Construction Delays Causing Risks on Time and Cost - a Critical Review

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Abstract

There is an increase in the number of construction projects experiencing extensive delays leading to exceeding the initial time and cost budget. This paper reviews 41 studies around the world which has surveyed the delay factors and classified them into Groups. The main purpose of this paper is to review research which has categorized the causes responsible for time delays and cost overruns in projects. The intention was to see whether these causes are valid for projects being executed in Sabah East Malaysia allowing a mitigation plan to be prepared. The collected list has 113 causes for delays which were categorized into 18 different groups. Most of the research has analysed the responses from Questionnaire surveys. The collected data are used to rank the problem factors. The data are further used to investigate and analyse the reported “Importance Index, Frequency Index, Severity Index, Relative Importance Index, Relative Importance Weight, Weighted Average, Mean, Standard Deviation and Variance”. The collective comparison has revealed that the ranking given by all the researchers is not the same. Further each and every study has different rank ratings from different group. This review paper attempts to provide an updated compilation of the earlier studies on ranking of the delay causers, which are never similar and constant for universal projects. From the critical review, it is concluded that this type of research requires a different method or approach to generate meaningful answers and that there is a strong case against opinion surveys.

Keywords: Construction delays, Cost risk, Time risk, Project Management

Introduction

The purpose of this study is to critically review and identify the applicability of past studies on determining the factors causing time delays and cost overrun in current projects. This goal has been accomplished by reviewing articles published during the last 15 years (since 1995) in various project management journals like: International Journal of Project Management (IJPM), Journal of Construction Management Economics (JCME), Journal of Management in Engineering (JME), Engineering Construction and Architectural Management Journal (ECAMJ) and others.

The biggest customer of the construction industry in most countries is the government (Okpala and Aiekwu, 1988). To the dislike of owners, contractors and consultants, many government projects experience extensive delays and thereby exceed the initial time and cost estimates (Odeh and Bataineh, 2002). This problem is more evident in the traditional type of contracts in which the contract is awarded to the lowest bidder. This procurement strategy is adopted by majority of government projects in developing countries. The Latham Report (Latham, 1994) suggested that ensuring timely delivery of projects is one of the important needs of clients of the construction industry. Severe criticisms of the industry arise if it takes much longer than the stipulated project time (Bennett et al., 1979; Flanagan et al., 1986). Completing projects on time is an indicator of an efficient construction industry (NEDO, 1988). Contractors are primarily

concerned with quality, time and cost and yet the majority of construction projects are procured on the basis of only two of these parameters, namely time and cost (Bennet and Grice, 1990). The literature emphasises time as an indicator for project success.

The construction process can be divided into three important phases, i.e. project conception, project design and project construction. Usually, the vast majority of project delays occur during the 'construction' phase, where many unforeseen factors are always involved (Chan and Kumaraswamy, 1997). In construction, delay could be defined as the time overrun either beyond completion date specified in a contract, or beyond the date that the parties agreed upon for the delivery of a project. It is a project slipping over its planned schedule and this is a common problem in construction projects. To the owner, delay means loss of revenue through non availability of production facilities and rentable space or a dependence on present facilities. In some cases, delay causes higher overhead costs to the contractor because of longer work period, higher material costs through inflation, and due to labour cost increases. Completing projects on time is an indicator of efficiency, but the construction process is subject to many variables and unpredictable factors, which result from many sources. The sources are the performance of parties, resources availability, environmental conditions, involvement of other parties, and contractual relations, and the completion of a project within the specified time is rare (Assaf, 2006).

Cost and schedule overruns occur due to wide range of factors. If project costs or schedules exceed their planned targets, client satisfaction would be compromised. The funding profile no longer matches the budget requirement and further slippage in the schedule could result (Kaliba et al., 2009). According to Ahmed et al. (2002), delays on construction projects are a universal phenomenon and road construction projects are no exception. Delays are usually accompanied by cost overruns. These have a debilitating effect on contractors and consultants in terms of growth in adversarial relationships, mistrust, litigation, arbitration, cash-flow problems, and a general feeling of trepidation towards other stakeholders (Ahmed et al., 2002). This problem is not unique to developed countries and is being experienced in most of the developing economies.

When projects are delayed, they are either extended or accelerated and therefore, incur additional cost. The normal practices usually allow a percentage of the project cost as a contingency allowance in the contract price and this allowance is usually based on judgment (Akinsola, 1996). Although the contract parties agree upon the extra time and cost associated with delay, in many cases there are problems between the owner and contractor as to whether the contractor is entitled to claim the extra cost. Such situations result in questioning facts, causal factors and contract interpretations (Alkass et al., 1996). Therefore, delays in construction projects cause dissatisfaction to all parties involved and the main role of the project manager is to make sure that projects are completed within the budgeted time and cost. Several studies have been undertaken on factors causing delays and cost overruns, and affecting quality, safety and productivity, etc. and specific problems in special types of projects. These studies usually focus on specific aspects of project performance. Practitioners need to develop the capacity to foresee potential problems likely to confront their current and future projects. Identification of the common problems experienced on past projects in their construction business environment is a good option (Long et al., 2004).

Frimpong et al. (2003) revealed that project management tools and techniques play an important role in the effective management of a project. PMBOK defines Project Management as the application of knowledge, skills, tools and techniques to project activities to meet the project requirements (PMI, 2008). Project management involves managing the resources—

workers, machines, money, materials and methods used (Giridhar and Ramesh, 1998). Some projects are effectively and efficiently managed while others are mismanaged, incurring much delay and cost overruns. Any construction project comprises two distinct phases: the preconstruction phase (the period between the initial conceptions of the project to awarding of the contract) and the construction phase (period from awarding the contract to when the actual construction is completed). Delays and cost overruns occur in both phases. However the major instances of project overruns usually take place in the construction phase (Frimpong et al., 2003).

Unfortunately, due to various reasons, project successes are not common in the construction industry, especially in developing countries. From several studies and empirical evidence it is clear that project overruns comprising delays and cost overruns occur during the 'construction' phase. Therefore, professionals and scholars have been motivated to take steps to meet this challenge.

Review of Construction Delays across the World

Realistic 'construction time' has become increasingly important because it often serves as a crucial benchmark for assessing the performance of a project and the efficiency of the contractor (Kumaraswamy and Chan, 2002). This study aims to identify the uncertainties and to foresee potential problems likely to confront the current and future projects, helping project teams to be proactive in managing their projects in which potential problems are fully anticipated (Long et al., 2004).

Research literature from all around the world has been collated and consolidated for the better understanding and to conceive the overall picture of the issues. This critical review is presented in five sections; Firstly Identification of Factors and Category, Secondly the Research Methodology adopted in earlier studies (reorganizing and tabulating the data from literature), Thirdly Analysis of Data, Fourthly Results and discussions and Fifthly Conclusions.

Identification of Factors and Category

The factors identified in the research articles are collated and grouped into 18 categories. The set of factors studied by different authors are collected and presented in Table 1. Different authors focus on selected categories for study and analysis. Table 1 tabulates the type of effect studied by different authors and the respective category as classified in their studies. From the review it is observed that certain factors have been categorized under different Groups by different authors. This has been tabulated in detail and discussed in following section of this paper.

