

## **TOWARDS A CENTRALIZED CONTRACTOR REGISTRATION SYSTEM THROUGH E-REGISTRATION**

**S. Thomas Ng**

Assistant Professor, Dept. of Civil Engineering, The University of Hong Kong, Pokulam Road, Hong Kong

**Mohan M. Kumaraswamy**

Associate Professor, Dept. of Civil Engineering, The University of Hong Kong, Pokulam Road, Hong Kong

**Ekambaram Palaneeswaran**

Senior Research Assistant, Dept. of Civil Engineering, The University of Hong Kong, Pokulam Road, Hong Kong

### **ABSTRACT**

Several influential industry reports have recommended the development of a centralized contractor registration (CCR) system to replace many current idiosyncratic contractor prequalification and performance reporting practices. Despite that, a CCR system for multi-stakeholders environment is still to be realized. A major barrier is that such a CCR system must be relatively easy to access to ensure that contractors' information is constantly updated (by contractors) for evaluation, and the latest analyzed information is available to authorized clients anytime anywhere. Being a powerful information exchange tool, the World Wide Web (when combined with available analytical tools) has a high potential for satisfying the above requirements. This paper aims to identify how a CCR system can be established using such web-based techniques. The conceptual framework of the proposed e-Registration system is developed and presented, and the functionality of each component is explained.

### **KEYWORDS**

Contractor Prequalification, Internet, Procurement, Registration, World Wide Web

### **1. INTRODUCTION**

The selection of contractors has been described as "an art where subjective judgment, based on an individual's experience, becomes an essential part of the process" (Russell and Skibniewski, 1988a:148). The information required by a number of decision criteria is qualitative in nature (Russell and Skibniewski, 1988b). The methods used to assess the qualitative information require a predictive judgment by the experts (Nguyen, 1985), while there is a considerable variation in approaches to evaluating contractor information (Hatush and Skitmore, 1997a).

Previous research has been focused on methods for reducing the subjectivity of the contractor assessment. Nguyen (1985) proposed the application of fuzzy set theory to representing the importance of pre-selection criteria. Russell and Skibniewski (1988b) suggested a knowledge acquisition strategy for collecting domain knowledge. The knowledge elicited was used to construct (i) a linear model (Russell and Skibniewski, 1990a), and (ii) a knowledge-based expert system (Russell and Skibniewski, 1990b). Russell and Ahmed (1989) suggested the application of the Programme Evaluation Review Technique (PERT) approach to contractor selection. Holt et al (1994) proposed a three-stage pre-selection and tender evaluation process based on multi-attribute analysis. Hatush and Skitmore (1997b) have also shown how utility theory can be applied to contractor pre-selection.

These research efforts have not had a significant influence on the current practice of contractor selection, as many clients continue to use their own idiosyncratic contractor selection systems (Holt et al, 1994). The selection of tenderers still relies heavily on the use of value judgments by the decision-makers (Lester, 1989) with the experience of decision-makers varying from one organization to another (Holt et al, 1995).

The methods of evaluating contractors' capabilities are unreliable and may result in the selection of an incompetent contractor or inhibit the selection of a competent contractor (Drew and Skitmore, 1992). Excessive subjectivity in bid evaluation may also give rise to corruption and other abuses of privileges. What is needed is a more rational, informed and systematic approach to contractor selection (Hatush and Skitmore, 1997a; Holt et al, 1993).

Over the years, several major reports in the UK (Emmerson, 1962; the Ministry of Building and Works, 1964; Latham, 1994), USA (Business Roundtable, 1982), and Australia (NPWC/NBCC, 1990) have pointed out that an improvement of contractor selection practices is needed. A recent survey found contractors to be in favor of a transparent process in which the selection criteria, together with any associated scoring mechanism is made available to contractors (Holt et al, 1996).

Latham (1994) urges for a centralized contractor registration (CCR) system. The introduction of the Contractor Management Information System (CMIS) by the Department of Environment in the UK (DOE, 1992) could be an initial step towards rationalization. However, there has been no detailed research as to how the CMIS can be applied to other public and private clients. In addition, the CMIS only deals with performance of contractors on some public sector projects. There is a need to acquire information concerning contractors' capabilities and performance from other sources, such as other public and private projects. However, the time and effort involved in collecting and analyzing this information would be tremendous, and it would be virtually impossible to identify and obtain adequate responses from all the project teams involved in other projects.

