

CAUSES OF DELAYS IN THE CONSTRUCTION PHASE OF CHINESE BUILDING PROJECTS

Abstract

Purpose - Delays during construction are one of the common scenarios in the construction industry. This research aims to identify the primary causes of delays in the construction phase of building construction projects in China.

Design/methodology/approach – Questionnaire survey approach was adopted across the four typical cities in China, namely, Beijing, Shanghai, Chongqing, and Shenzhen. One hundred and fifteen sets of valid responded questionnaires were collected and analysed.

Findings - The results show that the causes of variations, delays in progress payments, exceptionally low bids, and subcontractors' poor performance and communication issues were the most important causes of delays in China.

Originality/value - This research is the first questionnaire survey on the causes of delays in the construction phase of building construction projects in China. The comparative analysis shows two unique causes of delays in the Chinese construction industry, such as “difficulty in claiming indemnity” and “unreasonable upfront capital demanded by client”. It also reveals different ranked causes of delays as per distinguished political and economic situations in China. The research findings can be referred by construction projects in other countries that are funded or partnered with China.

Keywords: Delays; Time Overrun; Construction Phase; Building Projects; Risk Management; Empirical Analysis; Comparative Analysis; Construction Projects; Empirical Analysis; China.

1. INTRODUCTION

Completion on time is one of fundamental performance indicators in construction projects. In particular, schedules are used by project managers to control and manage construction projects and, thereby, contribute to the projects' performance (Zavadskas et al., 2014). However, the progress of projects is often poorly controlled. Causes of cost overrun have been studied (Flyvbjerg 2004). For example, the lack of control increases project costs (Sinesilassie et al., 2017) and reduces project quality (Agyekum-Mensah et al., 2017). Delays can also have serious legal consequences (Leishman 1991) and project risks (Zhi 1995). Most of existing studies focused on the causes of delays in construction projects during the construction stage, such as Hong Kong (Lo et al. 2006), Malaysia (Sambasivan et al. 2007), Egypt (Abd El-Razek et al. 2008), Jordan (Sweis et al. 2008), Zambia (Kaliba et al. 2009), Iran (Khoshgoftar et al., 2010), Turkey (Kazaz et al. 2012), India (Doloi et al. 2012), Pakistan (Choundhry et al. 2014), Singapore (Hwang et al. 2014), Chile (Ballesteros-Pérez et al. 2015), Cambodia (Santoso and Soeng, 2016), and United Arab Emirates (Mpofo et al., 2017). Some studies also addressed the delays at the pre-construction stage through identifying causes of delays from the planning and design activities (Yang and Wei 2010), making clear contract conditions on delays (Chong et al. 2014), and designing a risk management methodology at the design stage (Albogamy, A. and Dawood 2015).

Surprisingly, although researchers have identified key risks in constructions in China (Zou et al. 2007), none of the previous studies has investigated the causes of delays in building construction projects in China. This oversight is a vital research gap that needs to be addressed because the existing research findings may not be relevant to China due to the political and economic differences. Furthermore, the Chinese construction industry has developed into one of the largest markets in the world, employing approximately 45 million workers, completing 19.36 trillion RMB (about \$2914billion US) of construction in 2016, which contributes significantly to China's 2016 gross domestic product (China 2017). The construction industry is in transition from its historically centrally planned economy to a more market-based industry. Examples of these changes include the development of capital markets and standardization of contracts and processes. However, the data collected as part of the current work and literature indicate that China's construction industry continues to be deeply influenced by the nation's centrally planned economic system (Luo, Gale 2000).. An in-depth understanding on the delays of building construction projects that are specific to China is critical for improving

Chinese construction practices. Therefore, the research aims to identify the primary causes of delays in the construction phase of building construction projects in China. Quantitative research approach was adopted by using questionnaire survey method across the four typical cities in China, namely, Beijing, Shanghai, Chongqing, and Shenzhen. Two comparative analyses were designed to (a) test any different views among the respondents on the analyzed data, and (b) compare the research findings with the related previous studies.

The remainder of this paper is structured as follows. A review of previous research on the causes of delays in different countries is used to establish the knowledge gap for the current work. The general research approach and survey tool development and use are then described. Results are described with the mean values of participant responses. The expected value approach is adopted to investigate the impact of the causes of delays on project schedule performance. Finally, the results are compared with previous research to provide an insightful understanding for Chinese building construction.

2. RELATED STUDIES ON CAUSES OF DELAY

Generally, delays may be caused by the client (compensable delays), the contractors (nonexcusable delays), or acts of God or a third party (Majid, McCaffer 1998). Delays can be defined as the time overrun either beyond completion date specified in a contract, or beyond the date that the parties agreed upon for delivery of a project (Assaf and Al-Hejji 2006). Previous research has considered identifying delay causes as a critical step in developing and implementing ways to minimize delays (Ramanathan et al., 2012). Researchers have taken different perspectives for describing delay causes (Hwang et al., 2015). For example, Bramble and Callahan (2010) outlined causes of delays created by clients, designers, contractors, and subcontractors. In contrast, Pickavance (2010) sought to identify management issues that cause delays and reveal poor site management as important causes that impact project productivity. Others have focused on a single project type, such as Assaf et al. (1995), whose work on large building construction projects found 56 delay causes, Mahamid et al.'s (2012) study of road construction projects and Hwang and Leong (2013)'s comparative analysis between traditional and green construction projects.