Category No.	Category	No. of causes / factors / problems	Type of Effect Studied	References
1	Financier	4 3	Time delay Time delay	Long et.al 2004 Assaf et.al. 1995
2	Project	6 5	Time delay Time overrun	Assaf and Hejji 2006 Chan & Kumaraswamy 1997
3	Project Attributes	8	Time and cost overrun	Long et.al 2004

Table 1 cont'

Category No.	Category	No. of causes / factors / problems	Type of Effect Studied	References
4	Owner / Client	10	Time and cost overrun	Assaf and Hejji 2006
		10	Time and cost overrun	Long et.al 2004
		5	Time delay	Alaghbari et.al. 2007
		4	Time delay	Odeh & Battaineh 2002
		4	Time overrun	Chan & Kumaraswamy 1997
5	Contractor	13	Time and cost overrun	Assaf and Hejji 2006
		17	Time and cost overrun	Long et.al 2004
		12	Time delay	Alaghbari et.al. 2007
		6	Time and cost overrun	Odeh & Battaineh 2002
		4	Time overrun	Chan & Kumaraswamy 1997
6	Consultant	7	Time and cost overrun	Assaf and Hejji 2006
		7	Time and cost overrun	Long et.al 2004
		6	Time delay	Alaghbari et.al. 2007
		4	Time and cost overrun	Odeh & Battaineh 2002
7	Design	8	Time and cost overrun	Assaf and Hejji 2006
		3	Time overrun	Chan & Kumaraswamy 1997
8	Coordination	7	Time and cost overrun	Long et.al 2004
9	Materials	7	Time and cost overrun	Assaf and Hejji 2006
		2	Time and cost overrun	Odeh & Battaineh 2002
		4	Time overrun	Chan & Kumaraswamy 1997
		5	Time and cost overrun	Assaf et.al. 1995
10	Plant / Equipment	5	Time and cost overrun	Assaf and Hejji 2006
		1	Time delay	Odeh & Battaineh 2002
		4	Time overrun	Chan & Kumaraswamy 1997
		5	Time and cost overrun	Assaf et.al. 1995

Table 1 cont'

Category No.	Category	No. of causes / factors / problems	Type of Effect Studied	References
11	Labour / Manpower	5	Time and cost overrun	Assaf and Hejji 2006
		2	Time and cost overrun	Odeh & Battaineh 2002
		4	Time overrun	Chan & Kumaraswamy 1997
		3	Time and cost overrun	Assaf et.al. 1995
12	Environment	9	Time and cost overrun	Long, et.al 2004
		4	Time and cost overrun	Assaf et.al. 1995
13	Contract	2	Time & cost disputes	Odeh & Battaineh 2002
14	Contractual relationships	3	Time & cost effects	Odeh & Battaineh, 2002
		14	Time delay	Assaf et.al. 1995
15	External	12	Time and cost overrun	Assaf and Hejji 2006
		4	Time delay	Odeh & Battaineh 2002
		2	Time overrun	Chan & Kumaraswamy 1997
		8	Time delay	Alaghbari et.al. 2007
16	Changes	7	Time delay	Assaf et.al. 1995
17	Scheduling & Controlling	11	Time delay	Assaf et.al. 1995
18	Government relations	4	Time delay	Assaf et.al. 1995

Table 1 Factors and Categories

Research Methodology

Chan and Kumaraswamy (1997) adopted a Questionnaire survey with 83 hypothesized delay factors which was designed in late 1994 on the basis of a pilot survey. The 83 factors have been grouped into eight major factor categories. Odeh and Battaineh (2002), Frimpong et al (2003), Long et al (2004), Assaf and Al-Hejji (2006), Abdul-Rahman et al. (2006), Sambasivan and Soon (2007), Alaghbari et al. (2007), Adnan (2008), and Kaliba et al. (2009) also designed their research methodologies with questionnaire surveys comprising individual set of well recognized causes of delay.

The questionnaires were designed to evaluate the frequency of occurrence, severity and the importance of the identified causes (Assaf, 2006). The questionnaire was distributed to Contractors, Consultants and Clients. In the field survey the respondents were asked to indicate the level of importance of each cause using five-point Likert scale ranging from 1 (not important)

to 5 (extremely important). The number of firms that completed and returned the questionnaire sets are listed in Table 2 and graphically represented in Figures 1 and 2. Figure 1 shows the total number of questionnaires distributed and the total responses of the individual study. Figure 2 shows the response rate of individual sectors of respondents in Percentage.

Questionnaire Design and Methods:

The Questionnaire study adopted by each author has a different approach. They have been designed based on previous literature, current construction practice, personal experience and location of the project.

Assaf et al. (1995) conducted the investigation in two phases. The first phase included a literature search and interviews. The first phase identified 56 causes of delay. In the second phase a questionnaire was developed using these delay causes. His scope was limited to large public building projects in the Eastern Province of Saudi Arabia. The total population consisted of contractors, architects/engineers (A/Es), and public owners (Government agencies).

Chan and Kumaraswamy conducted two studies in 1997 and 2002. In the earlier study, a pilot study was carried out in early 1994 to investigate the principal causes of construction delay of both building and civil engineering projects which were completed in Hong Kong between 1990 and 1993. The latter survey was supplemented by site visits by industry experts with the aim of identifying the principal factors facilitating faster construction in Hong Kong projects.

Odeh and Battaineh (2002) distributed the questionnaire to a random sample of 100 contractors and 50 consultants representing different specializations in large projects. The sample size of each specialization is proportional to the distribution of the population of the different specializations. Given the sample size, the samples were selected randomly from the population in each specialization. Sambasivan and Soon (2007) adopted the same method in their study on the causes and effects of construction delays.

Long et al. (2004) developed their questionnaire survey to investigate several issues relating to large construction projects focusing only on the problems experienced. To suit the Vietnam construction conditions, the preliminary questionnaire was pilot tested. Six experienced professionals in the Vietnam construction industry were involved in the pilot test. Their comments were used to revise and prepare the final questionnaire. Responses to the questionnaire were then collected and analysed. The analysis included ranking the problems in terms of degree of occurrence and level of influence.

Frimpong et al. (2003) developed a questionnaire of 26 factors designed from previous preliminary investigations conducted in groundwater drilling projects between 1970 and 1999 in Ghana. The questionnaire was directed towards three groups in both public and private organisations: owners of the groundwater projects, consulting offices, and contractors working in the groundwater works.

Alaghbari et al. (2007) distributed the questionnaire among government bodies, main contractors, consultants and developers who were connected with the building systems construction projects. In order to accomplish this, the researchers contacted professional institutions, agents and government bodies. The sample was restricted to building system companies. The respondents were contractors, consultant, developers, subcontractors, engineers and architects who were involved in building system construction projects.

All the other studies were conducted by the random sampling of the three principal construction parties (Owners, Consultant and Contractor).

