EPPM: IMPACTS OF SITE COORDINATION PROBLEMS TO COST OVERUN IN BUILDING PROJECTS

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Abstract

In Hong Kong, main contractors of building projects tend to subcontract most of their work. However, many of the subcontractors complain that they are unable to perform to their full capacity due to main contractors' poor site coordination of temporary works and interfacing works and plant supports etc. Six critical site coordination problems caused by main contractors that had adversely influence to the performance of subcontractors was identified in a previous study.

A questionnaire survey was conducted to establish a model in the form of multiple regression equations that explain how the frequency of occurrence of the critical site coordination problems leading to the cost overrun of a building project in Hong Kong. The survey results were validated by neural network analysis. Backward elimination method was adopted to identify the 'most critical' site coordination problems that enable main contractors to formulate measures to prevent cost overrun. The survey results show that problems related to interfacing work between subcontractors are the 'most critical' site coordination problems.

Keywords: Site coordination problem, Cost, Performance

1. INTRODUCTION

Due to the rapid development in terms of complexity and size of building projects, the use of subcontractors has rapidly increased. As a result, the role of main contractors have gradually transformed from a constructor to a manager of subcontractors of the project. Frisby (1990) defined the management of the subcontractors as one of the key functions of the main contractor. The performance of the subcontractor is one of the most important factors governing project performance. However, in recent years, there are increasing complaints

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from subcontractors that they cannot performance effectively and efficiently due to poor site coordination by main contractors. An average of 35.10 per cent of productivity wasted due to site coordination problems caused by main contractors was stated by the respondents of a questionnaire survey.

From the client's point of view, time, cost and quality are the three most common fundamental project objectives for a building project (Stuckenbruck, 1990; Bennett, 1983; Walker, 1990). Among the three traditional building project objectives, time and cost are often more important than quality in the Hong Kong, which has developed a reputation for completing high-rise building projects in incredibly short periods of time. It arouses public interest as to the remarkable speed of construction and some even claim it can only be achieved in Hong Kong (Chan and Kumaraswamy, 1995). This is because the contract time set by the clients is usually unreasonably short due to the high cost of land.

Adopting the model developed by Tam and Harris (1996), the important factors influencing the performance of subcontractors in the HK building projects were selected for this study and classified into three main categories.

a. inherent project characteristics;
b. ability of the key participants; and
c. influence of the participants to the subcontract.

Site coordination problem caused by main contractor is one of the influences of main contractor to the subcontracts at construction stage. This paper presents a study on how the critical site coordination problems leading to the cost overrun of a building project in Hong Kong.

2. RESEARCH METHODOLGY

2.1 Site Coordination Problems

Nineteen common site coordination problems caused by the main contractors that would adversely affect subcontractors' performance were identified through literature review and advices from experienced industrial practitioners. According to their nature, these problems were classified into eight groups of problems critical to the successful site coordination of subcontractors work:

a. Construction information;
b. Working programme;
c. Preparation for work place;
d. Interfacing work;
e. Material support;
f. Plant support;
g. Response to site problems; and
h. Access to work place.

Among them, six critical problems listed in Table 1 were shortlisted by a questionnaire survey that assessed the aggregated importance score of each site problem (Ng and Price, 2005). Aggregated importance score was designed based on the model developed by Kadir *et al* (2005). It was taken as the combined score of frequency of occurrence and the potential degree of impact to the performance of subcontractors.

Table 1: Critical site coordination problem

Site coordination problem	**Code**
Short notice to commence site work	SCP1
Late to provide plant support	SCP2
Interfacing work not yet completed	SCP3
Interfacing work not accurately completed	SCP4
Construction information not detail enough	SCP5
Construction information unclear or contradictory	SCP6

2.2 Data Collection

Questionnaire survey method was adopted in this study. The questionnaires were distributed to industrial practitioners through private relationship and posted to subcontracting firms based on the information provided in the Hong Kong Builders Directory. Only the respondents performing the subcontractor role in building projects were included in the data analysis. They were requested to complete the questionnaire based on their current projects or the projects with highest contract sum if they were handling several projects at the same time currently.

The questionnaire consists of three parts. Part One was used to collect the background information of the respondents who were working in subcontractors for building projects. As multiple regression analysis method would be used to compute the data, respondents were requested to assign a score from 10 (represent 100% achievement) to 0 (represent 0% achievement) with a 0.5 interval to represent their views on the level of achievements on cost performance in their current projects in Part Two. The score of achievement in cost performance is the comparison of the expenditure with the project budget. The aim of Part Three is to collect data to establish the relationship between the six critical site coordination problems with the cost performance. Respondents were requested to assign a score from (10 occurred in every site operation) to 0 (never occurred in site operation) with a 0.5 interval to show the frequency of occurrence of the site coordination problems caused by main contractors in their current projects.

2.3 Statistical Methodology

Kinnear and Gray (2008) classified the nature of the research work into five types for the selection of the appropriate statistical technique for data analysis. As the nature of this research relates to the prediction of outcomes, multiple regression analysis is considered as an appropriate approach for this study. Regression techniques often have been used because of their relative simplicity in both concept and application. It has the ability to develop causal models where the structural relationships of the variable can be established in a predictable and explanatory way. Walker (1995) used multiple regression analysis to build up models to forecast the time performance for projects in Australia based on four variables. Chan and Kumaraswamy (1999), and Leung and Tam (1999) applied this technique to establish models to predict the overall duration and the hoisting time for a tower crane respectively for public housing projects. Skitmore and Ng (2003) adopted the same statistical approach using forward cross validation procedure to forecast the construction time and cost for the projects in Australia based on six variables. For the multiple regression equations generated in this study, the cost performance is the dependent variable and the six critical site coordination problems are the independent variables as per Equation (1).

$$\text{Time performance} = a + b_1SCP1 + b_2SCP2 + b_3SCP3 + b_4SCP4 + b_5SCP5 + b_6SCP6 \qquad (1)$$

Where SCPi (critical site coordination problems) are the independent variables

Time performance is the dependent variable

a is a constant which is the y-intercept

b_i is the partial regression coefficient for SCP

Some of the variables of the regression equations can be eliminated without having significant impact to the accuracy of the regression equations. An analysis using six independent variables can generate sixty-three different computations. The backward elimination method was adopted to reduce the number of computations. The variable was eliminated if probability of F-to-remove was equal or greater than 0.100. In each stage of elimination process, the most insignificant independent variable was removed. The process would be terminated until no variable satisfied the elimination condition such that the ‘most critical’ site coordination problems were kept in the last stage of regression equation.