## **2. A WEB-BASED APPROACH**

A CCR system should be relatively easy to access to ensure that (i) contractor's information is constantly updated (by contractors), (ii) contractor's performance is reported promptly (by project teams and occupiers), and (iii) latest analyzed information is available to the client anytime anywhere.

The web-based technology, being a powerful tool for communicating, will help in devising a CCR system to satisfy the above requirements. Web-based systems have been developed for various selection and decision-making problems, such as architectural design and performance evaluation (Goedicke and Meyer, 1999), procurement path selection (Molenaar and Songer, 1998), investment decisions (Aydogdu and Parikh, 1997) and project information transfer (Anumba and Duke, 1997). Doherty (1998) suggested that the web-based system is a convenient and cost effective tool for gathering, filtering, managing and sharing construction information.

The WWW has also been applied in construction procurement in practice. For instance, the Department of Defense of the United States has devised a Centralized Contractor Registration (CCR) system for obtaining vendors' information and evaluating their capabilities. The CCR system shares encrypted data with various government procurement and e-Business systems, such as the Defense Finance and Accounting Service to facilitate paperless payments through electronic funds transfer. Similarly, NASA developed a suite of e-Procurement tools, such as the electronic posting system, financial and contractual status on-line query system, and virtual procurement office. According to NASA (2001), these e-Procurement tools would ensure that the relevant stakeholders have immediate access to current and complete information to accomplish the procurement function. In Hong Kong, the Housing Authority is developing a web-based contractor registration system for in-house usage. Despite the above organizational initiatives, an industry-wide thrust for the sharing of contractors' performance data is yet to emerge. A centralized web-based CCR (also referred to as e-Registration hereafter) system should be set up.

## **3. FRAMEWORK OF E-REGISTRATION SYSTEM**

To facilitate discussions with the experts in contractor registration, the initial concept was derived based on previous research studies in related area (e.g. Russell and Skibniewski, 1988a, 1990b; Holt et al, 1994; Hatush and Skitmore, 1997b; Ng et al, 1998; Palaneeswaran and Kumaraswamy, 1999, 2001). These research studies help to identify the

problems and issues to be addressed in contractor registration and the major stakeholders involved in the contractor registration, should the process be centrally maintained. Major issues identified include the transparency of evaluations and decision made, fairness in inclusion or rejection, data security and protection, etc.

An initial conceptual framework was derived based on the previous research and the major issues identified. Web-based surveys and discussions were conducted to establish the structure and data requirements of the initial skeleton. To cater for the increasing usage of design and build methods, the system should take into account contractor's design and fast-tracking abilities. These were reflected in the proposed skeleton and prototype system.

The initial conceptual framework was presented to experts for validation and comments. The critique sessions provided useful feedback, for example on issues relating to the responsibilities for vetting and checking the raw data, and on an appeal mechanism. The framework as shown in Figure 1 has already taken into account the consolidated comments of the experts.

As shown in Figure 1, the proposed conceptual framework consists of five components: (i) data entry, (ii) vetting and checking, (iii) assessment, (iv) filtering, and (v) reporting.

### **3.1 Data Entry**

Data entry allows (a) registered contractors and those who are seeking registration to submit data on company's profile; (b) clients and consultants to enter contractor's performance; and (c) owners or occupiers to perform post-occupancy evaluation through the web-based interface. This module also allows contractors, clients and consultants to register as approved users of the system. Contractors have a duty to update their data periodically, or reminders will be dispatched via email once a pre-defined period has lapsed. Firms who do not have access to Internet may submit data manually to the system administrator for processing.

### **3.2 Vetting and Checking**

Vetting and checking aims to ensure the validity of data obtained. A potential problem of any web-based system is that data may be submitted from any sources, and there is a danger that the data may be invalid. The investigators envisage that all raw data obtained shall be vetted by the system administrator, and the vetted data shall then be subjected to further checking by an independent checking panel comprising of representatives from professional institutions, contractor and consultant federations, client groupings, etc. Various organizations and experts will be consulted to establish the best practice for vetting and checking the data.

### **3.3 Assessment**

Assessment evaluates contractor's organizational and performance-related data. According to Ng et al (1998), assessment consists of screening, overall suitability assessment, reviewing, and final assessment stages. Criteria for assessing contractor's data at different stages will be made transparent to the applicants and registered users of the system. Different assessment techniques proposed in previous research studies will be considered in this module. The main outcomes of this module are the results of registration and performance of contractors.

