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Evaluation of Common Delay Causes of Construction Projects in Singapore

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Abstract: The objectives of this paper were to identify and evaluating the common delay factors among owners, consultants and main contractors in building projects in Singapore. The interview and questionnaire method were used in this research. Randomly distributed questionnaire technique was applied to select samples of 74 various construction practitioners consisting of owners, consultants and main contractors to evaluat the severity of the 35 identified delay factors. The project investigated in this study included residential building and office building projects. The results found that delay in progress payment by owner, adverse weather conditions, main contractor financial problems, evaluation of completed works and act of god factor caused mostly severe delay in building construction project.

Key words: Construction delays, building construction, Singapore.

1. Introduction

The characteristic of construction industry is uncertainties, unpredictability and susceptible to understandings leading to delays. Delays in construction can affect the overall project participants adversely. It is the common interest of all parties to avoid the delay as much as possible at the first place and to minimize then even if the delays arise. Davision and Mullen [1] gave the concept of delay as the extension of time beyond planned completion dates traceable to the contractors. While, Aibinu and Jagboro [2] defined the concept of delay as situation when the contractor and the project owner jointly or severally contribute to the non-completion of the project within the original or the stipulated or agreed contractor period. The duration of project is normally specified by the owner and contractors have responsible to ensure the completion of the project within the owner's time frame. Construction researcher and practitioners have recently begun to emphasize the need for developing the concept of construction time performance to be used by clients, consultants and contractors [3]. Nonetheless, delay in construction projects have still been found from articles and research papers. Similarly, Chalab and Camp [4] conducted a review on project delays in developing countries during planning and construction stage. In their study, they found that the contractual disagreement caused both delay and cost overruns on the early stages of construction. Rwelamila and Hall [5] found that the timely completion of a project was frequently seen as a major criterion of project success. In Australia, Bromilow [6] found that only one-eight if building contracts were completed within the scheduled completion dates and the average time overrun exceeded 40%. Wilson [7] examined the role of the owner and architect/engineer's roles in the prevention delay and resolution of construction claims. Wilson also summarized the causes of construction claims which include change orders, adverse weather and unclear contract agreement.

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2. Literature Review

Delay is generally acknowledged as the most common, costly, complex and risky problem encountered in construction project. Construction

project can be susceptible to considerable pressure on the time delay. Such pressure environments lead to extension of time and cost. Delays in construction may be caused by one or a combination of several reasons. It may start with a simple reason and lead to a substantial set of interrelated complex disputes in contract agreement. Most of the typical delays are caused by factors such as unrealistic contract duration and cost, differing site conditions, change orders, delays, impact and ripple effects of delays, evaluation the quality and quantity of works, owner furnished items, difference in the interpretation of plans and specifications, unfulfilled duties, acceleration, inefficiency and disruption [8-11]. Facts about site conditions that are overlooked at the bidding stage could increase the cost and the risk of disagreement. During construction period, the conflict among owner and main contractor has become increasingly prone activity. Cost overruns may amount to a substantial percentage of the overall contract value and delays may reach disturbing proportions. The allocation of risk among the owner, the main contractor and the designer is stated in the construction contract. However, the construction contract is typically prepared by the owner who ensures that a considerable portion of the risk rests with the main contractor. The main contractor therefore faces a multitude of risk among which are inflation, strikes, labor problems, adverse weather, accidents, shortages of materials and staffs and unforeseen conditions at the construction site. Imbalances in risk allocation may eventually end up in disputes between involved parties and probably seek for settlement in court. Over the past decades, construction practitioners have tried to develop and implement the right contractual methods which fit the best approach of their needs and minimizing delays in construction project. Nonetheless, construction delays have still been found from research papers. Assaf and Al-khali [12] found extensive of 56 causes of disputes over delay identified and reported that the contract disagreement was one of their main delay causes in large building projects. Ayman [13] conducted a survey on causes of delay on public projects in Jordan. The results indicated that designing, change orders, weather, site conditions, late deliveries, economic conditions and increase in quantity were the main causes of dispute and consequently delay construction schedule. Similarly, Odeh and Battaineth [14] reported that interference, inadequate contractor experience, financing and payment, labor productivity, slow decision making were five most important causes of dispute and delay in construction project with traditional contract. Kululanga *et al*., [15] identified four sources of delay in construction; errors, defects and omissions in the contract documents, underestimating the real cost of the project in the beginning, changed conditions and stakeholders involved in the project. In fact, no project can be considered shielded from a potential delay. Such delay can lead to significant financial damages. The degree of delay is depended on its nature of cause, content and complexity of contract agreement. Walton and Dutton [16] found that conflicts in inter-organizational resulting in low trust and low respect which in turn has an adverse impact on performance. It required an effort and support from legal, design and construction team in order to mitigate the threat of delay among construction team. Therefore, the delay should be clear and understood by all parties, especially the main contractor so that they know how to avoid delay risks in a way that agreed completion of project date can be met.

