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ESSENTIAL SITE COORDINATION PROBLEMS IN HONG KONG BUILDING PROJECTS

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Abstract

In Hong Kong, it is a common practice for main contractors to divide the projects into work packages by trade and sublet to sub-contractors. The interaction between sub-contractors and main contractors is an important determinant to the success of a project. However, there is an increasing complaint from sub-contractors that they cannot perform to their full capacity because of poor site-coordination by main contractors. This paper aims to identify and categorize the common site coordination problems in Hong Kong Building Projects. Thirty-eight common site-coordination problems were identified through literature and they were classified into six main categories of problems: Construction document; Site management; Site layout; Equipment support; Material support; and Preparation of site area. A questionnaire survey was conducted to analyze the frequency of occurrence (F.I.) and degree of severity (S.I.) of the problems to the projects. The aggregated importance (IMP.I.), taking into account of the frequency of occurrence and degree of severity, of problems on sub-contractors' time performance were ranked. *Frequent changes of construction works* was found to be the most important site coordination problem. Most of the important problems caused the delay to subcontract works were primarily related to Construction document.

1 Introduction

In Hong Kong, main contractors tend to sublet most of the works to subcontractors. The subcontracting work packages enable the main contractors to decentralize and minimize potential risk throughout projects and attract the professional knowledge of subcontracting organizations. The good performance of subcontractors definitely contributes to the success of the construction project. However, subcontractors have criticized that they cannot perform effectively on site owing to the un-fulfillment of main contractors' obligations by providing good site coordination, which creates dissatisfaction with main contractors and the relationship is deteriorated (Kale and Arditi, 2001). Lack of tools and equipment, incomplete drawings, poor site condition and equipment breakdown were the factors affecting construction productivity, regarded as site coordination problems by main contractors (Kakulsawatudom and Emsley, 2001).

Time, cost and quality are the main criteria for measuring the success and performance of projects (Belassi and Tukel, 1996; Hatush and Skitmore, 1997). Completing projects within the specified period is a symbol of efficiency; hence, time is more important in Hong Kong where fast-speed construction of high-rise buildings is needed. Consequently, it arouses the concern on the construction time of subcontractors.

Most publications for site performance focused at the main contractors' level. Only few studies related to subcontractors performance. The aim of this study is to investigate the influences of the site coordination problems caused by main contractors on subcontractors' time performance in local building project.

2 Literature Review

The literature review primarily covered similar studies at main contract level so as to attain useful information for this research.

A multitude of publications have analyzed the causes affecting projects delays in construction industry, both locally and internationally. To investigate roots of delay in 130 public building projects built in Jordan during 1990-1997, it developed a regression model between planned and real project duration for various kinds of building facilities (Al-Momani, 2000). It found that the primary reasons of delays were late deliveries, site conditions, designer, economic conditions, increase in quantity, weather and user changes. A research regarding the analysis of causes of work delays for residential building projects was conducted in Indian construction filed (Megha and Rajiv, 2013). It recognized total 59 reasons under 9 categories which were ranked by weighting on project, owner, contractor, consultant, design, materials, equipment, labour and external groups. Consequently, total 4 causes were common in the ranking list, namely shortage in labours, delay in material delivery, low productivity level of labours and delay in progress payment by owner. 56 factors causing delay of projects were identified and categorized into nine prime groups with various degree of significance to different stakeholders (Assaf et al., 1995). In contractor aspect, it outlined that improper contractor finance, shortage of manpower, slow delivery of materials and errors happened during construction were the main causes influencing the delivery of building works. Also, inadequate construction methods used by main contractors and ineffective planning and scheduling of projects had contributions to delay in construction works. Some researches had been conducted to assess the success factors and time performance of Hong Kong construction projects. A hierarchy was developed to indicate causes having major contributions to working duration in Hong Kong (Chan and Kumaraswamy, 1995). Further study related to the causes of construction delays in Hong Kong were done by evaluating the relative importance again (Chan and Kumaraswamy, 1998). They classified 83 factors controlling construction time into 8 groups, namely plant-related, labour-related,

material-related, external, contractor-related factor, design-team–related, project-related and client-related factors.