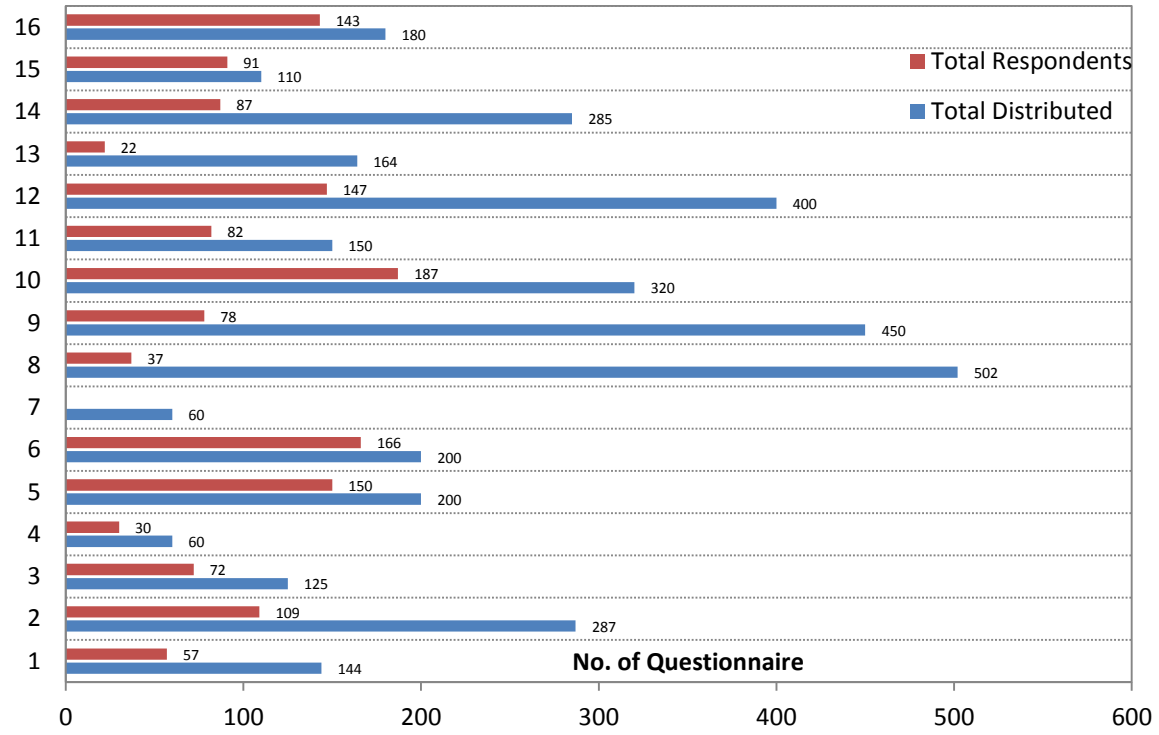

Figure 1 Total number of questionnaires distributed and response

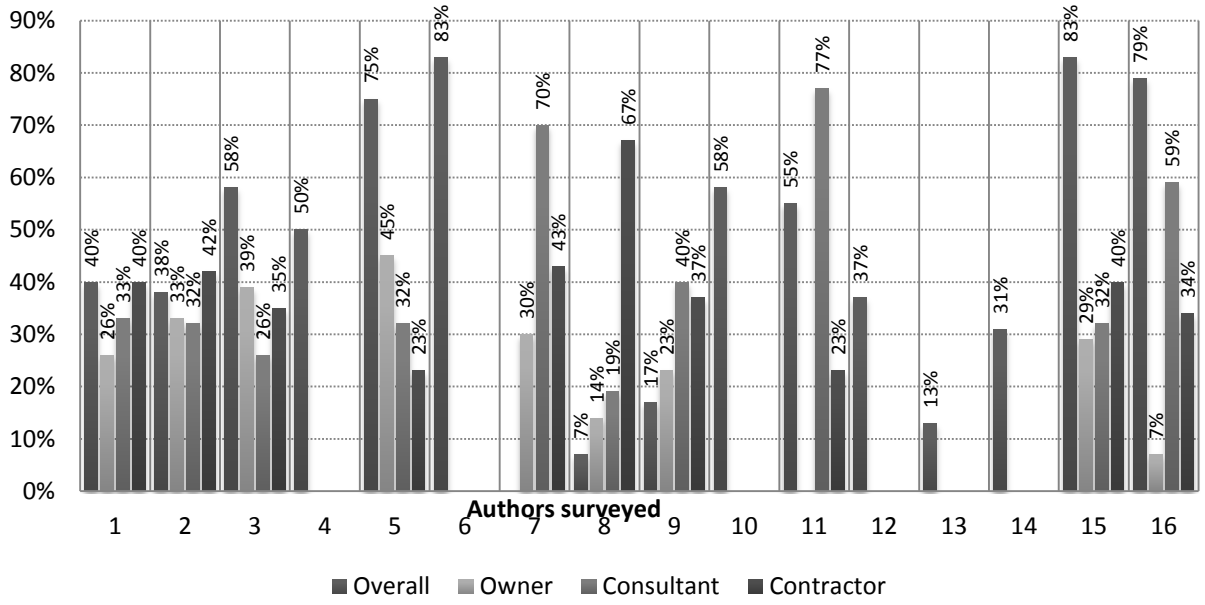

Figure 2 Response rate for different categories for the Questionnaire

Sl. No.	Description of study	Questionnaires distributed				Questionnaire Respondents				Proportional Response Rate*				References
		Total	Owners	Consultants	Contractors	**Total**	Owners	Consultants	Contractors	**Overall**	Owner	Consultant	Contractor	
1	Causes of delay	**144**	27	51	66	**57**	15	19	23	**40%**	26%	33%	40%	Assaf and Hejji 2006
2	Large projects in Vietnam	**287**	82	85	120	**109**	36	27	46	**38%**	33%	32%	42%	Long et.al 2004
3	Causes of delay Ghana Case study	**125**	55	30	40	**72**	28	19	25	**58%**	39%	26%	35%	Frimpong et.al 2003
4	Risk in D&B Projects in Malaysia	**60**	-	-	-	**30**	-	-	-	**50%**	-	-	-	Adnan et.al 2008
5	Causes and effects of delay in Malaysian projects	**200**	100	50	50	**150**	67	48	35	**75%**	45%	32%	23%	Sambasivan & Soon, 2007
6	Quantify schedule risk in projects	**200**	-	-	-	**166**	-	-	-	**83%**	-	-	-	Luu et.al. 2009
7	Schedule delays and cost escalation in Zambia projects	**60**	-	-	-	**-**	-	-	-		30%	70%	43%	Kaliba et.al. 2009
8	Delay Mitigation in Malaysian projects	**502**	8	81	413	**37**	5	7	25	**7%**	14%	19%	67%	Abdul-Rahman et.al. 2006
9	Factors causing delays in Malaysia	**450**	-	-	-	**78**	-	-	-	**17%**	23%	40%	37%	Alaghbari et.al. 2007
10	Schedule delay causes in BOT	**320**	-	-	-	**187**	-	-	-	**58%**	-	-	-	Yang et.al. 2010
11	Delays in Traditional contracts	**150**		100	50	**82**		63	19	**55%**	-	77%	23%	Odeh & Battaineh, 2002
12	Time overrun in HongKong	**400**	-	-	-	**147**	50	49	48	**37%**	-	-	-	Chan & Kumaraswamy 1997
13	Compressing duration Hong Kong	**164**	-	-	-	**22**	-	-	-	**13%**	-	-	-	Chan & Kumaraswamy 2002
14	Delay and cost overrun in Vietnam	**285**	-	-	-	**87**	-	-	-	**31%**	-	-	-	Le-Hoai. et. al. 2008
15	Delay in Jordan Projects	**110**	30	30	50	**91**	26	29	36	**83%**	29%	32%	40%	Sweis et.al. 2007
16	Time, cost and quality managt.	**180**	30	90	60	**143**	10	84	49	**79%**	7%	59%	34%	Bowen et.al. 2002

