

ASSESSING THE IMPACT OF MAIN CONTRACTOR'S SITE CO-ORDINATION ON SUB-CONTRACTORS' PERFORMANCE IN HONG KONG

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It is a common practice in Hong Kong for the main contractors of local building projects to sub-let most of their works, consequently their roles have gradually transformed from a constructor to a manager of sub-contractors of the project. The outcome of most projects therefore depends heavily on the sub-contractors' performance. However, most Hong Kong based sub-contractors complain that they are unable to operate efficiently and effectively due to main contractors' poor co-ordination of construction information, temporary works, interfacing works and temporary power supply. A list of the most serious problems caused by main contractors during the construction stage that reduce sub-contractors' performance has been produced. A questionnaire survey has been conducted to identify and analyse the frequency and potential impact of the problems. The aggregated impact on sub-contractors' site work is analysed. The findings have been used to formulate guidelines for the improvement of site co-ordination by main contractors.

Keywords: sub-contractor, site co-ordination, performance

INTRODUCTION

Sub-contracting plays a vital role in the construction industry as it is often used as a strategy to deal with long-term environmental uncertainties and to buffer the technical core of main contractors against short-term contingencies (Sozen, 1999). In Hong Kong, the main contractors sub-let most of their site operations to domestic sub-contractors. According to government statistics for 2003, sub-contractors (excluding labour-only sub-contractors) performed 47 per cent of the gross value of construction work. Due to the rapid development in terms of complexity and size of construction projects, the use of sub-contractors has rapidly increased. Frisby (1990) pointed out that the role of the main contractor on building construction projects was being gradually transformed from carrying out the actual site production work to the management of the sub-contractors. The performance of the sub-contractors was thus increasingly affecting the outcome of many building projects. However, most sub-contractors in Hong Kong complain that they are unable to efficiently and effectively perform their site works due to the main contractors' poor site co-ordination, for example: insufficient construction information and site reference points; and inaccurate interfacing works.

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AIMS AND SCOPE OF STUDY

There are many factors that affect project performance, with the sub-contractors' performance being one of the most critical factors. Ng and Price (2002) conducted a survey to identify the key success factors affecting the performance of the sub-contractors in the building construction projects in Hong Kong. The survey showed that main contractor's site co-ordination was the most important success factor for sub-contractors during the construction stage. This paper is an extension of that survey. It aims to identify and analyse the problems caused by the main contractors that can hinder sub-contractors' performance on local building projects. Based on the survey results, recommendations have been formulated to help the main contractors enhance their site co-ordination.

In Hong Kong, main contractors normally divide the project into work packages by trade and sub-let them to the first level trade sub-contractors. The first level trade sub-contractors further divide their work packages into smaller packages and sub-let them to the second level sub-contractors. The sub-letting process may sometimes go down several more levels and can be characterised as a multi-level sub-contracting system. It is assumed that the responses of this survey represent the comments from the main contractors and the first level sub-contractors' views. This paper only covers building projects because the main contractors of civil engineering projects do not sub-contract as much of their works to sub-contractors, mainly due to less labour being required.

PROJECT PERFORMANCE AND SUCCESS FACTORS

Project objectives and their level of importance vary from project to project, and from project participant to project participant. The success of a given project can be gauged by measuring the degree to which project goals and expectations are met (Sanvdo *et al.*, 1992) and the achieved degree of client satisfaction (Yasamis *et al.*, 2002). It is quite normal for clients to expect all of their aspirations to be met. However, Ward *et al.* (1991) pointed out that project objectives were not interdependent and trade-offs might have to be made between them. Regarding the performance of the sub-contractors, Ng and Price (2005) showed that time was the most important criterion expected by the main contractors. With the increasing public concerns on the construction projects, safety and health have become as important as the other two traditional performance indicators of cost and quality.

