipment lower than the contractor did.

An inventory of construction equipment represents a high capital cost overhead to a contractor. In consequence, not all competent potential bidders will maintain an inventory of high-value items that are in suitable condition for major contracts. In most cases contractors can readily purchase, lease, or hire equipment. It is thus usually unnecessary for prequalification to depend on the contractor's owning generally available items of equipment. The criteria adopted should therefore be limited only to those bulky or specialized items that are critical for the type of project to be implemented and which may be difficult for the contractor to obtain quickly. Even in such cases, main contractors may not own the equipment; rather they may rely on specialist subcontractors or equipment hire firms. Taking this into consideration, the owner may give less concern on this criterion than the contractor.

Table 18 Independent Samples Test Difference of Owners' and Contractors' Views in Major Criteria

No.	Major criteria	t	df	Sig. (2-tailed)	Ave. Diff.	Std. Error Diff.	95% Confidence Interval of the Diff.		Sig. at 5% Level
							Lower	Upper	
1	Legal entity status and business profile	-0.05	72	0.959	-0.007	0.14	-0.287	0.272	Not sig.
2	Financial capacity	-0.18	72	0.859	-0.024	0.136	-0.295	0.246	Not sig.
3	Construction capacity	0.78	72	0.441	0.113	0.146	-0.177	0.403	Not sig.
4	Construction experience	1.13	72	0.261	0.158	0.14	-0.12	0.437	Not sig.
5	Management capability	-0.39	72	0.699	-0.059	0.151	-0.36	0.243	Not sig.
6	Plant and equipment	-3.11	72	0.003	-0.585	0.188	-0.961	-0.21	Sig.
7	Key personnel of project team proposed	-2.26	72	0.027	-0.318	0.141	-0.598	-0.037	Sig.
8	Past performance and reputation	-0.11	72	0.916	-0.018	0.174	-0.364	0.328	Not sig.
9	Safety performance	-1.17	72	0.247	-0.251	0.215	-0.68	0.178	Not sig.
10	Public relationship	-0.39	72	0.694	-0.095	0.241	-0.576	0.385	Not sig.
11	Litigation history	0.36	72	0.722	0.084	0.234	-0.382	0.549	Not sig.

2) Key personnel of project team proposed.

From the average ranking shown in previous Table 4.5 and Table 4.6, it is found that the owner's rated key personnel of project team proposed as 7th rank, whereas the contractor rated it as 1st rank.

The managerial and technical competence of a contractor is largely related to its key personnel on site. Key personnel may include project managers, estimators, site superintendents, and foremen. Site management is viewed as being crucial to a successful project outcome, particularly the profitability of the contract (Holt et al, 1994). Qualifications and experience of key personnel in charge of site work are equally important to the project as management staff's quality. Key personnel with adequate amount of experience gained from the same company are more desirable as this continuous experience assures familiarity of organizational structure and optimum efficiency (Holt et al., 1994). Technical expertise is important in management for the success of a company. Knowledge can be acquired through a formal institution or knowledge can be embedded through experience. Either method can produce similar results. It is important for management to understand the specifications of the job as well as procedures that can optimize labor activities. Quality of detail planning and execution of the project is largely dependent on the performance of the site personnel.

Russell (1991) stated that lack of experience at the management level can be one of the major reasons for project failure. From contractor's point of view, the key personnel of project team are deeply involved in the construction activity's day-to-day running and they have to do with day-to-day management activities on site too. Therefore, the contractor gave highest concern to the key personnel of project team proposed. On the other hand, the owner may have overlooked the influence of key personnel of project team while rating the criteria, since many government agencies prefer to put their emphasis on the entire company rather than the individual characteristic.

Significant Test of Different Point of Views in Sub-criteria

The results of significant test of different point of view in sub-criteria are shown in Table 19. It revealed that only 5 sub-criteria where owner and contractor perceived impact were statistically different. The sub-criteria included: qualification of company owners, No of years worked for that position, management accountability, relationship with supplier and No. of arbitrations and litigations with clients. On the other hand, there are no significant difference between owner and contractor with regard to the rest of 81 sub-criteria.

1) Qualification of company owners (sub-criterion of management capability)

Smaller companies will often have owners involved in the management and operation of the company. Larger companies will tend to have shareholders as owners who will not have an interest in day-to-day operations. Owners who are involved in the day-to-day operations of the company have a vested interest in the success in the company and will probably spend a lot more time and energy insuring the company's success. Considered of this point, it is prudent for the contractor to concern about this issue. However, the qualification of company owners is crucial for those smaller companies, which there is higher degree of involvement of the owners of the construction company on management activities. The owner may focus on those larger companies and didn't give much attention on this criterion.

2) No. of years worked for that position (sub-criterion of key personnel of project team proposed)

Experience is the single most important attribute a company can have based on its most important employees. Employees who stay many years with the same company are a benefit to a company compared to someone with the same amount of experienced but spread out over a number of companies. The former will understand the company's structure and organization as well as procedures a lot better than a new employee of the company will. This may explain why the owner put more concern on this criterion than the contractor. However, experience is not

something that becomes more valued as it increases. Older employees may not be as flexible in changing company policies and younger employees may just not have enough exposure to be considered self-sufficient. Somewhere in the middle of these two extremes is generally regarded as most desirable.

3) Management accountability (sub-criterion of safety performance)

Management accountability for safety performance is an important factor in determining a company's safety procedures. Companies that hold their project management accountable for accidents along with productivity, schedules, quality, among others, are the ones which have the best safety records. In this point of view, the owner may overlook this sub-criterion.

4) Relationship with supplier (sub-criterion of public relationship)

The suppliers are the people that provide all the necessary material for the construction industry. Unsettled accounts and outstanding balances would not be looked on as favorable from an owner's perspective. A good relationship with the suppliers can prove to be a necessity. Outstanding balances can delay the delivery of building material to future projects until accounts from past projects are closed, which can cause delay in the project.

5) No. of arbitrations and litigations with clients (sub-criterion of litigation history)

This criterion was viewed by contractor as less important than the owner. The objective of this criterion is to see the litigation tendency of the contractor. For sure, many disputes or claims are not a good image for contractor. However, the contractor considered that not only the No. of litigations with clients should be considered, but also the causes of litigation. From the viewpoint of the owner, they focus on how to safeguard their project from claims and litigations; therefore, the owner may prefer to choose those contractors without too much litigation history regardless the causes of disputes. This may be the reason that the owner gave more emphasis on No. of arbitrations and litigations than the contractor.

Table 19 Independent Samples Test difference of Owners' and Contractors' Views in Sub-criteria

No.	Major Criteria	t	df	Sig. (2- tailed)	Ave. Diff.	Std. Error Diff.	95% Confidence Interval of the Diff.		Sig. at 5% Level
							Lower	Upper	
1	Legal status of company	0.27	72	0.79	0.04	0.14	-0.25	0.32	Not sig.
2	Type of ownership	-1.57	72	0.12	-0.30	0.19	-0.67	0.08	Not sig.
3	Subsidiaries and associated companies	-0.47	72	0.64	-0.12	0.25	-0.62	0.38	Not sig.
4	Number of years in construction	0.58	72	0.56	0.11	0.20	-0.28	0.51	Not sig.
5	Qualification grade	0.11	72	0.91	0.02	0.14	-0.26	0.29	Not sig.
6	Scope of construction	0.66	72	0.51	0.12	0.19	-0.25	0.49	Not sig.
7	Size of organization	-1.47	72	0.15	-0.30	0.21	-0.72	0.11	Not sig.
8	Associated trade organizations	-0.46	72	0.65	-0.10	0.23	-0.55	0.35	Not sig.
9	Head office location	-0.51	72	0.61	-0.14	0.27	-0.67	0.40	Not sig.
10	Membership of trade/specialist associations	-0.51	72	0.61	-0.14	0.27	-0.69	0.40	Not sig.
11	Ratio analysis	0.60	72	0.55	0.12	0.20	-0.28	0.52	Not sig.