Table 2 Details of the Questionnaire distribution in various studies and their response

* The decimals more than 0.5 are rounded to next whole number

Data Analysis	Abbreviation	Proposed Expression	Parameters	Reference	Place of study
Importance Index	I	$(I) = \sum_{i=1}^{4} \frac{a_i x_i}{3}$	Where *I* = importance index; a*i* = constant expressing the weight of the *i*th response, where a*i* = 0,1,2,3 for *I* = 1,2,3,4, respectively; *xi* = frequency of the *i*th response given as a percentage of the total response for each cause; *i* = response ategory index.	Assaf et.al. 1995	Saudi Arabia
Rank correlation coefficient		$\rho = \frac{1 - 6 \Sigma D^2}{N(N^2 - 1)}$	Where, D= difference between ranks given by one party and the rank given by another party for an individual cause and N= umber of cause or groups.	Assaf et.al. 1995	Saudi Arabia
Relative Importance Index	RII	$\frac{\sum w}{A \times N}, (0 \leq \text{index} \leq 1)$	where w = weighting given to each factor by the respondentsand ranges from 1 to 5 where '1' is 'not significant' and '5' is 'extremely significant', A = highest weight (i.e. 5 in this case), and N = total number of respondents.	Chan & Kumaraswamy, 1997	Hong Kong
Relative Importance Index	RII	$\text{RII} = \frac{\sum r}{A \times N}, (0 \leqslant \text{RII} \leqslant 1)$	where r = rating given to each factor by the respondents and ranges from 1 to 5 where '1' is 'not significant' and '5' is 'extremely significant', A = highest rating (i.e. 5 in this case), and N = total number of respondents.	Chan & Kumaraswamy, 2002	Hong Kong
Relative Importance Index	RII	$I = \frac{\sum_{i=1}^{5} W_i X_i}{\sum_{i=1}^{5} X_i}$	Where *i* = response category index, Wi = the weight assigned to the *i*th resonse. Xi = frequency of the *i*th response given as percentage of the total responses for each case.	Odeh & Battaineh, 2002	Jordan
Relative Importance Weight	RIW	$\frac{\sum_{i=1}^{5} a_i \cdot n_i}{\sum_{j=1}^{N} xj} \times 100$	where: xj=the sum of the jth factor; j=the factors 1, 2, 3, 4, ...N; N=total number of factors (26); ai=constant expressing the weight given to the ith response: i=1, 2, 3, 4, 5	Frimpong et al. 2003	Ghana
Frequency Index (%)	F.I. (%)	$\sum a(n/N) * 100/4$	a is the constant expressing weighting given to each response (ranges from 1 for	Assaf and Hejji 2006	Saudi Arabia

			rarely up to 4 for always), n is the frequency of the responses, and N is total number of responses.		
Severity Index (%)	S.I. (%)	$\sum a(n/N) * 100/4$	a is the constant expressing weighting given to each response (ranges from 1 for rarely up to 4 for always), n is the frequency of the responses, and N is total number of responses.	Assaf and Hejji 2006	Saudi Arabia
Importance Index (%)	IMP.I. (%)	$[\text{F.I. } (\%) * \text{S.I. } (\%)]/100$		Assaf and Hejji 2006	Saudi Arabia
Relative Importance Index	RII	$\text{RII} = \frac{\sum W}{A * N}$	where w = weighting given to each factor by the respondentsand ranges from 1 to 5 where '1' is 'not significant' and '5' is 'extremely significant', A = highest weight (i.e. 5 in this case), and N = total number of respondents.	Sambasivan & Soon 2007	Malaysia
Mean Score	MS	$\text{MS} = \left(4 - \frac{\sum(f \times s)}{N}\right) (1 \leq \text{MS} \leq 4),$	Where MS is the mean score, f is the frequency of responses to each rating (1-4), s is the score given to each factor by the respondents (ranges from 1 to 4), and N is the total number of responses concerning that factor	Alaghbari et al. 2007	Malaysia
Frequency Index (%)	F.I. (%)	$F.I. = \frac{\sum_{0}^{4} a_i n_i}{4N}$	*a* = constant expressing the weight assigned to each responses (ranges from 0 for *No happen* to 4 for *Always*), *n* = frequency of each response, *N* = total number of responses.	Le-Hoai et al. 2008	Vietnam
Severity Index (%)	S.I. (%)	$S.I. = \frac{\sum_{0}^{4} a_i n_i}{4N}$	*a* = constant expressing the weight assigned to each responses (ranges from 0 for *No happen* to 4 for *Always*), *n* = frequency of each response, *N* = total number of responses.	Le-Hoai et al. 2008	Vietnam
Relative Importance Index	RII	$IMP.I. = F.I. \times S.I.$		Le-Hoai et al. 2008	Vietnam

Table 3 Data Analysis Expressions used for various studies reported in literature.

Analysis of Data

Each and every study has a different scope and different conclusions. Hence, different approaches have been used and the data analysed with different expressions. Table 3 includes the expressions used by individual researchers to produce the results to meet the set objectives. It shows the data analysis approaches with abbreviations and the equations used to calculate the results. The table explains the parameters used in the expressions. The place where the study was performed is denoted in column 6 of the Table 6.

Results and Discussions

The data from the responses were analyzed by the authors of each and every study and the groups were ranked as shown in Table 4. It has collective listing of 18 different Groups/Category. The respective rankings results of the studies have been summarized to obtain an over view on the Groups that are highly responsible for the project delays.

The review findings shows that the group and factor ranking differs based on the location like Hong Kong, Jordan, Vietnam, etc. Sambasivan and Soon (2007) stated that "the effects of delays in construction projects can be country-specific" whereas other studies has proven that project characteristics may even be region-specific. None of the studies is comparable to any other and each study has different rankings for the groups/categories/sources of the delays and cost overruns. The groups most influential in earlier studies (in 1995) are now (2010) not considered high risk factors. The possible variations in the ranking results are most unlikely to be because of the different respondents. Table 4 clearly outlines that the studies have yielded different results. Even Sambasivan & Soon (2007) adopting the same 28 factors derived by Odeh & Battaineh (2002) has obtained different results of group influence and their responsible levels. Figure 3 shows the scatter diagram of the ranks obtained from the various related studies.

