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RESEARCH ARTICLE

CONSTRUCTION DELAYS IN HIGH-RISE BUILDING PROJECTS IN USA AND INDIA

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ABSTRACT

High-rise buildings are complex, high risk, and multi-contractor projects which are prone to construction delays. Construction delays lead to time overrun, affect the total duration of the project, are expensive and could result in litigation. High-rise buildings are a common sight in the major cities of India (especially Mumbai) due to their limited footprints. There are about 1200 high-rise and 1000 mid-rise buildings in Mumbai alone. In 2009 a total of 9 high-rise buildings were constructed in Mumbai. Construction delays are prevalent in the Architecture, Engineering, and Construction (AEC) industry. High-rise buildings are expensive undertakings, and delays in their completion could result in significant financial losses. A high-rise project management organization must be able to identify the causes of delays, estimate their impact and take the necessary action to eliminate them, if possible. This research work employed both literature review, and analysis of structured questionnaire surveys administered. Analysis of the survey results was to investigate the causes and severity of construction delays in high-rise buildings in India. A comparison was made between construction delays in the United States and India. The results would educate construction engineers of the differences between the United States and other potential international project sites.

INTRODUCTION

In most developing countries, the construction industry is considered as a major engine of growth. It is the second largest industry after agriculture or mining in developing economies and is a primary socio-economic sector in the global economy (Ye *et al*., 2013; Powl and Skitmore, 2005; Ofori, 1990). The construction industry contributes to gainful employment, creates housing and other infrastructure, generates economic income and accounts for a considerable proportion of gross domestic product (Song *et al*., 2006; Crosthwaite2000a, 2000b; Tse and Ganesan, 1997). Despite the importance of the construction industry, it is plagued by delays. Construction delays and their concomitant cost and schedule overruns are the hallmarks of the global construction industry. High rise buildings in developing economies (especially Asia) Play a significant role in fulfilling the housing needs of large urban populations. In most metropolitan cities in India (especially Mumbai), horizontal growth is not able to accommodate people, utilities, and other amenities because of space scarcity and high population densities. Thus, the best way to develop is via vertical growth. However, the construction of a high-rise building is an involved, high risk, and multi-contractor project, which makes them prone to construction delays and could lead to significant losses regarding schedule/time and cost overruns. Since banks and finance companies finance most of the projects, if delays occur during the construction phase, high-interest rates, high inflation rates, and increases in labor and material costs affect the overall budget (Marzouk *et al*., 2008). An extended delay could cause considerable work disruption and loss of productivity (Abdul-Rahman *et al*., 2006). Time and money are the most important factors during the entire life of a construction project. Delays are widespread in the construction industry, but they could be expensive in some situations (Aibinu and Odeyinka, 2006). A delay is a time overrun beyond the planned schedule (Assaf and Al-Hejji, 2006). The major players involved in delays in a construction project are the owner, the contractor, and the consultant. Disputes among these parties could result in project delays. Construction delays can be classified into critical or non-critical, excusable or non-excusable, concurrent or non-concurrent, compensable or non-compensable (Yates and Epstein 2006). An indicator of project efficiency is the successful completion of a project within the time frame and cost allocated to the project (Chan and Kumaraswamy, 1997). Tocomplete the project and reduce the loss of productivity, the high-rise construction manager should have an excellent and thorough knowledge of delays that may occur and should plan and utilize an efficient management system to address those delays. The present research investigates the likely construction

delay causes, their severity, and makes suggestions to amplify the productivity by minimizing the effect of delays. Delays during the construction of large building projects like high rise buildings are common. Time and money, the two critical issues for every construction project, are interconnected in this industry. Construction delays are often responsible for overall time overrun, which ultimately lead to budget overrun in many situations and drive the projects into losses. So, the potential causes of delays must be analyzed before the construction phase is started and minimized to handle the time and money as planned in the project schedule for the successful completion of the project. This research is aimed at identifying the possible causes of delays during the construction of high rise buildings in the United States and India. Additionally, it determines the relative importance of the principal causes of construction delays, studies the critical delay issues about the owners, and contractors, and compares the results from the two countries (The United States and India).

LITERATURE REVIEW

Delays are one of the most prevalent problems in the construction industry. The time extension or late start of any activity affects the following activities and leads to changes in the total duration of the project (Sweis *et al*., 2008). Time and cost overruns have been identified as the important effects of delays in the construction industry. Most of the delays pertain to the three major construction bodies: owner, contractor, and consultant. Ireland (1985) discussed the role of managerial actions in the cost, time and quality performance of high rise commercial building projects. Sanvido *et al*. (1992) determined that, the critical factors that could affect project success were a well-organized team to manage, plan, design, construct and operate the facility; a series of contracts that allow teams to work together without conflicts; and good experience in the project management and construction facilities as well as statistical information by all parties during the construction. Nkado (1995) discussed a total of 33 predefined factors and categorized them into six delay drivers. The most prominent of the factors were contractor's programming of the construction work, the client's specified sequence of completion, form of construction, the client's and designer's priority on construction time, complexity of the project, project location, constructability of the design, availability of the construction management team, and the completeness and timeliness of project information. Ogunlana *et al*. (1996) studied construction delays in the fast-growing economy of Thailand compared with other economies.

