

Owner and Contractor Perceptions Toward Factors Causing Delays in Structural and Finishing Works

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Abstract: A construction project comprises of a number of work packages, which are subjected to delays. These delays may be caused by many on-site factors. The aim of this research is to represent owner and contractors perceptions towards delay factors that frequently occur in structural and finishing works. Data for analysis were gathered by distributing questionnaire. A total of 198 sets of questionnaire were gathered and used for subsequent analyses. In general, design changes during construction are perceived by respondents as the most frequent factor to cause delay in all structural and finishing works. The results also show that there are a number of differences between owner's and contractor's perceptions towards the occurrences of the factors. Whilst most contractors concern that information factors related to project design and scope frequently causing delays in construction works, owners consider many contractor originated factors, as most frequent delay causes.

Keywords: Delays, delay factors, structural works, finishing works, work packages

Introduction

Construction possesses unique characteristics compared to other industries. It can be said even, that each project is different from each other, by presenting different problems during the construction process. Design and execution processes under time pressure and limited budget, labor oriented works with temporary assignment, and many change orders involved are few characteristics that may describe its uniqueness [1]. Due this, without appropriate plan and control, construction projects completion can easily slip from their original plan. In other words, delay will easily happen. Longer project completion will absolutely then cause cost overruns and may influence the reputation of the project participants.

For appropriate plan and control, it is thus important to understand what factors frequently cause delay during the construction stage. Further, it will be more valuable to signify factors that cause delays in different construction work packages from the perspectives of the owners and contractors. This paper intends to attain this objective.

Delay Factors in Construction Works

In construction claims, a delay can be described as the time during which some part of the construction project has been extended or not performed due to unanticipated circumstance [2].

An incident of delay may be caused by any factor that influences the construction project, which will be described in the followings.

Delay Factors

Based on the actor, delay may be caused by the contractor, the owner, the designers, other prime contractors, subcontractors, suppliers, labor unions, utility companies, nature, or any number of other organizations and entities, which participate in the construction process [3]. This paper focuses on factors at project level that may occur during the construction stage. Others at more macro level, such as political, social, economical, and law factors are beyond the scope of the study.

After reviewing a number of previous related works [4–9], this paper collected forty-three site related factors causing delay, which were grouped into seven categories, i.e. labor, site characteristics, information, material, equipment, managerial and other factors, as seen in Table 1. Detail explanations for each delay factor can be obtained from Lalitan and Loanata [10].

Construction Works

In general, a building project comprises of five work packages, i.e. preliminary, structural, finishing (architectural), MEP, and sanitary works, in which each may have special characteristics. Therefore attempts to generalize important factors causing delays to all work packages, as most studies cited above did, may have limited value. Since each construction stage may pose specific delay factors. It thus may demand different approach in mitigating them.

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The current study focuses only on structural and finishing work packages. The structural work is sub-packaged into three packages, i.e. lower structure (e.g. foundation and basement), upper structure (e.g. concreting of beam, slab, column structures and steel works) and roofing works (e.g. roof truss and roof tile). Meanwhile the finishing works are sub-packaged into five packages, i.e. floor finishing (e.g. floor tiles), interior masonry, exterior masonry (e.g. brick walls and plastering), interior wall finishing, exterior wall finishing (e.g. painting and doors and windows), and ceiling works (e.g. gypsum, painting). Readers are referred to [9] for more information about the work packages