Geographic locations as defined by nations have been a focus of several investigations of delay causes. Koushki et al. (2005) found change orders, clients' financial constraints, and clients' lack of experience to be

the most important causes of delays in Kuwait. Aibinu and Odeyinka (2006) identified 44 causes of delays in building projects in Nigeria and suggested that they have similar levels of impact on projects. El-Razek et al. (2008) used a survey to identify 32 causes of delays in Egypt and grouped them according to the responsible agent (contractor, consultant, or client). Abdul-Rahman et al. (2006) found financial problems, worker shortage, and changes in the project requirements to be delay factors in Malaysia. In Hong Kong, Chan and Kumaraswamy's study (1997) identified five delay causes: poor risk management and supervision, unforeseen site conditions, slow decision making, client-initiated variations, and work variations. In addition, similar studies also have been conducted in other countries, including Thailand (Ogunlana et al. 1996), Indonesia (Kaming et al. 1997), Hong Kong (Lo et al. 2006), United Arab Emirates (Faridi, El-Sayegh 2006; Mpofu et al., 2017), Jordan (Sweis et al. 2008), India (Doloi et al. 2012), Turkey (Kazaz et al. 2012), Pakistan (Choudhry et al. 2014), Chile (Ballesteros-Pérez et al. 2015), and Cambodia (Santoso and Soeng, 2016)

Despite this plethora of research on the causes of delays, no consensus has been reached on the factors that affect building construction durations (Sweis et al. 2008). Although some common causes of delay were interconnected (Parchamijalal and Shoar 2017); they are quite generic in nature and lack of detailed discussions by considering from the different culture and practice in their respective countries. Furthermore, very limited data are available for the causes of construction delays in China, especially in the construction phase of building projects.

3. RESEARCH APPROACH AND SURVEY DEVELOPMENT

The variables for Chinese building construction projects should consider all types of causes of delays at the beginning stage of this research. Subsequently, certain filtrations of them need to be conducted through interviewing local experts and pilot study to confirm the right and potential causes of delays for the use of questionnaire surveys in this research area. Hence, firstly, the survey of Chinese construction professionals was used to collect data on the causes of delays in the construction phase of building projects. However, a critical issue in survey development needs to be addressed, which was to identify potential delay causes that include in the questionnaire as too many unimportant potential causes would decrease participation rate and attention paid by the respondents. After reviewing the related literature, 69 potential delay causes were

identified and needed to be filtered through interviews and pilot study. These causes were then grouped into the seven categories, namely, client related, engineering related, contractor related, human behavior related, project related, external related, and resource related. The categories can provide a comprehensive and clear classification that suits building projects.

To ensure that all the potentially important delay causes were included and to test the effectiveness of the survey for data collection, six local experts were interviewed who consisted of two clients, two contractors and two consultants. All of them have had at least twenty years of working experience in the Chinese construction industry. Each interviewee reviewed the causes and suggested new causes. The interviews sought answers to two questions: “Does this cause affect construction phase project delays in the Chinese construction industry?” and “Are there other causes that might cause construction phase project delays?”. Based on these interviews, 6 new potential causes were added, which summed up to a total of 75 causes of delay. The new causes are “Unreasonable upfront capital demanded by client”, “Delegating insufficient authority to engineer by client”, “Ineffectiveness of safety and health system”, “Poor relationships between various stakeholders (client, engineer, contractor, and subcontractor)”, “Difficulty in claiming indemnity”, and “Project stakeholders breach the contract”.

However, the response rate would be expected to be too low if respondents were needed to answer 75 questions on delay causes, with two scales of selections on their occurrence and impact. Therefore, a pilot study was used to reduce unimportant delays for Chinese building projects. Four industry experts (senior project managers) and two academic experts (renowned professors) were participated in the pilot study, who have had a very high level of knowledge in Chinese construction delays. The pilot study identified potential causes with small relative expected risk (the product of the frequency and impact size). Possible values ranged from zero (does not occur, has no impact, or both) to 25 (occurs very often and has large impact). Causes with expected relative risk ratings less than or equal to five were eliminated from the pool of potential delay causes. As a result, 37 potential delay causes were finalised and used for the questionnaire survey as shown in Table 1. The questionnaire structure was designed into two parts to uphold its clarity and simplicity. The Part A was the questions for the respondents’ biographical information; while the 37 delay causes were asked in the Part B with two scales of selection for its frequency and schedule impact.