Table 19 (Cont'd)

No.	Major criteria	t	df	Sig. (2- tailed)	Ave. Diff.	Std. Error Diff.	95% Confidence Interval of the Diff.		Sig. at 5% Level
							Lower	Upper	
12	Working capital	1.24	72	0.22	0.18	0.14	-0.11	0.46	Not sig.
13	Magnitude of capital base	0.03	72	0.98	0.01	0.19	-0.37	0.38	Not sig.
14	Financial statement	-1.55	72	0.13	-0.27	0.17	-0.62	0.08	Not sig.
15	Average annual construction turnover	1.51	72	0.14	0.24	0.16	-0.08	0.55	Not sig.
16	Financial bidding capacity	0.16	72	0.87	0.03	0.19	-0.35	0.41	Not sig.
17	The available loan credit	-1.15	72	0.25	-0.21	0.18	-0.57	0.15	Not sig.
18	Bank's rating of contractor as a customer	-0.42	72	0.67	-0.07	0.17	-0.41	0.27	Not sig.
19	Bonding capacity	-1.05	72	0.30	-0.23	0.22	-0.66	0.20	Not sig.
20	Trade creditor references	-0.21	72	0.83	-0.03	0.16	-0.35	0.28	Not sig.
21	Bank references	-1.28	72	0.20	-0.22	0.17	-0.56	0.12	Not sig.
22	Size of company	0.25	72	0.80	0.04	0.17	-0.30	0.39	Not sig.

Table 19 (Cont'd)

No.	Major criteria	t	df	Sig. (2- tailed)	Ave. Diff.	Std. Error Diff.	95% Confidence Interval of the Diff.		Sig. at 5% Level
							Lower	Upper	
23	Average construction turnover	1.72	72	0.09	0.31	0.18	-0.05	0.66	Not sig.
24	Current workload	-0.09	72	0.93	-0.02	0.19	-0.40	0.36	Not sig.
25	Volume of uncompleted work-on-hand	0.50	72	0.62	0.08	0.16	-0.24	0.41	Not sig.
26	Bid backlog	0.28	72	0.78	0.05	0.19	-0.33	0.44	Not sig.
27	No. of similar construction experience	-0.99	72	0.33	-0.13	0.14	-0.40	0.14	Not sig.
28	National or local construction experience	0.44	72	0.66	0.08	0.18	-0.28	0.45	Not sig.
29	Success of previous work	-1.31	72	0.19	-0.26	0.20	-0.65	0.13	Not sig.
30	Experience on project specific matters	-0.17	72	0.87	-0.03	0.17	-0.38	0.32	Not sig.
30	Experience on project specific matters	-0.17	72	0.87	-0.03	0.17	-0.38	0.32	Not sig.

Table 19 (Cont'd)

No.	Sub-criteria Group	t	df	Sig. (2-tailed)	Ave. Diff.	Std. Error Diff.	95% Confidence Interval of the Diff.		Sig. at 5% Level
							Lower	Upper	
31	Type of projects completed	-0.49	72	0.62	-0.11	0.22	-0.56	0.34	Not sig.
32	Size of projects completed	-0.98	72	0.33	-0.19	0.20	-0.59	0.20	Not sig.
33	Company organizational structure	0.16	72	0.87	0.03	0.21	-0.39	0.46	Not sig.
34	Qualification of company owners	-2.29	72	0.02	-0.33	0.14	-0.62	-0.04	Sig.
35	Qualification of key personnel	0.68	72	0.50	0.11	0.16	-0.22	0.44	Not sig.
36	Adequacy of professional personnel	-0.98	72	0.33	-0.18	0.19	-0.55	0.19	Not sig.
37	Stability of key personnel and staffing	0.03	72	0.98	0.01	0.20	-0.39	0.40	Not sig.
38	Experience of key personnel	-0.16	72	0.87	-0.03	0.17	-0.36	0.30	Not sig.
39	Adequacy of skilled technician & labor	-1.29	72	0.20	-0.27	0.21	-0.70	0.15	Not sig.

Table 19 (Cont'd)

No.	Sub-criteria Group	t	df	Sig. (2-tailed)	Ave. Diff.	Std. Error Diff.	95% Confidence Interval of the Diff.		Sig. at 5% Level
							Lower	Upper	
40	Quality management & assurance system	-0.67	72	0.51	-0.10	0.16	-0.41	0.21	Not sig.
41	Schedule management system	-0.18	72	0.86	-0.04	0.19	-0.42	0.35	Not sig.
42	Project control procedures	-1.77	72	0.08	-0.36	0.20	-0.77	0.05	Not sig.
43	Co-operation with other project contractors	-1.50	72	0.14	-0.32	0.21	-0.74	0.10	Not sig.
44	Subcontractor management system	0.34	72	0.73	0.05	0.16	-0.26	0.36	Not sig.
45	Percentage of self performed work	0.29	72	0.77	0.05	0.18	-0.31	0.42	Not sig.
46	Percentage of sub-contracted work	-0.45	72	0.66	-0.09	0.21	-0.51	0.32	Not sig.
47	Implementation of total quality control system	-1.84	72	0.07	-0.38	0.20	-0.78	0.03	Not sig.

Table 19 (Cont'd)

No.	Sub-criteria Group	t	df	Sig. (2-tailed)	Ave. Diff.	Std. Error Diff.	95% Confidence Interval of the Diff.		Sig. at 5% Level
							Lower	Upper	
48	Implementation of ISO system	-0.50	72	0.62	-0.10	0.20	-0.50	0.30	Not sig.
49	Certified by ISO	0.70	72	0.49	0.15	0.22	-0.28	0.59	Not sig.
50	Routine training program	-1.15	72	0.25	-0.27	0.23	-0.73	0.20	Not sig.
51	Ownership of equipment	0.31	72	0.76	0.05	0.15	-0.25	0.35	Not sig.
52	Availability, sufficiency and adequacy	-0.52	72	0.61	-0.08	0.15	-0.38	0.22	Not sig.
53	Age and operating condition	-1.68	72	0.10	-0.28	0.17	-0.62	0.05	Not sig.
54	Maintenance program	-0.96	72	0.34	-0.17	0.17	-0.51	0.18	Not sig.
55	Experience in operating	-1.40	72	0.17	-0.26	0.19	-0.63	0.11	Not sig.
56	Procurement characteristics (own/lease)	0.31	72	0.75	0.07	0.23	-0.38	0.52	Not sig.
57	Level of qualification of project manager	0.41	72	0.69	0.06	0.15	-0.24	0.36	Not sig.