3. Methodology

The data collection process involved two stages. The first stage consisted of literature reviews for information on the causes of delay in other countries and non-structured interviews of 15 key players involved in the implementation process. The purpose of interviewing the key players was essentially to validate a preliminary set of construction delay causes gleaned from the literature and to determine from their experience other factors which cause construction

delay in buildings projects in Singapore. This phase resulted in the identification of thirty-five (35) delays factor. The second stage involved the development of questionnaire incorporating the 35 delays identified and data collection. The questionnaires comprised open-ended and closed-ended questions. A hand-delivered questionnaire method was used in order to mitigate the low respondents. Questionnaire was divided into three main parts. The first part was an introduction to explain the idea and purpose of the survey as well as the definition of the interested area of study. The second part contained general information questions including annual volume, specialization, experience and nationality of the company. The third part concerned the delay factors in building works projects. For each question, the respondents have five options .These are, "most severe", "severe", "moderately severe", "fairly severe" and "none severe". Furthermore, twenty-three of out seventy-four respondents were also available to answer questions relating to the questionnaire. The questionnaire was dispensed to each category of the respondents-clients, consultants and main contractors. The convenience or availability sampling approach was used in the selection of respondents. The survey resulted were analyzed by using the severity index approach and the Spearman's rank correlation coefficient formula to measure the degree of agreement in the ranking by contraction practitioners. The severity index was helped to be an approximation to tolerance limit data, the degree of delay tolerance to construction performance impact was needed, although there have been as much or more work in this area of dispute tolerance as in other countries. Based on the response to the survey, a severity index was calculated to interpret the degree of seriousness effect of those problems. This index was calculated as follows [17]:

$$\text{Severity index (I)} = \frac{\sum_{i=0}^{4} a_i x_i}{4\sum_{i=0}^{4} x_i} \times 100\% \qquad (1)$$

where

a_i = constant expressing weight given to i^{th} response: i = 0, 1, 2, 3, 4

x_i = variable expressing frequency of i^{th} response

i = response category index of 0, 1, 2, 3, 4 illustrated as follows:

x_0 = frequency of very often response and corresponds to $a_1 = 4$;

x_1= frequency of often response and corresponds to $a_2 = 3$;

x_2 = frequency of moderate response and corresponds to $a_3 = 2$;

x_3 = frequency of not often response and corresponds to $a_2 = 1$;

x_4 = frequency of seldom response and corresponds to $a_1 = 0$;

The respondent to the survey has to select one weight (level of significance) for each factor causing a delay. There are 5 level of weight, ranging from 0 (seldom to cause delay response) to 4 (very often to cause delay response). The summations of all of the respondents' answers are averaged using the Eq. (1). Eq. (1) was used to calculate the severity index for all disputes factors. The index was ranked for domestic and international funded public works projects. The severity index was categorized into five levels. The 0-15.5% was categorized as non severe; 15.5-38.5% is categorized as somewhat non-severe; 38.5-63.5% is categorized as moderately severe; 63.5-88.5% is categorized as severe; and 88.5-100% is categorized as most severe. The categorizations reflect the scale of the respondents answers to the questionnaire. The severity index of a category was the average severity indexes of all its related problems. As an example *I*, the average weighted perceived significance was computed as follows:

$$I = \frac{1}{4} \times \{\frac{a_1 \times x_1 + a_2 \times x_2 + a_3 \times x_3 + a_4 \times x_4}{a_1 + a_2 + a_3 + a_4}\} \times 100\% \qquad (2)$$