Table 1: Pilot Study and Interviews outcomes on causes of delay in Chinese building construction projects

Category	Delay Causes	Sources	Relative importance index (Pilot Study)	Outcomes
Client related (10 causes)	Client interference	Koushki et al. (2005); Aibinu and Odeyinka (2006)	10.33	Selected
	Client variations/Changes of scope	Kumaraswamy (1997); Lo et al. 2006	17.33	Selected
	Defective materials provided by client	Abdul-Rahman et al. (2006); Lo et al. (2006)	4.33	Deleted
	Delay in approving shop drawings and sample materials	Aibinu and Odeyinka (2006); Sambasivan et al. (2007)	14.83	Selected
	Delay in awarding construction contract	Lo et al. (2006); Abd El-Razek et al. (2008)	6.83	Selected
	Delay in progress payments by client	Sambasivan et al. (2007); Kazaz et al. (2012)	15.17	Selected
	Delay to furnish and deliver the site to the contractor by the client	Lo et al. (2006); Mpofo et al., (2017)	9.50	Selected
	Imbalance in the risk allocation	Lo et al. (2006); Sambasivan et al. (2007)	5.30	Deleted
	Late in revising and approving design documents by client	Lo et al. (2006); Sambasivan et al. (2007)	11.50	Selected
	Slowness in decision making process by client	Aibinu and Odeyinka (2006); Abd El-Razek et al. (2008)	12.33	Selected
	Unavailability of the site access area	Mpofo et al., (2017)	3.83	Deleted
	Unrealistic client requirements	Aibinu and Odeyinka (2006); Lo et al. (2006)	5.00	Deleted
	Unrealistic contract duration imposed by client	Aibinu and Odeyinka (2006); Lo et al. (2006)	7.83	Selected
	Unreasonable upfront capital demanded by client	From the interviews	14.17	Added and Selected
Engineer related (3 causes)	Delays in providing design information and approval of contractor submission	Doloi et al. (2012)	7.67	Selected
	Delegating insufficient authority to engineer by client	From the interviews	10.00	Added and Selected
	Inaccurate bills of quantities	Sambasivan et al. (2007)	6.00	Selected
	Inadequate experience of consultant	Lo et al. (2006)	5.50	Deleted
	Inconsistency in contract documents	Khoshgoftar et al., (2010)	3.83	Deleted
	Necessary variations / impossibility	Lo et al. (2006); Khoshgoftar et al., (2010)	4.17	Deleted

	Poor communication/coordination between consultant and other parties	Lo et al. (2006); Sambasivan et al. (2007)	3.50	Deleted
	Poor site management & supervision by consultant	Lo et al. (2006)	4.83	Deleted
	Slow coordination and seeking of approval from concerned authorities	Doloi et al. (2012)	4.50	Deleted
Contractor related (11 causes)	Delay caused by Domestic Subcontractor	Aibinu and Odeyinka (2006)	9.83	Selected
	Delay caused by Nominated Subcontractor	Kazaz et al. (2012)	11.67	Selected
	Difficulties in financing project by contractor	Aibinu and Odeyinka (2006); Lo et al. (2006)	13.67	Selected
	Exceptionally low bids	Aibinu and Odeyinka (2006); Lo et al. (2006)	8.67	Selected
	Ineffectiveness of safety and health system	From the interviews	8.67	Added and Selected
	Improper construction methods implemented by contractor	Abd El-Razek et al. (2008)	4.00	Deleted
	Ineffective planning and scheduling of project by contractor	Koushki et al. (2005)Sambasivan et al. (2007)	6.50	Selected
	Inexperienced contractor	Lo et al. (2006); Sambasivan et al. (2007)	10.83	Selected
	Occurrence of site accidents	Sambasivan et al. (2007)	3.33	Deleted
	Poor communication and coordination by contractor with other parties	Abd El-Razek et al. (2008)	4.50	Deleted
	Poor qualification of the contractor's technical staff	Abd El-Razek et al. (2008)	11.67	Selected
	Poor workmanship	Doloi et al. (2012)	7.83	Selected
	Rework due to errors during construction	Kazaz et al. (2012)	6.17	Selected
Unsuitable leadership style of contractor's construction manager	Lo et al. (2006)	6.50	Selected	
Human behaviour related (2 causes)	Adversarial/confrontational/controversial culture	Lo et al. (2006);	1.00	Deleted
	Delays in the response of project teams for potential dispute resolution	Abd El-Razek et al. (2008)	3.50	Deleted
	Labor disputes and strikes	Sambasivan et al. (2007)	7.33	Selected
	Lack of communication	Aibinu and Odeyinka (2006); Sambasivan et al. (2007)	2.67	Deleted
	Personal conflicts among labors	Sambasivan et al. (2007)	2.00	Deleted
	Personality clash between Contractor Agent and Resident Engineer	Sambasivan et al. (2007)	4.33	Deleted