Table 19 (Cont'd)

No.	Sub-criteria Group	t	df	Sig. (2-tailed)	Ave. Diff.	Std. Error Diff.	95% Confidence Interval of the Diff.		Sig. at 5% Level
							Lower	Upper	
57	Level of qualification of project manager	0.41	72	0.69	0.06	0.15	-0.24	0.36	Not sig.
58	Education of key personnel	0.13	72	0.89	0.02	0.16	-0.30	0.35	Not sig.
59	No. of working years for that position	3.71	72	0.00	0.64	0.17	0.30	0.99	Sig.
60	Past experience of key personnel on similar projects	0.17	72	0.86	0.03	0.17	-0.32	0.38	Not sig.
61	Appropriateness of project organization chart	-1.43	72	0.16	-0.26	0.18	-0.61	0.10	Not sig.
62	Language and regional experience	-1.61	72	0.11	-0.41	0.26	-0.92	0.10	Not sig.
63	Honor titles earned by the contractor	0.98	72	0.33	0.15	0.15	-0.16	0.45	Not sig.

Table 19 (Cont'd)

No.	Sub-criteria Group	t	df	Sig. (2-tailed)	Ave. Diff.	Std. Error Diff.	95% Confidence Interval of the Diff.		Sig. at 5% Level
							Lower	Upper	
64	Quality assessment track record of projects completed	-0.27	72	0.79	-0.04	0.14	-0.33	0.25	Not sig.
65	Number of failure to complete contract	-1.51	72	0.14	-0.25	0.17	-0.58	0.08	Not sig.
66	Compliance with specifications and quality standards	0.67	72	0.50	0.12	0.18	-0.24	0.49	Not sig.
67	Attitude towards correcting faulty or incomplete works	-1.62	72	0.11	-0.32	0.20	-0.71	0.07	Not sig.
68	Schedule track record of projects completed	-1.00	72	0.32	-0.20	0.20	-0.60	0.20	Not sig.
69	Cost overrun track record of projects completed	-0.20	72	0.84	-0.04	0.20	-0.44	0.36	Not sig.

Table 19 (Cont'd)

No.	Sub-criteria Group	t	df	Sig. (2-tailed)	Ave. Diff.	Std. Error Diff.	95% Confidence Interval of the Diff.		Sig. at 5% Level
							Lower	Upper	
70	Safety records	1.08	72	0.28	0.21	0.20	-0.18	0.61	Not sig.
71	Safety management system	1.34	72	0.18	0.22	0.17	-0.11	0.56	Not sig.
72	Compliance with on-site safety regulations	-1.39	72	0.17	-0.29	0.21	-0.71	0.13	Not sig.
73	Safety tool provision	-0.95	72	0.35	-0.18	0.19	-0.56	0.20	Not sig.
74	Management accountability	-3.18	72	0.00	-0.58	0.18	-0.94	-0.22	Sig.
75	Relationship with client	-1.96	72	0.05	-0.41	0.21	-0.84	0.01	Not sig.
76	Relationship with sub-contractor	0.49	72	0.63	0.09	0.18	-0.27	0.45	Not sig.
77	Relationship with supplier	-2.16	72	0.03	-0.44	0.20	-0.84	-0.03	Sig.
78	Relationship with labor	-0.94	72	0.35	-0.20	0.21	-0.62	0.22	Not sig.

Table 19 (Cont'd)

No.	Sub-criteria Group	t	df	Sig. (2-tailed)	Ave. Diff.	Std. Error Diff.	95% Confidence Interval of the Diff.		Sig. at 5% Level
							Lower	Upper	
79	Relationship with government agency	-0.66	72	0.51	-0.12	0.18	-0.47	0.24	Not sig.
80	Relationship with design & consulting firm	-1.05	72	0.30	-0.22	0.21	-0.64	0.20	Not sig.
81	No. of arbitrations and litigations with clients	2.68	72	0.01	0.56	0.21	0.14	0.98	Sig.
82	No. of litigations with sub-contractor and/labor	-1.92	72	0.06	-0.36	0.19	-0.74	0.01	Not sig.
83	Causes of arbitration/litigation	-1.34	72	0.19	-0.27	0.20	-0.66	0.13	Not sig.
84	No. of disputes in the past years	-1.02	72	0.31	-0.23	0.22	-0.67	0.22	Not sig.
85	Results and current status	-0.80	72	0.43	-0.17	0.21	-0.60	0.26	Not sig.
86	Debarment and fraudulent activity	-1.49	72	0.14	-0.30	0.20	-0.71	0.10	Not sig.

Criteria Grouping Using Factor Analysis

Review

In order to understand how the criteria work together in influencing to decision of owner and contractor during contractor prequalification and to explore further the structure of the obtained data, the factor analysis technique was employed. And the statistical package for the social science (SPSS) program was conducted to help in calculation. Factor analysis is a statistical technique for dealing with multiple variables, and many variables are grouped into a smaller number of factors. It aims to explain these correlations with a set of underlying, mutually uncorrelated factors and it is thus primarily a dimension-reducing multivariate technique. The primary purpose of factor analysis is data reduction and summarization.

Conducting Factor Analysis

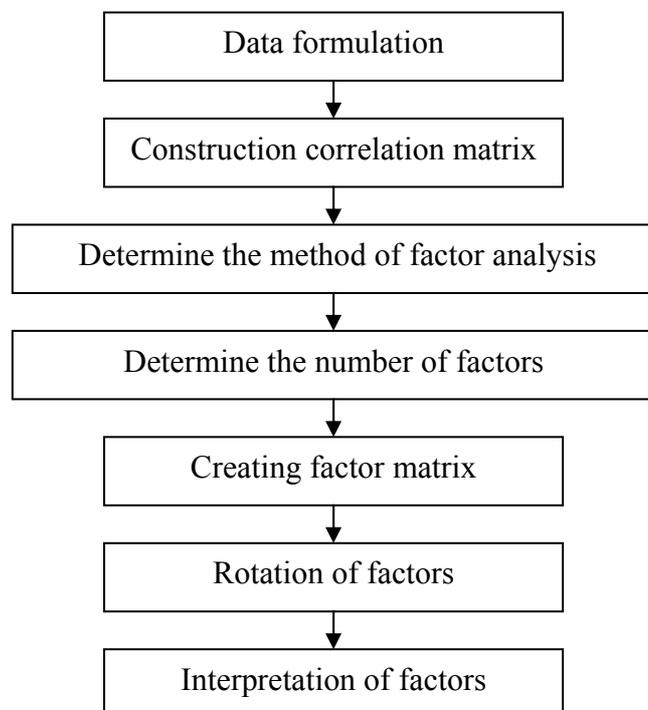


Figure 8 Factor Analysis Process

Step 1 Data formulation

First, the objective in this step is to identify the variable. The variables to be included in the factor analysis are specified based on current research, therefore, 11 major prequalification criteria has been specified as the variables. Norusis (1994) stated that the variables should be measured on an interval or ratio scale such as five-point scale or other scales. In our case, the five point scale is used to measure the variables correspond to the data collected from questionnaires.

