A COMPUTER SOFTWARE TOOL FOR TENDER EVALUATION

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ABSTRACT

As a dimension driving the globalization process, tender evaluation needs improvement by, for example, reducing the cost and time of tender-data analysis. To serve this need, several computer software tools for evaluating *contractor ability* exist, such as *Qualifier-1* and *Qualifier-2*. However, there appear to be limitations in existing software tools which are capable of evaluating tenders in terms of both *contractor ability* and bid price. As such, the research aim was to suggest a computer software tool for tender evaluation. This software tool was a further development of the tender evaluation model, *TenSeM*. This software was divided into seven main steps: (1) establishing the tender evaluation context, (2) selecting criteria and weight, (3) eliciting utilities, (4) evaluating contractor ability, (5) evaluating tenders, (6) reporting results and (7) making a database. All the steps were coded using MS Excel for data analysis and Visual Basic for Application (VBA) for user interaction. As the software is operating, *subjective inputs* are exchanged between the software and multiple decision-makers, or provided by multiple decision-makers that make the software flexible to any changes in situation. This software helps practitioners in the construction industry select the *best* contractor or rank the contractors, which results in a saving in cost and time of the tender-evaluation job. This then promotes the globalization process in the construction industry.

Keywords: Tender evaluation, contractor ability, computer software, utility function, social welfare function

INTRODUCTION

Many developing countries have accepted economic alternation policies to penetrate the global market. These policies lead to the improvement of the countries' performances concerning accountability, competitiveness, liberalization of trade and so on. One dimension of dealing with these concerns is making the tender evaluation process transparent, i.e., no barriers to entry. This needs a reasonable computer software tool to evaluate tenders (*contractor ability* and bid price) effectively in terms of cost and time. Then, the results can be put on the web for public access in order to make the tender evaluation process more accountable. However, most existing software tools such as *Qualifier-1* [Russell and Skibniewski, (1990)] and *Qualifier*-2 [Russell *et al.*, (1990)] are designed for evaluating only *contractor ability*, which is a half-finished tender evaluation. Thus, the study aim was to introduce a computer software tool capable of evaluating both *contractor ability* and bid price. As the theoretical framework, the computer software

tool has been developed using a combination of a utility function and a social welfare function. Also, this software tool comprises seven main steps: (1) establishing the tender evaluation context, (2) selecting criteria and weight, (3) eliciting utilities, (4) evaluating *contractor ability*, (5) evaluating tenders, (6) reporting results and (7) making a database. MS Excel and Visual Basic for Application (VBA) are used for coding all the steps, which provides users with good calculations and friendly interaction.

THE THEORETICAL FRAMEWORK

Uncertainty is always associated with tender evaluation decisions. This uncertainty then leads to the risk of unfavorable consequences when selecting a contractor as the *best* contractor to complete a project. To handle the uncertainty, a utility function is one of the best techniques. In addition, multiple decision-makers are always involved in tender evaluation decisions, but the utility has limitations in dealing with the involvement. To handle this involvement, a social welfare function is introduced to aggregate all individual utilities so as to rank the contractors or to find the *best* contractor that satisfies all the decision-makers. More details of the application of a utility function and a social welfare function for tender evaluation can be seen in Pongpeng and Liston (2003a).

UTILITY QUANTIFICATION

Different decision-makers have different utility functions. The differences in the decision-makers' utility functions then show the different degrees of their attitude towards risk. Broadly, three patterns of utility function have been found: risk aversion, risk neutrality and risk propensity [Gupta and Cozzolino, (1974), Keeney and Raiffa (1976)].

Finding a utility function is time-consuming and fatiguing, if a number of attributes are involved. In addition, the utility function (including the choice of weights) can change over time in relation to a particular situation, which means a lot of effort is spent on finding the utility function but it can be used only once for a particular situation. As such, a utility function has to be developed every time for every situation. These considerations make the utility approach impractical for tender evaluation practitioners. To encourage the practitioners to use the utility idea, the theoretical method of finding a utility function has been modified to be discrete, and can be determined as shown in Fig. 1.

From Fig. 1, the utility of three broad patterns of attitude towards risk can be determined as follows:

- Firstly, risk-neutrality type people will articulate risk-neutrality utility (denoted U_{rn}), using the steps (a)-(b)-(b").
- Secondly, risk-propensity type people will express risk-propensity utility (denoted U_{rp}), using the steps (a)-(b')-(c')-(d').
- Thirdly, risk-aversion type people will express risk-aversion utility (denoted U_{ra}), using the steps (a)-(b)-(c)-(d).