The study grouped the problems in developing economies into three categories: problems of shortages or inadequacies in industry infrastructure, problems caused by clients and consultants, problems caused by contractor incompetence/ inadequacies. Change orders were the most frequent reason for creating delays traceable to construction owners. Kaming *et al*. (1997) investigated the factors influencing construction time and cost overruns of high rise building projects in Indonesia. The study ranked design changes, poor labor productivity, and equipment shortages as the most significant delays, followed by inadequate planning, and inaccuracy of materials estimating. Chan and Kumaraswamy (1997) developed a comparative study of causes of time overruns in the Hong Kong construction industry. This study used the findings of Ireland (1985) and identified 83 probable causes of delays, which were grouped into eight major categories.

The study observed that the most significant sources of delays were poor site management and supervision, unforeseen ground conditions, low speed of decision making involving all project teams, client-initiated variations, and important variations of work. The comparative study of Hong Kong, Saudi Arabia, and Nigeria observed many variations in the results because of the difference in countries and socio-economic factors. Al-Momani (2000) surveyed 130 projects in Jordan to investigate the causes of delays. The study concluded that the major causes of delays were poor design, change orders, weather, site conditions, late delivery, and economic conditions. Odeh and Battaineh (2002) identified the major causes of delays in the construction industry and concluded that the most important factors contributing to delays were owner interference and inadequate contractor experience. Others wereproblems with financing and payments of completed work, low labor productivity, poor site management, slow decision making, improper construction methods, inadequate planning, and problems with sub-contractors. Aibinu and Jagboro (2002) focused on the effects of construction delays on project delivery as well as its minimization in the Nigerian construction industry. The study,which was built upon the results of Chan and Kumaraswamy (1997), showed that client-related delays were frequent, and the significant effects were time and cost overruns, followed by disputes, total abandonment, arbitration, and litigation. The two methods which could be used to minimize cost and time overruns were acceleration of subsequent site activities to reduce or, if possible, eliminate time overrun as well as the inclusion of allowance in pre-contract estimate to buffer cost overrun. Chan *et al*. (2004) studied the factors that affect the success of a construction project.

The study used the research results of Sanvido *et al*.(1992), Chan and Kumaraswamy (1997), and Kaming *et al*. (1997) and concluded that five major variables affect project success.They areproject related factors, project procedures, project management actions, human-related factors, and external environmental factors. Long *et al*. (2004) discussed problems encountered in the management of large construction projects in developing countries through a case study from Vietnam. The study was built upon the findings of Ogunlana *et al.* (1996), Chan and Kumaraswamy (1997), and Al-Momani (2000) and revealed that project delays and cost overruns were the most severe problems in the construction industry. The important problems were inaccurate time estimation, slow site clearance, slow government permits, human and management flaws, the absence of capable owner's representatives, obsolete technology, and inadequate site compensation, high ratings regarding the degree of occurrence and level of influence. Iyer and Jha (2005) identified the factors that affect the cost performance of Indian construction projects. The study used the findings of Chan and Kumaraswamy (1997) and explored factors such as project success, failure attributes, and critical success. The study revealed 30 success attributes and 23 failure attributes. The critical success factors are the project manager's competence, top management support, project manager's coordination and leadership skill, top management and owner involvement in the project, the interaction between project participants, owner's competence, and favorable climatic conditions. The critical failure factors are conflict among project participants, ignorance and lack of knowledge, indecisiveness, hostile socio-economic and climatic condition, reluctance in making timely decisions, aggressive competition

at tender stage, and short bid preparation time. Abdul-Rahman *et al*. (2006) investigated the causes of delays and delayed mitigation in the Malaysian construction industry. The study identified the causes of construction delays and suggested recommendations to overcome the effects of delays. The major causes of delays were financial problems, client's interference, human resources problems and poor site management, sub-contractors, authority approvals, design problems, construction methods, labor shortage and lack of skills, poor planning, and scheduling. Yates and Epstein (2006) showed how claims are generated during a construction project, their causes, and the methods used to minimize claims in relational contracting. The research investigated technical and legal approaches used to analyze claim practices in the construction industry. The categories of damages that can be recovered by delays were labor escalation, material escalation, increased engineering and supervision, loss of productivity or loss of efficiency, interest, equipment costs, impact costs, field office overhead, main office overhead, insurance, and bonding/loss of bonding. The study suggests that claims could be reduced by the proper implementation of CPM scheduling, and addressing problems and documenting job progress. Concerning weather delays, force majeure clauses, which help owners pay for delay claims, should contain as much specific and objective criteria as possible. Assaf and Al-Hejji (2006) studied the causes of delays in large construction projects. The study used the research results of Chan and Kumaraswamy (1997), Kaming *et al.* (1997), and Al-Momani (2000) and determined 73 causes of construction delays, summarized in nine groups. This research concluded that the average time overrun was between 10% and 30% of the actual duration and the most severe causes are related to contractors and labor.

