Second International Conference on Construction in the 21st Century (CITC-II)
"Sustainability and Innovation in Management and Technology"
10-12 December 2003, Hong Kong

Modeling the Satisfaction of Clients and Architects Based on The Performance of UK Contractors

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Abstract
An assessment of the performance of UK contractors as considered by clients and architects is presented and used to develop models of client and architect satisfaction respectively, using the artificial neural network technique. The models suggest that contractors should prioritise their attempts to complete projects on budget and on time. Further, the models highlight the importance of the procurement of the contractor which needs to be carefully considered. Due to its adversarial nature, the competitive tendering approach is likely to discourage good performance and hence lower satisfaction levels. In this case, a contractor selection methodology based on negotiation and previous working relationships would encourage higher satisfaction levels. The models demonstrate accurate and reliable predictive power as confirmed by validation tests. Although several variables identified were uncontrollable (i.e. dependent on the subjective perceptions of the assessors and the type of project), coalition participants could use the models to help improve contractor performance leading to more successful project implementation. This will also promote the development of harmonious working relationships within the construction project coalition.

Keywords
Artificial Neural Network, Contractor Performance, Performance and Satisfaction Attributes, Performance Assessment, Project Coalition

1. Introduction

On any construction project, harmonious working relationships between the key project participants are essential for achieving project success. To maintain this relationship throughout project life, these participants should appreciate the interaction and interdependency between their performance. Here, in order to perform effectively, a reciprocal requirement exists, whereby each participant requires the other participants to perform their duties effectively and in harmony with others. Notwithstanding this mutual dependency, the performance of individual participants remains important because overall project performance is a function of the performance of each participant (Liu and Walker, 1998).

Various UK governmental reports (e.g. Latham, 1994; Egan, 1998, 2002) have urged contractors to improve their performance in a strive to satisfy their clients. In a wider sense, contractors should also perform to the satisfaction of other participants (e.g. architects) to maintain this relationship. There is a need therefore, to assess contractor performance from the viewpoint of other participants from which models for predicting levels of 'assessor' satisfaction can be developed. These models would allow contractors to focus on specific performance aspects which will enhance 'assessor' satisfaction levels for the benefit of overall project performance.

This paper describes the findings of such an assessment based on the views of UK clients and architects. These views were chosen because they represent the traditional principal members of the construction project coalition (PC) (i.e. client, architect and contractor). Data were collected through a questionnaire survey in which clients and architects were asked to assess the performance of contractors encountered on a recent 'case project'. The artificial neural network technique was used to identify significant attributes influencing expressed satisfaction/dissatisfaction (i.e. levels of satisfaction). The models can be used to predict client's and architect's satisfaction levels derived from the performance of contractors at various project stages (e.g. before commencement of work on site); thereby enabling suitable actions to be implemented to address areas of concern. This may ultimately help enhance overall project performance due to a more co-operative and performance enhancing PC.

2. Conceptual Model of Performance Assessment

Satisfaction is regarded as an internal frame of mind, tied only to mental interpretations of performance levels (Oliver, 1997). That is, a performance assessor (e.g. client or architect) will have their own psychological interpretation of the performance of others (e.g. contractors). This psychological process is subjective and difficult to interpret. Based on this theorem, a conceptual model of performance assessment has been developed (refer to Figure 1).

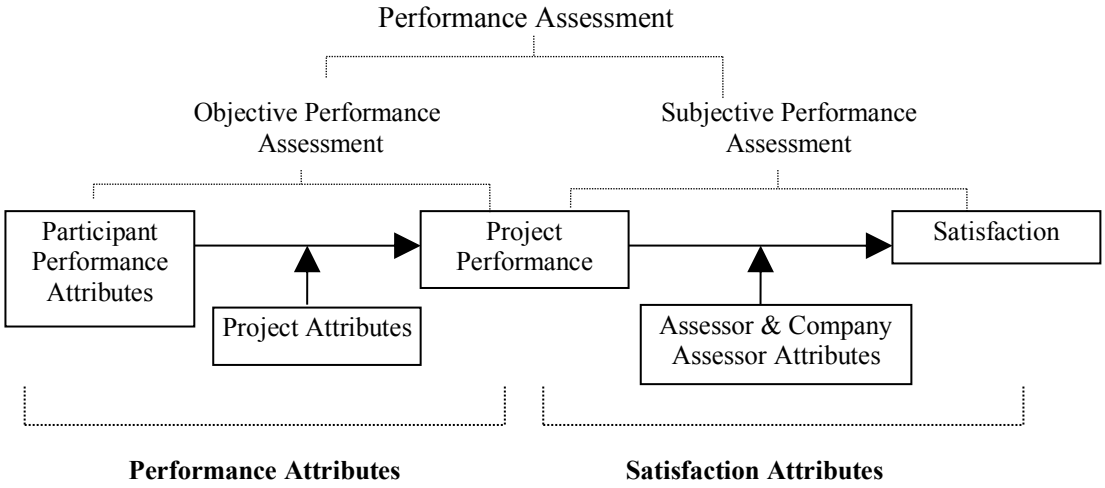

Figure 1: Conceptual Performance Assessment Model

Conceptually, the outcomes of performance assessment (in terms of satisfaction levels) can be influenced by two major attributes; those of the performer (i.e. performance attributes) and those of the assessor (i.e. satisfaction attributes). Satisfaction attributes are differentiable from performance attributes mainly due to their unique nature; they being inherent within an individual (i.e. assessor). That is, performance attributes may reflect on both participants and projects, and will influence both participant and project performance. In contrast, satisfaction attributes reflect solely on the assessor and influence their performance assessment and as such are beyond the control of the performer.