Table 1. Seven Categories of Delay Factors

<p>Labor Factors</p> <ul style="list-style-type: none"> • Labor shortage • Low productivity • Low skill • Labor turnover • Low discipline <p>Equipment Factors</p> <ul style="list-style-type: none"> • Equipment shortage • Equipment damage • Unskilled operator • Insufficient equipment • Slow delivery of equipment • Low quality of equipment <p>Information Factors</p> <ul style="list-style-type: none"> • Poor communication contractor – owner • Poor communication contractor organization • Design changes before construction • Design changes during construction • Design errors • Slow shop drawing delivery • Slow shop drawing approval • Scope changes before construction • Scope changes during construction 	<p>Material Factors</p> <ul style="list-style-type: none"> • Material shortage • Material damage • Material change • Insufficient material • Poor quality of material • Slow delivery of material <p>Site Characteristics Factors</p> <ul style="list-style-type: none"> • Bad weather • Difficult site condition • Poor access • Local regulation • Adjacent building • Insufficient working area • Insufficient material storage <p>Managerial Factors</p> <ul style="list-style-type: none"> • Insufficient experiment • Slow contractor payment • Owner interference • Poor site layout • Inappropriate work method • Improper planning • Poor work quality • Poor supervision <p>Others</p> <ul style="list-style-type: none"> • Accidents • Force Majeure
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Research Method

The study employed questionnaire survey method to gather the required data. The targeted respondents were contractors and owners. The questionnaire consisted of three major parts, i.e. general information, frequency of occurrences of the delay factors listed in Table 1, and time impact if the delay occurred. This paper will discuss only the results of

the first and second part. For the purpose of the study, the respondents were required to indicate whether a specific delay factor often occurred in a specific construction work package (if any) by choosing the designated boxes.

Table 2 presents an example of the questionnaire in structural works. There, for each delay factor, respondents may choose one or more, or none of the work packages. For example in Table 2, a respondent perceives “labor shortage” frequently occur in lower and upper structural work packages. The complete questionnaire can be gathered from [10].

Table 2. An Example of Questionnaire

No.	Delay Factors	Structural Work Packages		
		Lower Structure	Upper Structure	Roofing
1	Labor shortage	X	X	
2	Bad Weather		X	X

Frequency analysis of delay factors was performed for each work package by calculating the number of respondents (in percentage) selecting the factor. A cut off point of 75% was taken to decide whether the occurrence of an on-site delay factor is frequent or not. For the purpose of comparison, frequency analyses were carried out for different types of respondents, i.e. owner and contractor, for each work package and also overall structural and finishing packages.

Results and Discussions

General Information

A total of 198 respondents, consisting of 160 contractors (81%) and 38 owners (19%), participated in the survey. Most owners and contractors had experiences in more than one type of projects. However, the types of project mostly experienced by the respondents were building and medium to high class residential projects. About 82% and 78% of the owner and contractor respondents, respectively, experienced in building type of project. Table 3 exhibits more general information about the respondents.

Table 3. General Information of the Respondents

No.	Information	Owner	Contractor
1.	No. of respondents	38 (19%)	160 (81%)
2.	<u>Education</u>		
	Bachelor	9 (24%)	40 (25%)
	Diploma & below	29 (76%)	120 (75%)
3.	<u>Projects experienced</u>		
	Building	81.58%	78.13%
	Residential	60.53%	50.00%
	Shop-house	57.89%	42.50%
	Warehouse	23.68%	28.75%

Delay Factors in Structural Works

Table 4 presents the frequency of occurrence (in percentage) of delay factors in each structural work packages perceived by both owners and contractors. The shaded boxes highlight the factors that frequently occur in a specific structural works (indicated by the percentage value of 75% or more). Meanwhile the overall frequency and its respective rank for structural work packages are exhibited in Table 5.

Contractors Perceptions toward Delay Factors in Structural Works

According to the contractors, there are nine delay factors that frequently occur. The followings are the factors in each work package (Table 4).

- *Lower (substructure) works*: difficult site condition (95.63%), slow shop drawing approval (90%), bad weather (85.63%), poor access (85%), design changes during construction (80.63%), design errors (76.25%), and slow delivery of material (75.63%).
- *Upper structure works*: design changes during construction (95.63%), slow shop drawing approval (90%), material shortages (80%), and scope changes during construction (76.88%).
- *Roofing works*: design changes during construction (86.25%), slow shop drawing approval in all structural work packages (81.88%)

Considering the overall frequency (Table 5), two factors are considered by the contractor to frequently occur in overall structural works. They are:

- design changes during construction (87.50%)
- slow shop drawing approval (87.29%)

Owners Perceptions toward Delay Factors in Structural Works

Meanwhile as perceived by the owners, there are twenty factors, which frequently cause delay to structural works. The followings are the factors in each structural work package (Table 4).