	Poor relationships between various stakeholders (client, engineer, contractor and subcontractor)	From the interviews	10.17	Added and Selected
Project related (4 causes)	Buildability	Lo et al. (2006)	2.33	Deleted
	Design errors made by designers	Doloi et al. (2012)	6.00	Selected
	Designers' delay in work approval	Lo et al. (2006); Sambasivan et al. (2007)	10.17	Selected
	Legal disputes between various parts	Sambasivan et al. (2007)	4.17	Deleted
	Original contract duration is too short	Sambasivan et al. (2007)	10.17	Selected
	Type of construction contract (Turnkey, construction only,)	Abd El-Razek et al. (2008)	1.67	Deleted
	Unforeseen ground conditions	Sambasivan et al. (2007)	8.67	Selected
	Works in conflict with existing utilities	Sambasivan et al. (2007)	3.33	Deleted
External factor (2 causes)	Accident during construction	Sambasivan et al. (2007)	2.33	Deleted
	Changes in government regulations and laws	Aibinu and Odeyinka (2006); Sambasivan et al. (2007)	4.17	Deleted
	Civil unrest	Khoshgoftar et al. (2010)	1.50	Deleted
	Cost escalation	Lo et al. (2006)	5.17	Deleted
	Delay in obtaining permits from municipality	Lo et al. (2006)	2.83	Deleted
	Delay in performing final inspection and certification by a third party	Koushki et al. (2005); Lo et al. (2006)	4.83	Deleted
	Difficulty in claiming indemnity	From the interviews	14.33	Added and Selected
	Environmental restrictions	Khoshgoftar et al., (2010)	3.67	Deleted
	Inclement weather	Lo et al. (2006); Abd El-Razek et al. (2008)	4.33	Deleted
	Natural catastrophes (earthquakes, flood, etc .)	Lo et al. (2006)	4.83	Deleted
	Project stakeholders breach the contract	From the interviews	12.83	Added and Selected
	Traffic control and restriction at job site	Lo et al. (2006)	2.67	Deleted
	Unavailability of utilities in site (such as, water, electricity, telephone, etc.)	Lo et al. (2006)	2.17	Deleted
Resource related (5 causes)	Delay in material delivery	Aibinu and Odeyinka (2006); Lo et al. (2006)	5.17	Deleted
	Inadequate resources due to contractor/lack of capital	Lo et al. (2006)	9.67	Selected
	Lack of skilled labour/technical person	Aibinu and Odeyinka (2006); Lo et al. (2006)	9.00	Selected

	Late procurement of materials	Aibinu and Odeyinka (2006);	6.33	Selected
	Low level of equipment-operator's skill	Lo et al. (2006)	5.17	Deleted
	Low productivity and efficiency of equipment	Lo et al. (2006)	3.50	Deleted
	Shortage of construction materials in market	Sambasivan et al. (2007)	4.33	Deleted
	Shortage of equipment	Lo et al. (2006)	3.50	Deleted
	Shortage of labors	Khoshgoftar et al., (2010)	9.00	Selected
	Unqualified workforce	Lo et al. (2006); Sambasivan et al. (2007)	9.33	Selected

Apart from that, a second critical issue in the survey development was choosing what information to be gathered from each of the delay causes. As described, delays can pose a major risk to project success. Therefore, the survey was designed to collect data on two important features of delay causes related to the risks they create: frequency of occurrence and size of impact on project schedule performance. Although lengths of delays are typically described in time units (e.g., days, weeks, months), delays due to the same cause and with similar frequencies and sizes can have different impacts on project performance. To make clear this, respondents were asked to rate delay cause frequency and impact size on two project-size-independent Likert scales. The frequency scale ranged from 1 to 5, indicating 1 = rarely, 2 = seldom, 3 = sometimes, 4 = often, and 5 = very often. Similarly, the impact scale ranged from 1 to 5, indicating 1 = negligible, 2 = small, 3 = moderate, 4 = large, and 5 = very large.

3.1 Target Respondents

The targeted respondents were experienced construction professionals in the primary participant organizations in the construction phase of Chinese building projects. The traditional design-bid-build process is the dominant construction procurement process in China. During the construction phase clients, construction consultants, and contractors are the principal parties of the construction process. Therefore, these three firm types were chosen for the current work, and projects were restricted to the construction phase of design-bid-build projects. Respondents from firms with significant experience in building construction were sought. In China each client,

contractor, and consulting firm is ranked into a class and only firms in certain classes are allowed to work in specific construction market segments, defined by project size and geographic location (see Lu et al. 2008). Firms are classified based on six factors: 1) registered capital, 2) throughput, 3) previous performance, 4) technical staff, 5) technical facilities, and 6) fixed assets. Clients and contractors were ranked into one of four classes. Consulting firms were ranked into one of three classes. The firms used in the survey were limited to those in the highest classes that focus on the construction of buildings, thereby increasing the likely experience level of respondents. Diversity of respondents across geographic locations was also sought to reflect the Chinese construction industry as a whole (versus centers of intense construction or other atypical conditions). Therefore, firms from four typical cities in China (Beijing, Shanghai, Chongqing, and Shenzhen) were used., which most of the projects have been developing in the areas.