3. DATA ANALYSIS

3.1 Respondents

One hundred and seventeen replies were received in this questionnaire survey. The respondents are classified into three categories and are summarized in Table 2.

Table 2: Type of respondent

Type	Number of reply
Finishing work subcontractors	43
Structural work subcontractors	34
Building services work subcontractors	40
Total	117

3.2 Coding System

The coding system shown in Table 1 and Table 3 is used to simplify the description of the repeated terms and enhance the understanding of the flow of the data analysis work in this paper. In this study, the multiple regression analysis covered one main model that included all replies and three sub-models for each type of subcontractors.

Table 3: Model coding system

Model code	Type of model	Type of subcontractor
Cost-All	Main model	All type of subcontractors
Cost-Fin	Sub-model	Finishing work subcontractors
Cost-Str	Sub-model	Structural work subcontractors
Cost-BS	Sub-model	Building services work subcontractors

The regression equations of the models comprised six independent variables. For ease of reference, the regression equation containing all the variables is called standard form regression equation. The last stage regression equation containing the 'most critical' site coordination problems generated in the backward elimination process is called the simple form regression equation. Table 4 lists the regression equation codes for different models.

Table 4: Regression equation coding system

Regression equation code	Form of regression equation
Cost-All-1	Standard form
Cost-All-final	Simple form
Cost-Fin-1	Standard form
Cost-Fin-final	Simple form
Cost-Str-1	Standard form
Cost-Str-final	Simple form
Cost-BS-1	Standard form
Cost-BS-final	Simple form

3.3 Multiple Regression Equations

R is the absolute value of Pearson correlation coefficient (r). It describes what proportion of the variability of the dependent variable is explained by the regression equation. All the four standard regression equations are closely related to cost performance as their R(RG) values generated from multiple regression method are from 0.630 to 0.483. The R(NN) values generated from neural network analysis are from 0.741 to 0.472. There two sets of R values are close.

Table 5: Summary of the standard form regression equations for cost performance

Model	**Regression equation**	**R value (RG)**	**R value (NN)**
SP-Cost-BS-1	Cost = 8.858 + 0.067xSCP1 - 0.014xSCP2 - 0.535xSCP3 + 0.084xSCP4 - 0.002xSCSCP5 - 0.046xSCP6	0.630	0.741
SP-Cost-Fin-1	Cost = 11.013 - 0.155xSCP1 +.179xSCP2 - 0.277xSCP3 - 0.569xSCP4 – 0.016xSCP5 +0.098xSCP6	0.621	0.565
SP-Cost-All-1	Cost = 9.522 + 0.015xSCP1 - 0.040xSCP2 - 0.308xSCP3 -0.162xSCP4 + 0.084xSCP5 - 0.087xSCP6	0.506	0.594
SP-Cost-Str-1	Cost = 8.223 + 0.249xSCP1 - 0.371xSCP2 - 0.118xSCP3 + 0.065xSCP4 + 0.067xSCP5 - 0.043xSCP6	0.483	0.472

The R(RG) and R(NN) values of the four simple regression equations are from 0.623 to 0.463 and from 0.66 to 0.422 respectively. There pattern of the two sets of R values are quite consistent. SCP3 and SCP4 are found to be more critical to the cost performance of subcontractors as these two site coordination problems appear in two simple regression equations. The two problems are related to the interfacing works between different trades such as the coordination work for the suspended ceiling work and building services works inside the ceiling void.

Table 6: Summary of the simple form regression equations for cost performance

Model	**Regression equation**	**R value (RG)**	**R value (NN)**
SP-Cost-All-final	Cost = 9.490 - 0.311xSCP3 - 0.176xSCP4	0.496	0.514
SP-Cost-Fin-final	Cost = 10.478 – 0.635xSCP4	0.606	0.578
SP-Cost-BS-final	Cost = 9.077 – 0.472xSCP3	0.623	0.688
SP-Cost-Str-final	Cost = 8.096 + 0.226xSCP1– 0.399xSCP2	0.463	0.422

4. SUMMARY

It is a common practice in Hong Kong that main contractors would subcontract most of their work to subcontractors. In recent years, there are increasingly complaints from subcontractors that they cannot perform to their full capacity due to site coordination problems caused by main contractor. This results to the cost overrun of their projects. A questionnaire survey was conducted to establish a model in the form of multiple regression equations to assess the impact of the occurrence of the critical site coordination problems leading to the cost overrun of a building project in Hong Kong.

Six critical site coordination problems caused by main contractors that had adversely influence to the performance of subcontractors identified in a previous study were used to generate the multiple regression equations. The analysis covered one main model that included all replies and three sub-models for each type of subcontractors. Among the six critical site coordination problems, some are more critical to the cost performance of the subcontractors. Backward elimination method was adopted to identify the 'most critical' problems for each type of subcontractors that enable main contractors to formulate measures to prevent cost overrun. The survey results show that problems related to interfacing work between subcontractors are the 'most critical' site coordination problems.

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