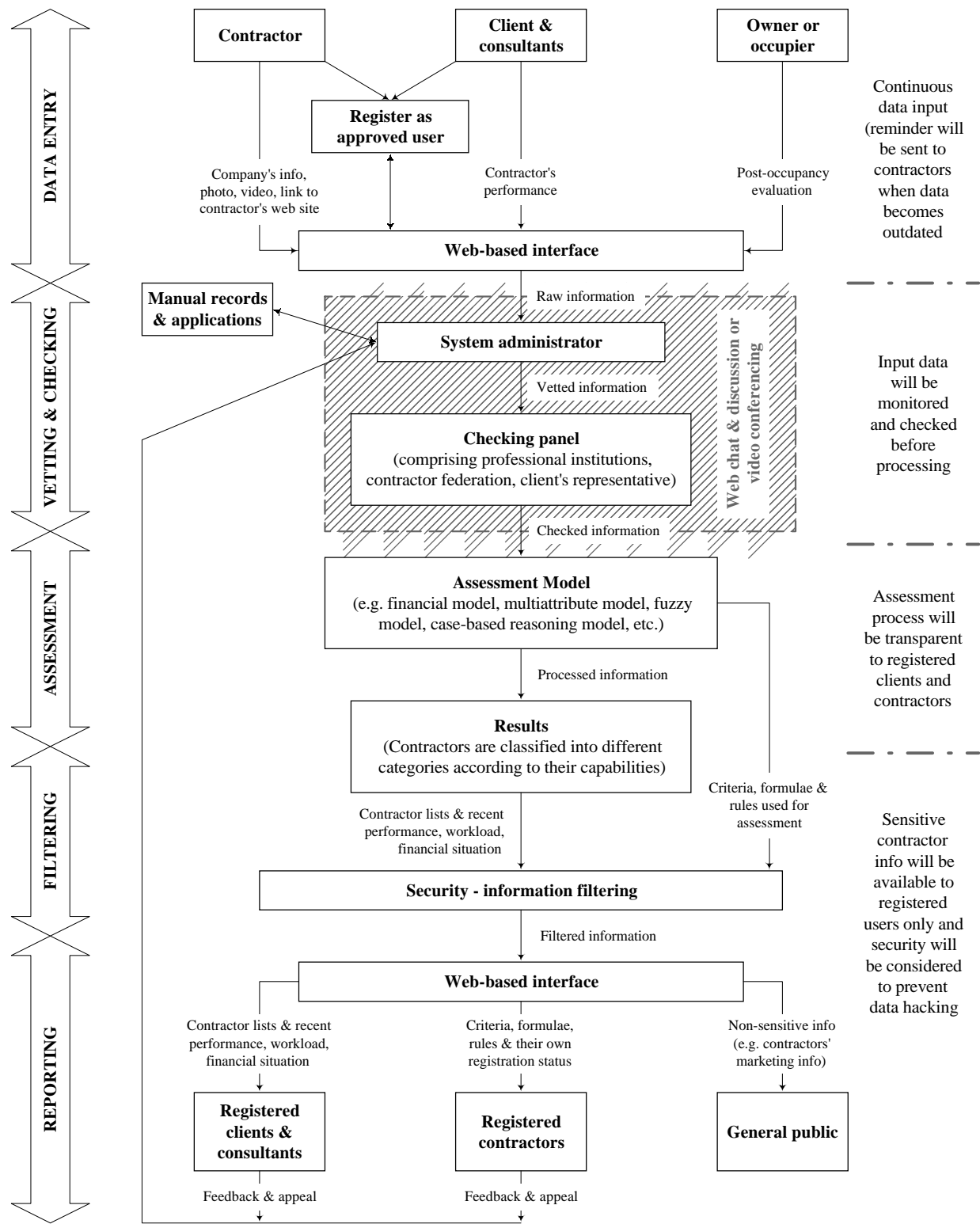
### **3.4 Filtering**

Filtering aims to ensure that sensitive contractor information will not be divulged to unregistered users of the system. The web-based system must have stringent security measures to prevent hackers from accessing sensitive information. Filtering will determine what information is to be made available to the general public and what will be restricted to clients and contractors.