To cope with the need for the survey to be representative of the whole construction industry in China, the authors monitored the responses being received weekly and ensured a balance from the responded questionnaires. Consequently, a total of 320 responses (80 firms from each city) were distributed. All responses were collected in a spreadsheet for analysis.

3.2 RESPONSES AND RESULTS

A total of 115 valid responses (36%) were collected. Respondents were relatively evenly distributed across firm type (38% client, 35% contractor and 27% consultant), location (24% Beijing, 22% Shanghai, 27% Shenzhen and 27% Chongqing), and organization ownership (24%–39% of respondents in each ownership type). Most (74%) were senior engineers or managers and over 99% had at least ten years of construction experience. Based on the diversity of characteristics and experience of the respondents the results were viewed as representative of the target population. The sample size was considered sufficient based on the Central Limit Theorem, where the mean of the samples would approach to a normal distribution (Araujo and Gine, 1980). Nevertheless, Cronbach's coefficient alpha (Develles 1991) values were calculated (Carmines, Zeller 1979) to check and determine the internal reliability of the frequency and impact size data using:

$$\alpha = Kc/(v+(K-1)c) \quad (1)$$

where: α —Cronbach's coefficient alpha

K—the number of components

C—the average of covariances between the components

v—variance of each component.

Alpha values measure the intercorrelations of data. Values cannot exceed 1.0 and those greater than 0.7 are considered acceptable (Nunnally, Bernstein 1994). The alpha value for the frequency data was 0.874 and 0.911 for the impact size data. These values confirmed that the data were internally reliable.

Chan and Kumaraswamy's research (1996) was extended to calculate the Mean Respondent Frequency Rating and Mean Respondent Impact Size Rating, as follows:

$$\text{Mean Respondent Frequency Rating} = \frac{\sum f \times a}{N} \quad (2)$$

$$\text{Mean Respondent Impact Size Rating} = \frac{\sum s \times a}{N} \quad (3)$$

$$\text{Expected Risk Rating} = (2) \times (3) \quad (4)$$

where: a—score given to each cause of delay by the respondents

f—frequency of responses to each score for each cause of delay

s—size of delay of responses to each score for each cause of delay

N—total number of respondents

The expected risk rating (Heldman 2005; Loosemore et al. 2006) was used to combine the frequency and impact size of the causes of delays into a single measure of risk to project schedule performance. The expected risk created by each cause of delay as perceived by each participant type and all respondents was calculated as the product of its average frequency rating and average impact size rating. By combining the perceived frequency and impact size ratings, the analysis provides a more accurate description of the effects of delay causes than either the frequency or impact size data alone can supply alone. This would clarify and explain better for the primary causes of delays from the project schedule performance.

3.3 Frequency Rating

The mean values of the frequency rating provided by all respondents and by each participant type (client, contractor, or consultant) were calculated for each delay cause. Table 2 shows the survey results for the ten most-frequent causes based on all respondents that listed in descending order of frequency of occurrence. Respondents in aggregate considered delayed progress payments to be the most frequent cause of delays, followed by changes to scope and delays caused by nominated (vs. domestic) subcontractors. Nominated subcontractors are chosen by the owner, in contrast to domestic subcontractors who are chosen by the general contractor and approved by the owner or consultant. This result suggests that the most frequent causes of delay are client related. However, disaggregating the data into respondent types reveals the different perspectives of the project participants. Clients consider the most frequent causes of delays to be those caused by contractors and contractors consider the most frequent causes of delays to be those caused by clients. More specifically, client respondents indicated that delays by subcontractors are the most frequent causes and contractor respondents indicated that payment delays by clients and client changes are the most frequent causes. This reflects the tension between clients and contractors to meet the project objectives of their own organizations that is inherent in the design-bid-build process and provides face validity to the survey results. The responses of consultants are closer to those of contractors than clients, with some exceptions.

Table 2. Rating of Delay Cause Frequencies in Chinese Building Projects

Cause of Delay	Project Participant Type							
	Overall		Client		Contractor		Consultants	
	Mean frequency rating	Rank	Mean frequency rating	Rank	Mean frequency rating	Rank	Mean frequency rating	Rank
Delay in progress payments	3.32	1	2.84	5	3.68	1	3.55	1
Variations/Changes of scope	3.00	2	2.89	4	3.48	2	2.55	10
Delay caused by Nominated Subcontractor	2.98	3	3.05	2	3.25	3	2.55	9
Client interference	2.96	4	2.98	3	3.08	7	2.77	4
Delay caused by Domestic Subcontractor	2.91	5	3.14	1	3.00	9	2.48	11
Unreasonable upfront capital demanded by client	2.88	6	2.14	28	3.25	4	3.45	2
Difficulty in claiming indemnity	2.87	7	2.59	13	3.15	6	2.90	3
Insufficient authority delegated to engineer by client	2.79	8	2.64	11	2.98	10	2.77	5
Exceptionally low bids	2.73	9	2.59	14	2.93	12	2.68	7
Inaccurate bills of quantities	2.70	10	2.68	6	2.95	11	2.39	15

3.4 Impact Size Rating

The means of the impact size rating (reflecting relative delay length) provided by all respondents and by each participant type were calculated. Survey results of the ten causes with the greatest impact according to all respondents are shown in Table 3, listed in descending order of size of impact. Exceptionally low bids and labor shortages were considered the causes of the longest delays by all respondents, with less agreement about the size of the delays because of other causes. Clients indicated that the severest causes of delay are contractor related (inadequate resources because of contractor’s lack of capital) and project related (unforeseen ground conditions). Contractors indicated that both contractor-related (exceptionally low bids) and client-related (changes to scope) causes had the greatest impacts. Consultants considered the severest causes of delays were tardy progress payments and labor shortages.