There have been a large number of publications that analyse the factors that influence the success of a construction project. Jaselkis and Ashlsy (1988) identified twenty-seven success factors and grouped them into four headings: project manager's capabilities; experience and authority; the stability of project team; project planning; and control effort. Mohini and Davidson (1992) adopted *inter-organizational conflict* among the project's task-organizations as a yardstick to analyse the significant determinants of performance for construction projects. The determinants were categorised into three main groups: domain consensus; availability and access to information; and interdependence of tasks.

Some publications focus the success factors for a particular location. Kaming *et al.* (1997) reviewed the factors influencing construction time and cost overruns in Indonesia. Inflationary increases in material cost, inaccurate material estimating and project complexity were found to be the main causes of cost overruns on high-rise building projects. The predominant causes of delay were design changes, poor labour productivity and inadequate planning. Burrows *et al.* (2004) analysed the influences of

the six variables available at the early stage of projects to the project duration in the UK.

Some studies have been conducted on construction projects in Hong Kong. Tam and Harris (1996) developed a model to predict the performance of the main contractors in local construction projects from the client's perspective. The model measured the three dimensions of a project: the inherent characteristic of the project; the contractor's internal attributes; and the external influence of the project team. Chan and Kumaraswamy (1995 and 1998) classified the essential factors governing construction durations into eight categories: project-related factors; client-related factors; design team-related; contractor-related factors; material-related factors; labour-related factors; plant/equipment-related factors; and external factors. These studies normally evaluate the success factors from main contract level, consequently, their relevance to sub-contracts may be considered a bit remote. Adopting the model developed by Tam and Harris (1996), Ng and Price (2002) identified and analysed the important factors governing the performance of the sub-contractors in the building projects in Hong Kong from the perspective of different participants. The factors were grouped into three categories: inherent project characteristics; ability of the key participants; and the influences of the participants to the sub-contracts. The inherent project characteristics included: the nature and complexity of the sub-contract work; and the relationships among the key participants. These factors characterise the basic constraints of a project. The ability of the key participants refers to the experience and knowledge of the participants. These factors reflect their potential to achieve their assigned tasks under the sub-contract. The influences made by the participants such as design change are dynamic success factors. Main contractor's site co-ordination was found to be the most important influence at the construction stage.

RESEARCH METHODOLOGY

Nineteen problems caused by the main contractors that influence sub-contractors' site work were identified through literature review, observed common industrial practices and advice from the experienced industrial practitioners. These problems were categorised into eight groups: Construction information; Working programme; Preparation for work place; Interfacing works; Access to work place; Plant support; Material support; and Response to site problems, as summarised in Table 1.

A questionnaire survey method was adopted in this study. The questionnaires were posted to one hundred and fifty industrial practitioners, 35 valid replies were received. The overall degree of influence of the problems on sub-contractors' performance depends on their frequency as well as the potential degree of impact on site work. Based on their current projects or experiences, respondents were requested to rate: from 1 (never happen) to 9 (happen every time) 0.5 interval for the frequency of occurrence; and from 1 (very unimportant) to 9 (very important) with 0.5 interval for the degree of potential impact to site work for each problems. In this 9-points scoring scale system, 5 represented that the problem occurred fairly frequently and had neutral importance to site works.

Table 1: Mean score for problems to sub-contractors' performance

		Mean score (Frequency) (F)	Mean score (Potential Impact) (PI)	Aggregated importance score (F x PI)
Factor:	Construction information			
Problems:	a. information not detail enough	7.08	5.65	40.00
	b. unclear or contradictory information	7.10	6.25	44.38
Factor:	Working programme			
Problems	a. working programme not detail enough	4.65	4.38	20.37
	b. working sequence not practical	3.95	6.03	23.82
	c. short notice for commencing site work	4.73	6.25	29.56
	d. late change of working programme	3.68	6.13	22.56
Factor:	Preparation for work place			
Problems:	a. work place environment not yet prepared such as general site cleaning, fresh air supply, lighting	4.63	3.13	14.49
	b. inadequate or insufficient site reference points	3.10	6.98	21.64
	c. inadequate or insufficient temporary work support such as scaffolding, water & power supply	3.50	5.85	20.48
Factor:	Interfacing work to be completed by other sub-contractors			
Problems:	a. work not yet completed	5.55	6.05	33.58
	b. work not accurately completed	5.70	6.78	38.65
Factor:	Access to work place			
Problems:	a. access road not yet ready	4.60	3.78	17.39
	b. access routing not convenient	3.93	3.05	11.99
Factor:	Plant support			
Problems:	a. late to provide plant support	5.10	6.38	32.54
	b. type of plant provided not appropriate	3.63	4.58	16.63
Factor:	Material support			
Problems:	a. insufficient amount	2.98	6.40	19.07
	b. type of material provided not appropriate	3.05	5.88	17.93
Factor:	Response to site problem			
Problems:	a. late response to site problems	5.03	3.78	19.01
	b. solution recommended not practical	3.40	5.73	19.48