Thirty-eight site coordination problems attributed by main contractors affecting subcontractors' construction time performance were identified by literature review. They were categorized into 6 groups: Construction document; Site management; Site layout; Equipment support; Material support and Preparation of site area. Table 1 summarizes the literature findings.

3 Research Methodology

3.1 Questionnaire design

Questionnaire survey method was used to collect views from the industrial practitioners on the importance of the identified common site coordination problems. The questionnaire has 2 main sections. Section A is used to collect the background information of respondents. For section B, it aims to collect the data to analyze the relationship between the common site coordination problems with subcontractors' construction time performance. Respondents were asked to assign a score from 1 (never happen) to 10 (happen in every site operation) to indicate the frequency of occurrence of the common site coordination problems in their projects. Respondents were also requested to indicate their opinions on the potential impacts of site essential site coordination problems on construction time performance. They would rate each problem from 1 (un-severed) to 10 (extremely severe).

3.2 Statistical analysis method

Applying appropriate data analysis approaches is a crucial process in executing a research project (Miller, 1991). In this study, the Importance Index model designed by Assaf and AL-Hejji (2006) and Kadir et al. (2005) was adopted to analyze the frequency of occurrence and the degree of severity of the essential site coordination problems to subcontractors' time performance.

$$\text{Frequency Index (F.I.) (\%)} = \sum a \left(\frac{n}{N}\right) \times \frac{100}{10}$$

In which, a is a constant expressing weighting given to each response (ranging from 1 rarely to 10 always), n is the frequency of responses and N is the total number of responses.

$$\text{Severity Index (S.I.) (\%)} = \sum b \left(\frac{n}{N}\right) \times \frac{100}{10}$$

In which, b is a constant expressing weighting given to each response (ranging from 1 un-severe to 10 very severe), n is the frequency of responses and N is the total number of responses.

Importance Index is a function of Frequency Index and Severity Index that reflects the importance of the essential site coordination problem to time performance of subcontractors.

$$\text{Importance Index (IMP.I.) (\%)} = \text{F.I x S.I.}$$

4 Result

Thirty-three valid replies were received. Around 42% and 15% of the respondents have 6 to 10 and 11 to 15 years of experience in construction industry respectively. All of them were working in construction firms. Around 60% and 40% of the respondents were frontline and management staffs respectively. It is assumed that all common problems have same weighting to their respective category of problems and the index for each category is the mean of the index of all problems in that category. Table 1 presents the results of analysis. In ranking column, it has been classified into 2 types: Ranking (G) shows the ranking of the problems in its respective group whilst Ranking (O) shows the ranking of that group of problem.