### **3.5 Reporting**

Reporting provides the required information to users via the web-based interface. Information relevant to registered clients and consultants includes contractors' status on the approved list, performance, and current workload and financial situation, etc. Registered contractors will be able to enquire about their current registration status, and also about criteria and rules used for assessment. In addition, a feedback and appeal routine will be provided to registered

clients, consultants and contractors to moderate the results of assessment. Information for general public is likely to be limited to contractors' marketing information only.

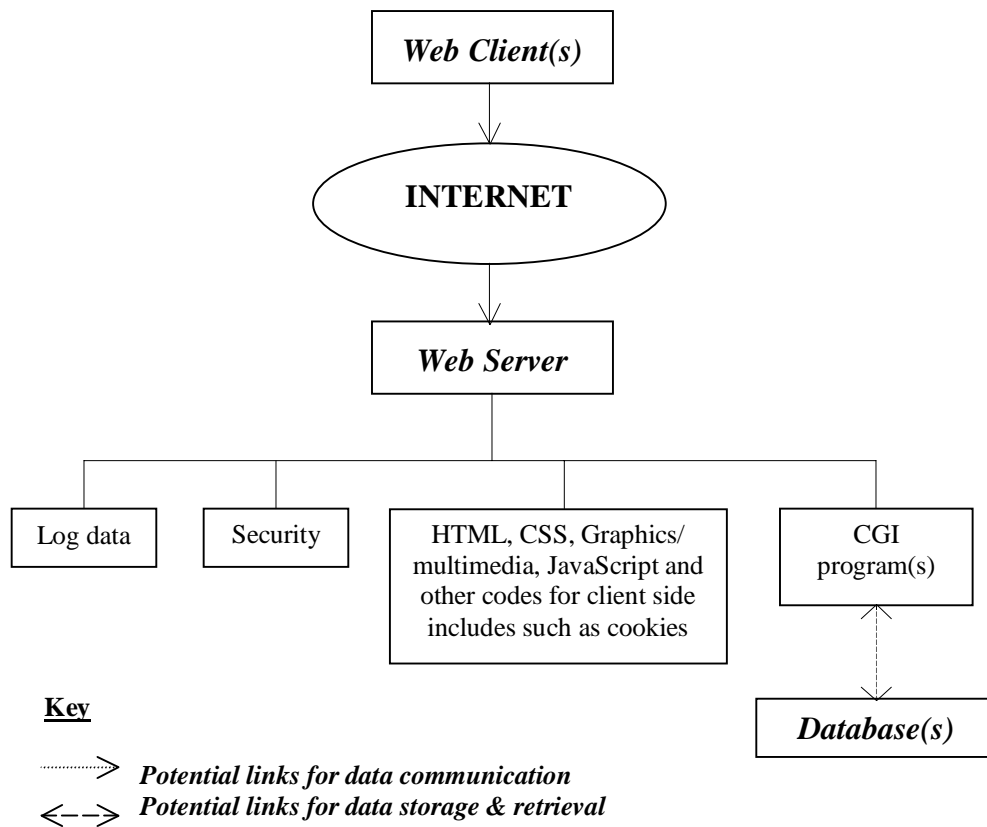


**Figure 1: Conceptual framework of the e-Registration system**

#### 4. POSSIBLE CONSTRAINTS AND POTENTIAL SOLUTIONS

Since the proposed e-Registration system will be made available to different stakeholders in the construction industry, it would be difficult, if not impossible, to restrict the users to a particular hardware or software platform. The system must therefore be flexible enough to allow registered users to upload or download information from a range of web-based interfaces, such as networked personal computers, laptops or PDA, and through various web client browsing software that is capable of handling 'Cookies' and JavaScript, such as Netscape Navigator™ or Microsoft Internet Explorer™.

In view of the above considerations, a freely available (yet highly configurable) web server platform known as "APACHE™ HTTP Personal Server" is proposed for prototype development. In addition, XHTML (i.e. a blend of XML and HTML), Java scripts, Cascading Style Sheets (CSS) and Common Gateway Interface (CGI) scripts using Practical Extraction and Reporting Language (PERL) would be used for programming the client and server side web based transactions in the prototype. In the prototype framework, some data would be accessed from Microsoft Excel™ spreadsheets as Comma Separated Variables (CSV). However, a suitable enterprise level server and database platform (such as Oracle) could be interfaced in the final system for implementation in the industry. The basic architecture of the system with potential data communication and storage/retrieval modalities is summarized in Figure 2.