All the collected information from the survey were examined and verified for their correctness. Data

cleaning was carried out by checking the frequency and descriptive statistics as well as coding and data entry. The cleaned data were then computed and analyzed to obtain frequency, statistical descriptive analysis and variance. SPSS 12.0 was used for multiple comparison tests. The results of the survey are shown in Table 4 and Table 5.

Rank agreement

The spearman's rank correlation, was a non-parametric measure of statistical dependence between two variables. It offered an advantage of not requiring the normality assumption or homogeneity of variance assumption. The subjected can be compared, as results have one or two outliers, their influence can be negated. In this study, the relationship among different parties or factors was measured. A perfect spearman correlation of +1 or −1 occurred when each of the variables was a perfect monotone function of the other. A +1 indicated a perfect positive relationship among respondents, whereas-1 presented that there was a negative relationship among their respondents opinion. The spearman's rank correlation coefficient, r_s was used to measure and compare between the rankings of owners and main contractors for a single cause of delay. These results were used to test the significance level at 5%. The coefficient can be computed as follows:

$$r_s = 1 - \frac{6\sum d_1^2}{N(N^2 - 1)} \quad (3)$$

where

r_s = Spearman's rank correlation coefficient between two parties.

d = The difference in ranking between ranks assigned to variables for each cause (owner and consultants, owner-contractors, consultants-contractors), and

N = The number of pairs of rank, equals to 35 and 4 for all the delay factor and for the main categories of delays, respectively.

The classification of construction delays were caused by several factors. Based on literature reviews and interviews with owners, consultants and main contractors in the related area of study resulted in the identification of 35 common delay factors. In order to present the identified problems; they were classified into four main delay groups. The classification of main group was based on Assaf et al.'s [18] delay classification; with slightly modified into contract and specification dispute, financial dispute, environment delay and other common issue delay. Each group reflects issues that have a common purpose.

4. Results and Discussions

The informations on respondent among owners, consultants and main contractors with their response rate were shown in Table 1. The total rate of response to the questionnaires was 83%(66). The owners filled questionnaires with success rate of 83%(12) whilst domestic and international main contractors and consultant companies filled questionnaires with success rate of 88%(18), 95%(19) and 67%(15) respectively. The evaluation of overall success rate was considered as excellent [17]. Babbie suggested that any rate of success over 50% can considerably be reported, while the overall value above 60% and 70% can be mentioned as good and excellent respectively. Information on type of building projects were shown in Table 2. While, comparison severity issues in building projects were shown in Table 3. These profiles indicated

Table 1 Type of organization with their response rate.

Organization	Number of questionnaires		Percentage of responses
	Sent	Filled	
Owner	14	12	83
Main contractor (Domestic)	20	18	88
Main contractor (International)	20	19	95
Consultant	20	15	67
Total	74	66	83

Table 2 Profiles of projects.

Classification	Number of projects
Residential building	40
Office Buildings	42
Total	82

Table 3 Comparison severity index factors in building projects.