No.	Site Coordination Problems	Frequency			Severity			Importance		
		Index	Ranking(G)	Ranking(O)	Index	Ranking(G)	Ranking(O)	Index	Ranking(G)	Ranking(O)
A	**Construction Document**	**0.618**		**1**	**0.543**		**2**	**0.337**		**1**
1	Delay in approval construction process	0.558	5		0.539	3		0.301	4	
2	Delay in providing construction documents and information	0.685	2	(3)	0.533	4		0.365	2	(3)
3	Mistakes and discrepancies in documents	0.630	3	(4)	0.570	2	(9)	0.359	3	(5)
4	Unclear details and specification of information	0.715	1	(1)	0.582	1	(5)	0.416	1	(2)
5	Poor quality document	0.581	4	(9)	0.515	6		0.299	5	
6	Lack of providing documents and drawings	0.539	6		0.521	5		0.281	6	
B	**Site Management**	**0.569**		**2**	**0.563**		**1**	**0.318**		**2**
7	Frequent changes of construction works	0.691	1	(2)	0.618	1	(1)	0.427	1	(1)
8	Late changes of construction works	0.521	9		0.569	5	(10)	0.296	8	
9	Delay in making decisions of construction works	0.552	7		0.527	9		0.291	9	
10	Use improper construction methods	0.576	3	(10)	0.552	7		0.318	5	(10)
11	Use ineffective planning and scheduling of works	0.533	8		0.564	6		0.301	7	
12	Lake of planning construction works	0.564	6		0.587	3	(4)	0.331	3	(8)
13	Frequent reworks or repair	0.612	2	(5)	0.588	2	(3)	0.360	2	(4)
14	Frequent remeasurement of provisional works	0.491	10		0.509	10		0.250	10	
15	Unclear construction orders	0.570	5		0.575	4	(8)	0.328	4	(9)
16	Short announcement of starting site works	0.575	4		0.545	8		0.313	6	
C	**Site Layout**	**0.548**		**3**	**0.519**		**5**	**0.285**		**3**
17	Not ready for providing temporary access	0.589	1	(7)	0.515	3		0.303	2	
18	Not convenient for temporary assess	0.515	6		0.467	5		0.241	6	
19	Lack of space for constructing temporary facilities	0.551	2		0.491	4		0.271	5	
20	Lack of space for working	0.538	5		0.539	2		0.290	4	
21	Lack of space for storage	0.550	3		0.552	1		0.304	1	
22	Use distant location for storage	0.545	4		0.552	1		0.301	3	
D	**Equipment Support**	**0.516**		**4**	**0.525**		**4**	**0.272**		**4**
23	Not available for equipment	0.532	2		0.521	3		0.277	2	
24	Use inappropriate equipment	0.485	4		0.521	3		0.253	5	
25	Use of out-dated equipment	0.509	3		0.533	2		0.271	3	
26	Frequent breakdowns of equipment	0.509	3		0.503	4		0.256	4	
27	Late delivery of equipment on site	0.582	1	(8)	0.576	1	(7)	0.335	1	(7)
28	Provide low productivity and efficiency of equipment	0.479	5		0.497	4		0.238	6	
E	**Material Support**	**0.504**		**5**	**0.533**		**3**	**0.271**		**5**
29	Not available of materials	0.473	3		0.491	5		0.232	4	
30	Use inappropriate materials	0.455	5		0.485	4		0.221	5	
31	Late delivery of materials on site	0.611	1	(6)	0.581	2	(6)	0.355	1	(6)
32	Frequent damage of materials	0.466	4		0.509	3		0.237	3	
33	Provide poor quality of materials	0.514	2		0.600	1	(2)	0.308	2	
F	**Preparation Of Site Area**	**0.492**		**6**	**0.510**		**6**	**0.252**		**6**
34	Delay in providing temporary supports	0.484	3		0.479	3		0.232	3	
35	Insufficient or improper temporary supports	0.527	1		0.568	1		0.299	1	
36	Delay in providing services from utilities	0.508	2		0.558	2		0.283	2	
37	Insufficient or improper services from utilities	0.473	4		0.473	4		0.224	4	
38	Improper site reference points	0.467	5		0.473	5		0.221	5	

Table 1 Ranking of site coordination problems based on Frequency, Severity and Importance Index

5 Discussion

5.1 Frequency of occurrence (F.I.)

Table 2 shows those problems with Frequency Index higher than 0.6 in a descending order of priority.

Ranking	Problem	Frequency Index
1	Unclear details and specification of information	0.715
2	Frequent changes of construction works	0.691
3	Delay in providing construction documents and information	0.685
4	Mistakes and discrepancies in documents	0.630
5	Frequent reworks or repair	0.612
6	Late delivery of materials on site	0.611

Table 2 Most frequently occurred problems

Three out of six most frequently occurred essential site coordination problems are related to Construction document group. The mean index of this category is the highest (F.I. = 0.618). Unclear details and specification of information is the most frequently occurred problem (F.I. = 0.715). This result is in line with the finding of Battaineh & Odeh (2002) and Sambasivan (2007). In local building construction industry, the project duration is critical because of high land price (Ng and Price, 2002). With very tight project schedule, main contractors have to finish a number of activities on time with little time to comprehend the required construction documents and to manage the subcontractors. High quality information should be resulted from careful gathering and analysis with teams, scrutiny of recorded information and manipulation of data through software (Hampson and Mohamed, 2002).

Frequent changes of construction works is the second frequently occurred issue (F.I. = 0.691). It is quite common that client changes their project requirements frequently and also they always underestimate the impacts to the project. Design changes may happen frequently in architectural, structural, plumbing or site work perspectives of building works (Hampson and Mohamed, 2002). Also updated information may not be available to subcontractors on time due the multilayered subcontracting system.