Clearly, the difference of utility between risk-aversion type people and risk-neutrality type people is the variation of utility below U_{rn}; whilst that between risk-propensity type people and risk-neutrality type people is the variation of utility above U_{rn}. Also, the greater the variation, the higher the degree of attitude towards risk.

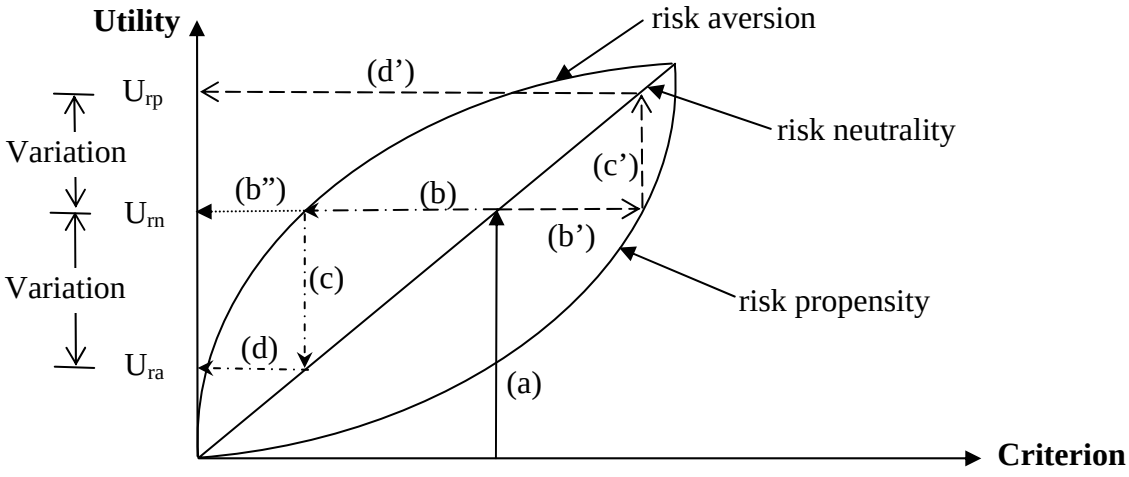

Fig. 1 Utility quantifying [adapted from Pongpeng and Liston, 2003a]

Finally, to determine a utility simply, the following steps are suggested:

- Regardless of risk, think of the utility for the criterion.
- Contemplate risk in selecting whether the contractor will meet project requirements.
- Articulate utility for the criterion (U_{ra} or U_{rp} or even U_{rn}) based on your attitude towards risk.

THE STEPS IN THE SOFTWARE TOOL

The software tool was programmed using MS Excel with Visual Basic for Application, VBA. There are seven main steps in this tool: (1) establishing the tender evaluation context, (2) selecting criteria and weight, (3) eliciting utilities, (4) evaluating *contractor ability*, (5) evaluating tenders, (6) reporting results and (7) making a database, as shown in Fig. 2.

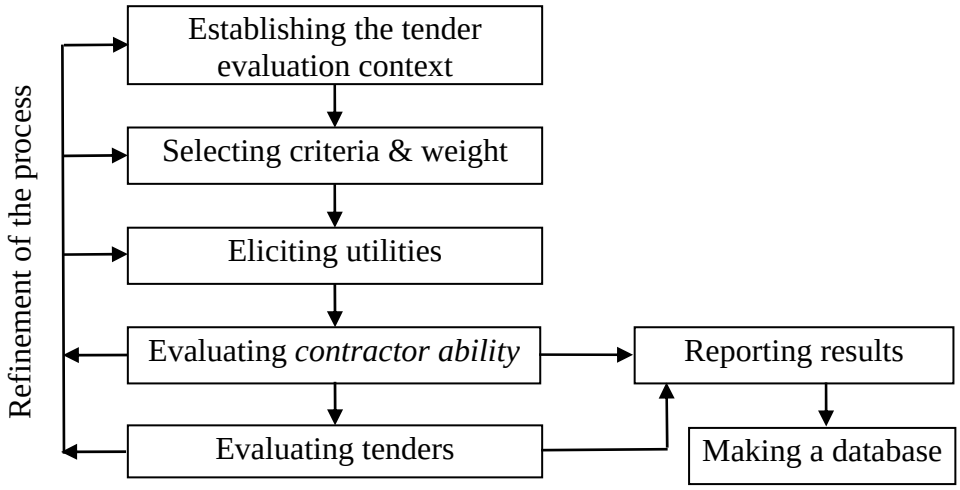

Fig. 2 The steps in the software tool [Pongpeng, 2002]

ESTABLISHING TENDER EVALUATION CONTEXT

This step lets users identify a tender context, namely: user context, type of project, project context, project ID no., project name, project start date, objective identification, decision-maker identification, and contractor identification, as per the example shown in Fig. 3.