Delay factors	Owner		Consultant		Main contractor	
	I (%)	Rank	I (%)	Rank	I (%)	Rank
Contract and specification category	56.4	1	52.5	2	56.3	2
Insufficient working drawing details	68.2	5	65.9	5	68.2	5
Inaccurate bill of quantities	62.5	10	54.1	14	63.9	9
Inability of main contractor to sublet the contract during bidding	29.7	31	26.4	31	29.7	33
Violating condition of the contract	52.4	24	44.6	25	52.4	21
Poorly written contract	59.1	11	52.0	17	59.1	14
Unrealistic contract durations	58.8	12	55.1	13	58.4	15
Mistakes and discrepancies in design documents	55.4	20	58.1	9	55.4	20
Change orders	58.1	13	56.8	11	58.1	16
Shop drawing approval	63.5	9	59.5	7	61.5	11
Financial category	55.3	2	54.5	1	57.1	1
Delay in progress payment by owner	86.5	1	76.4	1	72.0	3
Payment system of owner	48.3	27	29.1	30	43.6	29
Main contractor financial problems	77.7	2	70.3	3	77.7	2
Inflation	16.9	33	31.4	29	33.4	32
Exchange rate	21.3	32	25.0	32	33.8	31
Accuracy of project cost estimate	66.6	6	60.5	6	62.8	10
Evaluation of completed works	72.3	4	73.3	2	66.9	6
Fluctuation in materials cost and labor during construction	52.7	23	69.9	4	66.2	7
Environment category	42.8	4	34.5	4	47.7	4
Adverse weather conditions	73.3	3	43.2	26	78.4	1
Act of gods	64.9	7	42.2	27	71.3	4
Unforeseen problem underground	63.9	8	56.4	12	60.1	12
Inappropriate type of foundation	56.1	19	44.9	24	57.4	17
Noise pollution	10.8	35	16.9	34	20.6	34
Dust pollution	11.8	34	13.9	35	16.6	35
Approval environment assessing impact from local authority	53.4	22	34.8	28	65.9	8
Debris and construction junks	8.1	36	24.0	33	11.5	36
Others commons category	52.3	3	50.8	3	49.6	3
Lack of skill labor and engineers	57.8	14	57.1	10	59.5	13
Slow in making decision from owner	47.3	29	47.0	21	49.3	25
Deficiencies in contractor's organization	56.4	17	47.3	22	51.7	23
Unexpected social events	57.4	15	46.3	23	56.4	19
Bureaucratic	56.8	16	46.6	20	52.0	22
Third party delays	49.0	26	52.7	16	48.0	27
Major accidents	54.4	21	51.0	17	48.6	26
Communication with engineers and main contractor	47.0	30	53.4	15	34.8	30
Poor quality of completed works	47.6	28	48.6	19	50.0	24
Poorly done planning and scheduling	49.7	25	58.4	8	45.6	28

that delays in building projects were fairly common in Singapore. Table 4 showed comparison spearman rank correlation and Table 5 summarized the responses in respect of the 5 most delays factor in building projects.

As far as 4 main delay categorizes were compared in Table 5. The contract and specification delay category was rated as the highest severity index by owner with severity of 56.4% while consultants and main contractors had seen differently. Contract and specification delay category was rated as second highest severity index by consultants and main contractors with severity of 52.5 and 56.3%

respectively. From interviewee's point of view, the payment was sometime delayed. This was due to mis-management in cash flow of owner. The delay in payment caused difficulties to main contractors in bringing the performance of completion as it was stated in contract agreement. In multi-international funded projects, it further required authorized representative persons from loan provider to sign necessary documents as double-standard system before it could be further processed. The progress payment was usually transferred to main contractor designated bank account within 14 days after all requested documents had been approved by authorized persons [19-22].

Table 4 Comparison spearman rank correlation.

Delay category	Spearman rank correlation coefficient	
	Main delay categories	All delay factors
Owners-Main contractors	0.8	0.61
Main contractors-Consultants	0	0.89
Owners-Consultants	0.8	0.65

Table 5 Comparison severity index factors in five most delays factor in building projects.

Sector	Five most severity index	Index
Overall	Delay in progress payment by owner	86.5
	Adverse weather conditions	78.4
	Main contractor financial problems	77.7
	Evaluation of completed works	73.3
	Act of gods	71.3
Owner	Delay in progress payment by owner	86.5
	Main contractor financial problems	77.7
	Adverse weather conditions	73.3
	Evaluation of completed works	72.3
	Insufficient working drawing details	68.2
Consultant	Delay in progress payment by owner	76.4
	Evaluation of completed works	73.3
	Main contractor financial problems	70.3
	Fluctuation in materials cost and labor during construction	69.9
	Insufficient working drawing details	65.9
Main contractor	Adverse weather conditions	78.4
	Main contractor financial problems	77.7
	Delay in progress payment by owner	72
	Act of gods	71.3
	Insufficient working drawing details	68.9