Step 2 Construct the Correlation Matrix

A correlation matrix is a lower triangle matrix showing the simple correlations, r , between all possible pairs of variables included in the analysis. The analytical process is based on a matrix of correlations between the variables. It consists of correlation coefficients (r) as a measure of association between two variables. A correlation coefficient is calculated using the following formula:

$$r = \frac{S_{xy}}{\sqrt{S_{xx}S_{yy}}} = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2 \sum_{i=1}^n (y_i - \bar{y})^2}} \quad (8)$$

Where,

x_i, y_i = Two variables to find association between them

n = Number of data from all respondents ($n = 74$)

The values of r will range from -1 to +1. A value of +1 or -1 indicates perfect association between two variables. The plus sign occur for high relationship and the minus sign occur for reverse relationships. When r -value is close to zero, we would conclude that the variables are uncorrelated. (Norusis, 1994)

Table 20 Correlation Matrix

	LES	FC	CC	CE	MC	PE	KP	PPR	SP	PR	LH
LES	1.00	0.12	0.39	-0.07	0.12	0.02	0.03	-0.05	0.25	0.09	0.15
FC	0.12	1.00	0.11	0.20	0.08	0.11	0.11	0.39	-0.32	-0.10	0.18
CC	0.39	0.11	1.00	0.21	0.46	0.05	0.12	0.05	0.33	0.07	0.14
CE	-0.07	0.20	0.21	1.00	0.26	0.08	0.06	0.41	-0.17	-0.07	0.09
MC	0.12	0.08	0.46	0.26	1.00	0.05	0.30	0.27	0.08	-0.11	-0.07
PE	0.02	0.11	0.05	0.08	0.05	1.00	0.39	0.20	0.09	0.08	0.19
KP	0.03	0.11	0.12	0.06	0.30	0.39	1.00	0.38	0.16	0.23	0.04
PPR	-0.05	0.39	0.05	0.41	0.27	0.20	0.38	1.00	-0.12	0.06	0.21
SP	0.25	-0.32	0.33	-0.17	0.08	0.09	0.16	-0.12	1.00	0.50	0.32
PR	0.09	-0.10	0.07	-0.07	-0.11	0.08	0.23	0.06	0.50	1.00	0.56
LH	0.15	0.18	0.14	0.09	-0.07	0.19	0.04	0.21	0.32	0.56	1.00

Short form used in Table 20 is as follow:

LES stands for Legal entity status and company profile; FC stands for Financial capacity; CC stands for Construction capacity; CE stands for Construction experience; MC stands for Management capability; PE stands for Plant and equipment; KP stands for Key personnel of project team proposed; PPR stands for Past performance and reputation; SP stands for Safety performance; PR stands for Public relationship; LH stands for Litigation history.

Testing sampling adequacy

To ensure the suitability of the data for this analysis, the determinant of the correlation matrix shown in Table 4.16 is 0.025, which is greater than the required 0.00001. The purpose is to make sure that “this data matrix does not suffer from multi-collinearity or singularity (Kometa and Olomolaiye, 1997)”. The determinant of correlation matrix (D or det r) was calculated as the following formula;

$$D = \det (r) = \begin{vmatrix} r_{11} & r_{12} & \dots & r_{1n} \\ r_{21} & r_{22} & \dots & r_{2n} \\ \dots & \dots & \dots & \dots \\ r_{n1} & r_{n2} & \dots & r_{nn} \end{vmatrix} > 0.00001 \quad (9)$$

Where

r_{ij} = The correlation coefficient in matrix

n = The total number of correlation coefficient = 11

Furthermore, the data sample size is measured by Kaiser-Meyer-Olkin (KMO) method. The value of the KMO statistic should be required larger than 0.5 for sampling adequacy because the small values of the KMO statistic indicate that the correlations between pairs of variables cannot be explained by other variables and that factor analysis may not be appropriate (Norusis, 1994). The formula of calculation is shown below:

$$KMO = \frac{\sum \sum_{i \neq j} r_{ij}^2}{\sum \sum r_{ij}^2 + \sum \sum_{i \neq j} a_{ij}^2} > 0.5 \quad (10)$$

Where,

r_{ij} = the simple correlation coefficient between variables i and j

a_{ij} = the partial correlation coefficient between variables i and j

Table 21 KMO Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.576
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After checking the value of the Kaiser-Meyer-Olkin statistic through SPSS program, it was found to be 0.576, which is greater than 0.5. Therefore, the sampling adequacy is acceptable.

Step 3 Determine the Method of Factor Analysis

There are two basic methods of factor analysis, the most common being principal components analysis (PCA) and another being common factor analysis (CFA).

In principal components analysis, the total variance in the data is considered. The diagonal of the correlation matrix consists of unities, and full variance is brought into the factor matrix. Principal components analysis is recommended when the primary concern is to determine the minimum number of factors that will account for maximum variance in the data for use in subsequent multivariate analysis. The factors are called principal components.

In common factor analysis, the factors are estimated based only on the common variance. Communalities are inserted in the diagonal of the correlation matrix. This method is appropriate when the primary concern is to identify the underlying dimensions and the common variance is of interest. This method is also known as principal axis factoring.

In this study, PCA was used because the research purpose is data reduction (to reduce the information in many measured variables into a smaller set of components).

Step 4 Determine the Number of Factors

Determining the optimal number of factors to extract is not a straightforward task since the decision is ultimately subjective. There are several criteria for the number of factors to be extracted, but these are just empirical guidelines rather than an exact quantitative solution. Some of the most commonly used guidelines are the Kaiser-Guttman rule, percentage of variance, the scree test, size of the residuals, and interpretability. In this study, the Kaiser-Guttman rule guideline will be used and the number of factors that should be extracted can be based on eigenvalues.

Kaiser-Guttman rule means eigenvalues greater than one rule, which has been most commonly used due to its simple nature and availability in various computer packages. It states that the number of factors to be extracted should be equal to the number of factors having an eigenvalue (variance) greater than 1.0. The eigenvalue represents the total variance explained by each factor. The rationale for choosing this particular value is that a factor must have variance at least as large as that of a single standardized original variable. Kometa and Olomolaiya (1997) stated that factors with eigenvalues of less than one are not selected because an eigenvalue is a measure of standardized variance with a average of zero and standard deviation of one. The variance that each standard variable contributes to the principle components extraction is one; a component with an eigenvalue of less than one is less important than an observed variable and can therefore be ignored. The following Table 22 and Table 23 are part of the results of principal components analysis.

Table 22 Communalities

	Initial	Extraction
Legal entity status and business profile	1.000	.526
Contractors financial capacity	1.000	.645
Construction capacity	1.000	.764
Construction experience	1.000	.440
management capability	1.000	.703
Plant and equipment	1.000	.456
Key personnel of project team proposed	1.000	.732
Past performance and reputation	1.000	.685
Safety performance	1.000	.761
Public relationship	1.000	.740
Litigation history	1.000	.787

Communality is the amount of variance a variable shares with all the other variables being considered. This is also the proportion of variance explained by the common factors.

Table 23 Initial Eigenvalues Values

Component	Initial Eigenvalues		
	Eigenvalues	% of Variance	Cumulative % of Variance
1	2.467	22.429	22.429
2	2.051	18.650	41.079
3	1.514	13.763	54.841
4	1.207	10.969	65.810
5	.991	9.005	74.815
6	.749	6.805	81.620
7	.565	5.135	86.755
8	.460	4.183	90.938
9	.407	3.697	94.636
10	.316	2.868	97.504
11	.275	2.496	100.000

Extraction Method: Principal Component Analysis.

Based on the results shown above, four factors were extracted from the analysis based on their eigenvalue being greater than one.

Step 5 Create factor matrix

A factor matrix contains the factor loadings of all the variables on all the factors extracted. Factor loadings are simple correlations between the variables and the factors. After defining the four factors, the coefficients that relate the variables to the four factors were calculated and shown in Table 24. These coefficients are factor loadings, which indicate how much weight is assigned to each factor.