- *Lower structure (substructure) works*: poor access (92.11%), difficult site condition (92.11%), bad weather (89.47%), adjacent building (81.58%), poor quality of material (81.58%), slow delivery of material (81.58%), poor site layout (78.95%), insufficient material storage (78.95%), inappropriate work method (78.95%), equipment shortage (78.95%), slow delivery of equipment (78.95%), slow payment to contractor (76.32%), and poor supervision (76.32%).
- *Upper structure works*: insufficient material (92.11%), slow payment to contractor (89.47%), poor quality of material (89.47%), force majeure

in upper structure works (89.47%), material shortage (86.84%), design changes during construction (86.84%), poor supervision (78.95%), labor turnover (78.95%), scope changes during construction (76.32%), slow delivery of material (76.32%), equipment shortage (76.32%), and slow delivery of equipment (76.32%).

- *Roofing works*: slow payment to contractor (76.32%)

For the overall structural works (Table 5), the owners perceive three frequent factors. They are:

- slow payment to contractors (80.70%)
- design changes during construction (78.07%)
- force majeure (75.44%)

Discussions

Both owners and contractors agree that many factors related to construction site (site characteristics factors) frequently cause delays in substructure works, which may include excavation, piling and raft foundation works. Without proper planning and preparation, the construction of deep basement and deep foundation would easily be delayed by heavy rain, which usually generates flooded area.

As for the contractors, they consider information related factors as the most frequent causes of delay in almost all structural works. The information may include changes in design, scope and shop drawings. The results are in line with the previous findings in Indonesia and other countries, which reported design related risks as critical and major sources of construction claims and disputes [11,12,13,14,15,16].

On the other hand, owners note that slow payment to contractor is the most frequent cause of construction delay in all structural works. The owners realize that without timely payment, contractors may not be able or may not want to continue their works, especially for those contractors with limited capital. The owners, as indicated in Table 4, also point out many material factors (e.g. availability and quality) as delay causes, especially in upper structure works, whilst the contractors did not.

It is interesting to see that the owners disagree with the contractors regarding to the factor of slow shop drawing approval as one frequent delay cause. The owners rank the factor low (27th) as opposed to that of the contractors (2nd). In general, it can be said that the owners' perceptions were higher than the contractors' as to the frequency of contractor originated factors, such as poor site layout, inappropriate work method, insufficient material storage, and labor factors.

Table 4. Frequency of Delay Factors (in Percentages) in Each Structural Work Package