Performance attributes consist of participant attributes and project attributes. Participant attributes represent the characteristics or nature of a particular participant or their organisation, such as company age, turnover. Project attributes represent the characteristics/nature of a project, comprising attributes which may be outside the control of the participants. Controllable attributes are for example, forms of contract, procurement route, extent of design completed prior to work on site. Uncontrollable attributes are for example, type of project, ground and weather conditions.

Satisfaction attributes include the personal attributes of the individual assessor (e.g. experience, vocational background) and attributes of their employer (e.g. company assessor attributes). Company attributes are characteristics of the assessor's company, which may influence their assessment (e.g. company age, turnover, number of employees).

Figure 1 demonstrates the relationships between these variables. The performance attributes of a participant have a direct influence on their own performance in the construction process. Project attributes indirectly influence the participant's performance since these may enable/hamper the participant in executing their duties. Performance assessment in this respect is considered as 'objective' (i.e. tangible) in nature. For example, contractor performance may be assessed in terms of cost, time and quality performance (Holt, 1995).

However, performance assessment goes beyond the objective aspects outlined above since it involves the feelings of the assessor, which in turn are dependent on their background, i.e. frame of reference. This assessment is considered 'subjective' and at a higher level. This research embraces both 'objective' and 'subjective' (or higher level) performance assessment. In this case, satisfaction is measured using expressed overall satisfaction on a Likert scale ranging from 0 to 10 (as dependent variable). A list of all performance and satisfaction attributes (as independent variables) identified from the literature is presented in Soetanto (2002).

3. Research Methodology

To provide the main source of data, a questionnaire was developed based on the attributes and performance criteria identified. Respondents (i.e. clients and architects) were asked to identify a recent (i.e. within 2 years) UK building project in which they were involved (referred to as the 'case project'). Respondents were asked to relate all their answers to the questions contained in the questionnaire to this one 'case project'. This strategy was designed in order to capture a true and realistic reflection of satisfaction / dissatisfaction feelings. To protect the confidentiality of the other parties involved in these case projects, respondents were not asked to identify projects, nor name other participants.

Following the development of the questionnaire and implementation of a pilot survey, a UK-wide questionnaire survey of clients and architects was conducted. Distribution involved 536 experienced UK private and public clients, defined as those who regularly procure construction works from the industry, and 528 top UK architects. Seventy-seven client and sixty-five architect responses were received representing 14.4 and 12.3 percent response rates respectively. This relatively low response rate is about the 'norm' for construction management research and in many ways can be associated with the 'confidential' nature of the questions and the comprehensive nature of the research instrument. Fifty client and fifty-four architect responses were used to develop the models and the remaining (27 and 11 responses) were used for validation.

3.1 Artificial Neural Network Technique

Artificial Neural Networks (ANNs) are particularly suitable for analogy-based decision problems prevalent in construction (Moselhi *et al*., 1991). Given the 'soft' nature of satisfaction and the involvement of subjective judgements, the data was expected to be noisy, biased, complex and non-linear. Moreover, there are a large number of attributes (i.e. input variables) which must be considered in parallel (Moselhi *et al*., *ibid*.). That is, ANN provided an appropriate technique for modelling given the nature of the data. *NeuroSolutions* neural network simulation environment version 3.02 consultants level was used (NeuroDimension, 1999) to develop the ANN models. Multilayer Perceptron (MLP), an ANN paradigm commonly used for general classification and regression problems, was used here. To optimise the modelling, a two-stage development process was adopted. Sensitivity analysis was applied (NeuroDimension, *ibid*.) to identify important independent variables, which were included in the second stage. This yielded a simpler model to those developed from the previous stage. This final model could then be used to predict client and architect satisfaction levels. For the purpose of brevity, only the second stage models (i.e. final models) are presented and discussed.

4. Satisfaction Models

Based on samples of 50 and 54 case projects, two ANN models were developed to predict levels of client and architect satisfaction arising from the performance of their contractors, using overall satisfaction levels as dependent (i.e. output) variables, and performance and satisfaction attributes as independent (i.e. input) variables. The network typologies for these models have been presented elsewhere (Soetanto, 2002). The results of validation tests showed that both models are valid and robust. Table 1 presents the independent variables used to predict client and architect satisfaction levels in descending order of importance based on the results of the sensitivity analysis. A considerable number of the variables (eight variables) are sensitive (i.e. significant) in both models suggesting a degree of commonality in client and architect assessments of contractor performance.