The relation between factors and variables can be represented as the following equation.

$$X_i = b_{i1}F_1 + b_{i2}F_2 + b_{i3}F_3 + \dots + b_{im}F_m \quad (11)$$

Where,

X_i = i th variable

b_{ij} = Multiple regression coefficient of variable i factor j

F = Factor from extraction

m = Number of factors

Table 24 Initial Factor Matrix (Unrotated Factor Matrix)

	Factor			
	1	2	3	4
Legal entity status and business profile	.360	-.251	.469	.337
Financial capacity	.314	.526	-.156	.496
Construction capacity	.573	-.058	.647	.117
Construction experience	.358	.529	.027	.176
Management capability	.487	.320	.535	-.279
Plant and equipment	.440	.081	-.335	-.379
Key personnel of project team proposed	.585	.123	-.183	-.583
Past performance and reputation	.552	.532	-.309	.035
Safety performance	.431	-.728	.142	-.160
Public relationship	.468	-.610	-.378	.080
Litigation history	.547	-.345	-.401	.455

Extraction Method: Principal Component Analysis.

Step 6 Rotation of factors

Although the initial or un-rotated factor matrix indicates the relationship between the factors and individual variables, it seldom results in factors that can be interpreted, because the factors are correlated with many variables. Therefore, through rotation the factor matrix is transformed into a simpler one that is easier to interpret. (Norusis, 1994)

In rotating the factors, we would like each factor to have nonzero, or significant, loadings or coefficients for only some of the variables. Likewise, we would like each variable to have nonzero or significant loadings with only a few factors, if possible with only one.

There are two types of rotation. One is called orthogonal rotation if the axes are maintained at right angles. Orthogonal rotation results in factors that are uncorrelated. Another is called oblique rotation when the axes are not maintained at right angles, and the factors are correlated. Therefore, orthogonal rotation is used for analysis in this study. The most commonly used method for orthogonal rotation is the varimax procedure, which minimizes the number of variables with high loadings on a factor, thereby enhancing the interpretability of the factors.

After varimax orthogonal rotation, the new factor-loadings are shown on Table 25, which is easier to interpret psychologically.

Based on the rotated factor matrix, the major criteria could be rearranged according to the factor loadings. Those factor loadings more than 0.5 or less than -0.5 shall be put together. A new rotated factor matrix after rearranged is shown in Table 26.

Step 7 Interpretation of factors

After rotation step, the obtained factor loadings in the factor matrix are grouped based on value of loadings. The variables with relative high loadings are examined as the same groups.

When the variables are grouped in the each factor, the interpretation of these factors is concerned in similar or relation between variables into those groups.

A factor can then be interpreted in terms of the variables that load high on it. Group 1 can be regarded as “corporate credibility of contractor”; Group 2 can be regarded as “reliability of contractor”; Group 3 can be regarded as “technical competency of contractor”; Group 4 may be called as “resources of contractor”.

Table 25 Rotated Factor Matrix

	Component			
	1	2	3	4
Legal entity status and business profile	.247	.019	.645	-.219
Financial capacity	.085	.795	.036	-.071
Construction capacity	.058	.093	.866	.050
Construction experience	-.106	.613	.179	.147
Management capability	-.326	.166	.644	.393
Plant and equipment	.166	.099	-.076	.643
Key personnel of project team proposed	.058	.049	.105	.845
Past performance and reputation	.085	.685	-.002	.457
Safety performance	.539	-.497	.423	.212
Public relationship	.817	-.164	.030	.212
Litigation history	.846	.259	.062	.020

(Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization)

Summary of Results of Factor Analysis

Factor analysis was done to find interrelationship of the criteria and to the basis of grouping the major qualification criteria into principal qualifying criteria. 4 factors were extracted (with eigenvalue more than one). As per the result of factor loading after varimax-rotation, the variables were grouped into the following Table 27.

Table 26 Rotated Factor Matrix (After Rearranged)

	Factor			
	1	2	3	4
Litigation history	0.846	0.259	0.062	0.02
Public relationship	0.817	-0.164	0.03	0.212
Safety performance	0.539	-0.497	0.423	0.212
Financial capacity	0.085	0.795	0.036	-0.071
Past performance and reputation	0.085	0.685	-0.002	0.457
Construction experience	-0.106	0.613	0.179	0.147
Construction capacity	0.058	0.093	0.866	0.05
Legal entity status and business profile	0.247	0.019	0.645	-0.219
Management capability	-0.326	0.166	0.644	0.393
Key personnel of project team proposed	0.058	0.049	0.105	0.845
Plant and equipment	0.166	0.099	-0.076	0.643

Table 27 Four Grouped Prequalification Factors

Major factors	Prequalification Criteria
Corporate credibility	Litigation history
	Public relationship
	Safety performance
Reliability (track record)	Financial capacity
	Past performance and reputation
	Construction experience
Technical competency	Construction capacity
	Legal entity status and business profile
	Management capability
Resources	Key personnel of project team proposed
	Plant and equipment

Prioritized List of Prequalification Criteria and Sub-criteria

Based on the overall importance of prequalification criteria and sub-criteria as perceived by the owner and the contractor together, a prioritized list of prequalification criteria and sub-criteria was developed as the guideline of roadway construction works prequalification.

The prioritized list of prequalification criteria and sub-criteria is shown in Table 28.

Table 28 Prioritized List of Prequalification Criteria and Sub-criteria

Rank	Prequalification Criteria and Sub-criteria		Overall Average
1		Legal entity status and company profile	4.57
	1	Legal status of company	4.65
	2	Qualification grade	4.61
	3	Scope of construction	4.12
	4	Type of ownership	3.99
	5	Number of years in construction	3.95
	6	Size of organization	3.55
	7	Subsidiaries and associated companies	3.34
	8	Membership of trade/specialist associations	3.30
	9	Head office location	3.27
	10	Associated trade organizations	3.20
2		Construction experience	4.54
	1	No. of similar construction experience	4.73
	2	National or local construction experience	4.50
	3	Experience on project specific matters	4.27
	4	Success of previous work	3.89
	5	Size of projects completed	3.78
	6	Type of projects completed	3.77
3		Management capability	4.54
	1	Experience of key personnel	4.50
	2	Qualification of key personnel	4.46
	3	Quality management & assurance system	4.46
	4	Certified by ISO	4.34
	5	Schedule management system	4.32
	6	Qualification of company owners	4.31

Table 28 (Cont'd)

Rank	Prequalification Criteria and Sub-criteria	Overall Average
3	Management capability	4.54
7	Subcontractor management system	4.26
8	Percentage of self performed work	4.26
9	Implementation of ISO system	4.18
10	Implementation of total quality control system	3.97
11	Stability of key personnel and staffing	3.95
12	Company organizational structure	3.93
13	Adequacy of professional personnel	3.93
14	Percentage of sub-contracted work	3.86
15	Project control procedures	3.84
16	Adequacy of skilled technician & labor	3.77
17	Routine training program	3.72
18	Co-operation with other project contractors	3.69
4	Financial capacity	4.47
1	Working capital	4.64
2	Average annual construction turnover	4.55
3	The available loan credit	4.41
4	Financial bidding capacity	4.22
5	Magnitude of capital base	4.20
6	Bank's rating of contractor as a customer	4.16
7	Ratio analysis	4.15
8	Bank references	4.03
9	Financial statement	4.00
10	Bonding capacity	3.85
11	Trade creditor references	3.81

Table 28 (Cont'd)