**Figure 2: Development environments proposed for the e-Registration System**

Another important consideration in designing the e-Registration system relates to the definition of access and functional rights for different entities (users), as not all contractor-related information should be disseminated or made equally accessible to every user. To control the data communication and to prevent unauthorized users from accessing restricted information, a three-level security framework is proposed for the system:

- an open access (i.e. no security) for non-sensitive information, such as reading contractor's basic information or browsing which list(s) a contractor has registered with;

- a simple “PIN and Password” protected filtering arrangement for handling low level confidential information, such as entering contractor project-specific performance evaluations or reading certain semi-confidential reports and publications; and
- a more complex encrypting and decrypting architecture through Public Key Infrastructure (PKI) with public and private keys and electronic signatures for highly secure and non-repudiatory data, such as updating project-specific performance evaluations or feeding-forward information on claims and disputes.

## **5. BENEFITS OF E-REGISTRATION SYSTEM**

The conceptual framework is being developed into a prototype e-Registration system based on the solutions proposed in the previous section. It is envisaged that the e-Registration system, once completed, will be a significant step forward in existing contractor prequalification and registration practice. The most notable benefits of the proposed system are:

- To provide a centralized knowledge-based repository of contractor information, which could be cooperatively shared among different stakeholders, such as clients, architects, engineers, project managers, contractors and/or the general public who may submit or request information from the system.
- To facilitate dynamic and just-in-time contractor selections, so that the latest information is accessed and/or used at any time of enquiry.
- To minimize the number and cost of transactions that would otherwise be duplicated or conducted repeatedly, e.g. for contractor to make multiple submissions of information to different clients or for various clients to assess the same contractor recurrently.
- To enable the stakeholders to share common benefits from lower procurement expenses and better usage of resources (such as procurement staff).
- To enhance the convenience and flexibility for more effective and efficient contractor selections.
- To improve transparency in contractor selections for potentially boosting contractor performance and confidence levels.

## **6. CONCLUSIONS**

Project failures can be minimized if contractor’s capabilities and performance are more carefully considered at the selection stage. An e-Registration system will help rationalize the contractor information obtained and assessment methods adopted, leading to more informed contractor selection decisions. The system will also eliminate duplicated efforts in collecting and assessing contractor details. The saving of billions of dollars, through better judgments at the time of contractor selection, may be achieved.

The e-Registration system will be significant to the construction industry as all relevant stakeholders will be able to review each contractor’s current capabilities, e.g. workloads, financial situation and technical experience, rather than relying on data obtained during the pre-selection stage (which may be out-dated by months to years). Instead, the most up-to-date performance of contractors will be available to the clients and project teams through the web-based system. This concurs with the current trends towards e-procurement, as the centralized contractor registration system will become a screening and quality checking mechanism for e-Procurement.

## **7. ACKNOWLEDGEMENT**

Special thanks go to the anonymous experts who participated in this study for providing the necessary information and validating the initial conceptual framework. The authors would also like to acknowledge the University of Hong Kong for supporting this research through the CRCG grant (No. 10203780).

## **8. REFERENCES**

Anumba, C.J. and Duke, A. (1997). “Internet and intranet usage in a communication infrastructure for virtual construction project teams”, *Journal of Engineering and Applied Science*, Jun 18-20, pp 56-61.