No	Delay Factors	CONTRACTORS			OWNERS		
		Sub-structure	Upper structure	Roof	Sub-structure	Upper structure	Roof
	Labor Factors						
1	Labor shortage	61.88	58.75	56.25	73.68	68.42	60.53
2	Low productivity	52.50	60.63	55.00	50.00	60.53	50.00
3	Low skill	48.13	55.63	48.75	47.37	60.53	60.53
4	Labor turnover	37.50	66.25	33.75	63.16	78.95	52.63
5	Low discipline	51.25	69.38	62.50	55.26	65.79	73.68
	Equipment Factors						
6	Equipment shortage	58.75	69.38	58.13	78.95	76.32	57.89
7	Equipment damage	56.25	49.38	45.00	55.26	73.68	52.63
8	Unskilled operator	56.25	51.88	50.00	52.63	36.84	26.32
9	Insufficient equipment	61.25	53.75	46.25	60.53	63.16	57.89
10	Slow delivery of eqpt.	65.00	73.75	51.88	78.95	76.32	55.26
11	Low quality of eqpt.	60.00	68.13	51.88	71.05	71.05	36.84
	Material Factors						
12	Material shortage	62.50	80.00	58.13	71.05	86.84	42.11
13	Material damage	50.00	55.00	46.25	42.11	60.53	15.79
14	Material change	66.25	72.50	55.00	50.00	68.42	47.37
15	Insufficient material	55.63	63.13	51.88	60.53	92.11	44.74
16	Poor quality of material	43.13	48.13	37.50	81.58	89.47	31.58
17	Slow delivery of material	75.63	71.25	50.63	81.58	76.32	55.26
	Site Characteristics Factors						
18	Bad weather	85.63	73.75	58.13	89.47	71.05	52.63
19	Difficult site condition	95.63	30.00	22.50	92.11	42.11	34.21
20	Poor access	85.00	46.25	41.88	92.11	60.53	39.47
21	Local regulation	15.00	16.88	11.25	63.16	44.74	39.47
22	Adjacent building	38.75	43.75	36.88	81.58	60.53	36.84
23	Insufficient working area	61.88	55.00	46.25	71.05	36.84	52.63
24	Insufficient material storage	41.25	45.00	38.13	78.95	57.89	57.89
	Managerial Factors						
25	Insufficient experiment of manager	58.13	60.00	58.75	63.16	71.05	55.26
26	Slow contractor's payment	65.63	67.50	65.63	76.32	89.47	76.32
27	Owner interference	62.50	63.75	53.75	71.05	76.32	57.89
28	Poor site layout	50.00	35.63	31.25	78.95	60.53	52.63
29	Inappropriate work method	47.50	55.63	48.13	78.95	65.79	60.53
30	Improper planning	56.25	55.63	47.50	55.26	52.63	39.47
31	Poor work quality	40.00	46.88	40.63	63.16	55.26	47.37
32	Poor comm. contractor–owner	59.38	63.75	55.63	50.00	57.89	39.47
33	Poor comm. contractor org.	57.50	64.38	64.38	63.16	60.53	36.84
34	Poor supervision	38.13	45.63	36.25	76.32	78.95	21.05
	Information Factors						
35	Design chg before const.	63.13	65.00	55.63	60.53	47.37	34.21
36	Design chg during const.	80.63	95.63	86.25	73.68	86.84	73.68
37	Design errors	76.25	67.50	65.63	57.89	60.53	44.74
38	Slow shop dwg. approval	90.00	90.00	81.88	47.37	63.16	57.89
39	Slow shop dwg. delivery	71.88	59.38	53.13	52.63	68.42	60.53
40	Scope chg before const.	36.25	23.75	18.13	47.37	44.74	36.84
41	Scope chg during const.	66.88	76.88	66.88	68.42	76.32	65.79
	Others						
42	Accidents	23.75	38.13	40.63	31.58	52.63	55.26
43	Force Majeure	67.50	60.63	61.25	65.79	89.47	71.05