SELECTING CRITERIA AND WEIGHT

Users are provided with nine *contractor ability criteria* derived from the questionnaire analysis [for more details see Pongpeng and Liston, (2003b)]. Then users have three options as shown in Fig. 4.

- Accept the suggested criteria and their weight. This will take users to the next step.
- Change the weight. Users agree with the suggested criteria but want to change the weight for each criterion. The model provides users with a menu to change the weight as required.
- Change both the criteria and weight. Users can select their own criteria and assign weight as required.

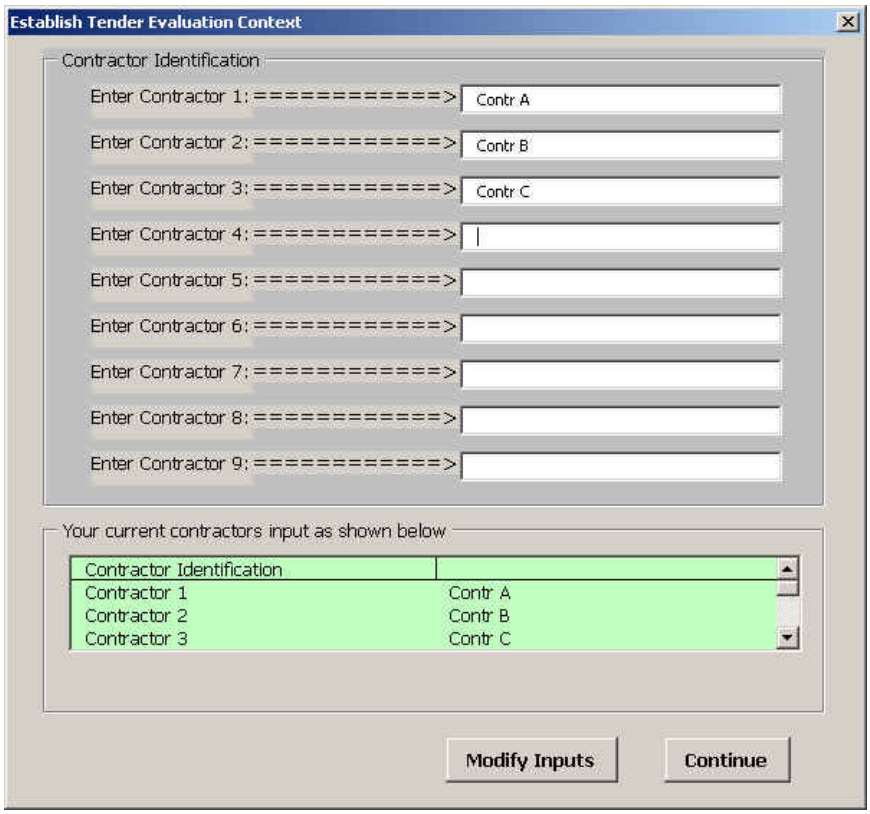

Fig. 3 Contractor identification menu

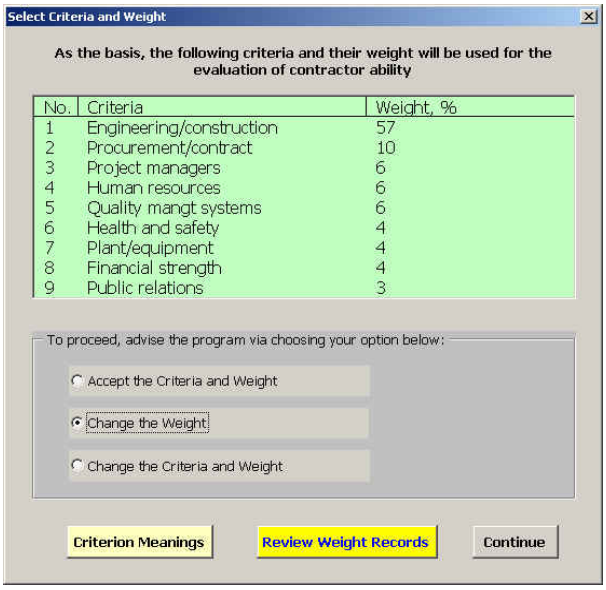

Fig. 4 A tender evaluation criteria selection menu

ELICITING UTILITIES

On the basis of utility quantification (explained by clicking on utility manual), users can express utility simply for each criterion for all contractors. The utility expression is

immediately presented to users in order to ensure that users are satisfied with their utility as shown in Fig. 5. If needed, the changes in utility can be made interactively.