As there is no correlation in the ranking of the different studies, the first five rankings influencing project delays and cost overruns from the entire set of results of each author has been collected. In the different studies the groups with Rank 1 to Rank 5 has been listed. The groups which appear more than once have been identified. This is tabulated in Table 5.

Even though the groups like Owner (Rank 1), Contractor (Rank 2), Design related and Plant and Equipments (Rank 3), Labour (Rank 4) and Consultant and Contractual relationships (Rank 5) fall more frequently within the first 5 rank category, other groups like Finance related, Materials, Schedule and Controlling, Coordination, Changes are also found in some studies but occurs only once in the collated studies. So out of all 18 categories 7 categories appears among the first five ranks and other 11 categories are rated consistently below Rank 5. This provides an overall view of the study, and is shown in Table 5.

The critical review has resulted in a consolidated list of factors/causes and their ranking (Table 6). This review study has identified 113 factors from the studies discussed in this article. Further analysis ranked all these factors according to the results in the respective studies. Table 6 compares the results of ten studies in 12 different sectors of the projects. The corresponding Factors and their Group wise categories are mentioned in the last column of the table 6. This comparative study brings together the results of various studies and combines the Factors / Causes, Ranking and Group classification.

The serial numbers in row 1 of table 6 represents authors, whose details are as follows: Column [1] Assaf et.al. 1995, col.[2] Chan & Kumaraswamy 1997, col. [3] Odeh & Battaineh

2002, col.[4] Frimpong et.al. 2003, col.[5] Long, et.al 2004, col. [6] Sambasivan& Soon 2007, col.[7] Alaghbari et al. 2007, col.[8] Le-Hoai. et al. 2008, col.[9] Luu et al. 2009 and col.[10] Tumi et al. 2009. Also (a) indicates "Contractor", (b) "Consultants", (c) "Occurrence" and (d) "Influence".

From the list of factors obtained in Table 6 from the previous studies, the first five important causes of delay and cost overruns in different developing countries are determined and summarized in Table 7.

The problem of delays in the construction industry is a global phenomenon. In Saudi Arabia, Assaf and Al-Hejji (2006) found that only 30% of construction projects were completed within the scheduled completion dates and that the average time overrun was between 10% and 30%. In Nigeria, Ajanlekoko (1987) observed that the performance of the construction industry in terms of time was poor. Odeyinka and Yusif (1997) have shown that seven out of ten projects surveyed in Nigeria suffered delays in their execution. Ogunlana and Promkuntong (1996) conducted a study on construction delays in Thailand. Al-Momani (2000) carried out a quantitative analysis on construction delays in Jordan. Frimpong et al. (2003) conducted a survey to identify and evaluate the relative importance of the significant factors contributing to delay and cost overruns in Ghana groundwater construction projects. Chan and Kumaraswamy (1997) studied delays in Hong Kong construction industry.

Conclusions

The critical review undertaken in this paper covers research studies in the area of construction delay with time and cost risks. Totally 18 categories of causes were identified from the various related studies reported in the literature. These 18 categories or Groups are (1) Finance-related, (2) Project-related, (3) Project Attributes, (4) Owner/Client, (5) Contractor, (6) Consultant, (7) Design-related, (8) Coordination, (9) Materials, (10) Plant/Equipment, (11) Labour/Manpower, (12) Environment, (13) Contract-related, (14) Contractual relationships, (15) External, (16) Changes, (17) Scheduling & Controlling and (18) Governmental relationship.

Generally, all the research studies were conducted by questionnaire surveys using randomly sampled responses and analysis of data obtained from the responses. The review study has ranked the responsible groups by combining the analysis results which are: Owner (Rank 1), Contractor (Rank 2), Design related and Plant and Equipments (Rank 3), Labour (Rank 4) and Consultant and Contractual relationships (Rank 5). These fall into the first 5 rank categories.

Each study has a unique approach and unique results are derived from the questionnaire response data. Various indices like Importance Index (I), Rank Correlation Coefficient, Relative Importance Index (RII), Frequency Index (FI), Severity Index (SI) and Mean Score (MS) have been determined to assess the impact of the Factors at various angles based on the requirement for the project.

Each study has rated the groups or factors with Ranks of influence. These ranks are compared for better understanding. But two studies have similar rating of ranks. Each and every Group in the various studies arrived at different weights of Ranks. It would appear that the Groups and Factors causing delays are country, location and project specific and that there are no root causes that can be generalised.

Sl. No.	Group	Overall / Average Ranking Studied										Combined Ranking
		Assaf et.al. 1995	Chan& Kumaraswamy, 1997	Odeh & Battaineh 2002		Long et.al 2004		Assaf and Hejji 2006			Sambasivan& Soon 2007	
				Contractors	Consultants	Occurrence	Influence	Frequency	Severity	Importance		
1	Finance – related	1	-	-	-	7	7	-	-	-	-	
2	Project – related	-	5	-	-	-	-	7	9	8	-	
3	Project Attributes	-	-	-	-	6	5	-	-	-	-	
4	Owner / Client – related	-	7	1	1	5	3	1	1	1	4	
5	Contractor – related	-	1	3	2	2	4	2	2	2	1	
6	Consultant – related	-	-	6	4	1	1	3	5	5	7	
7	Design – related	-	2	-	-	-	-	5	3	3	-	
8	Coordination	-	-	-	-	3	6	-	-	-	-	
9	Materials	2	8	7	5	-	-	6	6	6	2	
10	Plant/Equipments	7	6	2	3	-	-	9	7	9	3	
11	Labour	6	3	2	3	-	-	4	4	4	3	
12	Environment	9	-	-	-	4	2	-	-	-	-	
13	Contract	-	-	4	7	-	-	-	-	-	6	
14	Contractual Relationship	3		5	6	-	-	-	-	-	5	
15	External	-	4	8	8	-	-	8	8	7	8	
16	Changes	4	-	-	-	-	-	-	-	-	-	
17	Scheduling and Control	5	-	-	-	-	-	-	-	-	-	
18	Government relationship	8	-	-	-	-	-	-	-	-	-	