DATA ANALYSIS

Respondents had in average over seven years of working experience in construction industry. Table 1 above shows the mean of the scores rated by the respondents on the

frequency of happening and degree of potential impact on site work to each problem. As 9-points scoring scale system was adopted, the problems with mean score over 5.0 were shortlisted for detail discussion because these problems would occur more frequently and had significant impact to site works.

Frequency of occurrence

Table 2 below summarises the problems with mean score over 5.0 assigned by the respondents for frequency of occurrence in a descending order of priority, can be regarded as common problems in the local building construction projects.

Table 2: Most frequently occurring problems

Rank	Problems	Mean score for frequency
1	Construction information unclear or contradictory	7.10
2	Construction information not detail enough	7.08
3	Interfacing work not accurately completed	5.70
4	Interfacing work not yet completed	5.55
5	Late to provide plant support	5.10
6	Late response to site problems	5.03

The top two most frequent problems related to construction information. Their mean scores are well above the other problems. In the recent years, local main contractors have had less time and manpower to organise the construction information for their sub-contractors due to the rapid development in terms of the complexity and size of construction projects, and local property developers usually set a very tight programme for their projects.

Problems related to interfacing works to be completed by the other sub-contractors were founded to be the most fourth and fifth frequent site problems. The survey conducted by Lai (1987) shown that the number of sub-contract packages in the typical local building construction projects ranged from 17 to 54. The multi-level sub-contracting system in Hong Kong has imposed additional difficulties to the main contractors' site co-ordination. Main contractors' instructions may take a few days to pass through several levels before reaching the sub-contractors that actually carrying out the works. The content of the instructions may also be distorted due to the over-long communication path. Sub-contractors are sometimes unable to receive the latest working instructions for their own portions of interfacing work on time and accurately. Late to provide plant support and response to site problems happens fairly frequently as their mean scores are only slightly above 5.

Degree of potential impact on site work

Table 3 summarises the problems with mean score over 5.0 assigned by the respondents for the degree of potential impact on sub-contractors' site work in a descending order of priority, which can be regarded as important impact to sub-contractors' performance.

Table 3: Significant impact problems

Rank	Problems	Mean score for potential impact
1	Inadequate or insufficient site reference points	6.98
2	Interfacing work by other sub-contractors not accurately completed	6.78
3	Insufficient amount of material support	6.40
4	Late to provide plant support	6.38
5	Construction information unclear or contradictory	6.25
6	Short notice for commencing site work	6.25
7	Late change to working programme	6.13
8	Interfacing works not yet completed	6.05
9	Working sequence not practical	6.03
10	Type of material provided not appropriate	5.88
11	Inadequate or insufficient temporary work support	5.85
12	Solution recommended for site problem not practical	5.73
13	Construction information not detail enough	5.65

Thirteen out of the 19 problems selected for the questionnaire survey were considered as having significant potential impact. Experienced industrial practitioners were invited to highlight the problems that help to explain the survey results, some of their insights have been summarised below.