Rank	Prequalification Criteria and Sub-criteria		Overall Average
5		Construction capacity	4.46
	1	Average construction turnover	4.42
	2	Volume of uncompleted work-on-hand	4.24
	3	Current work load	4.16
	4	Bid backlog	3.74
6		Key personnel of project team proposed	4.43
	1	Level of qualification of project manager	4.69
	2	Past experience of key personnel on similar projects	4.47
	3	Education of key personnel	4.30
	4	Appropriateness of project organization chart	4.12
	5	No. of working years for that position	4.05
	6	Language and regional experience	3.55
7		Past performance and reputation	4.42
	1	Honor titles earned by the contractor	4.62
	2	Quality assessment track record of projects completed	4.61
	3	Number of failure to complete contract	4.30
	4	Cost overrun track record of projects completed	4.12
	5	Schedule track record of projects completed	4.09
	6	Attitude towards correcting faulty or incomplete works	3.95
	7	Compliance with specifications and quality standards	3.86
8		Plant and equipment	4.15
	1	Ownership of equipment	4.57
	2	Availability, sufficiency and adequacy	4.47
	3	Experience in operating	4.15
	4	Age and operating condition	4.11

Table 28 (Cont'd)

Rank	Prequalification Criteria and Sub-criteria	Overall Average
8	Plant and equipment	4.15
	5 Procurement characteristics (own/lease)	4.09
	6 Maintenance program	4.03
9	Safety performance	4.07
	1 Safety records	4.54
	2 Safety management system	4.43
	3 Management accountability	4.09
	4 Compliance with on-site safety regulations	3.96
	5 Safety tool provision	3.91
10	Litigation history	3.73
	1 No. of arbitrations and litigations with clients	4.32
	2 Causes of arbitration/litigation	4.20
	3 Results and current status	4.08
	4 No. of litigations with sub-contractor and/labor	3.86
	5 No. of disputes in the past years	3.85
	6 Debarment and fraudulent activity	3.81
11	Public relationship	3.38
	1 Relationship with government agency	4.34
	2 Relationship with client	4.07
	3 Relationship with supplier	4.03
	4 Relationship with labor	3.84
	5 Relationship with design & consulting firm	3.80
	6 Relationship with sub-contractor	3.68

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

This study has surveyed the current practices of contractor prequalification in Tianjin Roadway Administration Bureau, China, which is responsible for the whole roadway construction works in Tianjin, China.

The two main objectives of this study, as stated in chapter one, were to determine a list of prequalification criteria in selecting contractors in Tianjin Roadway Administration Bureau, China and evaluate their relative importance; and to investigate the different opinions of the relative importance and applicability of these criteria between public client and contractor.

The research objectives were achieved through the following process. A list of possible criteria and sub-criteria for contractor prequalification used in Tianjin Roadway Administration Bureau was developed through an extensive literature review. The list covered 11 groups of major criteria and 86 sub-criteria. An opinion survey was conducted through interviews and questionnaire to obtain insights of the owner and the contractor regarding the importance and applicability of these criteria and sub-criteria. Viewpoints of both groups were incorporated to derive a comprehensive prioritized list of group of criteria and sub-criteria to be considered in contractor prequalification.

The results revealed that both the owner and the contractor perceived the same 4 of 5 most important decision parameters in contractor prequalification. It was legal entity status and business profile, construction experience, management capability and financial capability. However, the hypothesis testing showed that there are significant differences of point of views towards plant and equipment criteria and key personnel of project team proposed criteria.

Besides, both groups gave priority on the following 8 sub-criteria as to be among the most important 10-decision parameter under their individual assessment. The same 8 sub-criteria were as below:

- (1) Working capital;
- (2) Level of qualification of project manager;
- (3) Honor titles earned by the contractor;
- (4) Legal status of company;
- (5) No. of similar construction experience;
- (6) Qualification grade;
- (7) Size of company;
- (8) Ownership of equipment.

The results also revealed that the owner and the contractor have the same opinion on the sub-criteria selection for contractor prequalification, except with 5 criteria (qualification of company owners, No of years worked for that position, management accountability, relationship with supplier and No. of arbitrations and litigations with clients).

Suggestions

Based on the finding of the survey, legal entity status and business profile, construction experience, management capability, financial capability and construction capacity are recommended as standards for contractor prequalification in roadway construction works, China. The contractor could be evaluated based on the major criteria and sub-criteria within each of these criteria as listed in Table 29. Each roadway administration bureau could practice the criteria recommended for contractor prequalification.

Table 29 Standard Criteria and Sub-criteria for Contractor Prequalification of Roadway
Construction Works

Rank	Prequalification Criteria and Sub-criteria
1	Legal entity status and company profile
	Legal status of company
	Qualification grade
	Scope of construction
	Type of ownership
	Number of years in construction
2	Construction experience
	No. of similar construction experience
	National or local construction experience
	Experience on project specific matters
	Success of previous work
	Size of projects completed
	Type of projects completed
3	Management capability
	Experience of key personnel
	Qualification of key personnel
	Quality management & assurance system
	Certified by ISO
	Schedule management system
	Qualification of company owners
	Subcontractor management system
	Percentage of self performed work
4	Financial capacity
	Working capital
	Average annual construction turnover

Table 29 (Cont'd)

Rank	Prequalification Criteria and Sub-criteria
4	Financial capacity
	The available loan credit
	Financial bidding capacity
	Magnitude of capital base
	Bank's rating of contractor as a customer
	Ratio analysis
5	Construction capacity
	Size of company
	Average construction turnover
	Volume of uncompleted work-on-hand
	Current work load

Recommendation for Further Study

This study focused on contractor prequalification used in roadway construction works in Tianjin, China. A further study on bid evaluation considering the viewpoints of the owner departments and contractors will help design of procurement system as a whole to be considered in the roadway construction works.

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APPENDIX

APPENDIX A

Questionnaire survey of public owner

Part 1: General Information

1. Respondent name _____ position _____
2. Name & address of the department/organization: _____

3. Number of years with the department: _____ years
4. Number of years of working in construction field: _____ years
5. Job responsibility

<input type="checkbox"/> General management	<input type="checkbox"/> Site management
<input type="checkbox"/> Project management	<input type="checkbox"/> Contract administration
<input type="checkbox"/> Procurement management	<input type="checkbox"/> Account & administration
<input type="checkbox"/> Head office engineer	<input type="checkbox"/> Project coordination
<input type="checkbox"/> Site engineer	<input type="checkbox"/> Other

Part 2: Type of Tendering Practice

6. What type of tendering practice does your organization generally perform for contractor selection?

<input type="checkbox"/>	Open tendering
<input type="checkbox"/>	Negotiated tendering
<input type="checkbox"/>	Others: _____

7. Does your organization have a formal prequalification system?

Yes

No

8. If yes, what form of prequalification is in use in your organization?

Prequalification

Postqualification

Part 3: Qualification System

In contractor qualification evaluation, each contractor will be assessed based on various criteria. The following factors or criteria deal with prequalifying a contractor. Based on your knowledge and experience, please give your opinion about the level of impact of the following criteria by tick on the number. If you think any criteria should be included into the predetermined list, please kindly specify.