Table 5. Frequency and Rank of Delay Factors for the Overall Structural Work

Delay Factors	Contractor		Owner	
	Frequency	Rank	Frequency	Rank
Design chg during const.	87.50%	1	78.07%	2
Slow shop dwg. approval	87.29%	2	56.14%	27
Bad weather	72.50%	3	71.05%	4
Scope chg during const.	70.21%	4	70.18%	7
Design errors	69.79%	5	54.39%	32
Material shortage	66.88%	6	66.67%	13
Slow contractor's payment	66.25%	7	80.70%	1
Slow delivery of material	65.83%	8	71.05%	5
Material change	64.58%	9	55.26%	30
Slow delivery of eqpt.	63.54%	10	70.18%	8
Force Majeure	63.13%	11	75.44%	3
Equipment shortage	62.08%	12	71.05%	6
Poor comm. contractor org.	62.08%	13	53.51%	33
Slow shop dwg. delivery	61.46%	14	60.53%	21
Design chg before const.	61.25%	15	47.37%	39
Low discipline	61.04%	16	64.91%	15
Low quality of eqpt.	60.00%	17	68.42%	9
Owner interference	60.00%	18	59.65%	24
Poor comm. contractor-owner	59.58%	19	49.12%	36
Labor shortage	58.96%	20	67.54%	11
Insufficient experiment of manager	58.96%	21	63.16%	20
Poor access	57.71%	22	64.04%	18
Insufficient material	56.88%	23	65.79%	14
Low productivity	56.04%	24	53.51%	34
Insufficient working area	54.38%	25	53.51%	35
Insufficient equipment	53.75%	26	60.53%	22
Improper planning	53.13%	27	49.12%	37
Unskilled operator	52.71%	28	38.60%	43
Low skill	50.83%	29	56.14%	28
Material damage	50.42%	30	39.47%	42
Inappropriate work method	50.42%	31	68.42%	10
Equipment damage	50.21%	32	60.53%	23
Difficult site condition	49.38%	33	56.14%	29
Labor turnover	45.83%	34	64.91%	16
Poor quality of material	42.92%	35	67.54%	12
Poor work quality	42.50%	36	55.26%	31
Insufficient material storage	41.46%	37	64.91%	17
Poor supervision	40.00%	38	58.77%	26
Adjacent building	39.79%	39	59.65%	25
Poor site layout	38.96%	40	64.04%	19
Accidents	34.17%	41	46.49%	40
Scope chg before const.	26.04%	42	42.98%	41
Local regulation	14.38%	43	49.12%	38

Table 6. Frequency of Delay Factors (in Percentages) in Each Finishing Work Packages