Table 3. Impact Size Rating of the Delay Causes

Cause of Delay	Project Participant Type							
	Overall		Client		Contractor		Consultants	
	Mean impact size rating	Rank	Mean impact size rating	Rank	Mean impact size rating	Rank	Mean impact size rating	Rank
Exceptionally low bids	3.25	1	3.05	4	3.58	1	3.13	7
Labor shortage	3.17	2	3.05	3	3.15	9	3.39	2
Unforeseen ground conditions	3.14	3	3.14	2	3.30	5	2.94	13
Variations/Changes of scope	3.11	4	2.96	5	3.48	2	2.87	15
Contractor lack of capital	3.11	5	3.36	1	2.75	21	3.23	5
Labor disputes and strikes	3.04	6	2.77	13	3.13	10	3.29	4
Short original contract duration	3.03	7	2.68	16	3.38	4	3.07	9
Delay in progress payments	3.03	8	2.46	24	3.30	6	3.48	1
Late procurement of materials	3.01	9	2.84	9	3.10	11	3.13	6
Delay caused by Nominated Subcontractor	2.95	10	2.71	14	3.38	3	2.74	21

3.5 Expected Risk Rating

To investigate the impact of the causes of delays on project schedule performance, the survey results were used to model the risk posed by each potential cause of project schedule slippage. The expected risk rating was adopted. The expected risk created by each delay cause as perceived by each participant type and all respondents was calculated as the product of its average frequency rating (from Table 2) and average impact size rating (from Table 3) as shown in Table 4. The three delay causes with the greatest risks were delayed progress payments, variations/changes to scope, and exceptionally low bids.

The average expected risk rating of the delay causes as perceived by the contractors, consultants, and clients were 7.43, 6.82, and 6.53, respectively. This indicates that contractors (7.43 average risk rating) perceive delay causes as generating the most risk to project schedule performance, followed by consultants (6.82 average risk rating) and clients (6.53 average risk rating). This is consistent with the shifting of schedule risk from clients to builders through most design-bid-build contract documents.

The expected risk model also reveals the previously mentioned differences in participant perspectives. According to clients' view, the largest risk is from domestic (contractor selected) subcontractors. But contractors and consultants consider this as the tenth and twelfth most important risk, respectively. Similarly, both contractors and consultants consider delays in payments by clients to be the largest risk, but clients consider this to be the fourteenth most important risk. Other delay causes have less variance across participants than these two examples, but reveal the different perspectives of the primary participants in the construction phase.

Table 4. Expected Delay Risk Rating by Causes in Chinese Building Projects

Cause of Delay	Project Participant Type							
	Overall		Client		Contractor		Consultants	
	Mean expected risk rating	Rank	Mean expected risk rating	Rank	Mean expected risk rating	Rank	Mean expected risk rating	Rank
Delay in progress payments	10.06	1	6.99	14	12.14	1	12.35	1
Variations/Changes of scope	9.33	2	8.55	2	12.11	2	7.32	9
Exceptionally low bids	8.87	3	7.90	6	10.49	4	8.39	4
Delay caused by Nominated Subcontractor	8.79	4	8.27	5	10.99	3	6.99	13
Delay caused by Domestic Subcontractor	8.41	5	8.98	1	8.85	10	7.04	12
Client interference	8.29	6	8.40	3	8.87	9	7.42	7
Difficulty in claiming indemnity	8.09	7	6.42	19	10.08	6	8.15	5
Short original contract duration	8.09	8	7.08	12	10.24	5	6.94	15
Contractor lack of capital	7.78	9	8.33	4	6.41	23	8.85	3
Amount of upfront capital demanded by client	7.60	10	4.58	30	9.69	8	10.14	2

3.6 Comparative Analyses

Two comparative analyses were conducted from the research findings, namely (a) to test any different views among the respondents on the analyzed data, and (b) to compare the research findings with the related previous studies.

Nonparametric tests were selected to compare the results given by the three groups of respondents. Kruskal Wallis and Mann Whitney U tests were used to analyze the top ten delay causes using the Statistical Package for the Social Sciences (SPSS) software. All causes of three ratings received a value of 0.00 (asymptotic significance) below 0.05 significant p-value, indicating the rejection of the null hypothesis. The null hypothesis means the population means are all equal. This indicates that there was a statistically significant difference in the delay causes among the respondents. This result is consistent with the fragmented practices in the construction industry in which each party has a different goal in the project especially for the selected traditional design-bid-build process in this research.