A1 Major Criteria Survey of Public Owner

Prequalification Criteria	Level of Impact				
	Very High	High	Moderate	Low	Very Low
Legal entity status/General information	5	4	3	2	1
Construction experience	5	4	3	2	1
Financial capacity/ stability	5	4	3	2	1
Construction capability (contractor's ability to perform sizable project)	5	4	3	2	1
Safety performance	5	4	3	2	1
Management capability (contractor's ability to manage and control project)	5	4	3	2	1
Plant and equipment resources	5	4	3	2	1
Key personnel of proposed project team	5	4	3	2	1

A1 (Cont'd)

Prequalification Criteria	Level of Impact				
	Very High	High	Moderate	Low	Very Low
Past performance and reputation	5	4	3	2	1
Public relationship	5	4	3	2	1
Litigation history	5	4	3	2	1
Other: _____	5	4	3	2	1
Other: _____	5	4	3	2	1
Other: _____	5	4	3	2	1

A2 Sub-Criteria Survey of Public Owner

Sub-criteria		Level of Impact				
		Very High	High	Moderate	Low	Very Low
Legal entity status/General information						
1	Legal status of company	5	4	3	2	1
2	Type of ownership	5	4	3	2	1
3	Subsidiaries and associated companies	5	4	3	2	1
4	Number of years in construction	5	4	3	2	1
5	Qualification grade	5	4	3	2	1
6	Scope of Construction	5	4	3	2	1
7	Size of organization	5	4	3	2	1
8	Associated trade organizations	5	4	3	2	1
9	Head office location	5	4	3	2	1
10	Membership of trade/specialist associations	5	4	3	2	1
11	Other: _____	5	4	3	2	1

A2 (Cont'd)

Sub-criteria		Level of Impact				
		Very High	High	Moderate	Low	Very Low
Financial capability						
12	Ratio analysis	5	4	3	2	1
13	Working Capital	5	4	3	2	1
14	Magnitude of capital base	5	4	3	2	1
15	Financial statement	5	4	3	2	1
16	Average Annual Construction Turnover	5	4	3	2	1
17	Financial bidding capacity	5	4	3	2	1
18	The available loan credit	5	4	3	2	1
19	Bank's rating of contractor as a customer	5	4	3	2	1
20	Bonding capacity	5	4	3	2	1
21	Trade creditor references	5	4	3	2	1
22	Bank references	5	4	3	2	1
23	Other: _____	5	4	3	2	1
Construction capability						
24	Size of company	5	4	3	2	1
25	Average construction turnover	5	4	3	2	1
26	Current work load	5	4	3	2	1
27	Volume of uncompleted work-on-hand	5	4	3	2	1
28	Bid backlog	5	4	3	2	1
29	Other: _____	5	4	3	2	1
Construction experience						
30	No. of Similar Construction Experience	5	4	3	2	1
31	National or Local construction experience	5	4	3	2	1
32	Success of previous work	5	4	3	2	1

A2 (Cont'd)

Sub-criteria		Level of Impact				
		Very High	High	Moderate	Low	Very Low
Construction experience						
33	Experience on project specific matters	5	4	3	2	1
34	Type of projects completed	5	4	3	2	1
35	Size of projects completed	5	4	3	2	1
36	Other: _____	5	4	3	2	1
Management capability						
37	Company organizational structure	5	4	3	2	1
38	Qualification of company owners	5	4	3	2	1
39	Qualification of key personnel	5	4	3	2	1
40	Adequacy of professional personnel	5	4	3	2	1
41	Stability of key personnel and staffing	5	4	3	2	1
42	Experience of key personnel	5	4	3	2	1
43	Adequacy of skilled technician & labor	5	4	3	2	1
44	Quality management & assurance system	5	4	3	2	1
45	Schedule management system	5	4	3	2	1
46	Project control procedures	5	4	3	2	1
47	Co-operation with other project contractors	5	4	3	2	1
48	Subcontractor management system	5	4	3	2	1
49	Percentage of self performed work	5	4	3	2	1
50	Percentage of sub-contracted work	5	4	3	2	1
51	Implementation of total quality control system	5	4	3	2	1
52	Implementation of ISO system	5	4	3	2	1
53	Certified by ISO	5	4	3	2	1

A2 (Cont'd)

Sub-criteria		Level of Impact				
		Very High	High	Moderate	Low	Very Low
Management capability						
54	Routine training program	5	4	3	2	1
55	Other: _____	5	4	3	2	1
Plant and equipment resources						
56	Ownership of equipment	5	4	3	2	1
57	Availability, sufficiency and adequacy	5	4	3	2	1
58	Age and operating condition	5	4	3	2	1
59	Maintenance program	5	4	3	2	1
60	Experience in operating	5	4	3	2	1
61	Procurement characteristics (own/lease)	5	4	3	2	1
62	Other: _____	5	4	3	2	1
Key personnel of proposed project team						
63	Level of qualification of project manager	5	4	3	2	1
64	Education of key personnel	5	4	3	2	1
65	No. of working years for that position	5	4	3	2	1
66	Past experience of key personnel on similar projects	5	4	3	2	1
67	Appropriateness of project organization chart	5	4	3	2	1
68	Language and regional experience	5	4	3	2	1
69	Other: _____	5	4	3	2	1
Past performance and reputation						
70	Honor titles earned by the contractor	5	4	3	2	1

A2 (Cont'd)

Sub-criteria		Level of Impact				
		Very High	High	Moderate	Low	Very Low
Past performance and reputation						
71	Quality assessment track record of projects completed	5	4	3	2	1
72	Number of failure to complete contract	5	4	3	2	1
73	Compliance with specifications and quality standards	5	4	3	2	1
74	Attitude towards correcting faulty or incomplete works	5	4	3	2	1
75	Schedule Track record of projects completed	5	4	3	2	1
76	Cost overrun track record of projects completed	5	4	3	2	1
77	Other: _____	5	4	3	2	1
Safety performance						
78	Safety records	5	4	3	2	1
79	Safety management system	5	4	3	2	1
80	Compliance with on-site safety regulations	5	4	3	2	1
81	Safety tool provision	5	4	3	2	1
82	Management accountability	5	4	3	2	1
83	Other: _____	5	4	3	2	1
Public relationship						
84	Relationship with client	5	4	3	2	1
85	Relationship with sub-contractor	5	4	3	2	1
86	Relationship with supplier	5	4	3	2	1

A2 (Cont'd)

Sub-criteria		Level of Impact				
		Very High	High	Moderate	Low	Very Low
Public relationship						
87	Relationship with labor	5	4	3	2	1
88	Relationship with government agency	5	4	3	2	1
89	Relationship with design & consulting firm	5	4	3	2	1
90	Other: _____	5	4	3	2	1
Litigation history						
91	No. of arbitrations and litigations with clients	5	4	3	2	1
92	No. of litigations with sub-contractor and/labor	5	4	3	2	1
93	Causes of arbitration/litigation	5	4	3	2	1
94	No. of disputes in the past years	5	4	3	2	1
95	Results and current status	5	4	3	2	1
96	Debarment and fraudulent activity	5	4	3	2	1
97	Other: _____	5	4	3	2	1

APPENDIX B

Questionnaire Survey of Contractor

Part 1: General Information

1. Respondent name _____ position _____

2. Name & address of the company: _____

3. Number of years with the company: _____ years

4. Number of years of working in construction field: _____ years

5. Job responsibility

- | | |
|---|---|
| <input type="checkbox"/> General management | <input type="checkbox"/> Site management |
| <input type="checkbox"/> Project management | <input type="checkbox"/> Contract administration |
| <input type="checkbox"/> Procurement management | <input type="checkbox"/> Account & administration |
| <input type="checkbox"/> Head office engineer | <input type="checkbox"/> Project coordination |
| <input type="checkbox"/> Site engineer | <input type="checkbox"/> Other: _____ |

Part 2: Attitude to Prequalification Method Adapted by Tianjin Roadway Administration Bureau (TRAB)

6. Are you familiar with the prequalification method adapted by TRAB?

Yes
 No

7. Do you think that the prequalification method adapted by TRAB is fair?

Yes

No

If no, please list the reasons:

The criteria used in contractor prequalification are not perfect.

The prequalification evaluation method is not perfect.

The prequalification process is not perfect.