However, before decision-makers express their utilities on all contractor ability criteria, they are encouraged to click on the "Utility Manual" button. Then the utility manual menu will pop up as shown in Fig. 6. The manual suggests decision-makers with a procedure for utility quantification as discussed in the previous section.

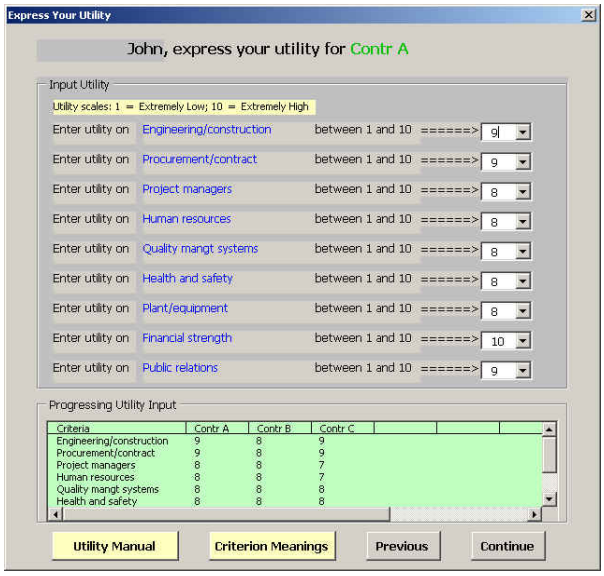

Fig. 5 A utility expression menu

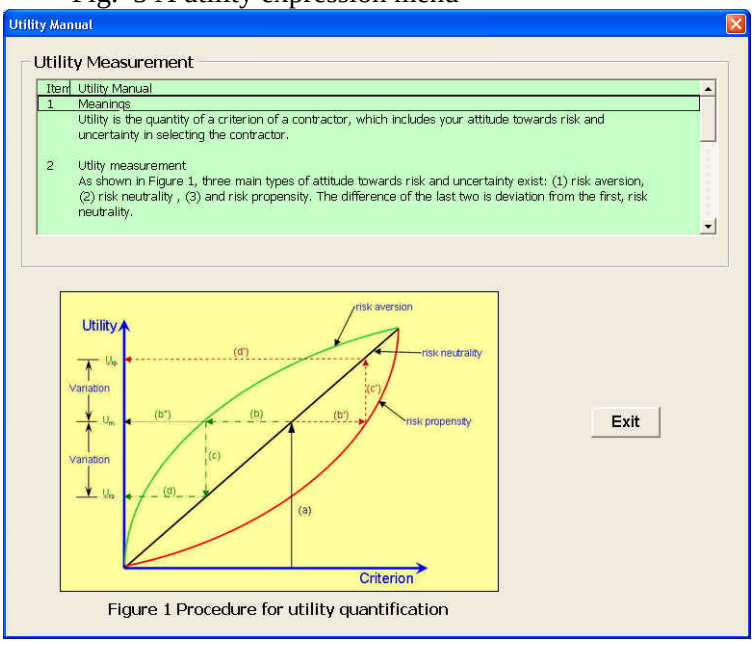

Fig. 6 The utility manual menu

EVALUATE CONTRACTOR ABILITY

After receiving the weights for all criteria and the utilities for all criteria for all contractors, the software tool will compute *contractor ability* for a decision-maker by multiplying all the utilities and their corresponding weights together and adding them all together, and then compute *overall contractor ability* for all decision-makers by summarizing the utilities (indicating *contractor ability*) of every decision-maker. An example of the results is shown in Fig. 7 [for more details see Pongpeng and Liston, (2003a)].