Table 5 compares the most important delay causes between the current work and the recent previous studies that were based on their related scope and quantitative research approach. In other words, the comparison excludes the previous works that were under a qualitative research approach. As a result, seven countries were selected and compared, namely, Hong Kong, Egypt, and Malaysia, India, Turkey and United Arab Emirates. All the top-10 delay causes have been listed and sorted in descending order of importance. This ranking can reveal the primary causes of delays in their countries, which the comparative analysis can be conducted quantitatively based on its ranking. Nevertheless, the exact comparison of causes is not possible due to different terminologies or phases used in the previous studies. The numbers in parentheses after delay causes indicate the ranking of that delay cause in the current study. If the numbers are smaller than the ranking as in the current study, it means that the causes are more important in the current study and vice versa. Several delay causes are found to be more important in the current study than in other studies, including those related to payments, client changes, coordination, and short initial durations. This suggests that these delay causes are more important in China than other countries. The causes of “difficulty in claiming indemnity” and “unreasonable upfront capital demanded by client” have been found to be an important cause in the current study but not one of the most important causes in the other studies. Particularly, the indemnity here refers to different practices of insurance policies in China (An and Chen 2014). The exceptionally low bids are the common problem and top-ranked cause in the Chinese construction projects but only one of the comparative studies (Hong Kong) has the similar view on this cause.

Table 5. Comparison of delay causes with the closely related previous studies

Rank	China (current study)	Hong Kong (Lo et al. 2006)	Egypt (Abd El-Razek et al. 2008)	Malaysia (Sambasivan et al. 2007)	Iran (Khoshgoftar et al., 2010)	India (Doloi et al. 2012)	Turkey (Kazaz et al. 2012)	United Arab Emirates (Mpofu et al., 2017)
1	Delay in progress payments	Inadequate resources because of contractor/lack of capital (9)	Financing by contractor during construction (9)	Contractor's improper planning	Finance and payments of completed work (1)	Delay in material delivery by vendors	Design and material changes (2)	Unrealistic contract duration imposed by client (8)
2	Variations/Changes of scope	Unforeseen ground conditions	Delays in contractor's payment by owner (1)	Contractor's poor site management	Improper planning	Nonavailability of drawing/design on time	Delay of payments (1)	Incomplete design at the time of tender
3	Exceptionally low bids	Exceptionally low bids (3)	Design changes by owner or his agent during construction (2)	Inadequate contractor experience	Site management	Financial constraints of contractor	Cash flow problems	Too many scope changes and change orders (2)
4	Delay caused by Nominated Subcontractor	Inexperienced contractor	Partial payments during construction (1)	Inadequate client's finance and payments for completed work (1)	Contract management (8)	Increase in scope of work (2)	Contractor's financial problems (9)	Inadequate planning and scheduling
5	Delay caused by Domestic Subcontractor	Works in conflict with existing utilities	Not using professional construction/contractual management	Problems with subcontractors (4,5)	Lack of communication between the parties	Obtaining permissions from local authorities	Poor labor productivity	Poor project planning and control
6	Client interference	Poor site management and supervision by consultant	Slow delivery of materials (9)	Shortage in material (9)	Subcontractors (4,5)	Delay in material to be supplied by the owner (6)	Estimation problems	Delay in obtaining permit/approval from municipality/different gov. authorities
7	Difficulty in claiming indemnity	Unrealistic contract duration imposed by clients (8)	Difficulty of coordination between various parties working on the project (4,5,6)	Labor supply (9)	Equipment availability and failure (9)	Slow decision from owner	Lack of feasibility studies	Poor labour productivity problems
8	Short original contract duration	Environmental restrictions	Slowness of the owner decision making process	Equipment availability and failure (9)	Shortage in material (9)	Poor site management and supervision	Construction defects	Slowness in decision-making process by owner
9	Inadequate resources due to contractor/lack of capital	Slow coordination and seeking of approval from concerned authorities	The relationship between different subcontractors' schedules	Lack of communication between parties	Inadequate contractor experience	Delay in materials procurement by contractor (9)	Unbalanced number of workers	Design changes
10	Unreasonable upfront capital demanded by client	Client variation/changes of scope (2)	Preparation of shop drawings and material samples	Mistakes during the construction stage.	Change orders (2)	Unrealistic time schedule imposed in contract	Fluctuation in materials prices	Inadequate site management, monitoring and control

4. DISCUSSIONS

Clients, contractors and consultants have different rankings of the delay causes. For example, clients perceive that the highest risk is due to the delay caused by domestic (contractor selected) subcontractors; while contractors and consultants consider delays in payments by clients to be the highest risk. Moreover, variations or changes of scope have been ranked the second highest risk by clients and contractors, but consultants consider it as the ninth important risk. Their disagreements explain the common scenario in Chinese building construction projects, which leads to the occurrence of delays during the construction stage. Although this situation is mainly due the fragmented practices and different objectives of project stakeholders in the traditional design-bid-build process, it reveals useful references for allocating fairer risks into the design-bid-build contracts for all contracting parties.