Other: _____

8. Do you think the existing criteria are sufficient for prequalifying contractor?

Yes

No

If no, please list the criteria you think important to be included in the prequalification evaluation: _____

9. Do you have any comments related to the prequalification practice that you want to add?

Part 3: Qualification System

In contractor qualification evaluation, each contractor will be assessed based on various criteria. The following factors or criteria deal with prequalifying a contractor. Based on your knowledge and experience, please give your opinion about the level of impact of the following criteria by tick on the number. If you think any criteria should be included into the predetermined list, please kindly specify.

A3 Major Criteria Survey of Contractor

Prequalification Criteria	Level of Impact				
	Very High	High	Moderate	Low	Very Low
Legal entity status/General information	5	4	3	2	1
Construction experience	5	4	3	2	1
Financial capacity/ stability	5	4	3	2	1
Construction capability (contractor's ability to perform sizable project)	5	4	3	2	1
Safety performance	5	4	3	2	1
Management capability (contractor's ability to manage and control project)	5	4	3	2	1
Plant and equipment resources	5	4	3	2	1
Key personnel of proposed project team	5	4	3	2	1
Past performance and reputation	5	4	3	2	1
Public relationship	5	4	3	2	1
Litigation history	5	4	3	2	1
Other: _____	5	4	3	2	1
Other: _____	5	4	3	2	1
Other: _____	5	4	3	2	1

A4 Sub-Criteria Survey of Contractor

Sub-criteria	Level of Impact				
	Very High	High	Moderate	Low	Very Low
Legal entity status/General information					
1 Legal status of company	5	4	3	2	1
2 Type of ownership	5	4	3	2	1

A4 (Cont'd)

Sub-criteria		Level of Impact				
		Very High	High	Moderate	Low	Very Low
Legal entity status/General information						
3	Subsidiaries and associated companies	5	4	3	2	1
4	Number of years in construction	5	4	3	2	1
5	Qualification grade	5	4	3	2	1
6	Scope of Construction	5	4	3	2	1
7	Size of organization	5	4	3	2	1
8	Associated trade organizations	5	4	3	2	1
9	Head office location	5	4	3	2	1
10	Membership of trade/specialist associations	5	4	3	2	1
11	Other: _____	5	4	3	2	1
Financial capability						
12	Ratio analysis	5	4	3	2	1
13	Working Capital	5	4	3	2	1
14	Magnitude of capital base	5	4	3	2	1
15	Financial statement	5	4	3	2	1
16	Average Annual Construction Turnover	5	4	3	2	1
17	Financial bidding capacity	5	4	3	2	1
18	The available loan credit	5	4	3	2	1
19	Bank's rating of contractor as a customer	5	4	3	2	1
20	Bonding capacity	5	4	3	2	1
21	Trade creditor references	5	4	3	2	1
22	Bank references	5	4	3	2	1
23	Other: _____	5	4	3	2	1

A4 (Cont'd)

Sub-criteria		Level of Impact				
		Very High	High	Moderate	Low	Very Low
Construction capability						
24	Size of company	5	4	3	2	1
25	Average construction turnover	5	4	3	2	1
26	Current work load	5	4	3	2	1
27	Volume of uncompleted work-on-hand	5	4	3	2	1
28	Bid backlog	5	4	3	2	1
29	Other: _____	5	4	3	2	1
Construction experience						
30	No. of Similar Construction Experience	5	4	3	2	1
31	National or Local construction experience	5	4	3	2	1
32	Success of previous work	5	4	3	2	1
33	Experience on project specific matters	5	4	3	2	1
34	Type of projects completed	5	4	3	2	1
35	Size of projects completed	5	4	3	2	1
36	Other: _____	5	4	3	2	1
Management capability						
37	Company organizational structure	5	4	3	2	1
38	Qualification of company owners	5	4	3	2	1
39	Qualification of key personnel	5	4	3	2	1
40	Adequacy of professional personnel	5	4	3	2	1
41	Stability of key personnel and staffing	5	4	3	2	1
42	Experience of key personnel	5	4	3	2	1
43	Adequacy of skilled technician & labor	5	4	3	2	1
44	Quality management & assurance system	5	4	3	2	1

A4 (Cont'd)

Sub-criteria		Level of Impact				
		Very High	High	Moderate	Low	Very Low
Management capability						
45	Schedule management system	5	4	3	2	1
46	Project control procedures	5	4	3	2	1
47	Co-operation with other project contractors	5	4	3	2	1
48	Subcontractor management system	5	4	3	2	1
49	Percentage of self performed work	5	4	3	2	1
50	Percentage of sub-contracted work	5	4	3	2	1
51	Implementation of total quality control system	5	4	3	2	1
52	Implementation of ISO system	5	4	3	2	1
53	Certified by ISO	5	4	3	2	1
54	Routine training program	5	4	3	2	1
55	Other: _____	5	4	3	2	1
Plant and equipment resources						
56	Ownership of equipment	5	4	3	2	1
57	Availability, sufficiency and adequacy	5	4	3	2	1
58	Age and operating condition	5	4	3	2	1
59	Maintenance program	5	4	3	2	1
60	Experience in operating	5	4	3	2	1
61	Procurement characteristics (own/lease)	5	4	3	2	1
62	Other: _____	5	4	3	2	1
Key personnel of proposed project team						
63	Level of qualification of project manager	5	4	3	2	1
64	Education of key personnel	5	4	3	2	1

A4 (Cont'd)

Sub-criteria		Level of Impact				
		Very High	High	Moderate	Low	Very Low
Key personnel of proposed project team						
65	No. of working years for that position	5	4	3	2	1
66	Past experience of key personnel on similar projects	5	4	3	2	1
67	Appropriateness of project organization chart	5	4	3	2	1
68	Language and regional experience	5	4	3	2	1
69	Other: _____	5	4	3	2	1
Past performance and reputation						
70	Honor titles earned by the contractor	5	4	3	2	1
71	Quality assessment track record of projects completed	5	4	3	2	1
72	Number of failure to complete contract	5	4	3	2	1
73	Compliance with specifications and quality standards	5	4	3	2	1
74	Attitude towards correcting faulty or incomplete works	5	4	3	2	1
75	Schedule Track record of projects completed	5	4	3	2	1
76	Cost overrun track record of projects completed	5	4	3	2	1
77	Other: _____	5	4	3	2	1
Safety performance						
78	Safety records	5	4	3	2	1
79	Safety management system	5	4	3	2	1

A4 (Cont'd)

Sub-criteria		Level of Impact				
		Very High	High	Moderate	Low	Very Low
Safety performance						
80	Compliance with on-site safety regulations	5	4	3	2	1
81	Safety tool provision	5	4	3	2	1
82	Management accountability	5	4	3	2	1
83	Other: _____	5	4	3	2	1
Public relationship						
84	Relationship with client	5	4	3	2	1
85	Relationship with sub-contractor	5	4	3	2	1
86	Relationship with supplier	5	4	3	2	1
87	Relationship with labor	5	4	3	2	1
88	Relationship with government agency	5	4	3	2	1
89	Relationship with design & consulting firm	5	4	3	2	1
90	Other: _____	5	4	3	2	1
Litigation history						
91	No. of arbitrations and litigations with clients	5	4	3	2	1
92	No. of litigations with sub-contractor and/labor	5	4	3	2	1
93	Causes of arbitration/litigation	5	4	3	2	1
94	No. of disputes in the past years	5	4	3	2	1
95	Results and current status	5	4	3	2	1
96	Debarment and fraudulent activity	5	4	3	2	1
97	Other: _____	5	4	3	2	1