Table 1: Sensitive Independent Variables Identified from Client and Architect Satisfaction Models

Sensitive Independent Variables Identified from		Ranking
Client Satisfaction Model	**Architect Satisfaction Model**	
Project overrun	Project overbudget	1
Any previous working rel'ship with the contr's site personnel	Method of contractor selection	2
Method of contractor selection	Type of project	3
Type of building	Type of building	4
Procurement route	Procurement route	5
Past performance in quality of construction	Project overrun	6
Method of contractor payment	Satisfaction arising from contractor performance in general	7
The extent of variations caused by contractor	Method of contractor payment	8
Project overbudget	The qualification and experience of director	9
Type of project	Financial soundness of contractor firm	10
Current work load	Any previous working rel'ship with the contr's site personnel	11
	Experience with project type	12
	Severity of variations	13

4.1 Discussion of Sensitive Independent Variables Identified from the Client Satisfaction Model

Project overrun was identified as the most important variable. This suggests the need to deliver projects on or before programme is essential for higher client satisfaction. Somewhat surprisingly, project overbudget was ranked in ninth place, suggesting that clients consider time performance much higher than cost performance.

Any previous working relationship with the contractor's site personnel was the second most important variable. Here, a well-established working relationship with the contractors' site personnel may produce higher satisfaction levels. Further, the procurement of the contractor must be carefully considered. Due to its adversarial nature, the competitive tendering approach is likely to discourage good performance and hence lower satisfaction levels. In this case, a contractor selection methodology based on negotiation would encourage higher satisfaction levels. These two variables suggest that long-term relationships would encourage higher client satisfaction levels.

It is interesting to note that different types of building and project influence satisfaction levels. In the context of this research, they are considered uncontrollable attributes which can not be altered by members of the PC.

The model also highlighted the need for contractors to deliver high quality. Method of contractor payment as a significant variable may suggest that the lump sum method of payment may discourage satisfaction in contrast to, for example, cost reimbursement. Here, the method of contractor payment should be carefully considered and negotiated before project commencement. Contractors should attempt to reduce variations since these have an adverse effect on satisfaction.

The contractor's current workload was a sensitive variable (ranked the last). Although an excessive workload can be detrimental to performance, a steady and continuous flow of work may enhance contractor performance through the opportunity to gain more experience, sustain the business financially, and to employ better and adequate resources.

4.2 Discussion of Sensitive Independent Variables Identified from the Architect Satisfaction Model

In stark contrast to the client model, project overbudget was the most important variable for architects. Moreover, project overrun was also an important variable and ranked sixth. This suggests that contractors should maintain their attempt to finish projects on budget and on time in order to satisfy their architects.

The method of contractor selection must be carefully considered. As suggested before, a contractor selection methodology based on negotiation is more favourable than the competitive tendering approach. Procurement route was also identified as an important determinant of satisfaction. The method of contractor payment and any previous working relationship with the contractor's site personnel were ranked eighth and eleventh. Generally, these variables suggest that long-term relationships would encourage higher levels of architect satisfaction.

As for the client satisfaction model, types of project and building influence the satisfaction levels of architects. From the viewpoint of contractors and in the context of this research, these are considered beyond the control of the participants.

A respondent attribute, the satisfaction arising from contractor performance in general was an important variable (ranked seventh). This variable suggests that some degree of subjectivity is prevalent in the architects' performance assessment. That is, those architects with a high perception of contractor performance in general, are more likely to yield higher satisfaction levels.

The qualification and experience of the contractor's director was also found to influence satisfaction levels. Directors are key persons who largely determine the performance of contractors. The contractor's financial soundness was an important variable suggesting that financially sound contractors may employ more effective resources and therefore able to perform better.

The model identified experience with project type as one of the important variables. Experience may help to improve performance because contractors executing similar projects may benefit from the lessons learnt on earlier projects. Severe variations may lower architect satisfaction levels since variations demand additional resources and add to the complexity of projects.

5. Conclusion

Project success is very much dependent on the quality of working relationships between participants of the construction project coalition. To achieve and nurture harmonious relationships throughout the project life, it is essential that each participant satisfies and is satisfied with the performance of other participants, hence highlighting the need for mutual performance assessment. Here, contractor performance as assessed by clients and architects has been modelled using the artificial neural network technique. The results suggest that to satisfy their 'assessors', contractors should focus on completing projects on budget (for architects) and on time (for clients). Clients, for their own satisfaction, should carefully consider the procurement of the contractor. Relationship-based procurement routes such as partnering and strategic alliances would encourage higher satisfaction levels, as opposed to the traditional competitive tendering. In addition to this, several contractor attributes (i.e. past performance, experience, director qualification, financial soundness, workload) should also be considered in the selection of contractor. Although several variables identified were uncontrollable (i.e. dependent on the subjective perceptions of the assessors and the type of project), coalition participants could use the models to help improve contractor performance leading to more successful project implementation. This will ultimately promote the development of harmonious working relationships within the construction project coalition.

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