The most common delay between all the parties involved in the construction is change orders. Aibinu and Odeyinka (2006) studied the causative factors of construction delays in the Nigerian construction industry. The study used the findings of Nkado (1995), Ogunlana *et al.* (1996), Chan and Kumaraswamy (1997), and Kaming *et al*. (1997) and identified 44 factors that contributed to delays. It was revealed that 88% (or 39) of the factors are placed in the highest priority and are responsible for 90% of the overall delays. The mean percentages of time delays range from 19% to 181% for projects. The mean percentages of cost overrun arising from delay expenses range from 19% to 45%. The top ten causes of delays include contractor's financial difficulties, client's cash flow problems, architect's incomplete drawings, sub-contractors slow mobilization, equipment breakdown and maintenance problems, supplier's late delivery of ordered materials, incomplete structural drawings, the contractor's planning and scheduling problems, price escalation, and sub-contractors financial difficulties. Faridi and El-Sayegh (2006) studied the significant factors causing delays in the UAE construction industry. The study was built upon the findings of Ogunlana*et al.* (1996), Kaming *et al.* (1997), and Odeh and Battaineh (2002). They found forty-four major causes of construction delays that affected the UAE construction industry. The causes were grouped into eight categories: contractor, consultant/designer, owner, financial, planning and scheduling, contractual relationship, government regulations, and unforeseen conditions. The Relative Important Index (RII) was used to analyze the causes of delays. The preparation and approval of drawings, inadequate early project planning, and a slow decision-making process by the owner were ranked high by both contractors and consultants. Murali and Wen (2007) conducted a study on the causes and effects of construction delays in the Malaysian construction industry. The study employed the research findings of Ogunlana *et al*. (1996), Chan and Kumaraswamy (1997), Al-Momani (2000), Aibinu and Jagboro (2002), Odeh and Battaineh (2002), and Assaf and Al-Hejji (2006). The survey identified the top ten causes of delays as a contractor's improper planning, a contractor's poor site management, inadequate contractor experience, inadequate client's finance and payments for completed work, problems with sub-contractors, shortage in material, labor supply, equipment availability and failure, lack of communication between parties and mistakes during the construction stage. The six main effects of delays were time overrun, cost overrun, disputes, arbitration, litigation, and total abandonment. Marzouk *et al*. (2008) showed an assessment of construction engineering related delays for Egyptian projects. This research grouped the 22 causes of delays into three categories: design development delays, workshop drawing delays, and changes by project party's delays.

They identified mistakes/changes in design documents as the most important cause of delays in Egypt. Sweis *et al*. (2008) discussed the delays in construction projects in Jordan. The 40 potential causes of delays were summarized into three groups: input factors, internal environment, and exogenous factors. The main causes of delays were several change orders from owners, financial difficulties faced by contractors and poor planning, or scheduling of the project by various contractors. The study showed that change orders resulted in about 5% to 10% increments in the original budget of the projects surveyed. Abd-El-Razek *et al*. (2008) discussed the causes of delays in building construction projects in Egypt. The study used the research results of Assaf and Al-Hejji (2006). A list of 32 causes of delays was identified and categorized into nine major groups. The study concluded that the most important causes of delays were the contractor's finances during construction, owner's delays in paying the contractors, design changes by the owner or his/her agent during construction, partial payments during construction and non-utilization of professional construction management services. The study concluded that all the parties in a construction project contributed to the delays and suggested that the prevention or mitigation of delay must be a joint effort of the parties involved in a construction project.

MATERIALS AND METHODS

The genesis of the research involves a comprehensive review of the literature about construction delays (especially for high rise buildings). Since the research topic involves a developing country, most of the reviewed (published) work was from developing economies like Egypt, Hong Kong, Nigeria, Thailand, and others. The results of the literature search were summarized under the literature review. From the literature studies, construction delays were prevalent in many projects in the construction industry. During the literature review, it was identified that the studies of Chan and Kumaraswamy (1997), Aibinu and Jagboro (2002), and Assaf and Al-Hejji (2006) were more comprehensive than the rest. The research in this area is expanding, and most of the research wasbased on the findings of previous studies. The literature study revealed that change orders by owners, financial problems of contractors, and project management issues are the most severe problems. Additionally, the three parties blamed each other as the source of construction delays. However, many research studies