No	Delay Factors	CONTRACTORS						OWNERS					
		Floor	External masonry	Internal masonry	External wall finishing	Internal wall finishing	Ceiling	Floor	External masonry	Internal masonry	External wall finishing	Internal wall finishing	Ceiling
	Labor Factors												
1	Labor shortage	63.75	70.00	54.38	61.88	63.13	69.38	65.79	97.37	68.42	92.11	63.16	71.05
2	Low productivity	50.00	55.63	50.00	52.50	49.38	56.25	57.89	73.68	55.26	76.32	55.26	63.16
3	Low skill	81.88	46.25	61.88	53.75	66.25	73.13	68.42	52.63	60.53	63.16	65.79	68.42
4	Labor turnover	34.38	23.75	26.25	31.25	26.88	31.88	42.11	52.63	42.11	52.63	42.11	42.11
5	Low discipline	48.75	45.00	46.25	44.38	41.88	44.38	50.00	52.63	52.63	57.89	44.74	52.63
	Equipment Factors												
6	Equipment shortage	36.88	34.38	36.88	40.63	36.88	45.63	50.00	73.68	52.63	76.32	55.26	76.32
7	Equipment damage	53.13	43.13	43.75	45.63	43.75	48.13	42.11	50.00	52.63	55.26	47.37	57.89
8	Unskilled operator	33.75	28.75	35.00	42.50	28.13	41.25	13.16	21.05	18.42	23.68	21.05	28.95
9	Insufficient equipment	36.25	42.50	43.13	50.00	48.13	51.25	50.00	50.00	63.16	57.89	57.89	63.16
10	Slow delivery of eqpt.	65.63	35.63	37.50	44.38	36.25	57.50	47.37	50.00	34.21	52.63	34.21	42.11
11	Low quality of eqpt.	36.88	33.13	30.00	46.88	36.88	36.88	28.95	39.47	31.58	47.37	39.47	44.74
	Material Factors												
12	Material shortage	56.88	51.25	50.00	60.00	52.50	55.00	76.32	60.53	65.79	65.79	68.42	52.63
13	Material damage	55.63	50.00	48.75	49.38	48.75	55.00	60.53	42.11	39.47	52.63	52.63	42.11
14	Material change	77.50	47.50	47.50	48.13	70.00	73.75	78.95	47.37	52.63	63.16	60.53	60.53
15	Insufficient material	59.38	49.38	50.00	46.25	45.63	65.00	78.95	73.68	57.89	78.95	68.42	55.26
16	Poor quality of material	76.88	55.00	41.88	46.25	40.00	47.50	60.53	47.37	47.37	57.89	57.89	34.21
17	Slow delivery of material	72.50	63.75	66.88	38.75	46.25	50.63	84.21	71.05	71.05	76.32	71.05	55.26
	Site Characteristics Factors												
18	Bad weather	17.50	49.38	14.38	66.25	20.00	24.38	5.26	86.84	31.58	71.05	15.79	10.53
19	Difficult site condition	16.88	10.63	13.75	15.00	19.38	21.25	31.58	34.21	28.95	26.32	26.32	13.16
20	Poor access	16.88	21.88	15.63	16.88	11.88	16.25	21.05	26.32	23.68	21.05	26.32	10.53
21	Local regulation	5.63	14.38	11.25	13.75	12.50	9.38	26.32	28.95	23.68	31.58	28.95	28.95
22	Adjacent building	11.25	30.00	13.75	28.75	6.25	8.13	26.32	36.84	28.95	28.95	26.32	28.95
23	Insufficient working area	17.50	23.75	21.88	23.13	25.00	17.50	42.11	28.95	31.58	34.21	36.84	36.84
24	Insufficient material storage	37.50	35.00	41.25	30.63	30.63	38.13	71.05	63.16	63.16	50.00	50.00	63.16
	Managerial Factors												
25	Insufficient experiment of manager	43.75	43.75	46.25	43.13	45.63	47.50	55.26	55.26	55.26	60.53	57.89	73.68
26	Slow contractor's payment	36.25	41.88	34.38	36.88	33.75	43.13	73.68	73.68	73.68	73.68	73.68	78.95
27	Owner interference	61.88	70.63	71.88	77.50	73.13	58.75	76.32	57.89	52.63	78.95	76.32	76.32
28	Poor site layout	26.25	30.00	36.88	23.75	23.75	27.50	36.84	42.11	39.47	39.47	39.47	34.21
29	Inappropriate work method	43.13	51.88	54.38	60.63	50.00	47.50	76.32	55.26	55.26	60.53	60.53	73.68
30	Improper planning	46.25	54.38	56.25	65.00	57.50	42.50	65.79	60.53	60.53	60.53	55.26	71.05
31	Poor work quality	43.13	40.63	40.63	45.00	41.88	50.00	63.16	44.74	44.74	65.79	65.79	63.16
32	Poor comm. contractor-owner	53.13	43.75	42.50	47.50	48.13	54.38	52.63	44.74	42.11	60.53	42.11	42.11
33	Poor comm. contractor org.	51.88	43.75	45.00	50.63	47.50	51.25	60.53	39.47	44.74	42.11	47.37	60.53
34	Poor supervision	38.75	32.50	34.38	35.63	35.00	39.38	73.68	55.26	55.26	78.95	78.95	78.95
	Information Factors												
35	Design chg before const.	50.63	16.88	36.88	22.50	45.63	45.63	55.26	39.47	39.47	52.63	52.63	50.00
36	Design chg during const.	83.13	63.75	82.50	66.88	83.13	83.13	94.74	71.05	84.21	84.21	97.37	97.37
37	Design errors	68.13	51.88	71.25	48.13	75.00	63.75	50.00	47.37	47.37	44.74	42.11	57.89
38	Slow shop dwg. approval	91.88	88.75	88.13	85.00	82.50	83.13	55.26	52.63	52.63	52.63	50.00	76.32
39	Slow shop dwg. delivery	73.75	67.50	76.25	74.38	71.88	70.63	60.53	71.05	71.05	71.05	68.42	52.63
40	Scope chg before const.	51.88	40.63	44.38	43.13	50.63	36.88	55.26	44.74	47.37	52.63	50.00	44.74
41	Scope chg during const.	69.38	79.38	82.50	82.50	77.50	78.75	73.68	68.42	52.63	63.16	60.53	68.42
	Others												
42	Accidents	23.75	38.13	19.38	44.38	29.38	39.38	21.05	44.74	23.68	42.11	21.05	44.74
43	Force Majeure	59.38	58.13	63.13	58.13	60.63	56.25	60.53	63.16	55.26	63.16	63.16	65.79