4.1 Contract and Specification Delay Category

Interviewees expressed their opinion on contract and specification delay category as delays mostly came from contract and specification which required the provision of clear working drawing. The violating condition of the contract must be monitored and improved. Fair-contract should as much as possible be encourage. It might help to minimize the violation of the contract. While consultants and main contractors gave their expression on contract and specification delay category as sometime contract was weak and specification was unclear. These caused further discussion among owner consultant and main contractor which caused delay in progress if owner had not finalized the project.

It was worth to point out that change orders in large construction project were a consequence of insufficient working drawing details, inaccurate bill of quantities and unrealistic contract durations which affect project durations during the execution of the project. This cause the dispute and delay between owner and main contractor. The main reason why considerable works have been frequently changed by most construction owners is due to sufficient time and effort are not spent at the preconstruction phase for feasibility studies, design and site survey and exploration.

4.2 Financial Delay Category

As far as financial delay category was concerned, the result showed in table 3 that the delay in progress payment by owner factor was rated as the mostly severe delay factor by owner consultant and main contractor. The explanations were given by interviewees as construction projects require steady and in-time payment from owner in order to utilize the payment to pay off their expenses. Delay in payment would have momentum on involved activities in construction projects. Work progress could be delayed or even ceased if the payment had been prolonged. Furthermore, those subcontractors had weaker in financial stability therefore ability to maintain their

works progress was low and vulnerable to went bankruptcy. This was natural of businessman to worry about the payment even though owner had already provided an evident to proof their ability to financial support throughout the project.

4.3 Environment Disputes Category

Adverse weather condition and unforeseen problem underground factor were main concerned factors for owners and main contractors. These factors caused delay for construction. In order to alleviate the delay factors, proper investigate on historic background of construction site should be deployed. Regarding to community health concern, noise and dust pollution factor were becoming a concern issue among owners, consultants and main contractors where construction site was located near high buildings and residential areas. Noise and dust might cause inconvenience for neighbors and pressing a complaint to local authority. Therefore, restricted time was given to main contractors. Approval environment assessing impact from local authority factor is now becoming another concern factor to owners, consultants and main contractors.

4.4 Others Commons Category

Interviewees make a high concerned on lack of skilled labors and engineers factor which owners expressed their deep concerned on consequence of lacking of skilled labors and engineers will effect to overall performance and progress of project as well as quality of works. In order to alleviate the problems group, owners and the main contractors should carefully review all aspects of project in order to ensure that there was a minimum error. Respondents also agreed that inadequate in open and factual communication between client and main contractor will lead to construction delays and disputes as the owners and main contractor unable to express the construction difficulties formally and in detailed so that consultants able to give solution in timely manner. Therefore, both parties should have a positive thinking and good-will when problems arose.

5. Conclusions

The conclusion can be drawn from studied and the results of the analysis of the survey delay problems in building projects in Singapore as follows.

This study has identified and classified 35 related factors of common delay in building projects in Singapore. These common delay factors among owners consultants and main contractors. The main delay category can be classified into 4 main categories: contract and specification, financial, environment and other common.

All main delay categories and their related delay factors were found to have frequency of very often response on the relationship among construction practitioners, Nonetheless, the degree of severity do vary.

Financial delay category was evaluated as moderately severe level by construction practitioners. It appeared that main contractors have paid their attention to financial greater than contract and specification delay category which caused severely delay in construction. Whist, owners gave their first attention to contract and specification delay category which believed to cause severe delay in the construction project.

The delay in progress payment by owner factor was rated as the highest overall severity index with 86.5 percent (severe level).

6. Limitation and Suggestion for Further Research

In this study, the first obstacle is shortcomings in the data can be identified such as the contract agreement and construction experience of the interviewees. The collecting of the company specific data are both costly and time consumed compared with that of publicity available data.

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