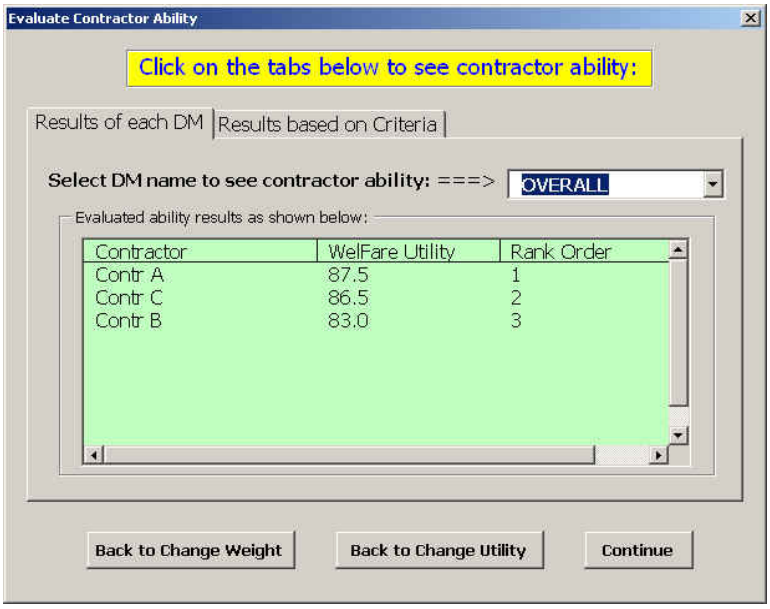

Fig. 7 The computation result of evaluating *overall contractor ability*

EVALUATING TENDERS

The bid price of each contractor is included in this step to finalize tender evaluation. The weights (to balance between bid price and *contractor ability*) are required as shown in Fig. 8.

Then, users input the bid prices of all contractors, and articulate utility for the bid price. After that, the software tool computes an *overall social welfare utility* by multiplying the utility of bid price and corresponding weight and multiplying the utility of *contractor ability* and corresponding weight, and then adding them all together [for more details see Pongpeng and Liston, (2003a)]. Figure 9 shows the calculations including the *should-win* contractor, social welfare utilities and ranking of the contractors.

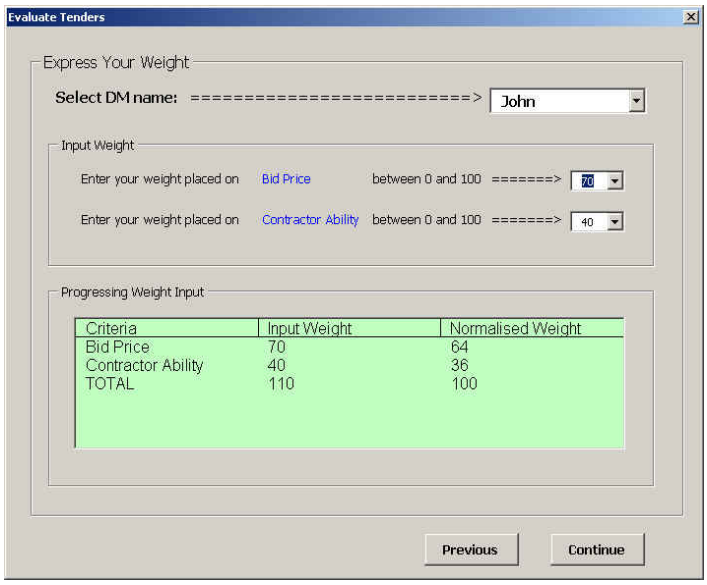

Fig. 8 A bid price and *contractor ability* balancing menu

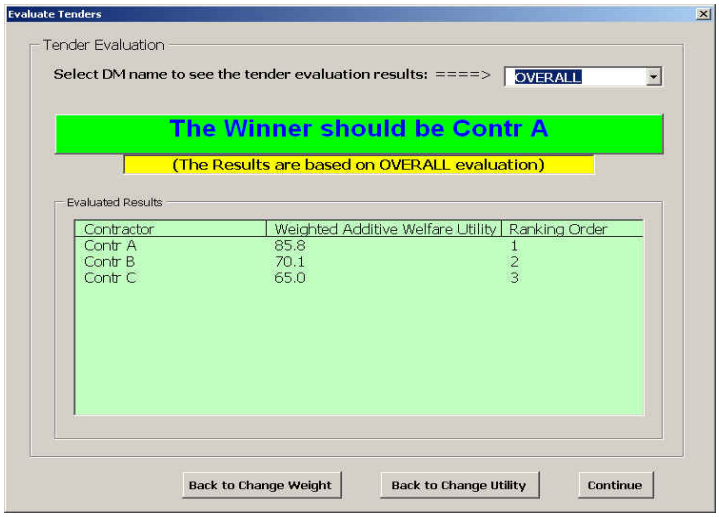

Figure 9 An overall social welfare utility menu

REPORTING RESULTS

The results are presented in a table for clarity of comparison of contractors. Three main results to be printed are:

- Overall tender evaluation. This result presents the ranking order and social welfare utility. Also, it suggests the *should-win* contractor.
- *Contractor ability* comparison, which shows the *contractor ability* in terms of the social welfare utility and ranking order.
- *Contractor ability* comparison on each selected criterion. Where the social welfare utilities of contractors are close in value, this result helps to determine strong and

weak areas of contractors in order to facilitate the selection of the *best* contractor.