- Aydogdu, E. and Parihk, M.A. (1997). "Web-based interactive multimedia system for investment decision-making", *Proceedings of Annual Meeting of the Decision Sciences Institute*, Nov 22-25, Vol. 2, Decision Science Institute, pp 512.
- Business Roundtable (1982). *Contractual Arrangements*, Report A-7, Construction industry Cost Effectiveness report, The Business Roundtable, New York, pp 19-20.
- DOE (1992). *CMIS – Contractor Management Information System*, The Department of Environment, England.
- Doherty, P. (1998). "Total cost management in Internet age", *Transactions of Annual Meeting of AACE - 1998*, Jun 28 - Jul 1, AACE Inc., pp 6.
- Drew, D.S. and Skitmore, R.M. (1992). "Competitiveness in bidding: a consultant's perspective", *Construction Management and Economics*, Vol. 10, No. 3, pp 227-247.
- Emmerson, H. (1962). *Survey of Problems Before the Construction Industry*, Report Prepared for the Ministry of Works, HMSO.
- Goedicke, M. and Meyer, T. (1999). "Web-based tool support for dynamic management of distribution and parallelism in integrating architectural design and performance evaluation", *Proceedings of International Workshop on Software Engineering for Parallel and Distributed Systems*, May 17-18, IEEE, pp 156-163.
- Hatush, Z.A. and Skitmore, R.M. (1997a). "Common criteria for contractor prequalification", *Construction Management and Economic*, Vol. 15, No. 1, pp 19-38.
- Hatush, Z.A. and Skitmore, R.M. (1997b). "Assessment and evaluation of contractor data against client goals using PERT approach", *Construction Management and Economic*, Vol. 15, No. 3, pp 327-340.
- Holt, G.D., Olomolaiye, P.O. and Harris, F.C. (1993). "A conceptual alternative to current tendering practice", *Building Research and Information*, Vol. 21, No. 3, pp 167-172.
- Holt, G.D., Olomolaiye, P.O. and Harris, F.C. (1994). "Evaluating prequalification criteria in contractor selection", *Building and Environment*, Vol. 29, No. 4, pp 437-448.
- Holt, G.D., Olomolaiye, P.O. and Harris, F.C. (1995). "A review of contractor selection practice in the U.K. construction industry", *Building and Environment*, Vol. 30, No. 4, pp 553-561.
- Holt, G.D., Olomolaiye, P.O. and Harris, F.C. (1996). "Tendering procedures, contractual arrangements and Latham: the contractors' view", *Engineering, Construction and Architectural Management*, Vol. 3, Nos. 1 & 2, pp 97-115.
- Latham, M. (1994). *Constructing the team*, Final report of the government/industry review of the procurement and contractual arrangements in the UK construction industry, HMSO, July.
- Lester, A. and Benning, A. (1989). *Procurement in the Process Industry*, Butterworth.
- Ministry of Building and Works (1964). *The Placing and Management of Contracts for Building and Civil Engineering Works*, HMSO.
- Molenaar, K.R. and Songer, A.D. (1998). "Design-build selector (DBS): an automated tool for project selection", *Proceedings of Congress on Computing in Civil Engineering*, Oct 18-21, ASCE, pp 147-156.
- NASA (2001). *Procurement Innovations: At a Glance*, Office of Procurement, NASA Headquarters, Washington, DC, USA, April 2001.
- Ng, S.T., Smith, N.J. and Skitmore, R.M. (1998) "A case-based reasoning model for contractor prequalification", *International Journal of Construction Information Technology*, Vol. 6 No. 1, pp 47-61.
- Nguyen, V.U. (1985). "Tender evaluation by fuzzy sets", *Journal of Construction Engineering and Management*, ASCE, Vol. 111, No. 3, pp 231-243.
- NPWC/NBCC (1990). *No dispute*, NPWC.
- Palaneeswaran, E. and Kumaraswamy, M.M. (1999). "Dynamic contractor prequalification", *Proceedings of 15th Annual ARCOM Conference*, Liverpool, UK, Association of Researchers in Construction Management, Vol. 2, pp 615-624.
- Palaneeswaran, E. and Kumaraswamy, M.M. (2001). "Recent advances and proposed improvements in contractor prequalification methodologies", *Building and Environment*, Vol. 36, pp 73-87.
- Russell, J.S. and Ahmed, I. (1989). "A PERT approach to contractor prequalification analysis", *Proceedings of Thirty Fourth Annual Association of Cost Engineers*, Boston, MA, D1.1-D1.6.
- Russell, J.S. and Skibniewski, M.J. (1988a). "Decision criteria in contractor prequalification", *Journal of Management in Engineering*, ASCE, Vol. 4, No. 2, pp 148-164.

Russell, J.S. and Skibniewski, M.J. (1988b). "Knowledge engineering in a knowledge-based system for contractor prequalification", *Proceedings of Microcomputer Knowledge-Based Expert Systems in Civil Engineering*, Nashville, Tennessee, May 10-11, ASCE, pp 169-185.

Russell, J.S. and Skibniewski, M.J. (1990a). "Qualifier-1: contractor prequalification model", *Journal of Computing in Civil Engineering*, ASCE, Vol. 4, No. 1, pp 77-90.

Russell, J.S. and Skibniewski, M.J. (1990b). "Qualifier-2: knowledge-based system for contractor prequalification", *Journal of Construction Engineering and Management*, ASCE, Vol. 116, No. 1, March, pp 157-171.