Table 7. Frequency and Rank of Delay Factors for the Overall Finishing Work

Delay Factors	Contractor		Owner	
	Frequency	Rank	Frequency	Rank
Slow shop dwg. approval	86.56%	1	56.58%	22
Scope chg during const.	78.33%	2	64.47%	10
Design chg during const.	77.08%	3	88.16%	1
Slow shop dwg. delivery	72.40%	4	65.79%	8
Owner interference	68.96%	5	69.74%	6
Low skill	63.85%	6	63.16%	14
Labor shortage	63.75%	7	76.32%	2
Design errors	63.02%	8	48.25%	30
Material change	60.73%	9	60.53%	17
Force Majeure	59.27%	10	61.84%	16
Slow delivery of material	56.46%	11	71.49%	4
Material shortage	54.27%	12	64.91%	9
Improper planning	53.65%	13	62.28%	15
Insufficient material	52.60%	14	68.86%	7
Low productivity	52.29%	15	63.60%	12
Material damage	51.25%	16	48.25%	29
Poor quality of material	51.25%	17	50.88%	25
Inappropriate work method	51.25%	18	63.60%	13
Poor comm. contractor org.	48.33%	19	49.12%	27
Poor comm. contractor-owner	48.23%	20	47.37%	31
Equipment damage	46.25%	21	50.88%	24
Slow delivery of eqpt.	46.15%	22	43.42%	33
Insufficient equipment	45.21%	23	57.02%	21
Low discipline	45.10%	24	51.75%	23
Insufficient experiment of manager	45.00%	25	59.65%	19
Scope chg before const.	44.58%	26	49.12%	26
Poor work quality	43.54%	27	57.89%	20
Equipment shortage	38.54%	28	64.04%	11
Slow contractor's payment	37.71%	29	74.56%	3
Low quality of eqpt.	36.77%	30	38.60%	34
Design chg before const.	36.35%	31	48.25%	28
Poor supervision	35.94%	32	70.18%	5
Insufficient material storage	35.52%	33	60.09%	18
Unskilled operator	34.90%	34	21.05%	43
Accidents	32.40%	35	32.89%	38
Bad weather	31.98%	36	36.84%	36
Labor turnover	29.06%	37	45.61%	32
Poor site layout	28.02%	38	38.60%	35
Insufficient working area	21.46%	39	35.09%	37
Poor access	16.56%	40	21.49%	42
Adjacent building	16.35%	41	29.39%	39
Difficult site condition	16.15%	42	26.75%	41
Local regulation	11.15%	43	28.07%	40

Delay Factors in Finishing Works

Similar to the above analyses, Table 6 portrays the frequency analysis of delay factors in each finishing work packages and Table 7 for the overall finishing work.

Contractors Perceptions toward Delay Factors in Finishing Works

Nine factors are indicated by the contractors to frequently occur in finishing work packages (see the shaded boxes in Table 6). For each work package, the followings are the most frequent delay factors.

- *Flooring works*: slow shop drawing approval (91.88%), design changes during construction (83.13%), low labor skill (81.88%), material changes (77.5%), and poor quality of material (76.88%).
- *External masonry works*: slow shop drawing approval (88.75%) and scope changes during construction (79.38%).
- *Internal masonry works*: slow shop drawing approval (88.13%), design changes during construction (82.5%), scope changes during construction (82.5%), and slow shop drawing delivery (76.25%).
- *External wall finishing works*: slow shop drawing approval (85%), scope changes during construction (82.5%), and owner interference (77.5%).
- *Internal wall finishing works*: design changes during construction (83.13%), slow shop drawing approval (82.5%), scope changes during construction (77.5%), and design errors (75%).
- *Ceiling works*: design changes during construction (83.13%), slow shop drawing approval (83.13%), and scope changes during construction (78.75%).

Considering the overall finishing works (Table 7), the contractors perceive three most frequent factors causing delays, i.e.