Besides, although differences in terminology in different studies prevent exact comparisons, the results of the current work show some similarities and differences as per the results of previous studies. It reveals two unique causes of delays in the Chinese construction industry, such as “difficulty in claiming indemnity” and “unreasonable upfront capital demanded by client”. It also shows different ranked causes of delays. Five of the major causes of delays in Malaysia (Sambasivan et al. 2007) are quite similar to some of the most important causes of delays in the current work: inadequate client’s finance and payments for completed work, problems with subcontractors, shortage in material, labor supply, and equipment availability and failure. Iran has a similar top-one ranked cause of delay as in China, which is related to the financial issues or delay in progress payments on the completed works (Khoshgoftar et al., 2010). The timely payment for contractors’ works is a problematic issue in China due to the low entry requirements and competitive markets for the Chinese contractors, and the overemphasis on the construction speed under the pressure of the rapid economic growth. These reasons are also relevant and able to explain the need for the upfront capital requested by employers to protect their interest. Meanwhile, the government is streamlining a public service platform for all construction activities and data in China (Ministry of Housing and Urban-Rural Development, China, 2017). It aims to monitor, record and share the construction activities and data for public scrutiny and use. The blacklisted construction stakeholders and organisations’ poor credit records will be announced publicly, which this will help to mitigate and/or address the top-ranked causes of delays in the Chinese construction industry.

During the current evolution process in China, contracting parties are more likely to use *guanxi* instead of a contract to solve problems due the lack of contractual awareness (Badi et al., 2017). *Guanxi* describes the rudimentary dynamic in personalized social networks of influence that relates to the cultivated harmony relationships to each other in Chinese culture (Gold et al., 2012). It emphasizes on implicit mutual obligations, reciprocity, and trust. This relates to the emphasis of relational governance in the construction practice instead of contractual governance. It will help in addressing the top-ranked delay causes more effectively instead of purely control them via strict contract provisions. It is because some of the primary delay causes in building construction projects require more on the coordination and communication among stakeholders. This is supported by the recent findings on the common issues on timely and successful sharing of information during the construction stage in building projects, which this can be effectively solved via establishing a clear point of contact; providing clear and understandable information for stakeholders; and timely sharing of information (Tran et al., 2017). Hence, decision makers need to balance and incorporate more relational governance in addressing the primary delay causes.

Apart from that, numerous international construction projects have been initiated and are working with China under the current Belt and Road Initiative, which the total investment is up to US Dollar \$1 trillion (China's State Information Centre, 2017). Many countries have received the investments or partnered with China for the first time on their projects. This research provides useful insights into the Chinese practice and culture in construction projects. The participating countries in this initiative can refer this research in avoiding and managing those top ranked causes of delays proactively. As a result, it would improve project performance via the successful completion of the projects.

5. CONCLUSIONS

The research has identified the primary causes of delays in the construction phase of Chinese building projects by surveying construction practitioners on filtered 37 delay causes. The ratings of the perceptions of the relative frequency of different delay causes and schedule impacts were analysed. The results show the most frequent delay causes are delayed progress payments, changes to scope, and delays caused by client-selected subcontractors. The subcontractors would encounter similar delay causes but their problems are mainly due to

their own poor performance and communication issues. Similarly, the delay causes with the largest impacts on project schedules are exceptionally low bids, labor shortages, and unforeseen ground conditions. The ratings of delay causes by the three participant types vary significantly and are generally consistent with design-bid-build projects. By combining the analyses of the frequency data and schedule impacts, delayed progress payments, changes to scope, and exceptionally low bids are the three delay causes that generate the most risk to project schedule performance. Subsequently, the findings were compared to the related previous studies from different countries. The comparative analysis shows two unique causes of delays in the Chinese construction industry, such as “difficulty in claiming indemnity” and “unreasonable upfront capital demanded by client”. Construction practitioners or decision makers can make appropriate adjustment on their relational or contractual practices in addressing the distinguished and primary causes of delays, especially for those construction projects in other countries that are funded or partnered with China.

Certain limitations need to be considered in the research. The results and conclusions are limited to the scope of the construction phase in Chinese building construction projects. New delay causes could be identified from different types of construction projects as well as other phases of the project lifecycle. Other groups of respondents could also be considered into the research apart from the selected main stakeholders of construction projects. Nevertheless, this research is valid and of significance for the causes of delays in Chinese building construction projects, especially under the traditional design-bid-build procurement system. It renders insightful references into the current culture and practices in China, which serves as a good foundation for implementing the related management strategies. Future research should focus on how project managers can effectively improve project schedule performance by reducing the occurrence of the causes identified and/or mitigating their impacts through the current trend and use of Building Information Modelling (BIM), especially controlling the primary delay causes in the 4D BIM model by leveraging the digital data. The continued expansion of the knowledge and understanding of the causes of construction delays will lead to solutions that improve project performance.

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