- Most of the local workers have little knowledge of site surveying techniques. They cannot set out their works unless main contractor can accurately mark the reference points on the work place and provide sufficient construction information.
- Sub-contractors have to split their site operations into several phases if the required interfacing works are not completed accurately on time. Site progress would be seriously affected and consequently additional cost would be incurred due to double handling of work.
- Most local sub-contractors are employed on a labour-only contract basis. Sub-contractors cannot proceed their works without sufficient material, plant and temporary work supports such as power and water supply, lighting and fresh air supply, and scaffolding from the main contractor.
- Due to tight project programme, sub-contractors have to perform the work with little time to digest the construction information. Clear and sufficient construction information could help them to investigate the potential site problems. Sub-contractors cannot efficiently and effectively organise their resource for the project if they always have very short notice for commencing the site work and the working instructions are always revised at the last minute.
- Sub-contractors sometimes need to revise or even to suspend their work due to unforeseen site problems. This can consume unnecessary manpower if practical solutions are not recommended by the main contractor early enough.

Aggregated importance score

Aggregated importance score for each problem is taken as the combined score of frequency of occurrence and the potential degree of impact. Figure 1 below summarises the aggregated importance scores for the problems on sub-contractors' performance in a descending order of priority.

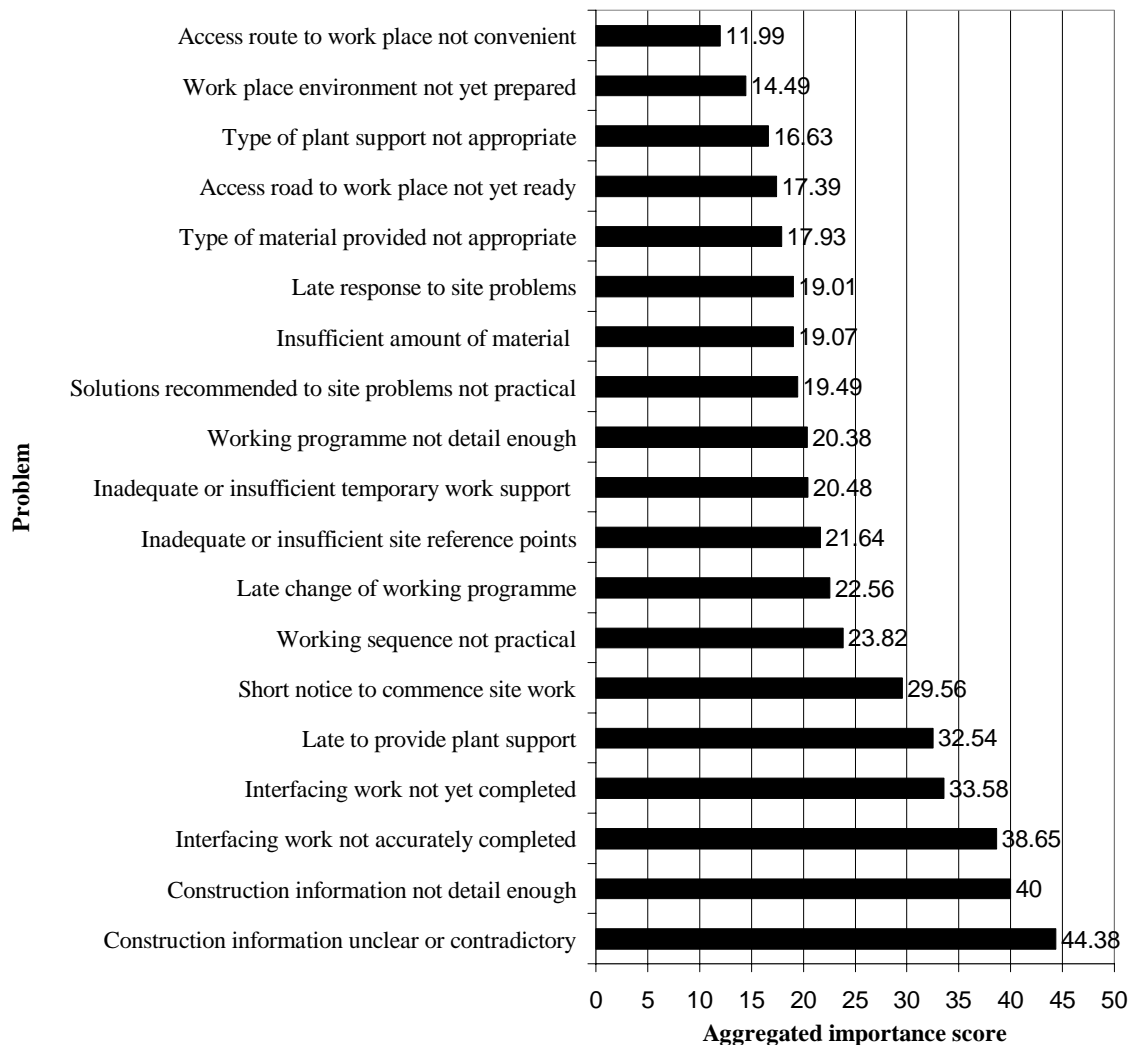


Figure 1: Aggregated importance score for problems to sub-contractors' performance

Unclear and contradictory construction information, and insufficient construction information were the top two essential problems. These two problems have high aggregated importance score because they happen very frequently in the local building construction projects and have significant impacts to site works.

Although incomplete interfacing works, inaccurate interfacing works and failure to provide plant support on time may not frequently happen, they are still the third, fourth and fifth most important problems because when they do happen they can induce a considerable consequential problems if they are not handled properly.

Time is the most important performance criterion used by the local main contractors to evaluate sub-contractors' performance (Ng and Price, 2005). Accordingly, the main

contractors would try to avoid having too short notice to commence site work, impractical working sequence and late change of working programme. This has lowered their aggregate importance scores even though their degree of potential impact scores are all above 6.