Table 4 Group rankings

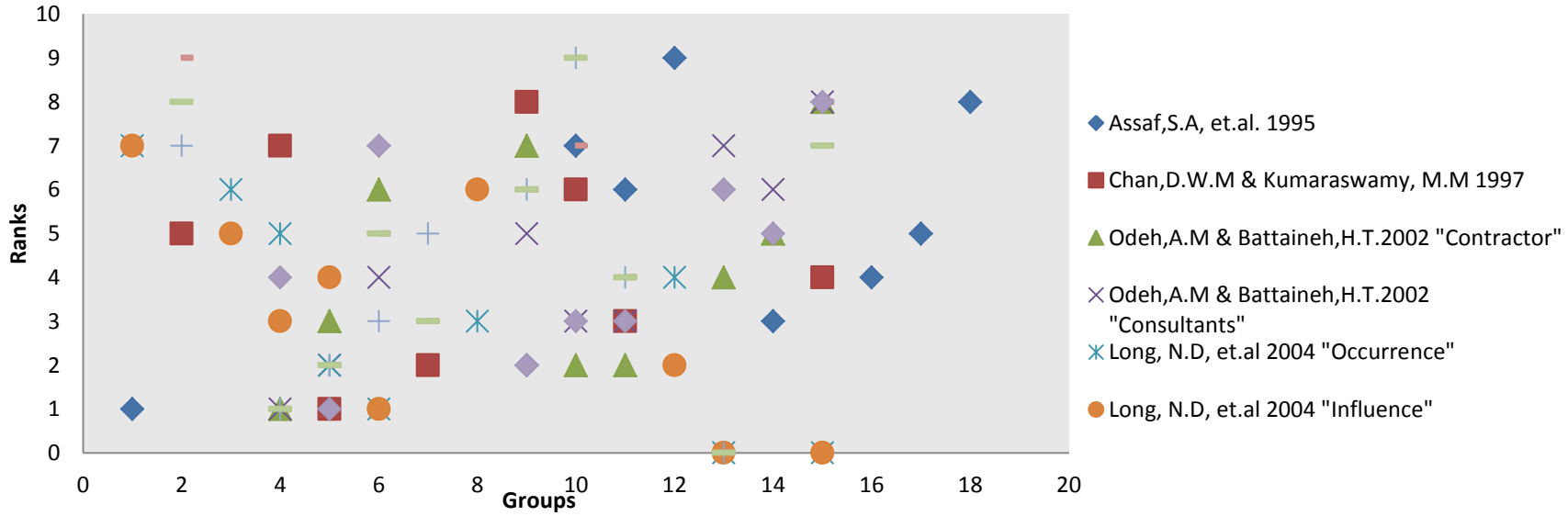

Figure 4 Scatter diagram of rank distribution

Research Study	Groups					Results	Place of study
	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5		
Assaf et.al. 1995	Finance-related	Materials	Contractual relationship	Changes	Schedule and controlling	Overall	Saudi Arabia
Chan & Kumaraswamy, 1997	Contractor	Design	Labour	External	Project – related	Overall	Hong Kong
Odeh & Battaineh, 2002	Owner	Plant and Equipment	Contractor	Contract	Contractual relationship	Contractor's response	Jordan
	Owner	Contractor	Plant and Equipments	Consultant	Materials	Consultant's response	
Long et.al 2004	Consultant	Contractor	Coordination	Environment	Owner	Occurrence	Vietnam
	Consultant	Environment	Owner	Contractor	Project attributes	Influence	
Assaf and Hejji, 2006	Owner	Contractor	Consultant	Labour	Design	Frequency	Saudi Arabia
	Owner	Contractor	Design	Labour	Consultant	Severity	
	Owner	Contractor	Design	Labour	Consultant	Importance	
Sambasivan & Soon, 2007	Contractor	Materials	Plant and equipment	Owner	Contractual relationship	Overall	Malaysia
Many occurrence (No.) and %	Owner (5) 50%	Contractor (5) 50%	Design (2) + Plant & Equipment (2) 40%	Labour (3) 30%	Consultant (2) & Contr. Relationship (2) 40%		

Table 5 Factors securing the first five rank in different studies

Sl. No.	Factors / Causes	[1]	[2]	[3] (a)	[3] (b)	[4]	[5] (c)	[5] (d)	[6]	[7]	[8]	[9]	[10]	Groups
1	Slow payment for completed works	5		4	2	1			4		7	6	9	Financing
2	Contractor financial difficulties	2				5	14	5		2	4	4	4	Financing
3	Cash problems during construction	1				7							5	Financing
4	Inflation					4								Financing
5	Financial difficulties to owner									1	3	1	4	
6	Necessary variations of works		8										7	Project
7	Obsolete technology						9	9						Project attributes
8	Unsatisfactory site compensation						10	7						Project attributes
9	Lack of involvement through project life						16	19						Project attributes
10	Incompetence project team						20	12						Project attributes
11	Slow site handover											5	8	
12	Owner interference			2	4				20					
13	Long waiting time for approval of drawings		3											Owner / Client
14	Client initiated variations		5								18		19	Owner / Client
15	Unrealistic contract durations imposed by client		13	13	6			18	24					Owner / Client
16	Unrealistic client initial requirement		20											Owner / Client
17	Low speed of decision making		4	8	5	26			13	8			4	Owner / Client
18	Slow site clearance difficulties						2	1				13		Owner / Client
19	Delays in subcontractors' work		9	9	3				5		13		6	Contractor
20	Poor site management and supervision		11	5	13		17		2	5	1	11	6	Contractor
21	Unstable management structure and style of contractor		12				15	20						Contractor
22	Shortage of Technical, managerial and supervisory personnel		15			20	7	4				14		Contractor
23	Construction method			5	17				15		13	8		Contractor
24	Improper planning			10	8				1					Contractor
25	Mistakes during construction			17	11	22			10	6	16	9	17	Contractor
26	Inadequate contractor experience			3	1			8	3			2	10	Contractor
27	Severe overtime						5							Contractor
28	Excessive contracts and subcontracts						18						11	Contractor
29	Lack of responsibilities							10						Contractor
30	Contract Management			12	7				19		11			Consultant
31	Delay in work approval					18							11	Consultant
32	Preparations and approval of drawings			21	19				16					Consultant
33	Quality assurance/Control			25	21	25			22				11	Consultant
34	Waiting for information					24							11	
35	Long waiting time for approval of test samples of material		16	18	15	25			23				11	Consultant
36	Poor contract management					2								Consultant
37	Supervision too late & slowness in making decision									3	15		11	
38	Slow to give instructions									4				
39	Lack of consultant's experience									9			10	
40	Poor project management assistance										2			

Sl. No.	Factors / Causes	[1]	[2]	[3] (a)	[3] (b)	[4]	[5] (c)	[5] (d)	[6]	[7]	[8]	[9]	[10]	Groups
41	Delay in design information		2											Design - related
42	Inadequate design team experience		6									15		Design - related
43	Mistakes and discrepancies in design		7								10		3	Design - related
44	Impractical design						19	11						Design - related
45	Slow information flow between project team		10								17			Coordination
46	Lack of communication between consultant and contractor		14	20	14				9				2	Coordination
47	Lack of communication between client and consultant		17	20	14				9				2	Coordination
48	Shortage	11		11	10	15			6	4	9	3	3	Materials
49	Change in type & Spec.	6												Materials
50	Procurement					3								Materials
51	Slow / late delivery	16				11				7			13	Materials
52	Damage in storage while needed at site	45												Materials
53	Delay in special manufacturer from foreign country (Imported)	16				17								Materials
54	Quality			26	23				12					Materials
55	Escalation in prices					6								Materials
56	Difficulty in obtaining at official current prices					13								Materials
57	Failure	42		7	16	16			8					Plant/Equipments
58	Shortage/Availability	36		7	16	15	6	17	8			16		Plant/Equipments
59	Unskilled operators	50												Plant/Equipments
60	Slow / late delivery	41				11								Plant/Equipments
61	Poor productivity	41												Plant/Equipments
62	Shortage / Supply	27		16	12	21			7		19			Manpower
63	Labour skills/Productivity	27		1	9				11		19			Manpower
64	Nationality of labour	49												Manpower
65	Hot weather effect on construction activity	42												Environment
66	Rain / inclement weather effect on construction activity	55	18	23	24	8			27		20	12	21	Environment
67	Insufficient available utilities on site	51												Environment
68	Social and cultural factor	54												Environment
69	Project delivery systems used. (#)	33							17					Contract
70	Mistakes and discrepancies in contract documents			14	22					10			18	Contract
71	Deficiencies/inaccurate in cost estimates					10	12	15			8			Contract
72	Low warded bid price					14						7		Contract
73	Conflicts between contractor & consultant	20											21	Contractual Relationship
74	Uncooperative owner	9												Contractual Relationship
75	Slowness of owner's decision–making process	2	19			26								Contractual Relationship
76	Joint owner ship of project	51												Contractual Relationship
77	Poor organization of contractor or consultant	11		22	18				25					Contractual Relationship
78	Difficulty of coordination with various parties in the project	11												Contractual Relationship