- slow shop drawing approval (86.56%)
- scope changes during construction (78.33%)
- design changes during construction (77.08%)

Owners Perceptions toward Delay Factors in Finishing Works

Thirteen factors are considered by the owners to frequently cause delays in finishing work packages (Table 6). They are described below as grouped by work package.

- *Flooring works*: design changes during construction (94.74%), slow delivery of material (84.21%), material changes (78.95%), insufficient material (78.95%), material shortage (76.32%), owner interference (76.32%), and inappropriate work method (76.32%).

- *External masonry works*: labor shortage (97.37%).
- *Internal masonry works*: design changes during construction (84.21%).
- *External wall finishing works*: labor shortage (92.11%), design changes during construction (84.21%), insufficient material (78.95%), owner interference (78.95%), poor supervision (78.95%), low labor productivity (76.32%), equipment shortage (76.32%), and slow delivery of material (76.32%).
- *Internal wall finishing works*: design changes during construction (97.37%), poor supervision (78.95%), and owner interference (76.32%).
- *Ceiling works*: design changes during construction (97.37%), slow contractor's payment (78.95%), poor supervision (78.95%), equipment shortage (76.32%), owner interference (76.32%), and slow shop drawing approval (76.32%).

As for the overall finishing works (Table 7), the analysis indicates two most frequent delay causes perceived by the owners, i.e.:

- design changes during construction (88.16%)
- labor shortage (76.32%)

Discussions

Similar to the structural works, information related factors (changes in design and scope, shop drawing) are cited by the contractors as the most frequent delay causes in all finishing works. Meanwhile the owners only agree with design changes during construction as the most frequent delay cause (ranked 1st).

The owners give more attentions to contractor originated factors, such as labor shortage, slow delivery of material and poor supervision (ranked 2nd, 4th, and 5th respectively). They also believe in material factors as the delay causes in floor finishing works. In overall the owners place higher percentage values than the contractors for the delay factors under the contractors responsibility.

Conclusions

This paper has presented the owners' and contractors' perceptions toward on-site factors frequently causing delays in two major construction work packages, i.e. structural and finishing works, and their respective sub-work packages. The most frequent and common factors causing delays in structural and finishing works as expressed by the contractors are associated with design information. The frequent occurrences of changes in design and scope of work during construction, which are usually initiated by the owners, may indicate that attentions

given to the design and planning stage are still inadequate. It will be more beneficial if the changes can be accommodated before the construction takes its place.

As a part of quality assurance program, shop drawing submitted by the contractor should be approved by owner (or its representative) before the construction works can take place. It was found that slow approval frequently occur to both work packages. To effectively reduce the problem, there should be a standard operating procedure regulating the shop drawing approval, including the time frame for submittal and review. As can be seen in the analyses above, the contractors themselves are also slow in delivery of the shop drawings. A computerized shop drawing administration system would be helpful in this case.

In structural works, factors related to site characteristics (such as bad weather, difficult site condition and poor access) have been considered by the respondents to frequently occur specifically in substructure works. In general these factors cause delay more in structural works than in finishing works. Factors related to equipment are also experienced more in structural works. This is because they utilize more equipment, such as the piling machines, excavator, mobile and tower cranes, and so on.

Some differences in owners and contractors perceptions are revealed in this study. Basically the contractors consider the owners as the main source of the delay in construction works. On the other hand, the owners place many factors originated by the contractors (related to material, labor, and managerial factors) as crucial in generating delays.

It should be noted that the principal purpose of identifying the frequent delay factors is to manage them before a project starts. Accordingly, one of the most interesting and important things is the way to respond to the factors. For an example, Minato and Ashley [17] suggest that it may be more beneficial to manage common risks (delay factors) at the corporate level rather than at project level. Thus it will be beneficial if analyses are conducted to compare the delay factors in structural and finishing works. This may result in two categories of factors, namely common and specific factors. Construction personnel equipped with the knowledge of delay factors that commonly occur in construction and also specifically in individual work package may consider different strategy in dealing with the risks. The authors will present the findings in another paper.

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