Although inadequate or insufficient site reference points is the most influential problems to sub-contractors' site works, it is only the ninth essential problem because most main contractors have already established a strong site surveying team to handle the setting out work for their projects.

Aggregated importance score for the eight main types of problems

In this study, the problems were classified into eight types of problems. It was assumed that the aggregated importance score for each type is the mean of the aggregated importance scores of all the problems in that group. This is a reflection to the importance of each type of problem to the sub-contractors' performance. Table 4 below shows the aggregated importance score for each type of problem in a descending order of priority.

Table 4: Aggregated importance score for the eight main types of problems

Rank	Types of problems	Aggregated importance score
1	Construction information	42.19
2	Interfacing works by other sub-contractors	36.09
3	Working programme	24.18
4	Plant support	23.89
5	Response to site problem	20.00
6	Preparation for work place	19.90
7	Material support	18.48
8	Access to work place	14.53

The aggregated importance scores for construction information and interfacing works were well above the other problems. Working programme and plant support were the third and fourth important types of problems. Response to site problem and preparation for work place were of almost equal importance. Access to work place had the least impact to sub-contractors' performance.

CONCLUSIONS

Based on literature and advice from experienced industrial practitioners, nineteen common problems caused by the main contractors during the construction stage that could hinder sub-contractors' performance on building projects in Hong Kong have been identified. These problems were classified into eight main types of problem associated with sub-contractors' site works.

This paper revealed the six most frequent problems on building projects. Problems relating to construction information and interfacing works were found to be the most frequent problems. Main contractors were often late to provide plant support to sub-contractors' works and respond to site problems.

Thirteen problems were identified as having significant impact to site works. Site reference points and interfacing works were found by far to have the most significant impact on subcontractors' performance.

Aggregated importance scores for the problems were calculated to reflect their degree of importance due to their frequencies and impacts. The results shows that problems related to construction information and interfacing works were considered to be the most important problems to sub-contractors' works.

The ranking of the aggregated importance score for the type of problem was used to develop guidelines to help main contractors enhance their site co-ordination. The guidelines recommend that as a priority main contractors should: improve the quality of construction information provided to sub-contractors; and ensure that the scope of interfacing works for each sub-contract are clearly specified in the sub-contract documents and well co-ordinated through the regular site meetings.

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