Sl. No.	Factors / Causes	[1]	[2]	[3] (a)	[3] (b)	[4]	[5] (c)	[5] (d)	[6]	[7]	[8]	[9]	[10]	Groups
79	Insufficient communication between the owner & design in the design phase.	21												Contractual Relationship
80	Unavailability of professional construction management	31												Contractual Relationship
81	Controlling subcontractors by general contractors in execution of works	6												Contractual Relationship
82	Unavailability of financial incentive for contractor to finish ahead of schedule	32												Contractual Relationship
83	Negotiations and obtaining of contracts	46												Contractual Relationship
84	Legal disputes between various parties in the const. project	46		15	20				14					Contractual Relationship
85	Problems with neighbors			28	27				28					External
86	Unforeseen ground conditions			24	25	23			18		6			External
87	Fraudulent practices and kickbacks						11							External
88	Price fluctuation										12	10		
89	Design changes by owner	9		19	26		3	13	21		5		14	Changes
90	Design changes made by designers (*)	14					3	13	21		5		14	Changes
91	Foundation conditions encountered in the field	33	1											Changes
92	Mistakes in soil investigation	27						16						Changes
93	Water table conditions on site	24												Changes
94	Geological problems on site	46				12								Changes
95	Errors committed during field construction on site	27												Changes
96	Inaccurate time estimates						1	3					1	Scheduling & Control
97	Planning and scheduling deficiencies					8	13	6						Scheduling & Control
98	Preparation and approval of shop drawing	11												Scheduling & Control
99	Waiting for sample materials approval	27												Scheduling & Control
100	Preparation of schedule networks and revisions by consultant during construction	33												Scheduling & Control
101	Lack of training personnel and management support to model construction operation	24												Scheduling & Control
102	Lack of database in estimating activity duration and resources	16												Scheduling & Control
103	Poor judgment and experience of involved people in estimating time and resources	6												Scheduling & Control
104	Inadequate early planning of project	16												Scheduling & Control
105	Inspection and testing procedures used in project	36												Scheduling & Control
106	Application of quality control based on foreign specification	42												Scheduling & Control
107	Traffic control regulation practiced at site	53												Scheduling & Control
108	Accident during construction	56												Scheduling & Control
109	Inadequate control procedures					19								Scheduling & Control
110	Obtaining permits from Government	21					4	2			21			Govt. relations
111	Obtaining permits from labourers	24									21			Govt. relations
112	Excessive bureaucracy in project-owner operation	11					8	14					7	Govt. relations
113	Building codes used in design of projects	8		27	28				26					Govt. relations

Table 6 Consolidated list of Factors / Causes and their Ranking

* (Due to unfamiliarity with local conditions and environment)

\# (Design & Build, General Contracting, turnkey, etc.)

	Major Causes					Author
	1	2	3	4	5	
Vietnam (a)	Poor site management and supervision	Poor site management and assistance	Financial difficulties of owner	Financial difficulties of contractor	Design Change	Le-Hoai et. al. 2007
Malaysia (b)	Improper planning	Site management	Inadequate contractor experience	Finance and payments of completed works	Subcontractors	Sambasivan, 2007
Jordan (b)	Financial difficulties faced by the contractor	Too many change order from the owner	Poor planning and scheduling by the contractor	Presence of unskilled labours	Shortage of Technical professionals with the contractor	Sweis, 2007
South Korea (b)	Public interruptions	Changed site conditions	Failure to provide site	Unrealistic time estimation	Design Error	Acharya et al. 2006
Hong Kong (b)	Inadequate resources due to contractor/lack of capital	Unforeseen ground conditions	Exceptionally low bids	Inexperienced contractor	Works in conflict with existing Utility	Lo, 2006
UAE (b)	Preparation and approval of drawings	Inadequate early planning of the project	Slowness of the owner's decisions making process	Shortage of manpower	Poor supervision and poor site management	Faridi, 2006
Nigeria (b)	Contractor's financial difficulties	Client's cash flow problem	Architects incomplete drawing	Subcontractor's slow mobilization	Equipment breakdown and maintenance problem	Aibinu, 2006
Saudi Arabia (b)	Changes in orders by owner during construction	Delay in progress payments	Insufficient planning and scheduling	Shortage of labour	Difficulties in financing contract	Assaf 2006
Kuwait (b)	Change orders	Financial constraints	Owner's lack of experience	Materials	Weather	Koushki, 2005
(c)	Contractor	Materials	Financial constraints	Change orders	Weather	
Ghana (a)	Monthly payment difficulties	Poor contract management	Material procurement	Inflation	Contractor's financial difficulties	Frimpong, 2003
Jordan (b)	Poor design	Changes in orders/design	Weather	Unforeseen site conditions	Late deliveries	Al-Moumani 2000
Saudi Arabia (b)	Cash flow problem financial difficulties	Difficulties in obtaining permits	"Lowest bid wins" system			Al-Khal 1999
Lebanon (b)	Owner's more concern in financial issues	Contractors regarded the contractor relationship the most important	Consultant considered project management most important			Mezher et al. 1998
Saudi Arabia (b)	Slow preparation and approval of shop drawings	Delays in payment to contractors	Changes in Design/Design errors	Shortage of Labour supply	Poor workmanship	Assaf et al. 1995

Table 7 Comparison of previous studies on delay and cost overrun in construction projects in different Countries

(a): Delay and cost overruns; (b): Delays only; (c): Cost overruns only

This study has identified 113 distinct factors classified into 18 groups responsible for delays through critical review of 41 previous research studies performed in the relevant field. This gives all the combination of factors and categories responsible for construction delays. But this critical review of forty one studies also demonstrates that none of the studies can be generalised and directly applicable 'as is'. This presents a strong case against opinion surveys when as in this case, statistical analyse of actual projects could be done which potentially could generate meaningful answers.