A research about significant factors causing time-overrun was conducted in Hong Kong building projects (Dissanayaka and Kumaraswamy, 1999), it was found that 'Levels of complexity due to changes: Frequency and significance of change order or variations' gained a high Significant Level (0.95), which is similar to the finding of this study.

Frequent rework and repair (F.I. = 0.612) is another frequently occurred problem. In a report in Chile, it mentioned that the general types of repairs may be defined as changes of working orders, design errors or lack of project definition (Rivas et al., 2011). Also, he found that on-site errors and misunderstandings may cause reworks. Some construction works carried out by main contactors may not meet the standard of Code of Practice. Sometimes, to lower the cost, main contractors may use

inconsistent equipment rather than those approved by supervision team, causing progress delay to subcontractors with little time usage and reduction in productivity.

Late delivery of material on site is another main concern. Material is so important to a project that in general accounts for 50% of project sum. The cause to this coordination problem is complicate as it involves the control at various stage of material acquisition including procurement, inspection, transportation, handling and storage before and during construction.

Frequent damage of materials problem has the lowest index (F.I. = 0.466).

5.2 Degree of Severity (S.I.)

The top five severe problems are shown in Table 3. Three out of the five most severe site coordination problems are related to Site management group. This category has the highest mean severity index (S.I. = 0.563) in the study. In this category, S.I. of Frequent changes of construction work is the highest. About a research about the percentage of changing construction costs to final project cost, 40% of all construction projects undergo more than 10% change, as measured by the ratio of final project costs to estimated project costs. When change exceeds 20%, productivity would fall below planned rates. For the statistic on rework value, the study also realized that the gross value of rework and repair was up to HK$48.3 billion contributing to over 53.6% of whole construction market in 2006, revealed the seriousness of it (Polytechnic University of Hong Kong and the University of Hong Kong, 2008). Poor planning and interfacing works frequently leaded to changes of works and rework.

The S.I. for *Providing poor quality materials* (S.I. = 0.6) is the second highest. Ng & Price (2005) had the same opinion with this result. Many local sub-contractors are employed under the labour-only contractual arrangement such that they could hardly finish the works on time without the steady supply of adequate quality of construction material.

Improper site reference points is the least serious problem to subcontractor's time performance that is mainly because most main contractors have already established a professional site surveying team to tackle the setting-out works for projects (Ng & Price, 2005).

Ranking	Problem	Severity Index
1	Frequent changes of construction works	0.618
2	Provide poor quality of materials	0.600
3	Frequent reworks or repair	0.588
4	Lake of planning construction works	0.587
5	Unclear details and specification of information	0.582

Table 3 Top five severe problems

5.3 Importance Index (IMP.I.)

Importance index (IMP.I.) is calculated by combining the index of Frequency of Occurrence (F.I.) and Degree of Severity (S.I.). Problems with IMP.I. higher than 0.25 are regarded as important problems.

As shown in Table 1, 20 out of 38 common site coordination problems have IMP.I. higher than mean index (0.294). Top 10 most important problems are presented in Figure 1. Top 5 ranking problems are selected for discussion.