MAKING A DATABASE

In this step, the average weights, as measures of central tendency, are automatically calculated. Then, the average weights placed on criteria are recorded, corresponding to a specific type of project, for future use. The development of this database is an ongoing research of the author.

SOFTWARE TEST

To obtain a realistic working product, the software tool was tested for user-friendliness, verification, sensitivity analysis, and validation. The tests for user-friendliness relied upon the planning structure of the software tool and upon the requirements of Thai tender evaluation practitioners. Verification used experimental proof by comparing the model results and those solved manually. The sensitivity of the model was tested by the variation of data inputs (i.e., weight and utility). As an ultimate test, the software tool results were validated with the two real-case results. The tests showed that the software tool evaluating both *contractor ability* and bid price was a rational product in solving tender evaluation problems. The details of the tests can be seen in [Pongpeng and Liston (2003a)]. Consequently, selecting the *best* contractor or ranking the contractors using this software tool results in (1) a saving in time and (2) the selection of a contractor that is likely to perform within time, budget, quality and safety requirements. However, for greater acceptance, wider-ranging tests with more tender evaluation practitioners are an ongoing research of the author.

CONCLUSIONS

Globalization influences the way both public and private organizations perform their tasks. It provides an opportunity to make the tender evaluation process more transparent and effective for the construction industry. Thus, a reasonable software tool capable of evaluating both *contractor ability* and bid price is necessary. Accordingly, this study suggests a software tool which has such capability. This software tool uses a method that combines a utility function and a social welfare function as the theoretical framework for its development. As the software tool is operating, *subjective inputs* (statements of preference) are exchanged between the tool and the users or provided by users, for example:

- In the step selecting criteria and weight, nine criteria with their weights of relative importance are suggested to the users. However, the users are allowed to change the weights and/or criteria, if required, making the model flexible to changes in relation to a particular situation.
- In the step eliciting utilities, the users provide *subjective inputs* through expressing utilities for *contractor ability criteria*. Here, a new utility quantification is introduced so as to reduce the difficulty in finding a utility function.

- In the step evaluating tenders, *subjective inputs* are provided via the articulation of weights for bid price and *contractor ability*. Then, the *subjective inputs* are exchanged again through the suggestion of utility for the bid price (by the software tool) and the expression of utility for the bid price (by the users). *Percentiles* are used to guide the users in expressing utility for bid price. This suggestion helps to reduce the utility-expression onus on the users.

In addition, using MS Excel with VBA to create the software tool renders a good calculating and reporting device and offers friendly interaction. Therefore, this software tool helps practitioners to reduce the time of tender-data analysis, which leads to more transparency and effectiveness. This then supports the process of globalization in the construction industry.

REFERENCES

Gupta, S K and Cozzolino, J M (1974) *Fundamentals of operations research for management*, Holden-Day, San Francisco.

Keeney, R L and Raiffa, H (1976) *Decisions with multiple objectives: preferences and value tradeoffs*, John Wiley & Sons, New York.

Pongpeng, J (2002) *Multicriteria and multidecision-makers' in tender evaluation*, PhD thesis, Queensland University of Technology, Brisbane.

Pongpeng, J and Liston, J (2003a) TenSeM: a multicriteria and multidecision-makers' model in tender evaluation. *Construction Management and Economics*, Vol.21, No.1, pp.21-30.

Pongpeng, J and Liston, J (2003b) Contractor ability criteria: a view from the Thai construction industry. *Construction Management and Economics*, Vol.21, No.3, pp.267-282.

Russell, J S, and Skibniewski, M J (1990) Qualifier-1: Contractor Prequalification Model. ASCE Journal of Computing in Civil Engineering, Vol.4, No.1, pp.77-90.

Russell, J S, Skibniewski, M J and Cozier, D R (1990) Qualifier-2: Knowledge-Based System for Constructor Prequalification. ASCE Journal of Construction Engineering and Management, Vol.116, No.1, pp.157-171.