REFERENCES

Abdul-Rahman, H., Berawi, A.R., Berawi, A.R., Mohamed, O., Othman, M. and Yahya, I.A. (2006) 'Delay Mitigation in the Malaysian Construction Industry', *Journal of Construction Engineering and Management*, **132** (2), 125-133

Acharya, N.K., Lee, Y.D. and Im, H.M. (2006) 'Investigating delay factors in construction industry: A Korean perspective', *Korean Journal of Construction Engineering and Management,* **10**, 177-190

Adnan, H., Jusoff, K. and Salim, M.K. (2008) 'The Malaysian Construction Industry's Risk Management in Design and Build', *Journal of Modern Applied Science*, **2** (5), 27-33

Ahmed, S., Azher, S., Castillo, M. and Kappagantula, P. (2002) Construction delays in Florida; an empirical study, Florida, 2002. http://www.cm.fiu.edu/publication/Delays .pdf

Aibinu, A.A. and Odeyinka, A. (2006) 'Construction delays and their causative factors in Nigeria', *Journal of Construction Engineering Management,* **132** (7), 667-677

Ajanlekoko, J.O. (1987) 'Controlling cost in the construction industry', *Lagos QS Digest*, Lagos, **1** (1), 8–12

Akinsola, A.O. (1996) 'Neural network model for predicting building projects' contingency', In *Conference proceedings of association of researchers in construction management*, ARCOM 96, Sheffield Hallam University, England, 507–16

Alaghbari, W., Kadir, M.R.A., Salim, A. and Ernawati (2007) 'The significant factors causing delay of building construction projects in Malaysia. Engineering', *Construction and Architectural Management Journal,* **14** (2), 192-206

Alkass, S., Mazerolle, M. and Harris, F. (1994) 'Construction delay analysis techniques', *Journal of Construction Management Economics,* **14** (5), 375–94

Al-Khalil, M. and Al-Ghafly, M. (1999) 'Important causes of delay in public utility projects in Saudi Arabia', *Journal of Construction Management Economics,* **17** (5), 647–55

Al-Moumani, A. (2000) 'Construction delay: a quantitative analysis', *International Journal of Project Management,* **20**, 51–59

Assaf, S.A. and Al-Hejji, S.A. (2006) 'Causes of delay in large construction projects', *International Journal of Project Management,* **24**, 349-357

Assaf, S.A., Al-Khalil, M. and Al-Hazmi, M. (1995) 'Causes of Delay in Large Building Construction Projects', *Journal of Management in Engineering*, 45-50

Bennett, J. and Grice, T. (1990) 'Procurement systems for building', In:Brandon, P. (ed) *Quantity Surveying Techniques: New Directions*, Blackwell Scientific Publications, Oxford

Bennett, J., Flanagan, R., Goodacre, P., Gray, C., McLaughlin, N. and Norman, G. (1979) UK and US Construction Industries: A comparison of Design and Contract Procedures Surveyors Publications, UK London

Bowen, P.A., Hall, K.A., Edwards, P.J., Pearl, R.G. and Cattell, K.S. (2002) 'Perceptions of Time, Cost and Quality Management on Building Projects', *The Australian Journal of Construction Economics and Building*, **2**, 48-56

Chan, D.W.M and Kumaraswamy, M.M. (1997) 'A comparative study of causes of time overruns in Hong Kong construction projects', *International Journal of Project Management,* **15** (1), 55-63

Chan, W.M.C. and Kumaraswamy, M.M. (2002) 'Compressing construction durations: lessons learned from Hong Kong building projects', *International Journal of Project Management,* 20, 23-35

Faridi, A.S. and El-Sayegh, S.M. (2006) 'Significant factors causing delay in the UAE construction industry', *Journal of Construction Management and Economics*, **24** (11), 1167-1176

Flanagan, R., Norman, G., Ireland, V. and Ormerod, R. (1986) A Fresh Look at the UK and US construction Industry Building Employers Confederation, UK, London

Frimpong, Y., Oluwoye, J. and Crawford, L. (2003) 'Causes of delay and cost overruns in construction of groundwater projects in a developing countries; Ghana as a case study', *International Journal of Project Management,* **21**, 321-326

Giridhar, P. and Ramesh, K. (1998) Effective management of Turnkey projects, Aace Transactions, PM7- PM11. Istanbul

Kaliba, C., Muya, M. and Mumba, K. (2009) 'Cost escalation and schedule delays in road construction projects in Zambia', *International Journal of Project Management,* **27**, 522-531

Koushki, P.A., Al-Rashid, K. and Kartam, N. (2005) 'Delays and cost increases in the construction of private residential projects in Kuwait', *Journal of Construction Management and Economics,* **23** (3), 285-294

Latham, M. (1994) Constructing the Team, HMSO, London, 87-92

Le-Hoai, L., Lee, Y.D. and Lee, J.Y. (2008) 'Delay and Cost Overruns in Vietnam Large Construction Projects: A comparison with other selected countries', *KSCE Journal of Civil Engineering,* 367-377

Lo, T.Y., Fung, I.W.H. and Tung, K.C.F. (2006) 'Construction delays in Hong Kong civil engineering projects', *Journal of Construction Engineering Management,* **132** (6), 636-649

Long, N.D., Ogunlana, S., Quang, T. and Lam, K.C. (2004) 'Large construction projects in developing countries: a case study from Vietnam', *International Journal of Project Management,* **22**, 553-561

Luu, T.V., Kim, S., Tuan, N.V. and Ogunlana, S.O. (2009) 'Quantify schedule risk in construction projects using Bayesian belief networks', *International Journal of Project Management,* **27**, 39-50

Mezher, T. and Tawil, W. (1998) 'Causes of delays in the construction industry in Lebanon', *Engineering Construction Architecture Management Journal,* **5** (3), 252–60

NEDO (1988) Faster Building for Commerce HMSO, UK. London

Odeh, A.M. and Battaineh, H.T. (2002) 'Causes of construction delay: traditional contracts', *International Journal of Project Management,* **20**, 67-73

Odeyinka, H.A. and Yusif, A. (1997) 'The causes and effects of construction delays on completion cost of housing project in Nigeria', *Journal Financial Manage Property Construction,* **2** (3), 31–44

Ogunlana, S.O. and Promkuntong, K. (1996) 'Construction delays in a fast growing economy: comparing Thailand with other economies', *International Journal of Project Management,* **14** (1), 37–45

Okpala, D.C. and Aiekwu, A.N. (1988) 'Causes of high costs of construction in Nigeria', *Journal of Construction Engineering and Management*, **114** (2), 233-244

Project Management Institute (PMI) (2008) A guide to the Project Management Body of Knowledge, Fourth Edition, PMBOK, Atlanta

Sambasivan, M. and Soon, Y.W. (2007) 'Causes and effects of delays in Malaysian construction industry', *International Journal of Project Management,* **25**, 517-526

Swies, G., Swies. R., Hammad. A. A. and Shboul, A. (2008) 'Delays in construction projects: The case of Jordan', *International Journal of Project Management,* **26**, 665-674

The Hindu (2007) Hit by delays and cost escalation
http://www.hindunnet.com/2007/07/06/stories/2007070657310100

Tumi.S.A.H., Omran.A. and Pakir.A.H.K. (2009) 'Causes of delay in construction Industry in Libya', *The International Conference on Administration and Business*, 265-272

Yang.J., Yang.C. and Kao.C. (2010) 'Evaluating schedule delay causes for private participating public construction works under the Build-Operate-Transfer model', *International Journal of Project Management,* **28**, 569-579