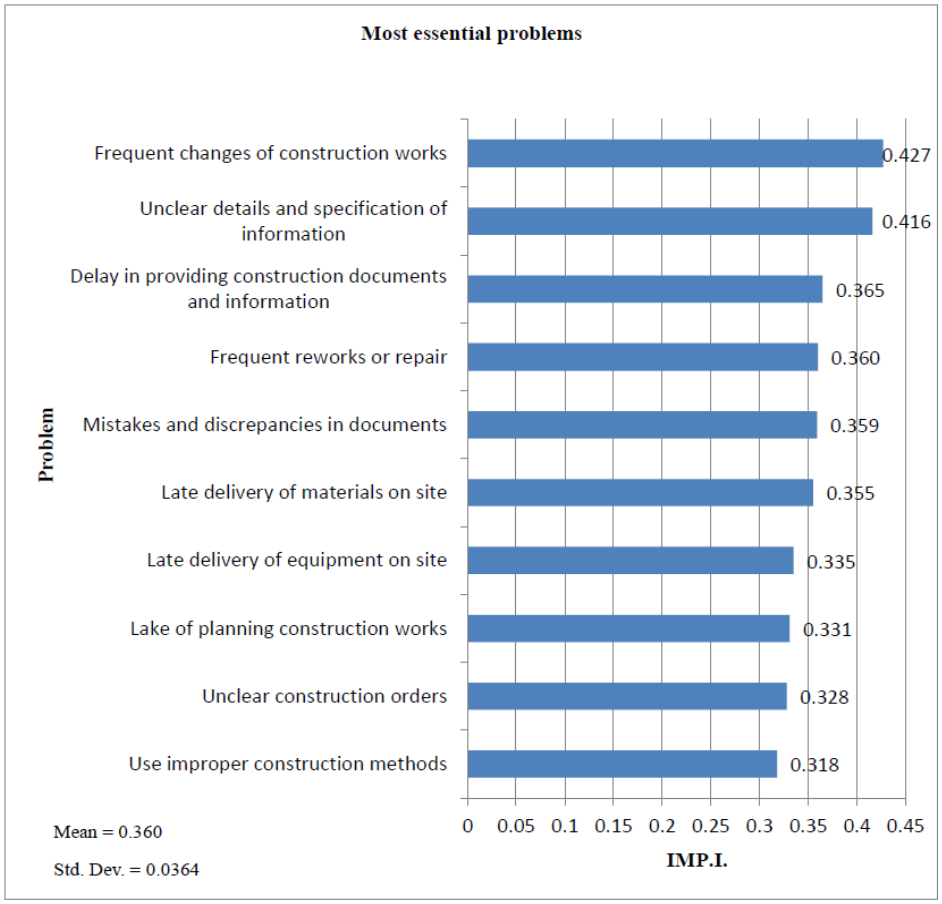

Figure1 Most Important Problems

Frequent changes of construction work and *Unclear details and specification of information* are the top two important site coordination problems that adversely affected subcontractors' time performance as both of them have IMP.I. higher than 0.4. These two problems happened frequently at local building works and also had significant impact to site works. Five out of top 10 problems are related to Site management. Three out of the top 10 problems are under the Construction documentation group. This indicates that these two groups of problems have significant contribution to the delay of the subcontractor work.

Frequent changes of construction works is also closely related to frequent reworks and repair problem. Construction errors in HK projects demand frequently reworks which were mainly due to poor skills and experience of the operators of main contractors on site work (Palaneewaran and Ramanathan, 2007). Late discovery of the errors would have significant impacts on subcontractors' time performance.

Unclear details and specification of information (IMP.I. = 0.416) and Delay in providing construction documents and information (IMP.I. = 0.365) are the second and third important problems. The amount of subcontract packages in local building projects is summarized to around 17 to 54 (Lai, 1987). Under this colossal multi-layered subcontracting system, main contractors' instructions may take a long path to pass through several layers of subcontracting before reaching the workers that are directly responsible for the production works. Owing to the long-path communication path, the content of the instructions may even be misrepresented.

Mistakes and discrepancies in documents is also an important problem affecting subcontractors' time performance (IMP.I. = 0.359). However, from Table 3, its degree of severity is slightly low (S.I. = 0.57). Most of the local main contractors have already well established their document control system under ISO 9001 system as it is a mandatory requirement of most of the government projects. However, due to rapidly increasing of project complexity in terms of design and scale of work as well as very short preconstruction preparation time, this problem occurred frequently leading to high important index.

6 Conclusion and Recommendation

The ranking of the site coordination problems aims to provide information for main contractors to prepare guideline to better coordinate the sub-contract works on site. Thirty-eight site common site coordination problems caused by main contractors that adversely affected sub-contractors' time performance in local building projects have been identified through literature review, which were then classified in six groups of problems. Through questionnaire survey, the frequency of occurrence of these problems and their degree of severity to time performance of subcontractors were investigated. Aggregated Importance Index of the problems was calculated for ranking their importance on subcontractors' time performance in local building project. This study has identified seventeen frequently occurred problems. Among them, *Unclear details and specification of information* is the most frequently occurred one. Twenty problems were found as having significant impacts to subcontractors. *Frequent changes of construction works* and *Poor quality of materials* are the most essential problems. In the Importance Index analysis*, Frequent changes of work* was found to be the most important problem whilst *Improper site reference points* is the least important problem during construction stage.

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