revealed that most of the delays (poor performance, inability to work, lack of experience, and financial problems) could be attributed to the project contractor. Table 1 lists all the causes of delays extracted from the literature analysis. The count in this table for a cause of delay depends on how many times it was used independently by different research studies. If five different studies use a particular cause of the delay, then the count is five. The ranks are given based upon the count value. Based on the literature review, this study extracted several causes of delays from the previous research studies. The delays were further refined based on their importance, severity, and relevance. Some of the similar delay causes were merged, and some new delay causes were added. Thus, the possible total number of delay causes added up to 42 for the construction of high rise buildings. Table 2 lists all the possible causes of delays identified by the present study, and all the causes of delays extracted from the previous studies as listed in Table 1. A structured questionnaire survey was designed and carried out in the United States and India to ascertain the causes of delays of high rise buildings. The scope of the study was limited to the construction of high rise buildings, including the residential and commercial type of buildings. After an IRB review and approval, owners, contractors, architects, construction managers, and civil engineers were surveyed. A total of 295 surveys were randomly sent to construction professionals in the two countries. The study was limited to the construction of high rise buildings, including the residential and commercial type of buildings.

For all the delay causes, respondents were asked to indicate their preference level on a scale (Likert scale) ranging from 1 to 5 (Strongly disagree, Disagree, Neutral, Agree, strongly agree). The five-point Likert scale gives the participants excellent chances to indicate their preference from strongly disagree to agree strongly. The resulting survey data was subjected to mathematical and statistical analysis, and the results were discussed. Finally, a comparative analysis of delays in the USA and India was made. The study analyzed several possible methods to select an appropriate method for the analysis of the survey results. The relative importance index (RII) method used by Abd El-Razek *et al*. (2008), Aibinu and Jagboro (2002), Chan and Kumaraswamy (1997), Faridi and El-Sayegh (2006), Iyer and Jha (2005), Murali and Wen (2006), Odeh and Battaineh (2002) was adopted to perform the analysis of the survey data to determine the critical causesof construction delays.This relative importance method was appropriate because it calculated the weighted average of the participants' opinions and it was the most commonly used method. The relative essential indices were calculated using the formula:

$$\text{RII}\ (\%) = \frac{\sum_{i=1}^{5} W_i X_i}{5N}\ X\ 100 \quad (1)$$

Where W_i = Weight assigned to i^{th} response
W_i = 1,2,3,4 and 5 for i = 1,2,3,4 and 5, respectively
X_i = Number of respondents for i^{th} response
i = Response category index = 1,2,3,4, and 5 for Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree respectively

N = total number of respondents. Finally, the index is multiplied by 100 to be calculated as a percentage. The RII value ranges from 0 to 100%. The severity of the cause of the delay increases as the RII value increases. A higher RII value indicates that the cause of the delay is more severe, whereas a lower RII value indicates that the cause is less severe. The RII values are then used to determine the severity ranks for each delay cause. These rankings made it possible to compare the relative importance of the causes of delay for the two nations, India and the United States. The analysis was performed for the USA and India. A comparative analysis is shown at the end of this study to depict the differences between the two countries. The statistical analysis of the data reveals the actual causes of delays and their severity. The delays were ranked based on their severity. The final results include the survey participants' recommendations to minimize the determined delay causes for the construction of high rise buildings. The responses received are summarized in Table 3.

RESULTS AND DISCUSSION

This research study compared the survey results of the USA and India to establish the differences between the two construction industries. The analysis shows that there is a clear difference between the results of the two nations. The Indian high-rise construction industry has been facing more problems with construction delays than the American construction industry. The results show that 28.4% of Indian projects are experiencing more time delays than American projects. The Indian projects are experiencing cost overrun every time (100% of projects) along with the presence of overall time overrun, whereas, in the USA, 69% of projects are experiencing cost escalations as the effect of overall time overrun. The results are presented in Figure 1. However, there is asignificant difference observed between American and Indian projects in the case of average high-rise projects' time delay experience. The average time overrun of high rise building projects in the USA was 81.3%, whereas the Indian projects experienced 81.8% overrun. The respondents from both the USA and India indicated that overall time and cost overruns are the most severe effects of construction delays. However, the cost overrun is less severe than time overrun for the USA, whereas the two effects are equally important for India. It is also evident that there are more disputes and litigations for Indian projects. The results show that most of the American projects use arbitration to resolve disputes, and the chances for litigations (trying cases in courts) are very low, whereas the scenario for Indian projects is quite the opposite. All the respondents agreed that the chance for the total abandonment of projects is very poor as the effect of construction delays. The results for severe effects of construction delays are shown in Figure 3.The extensive delays category shows a difference between the opinions of participants from the two nations. The results of extensive delays are more severe for India compared to the USA since the relative importance indexes for most of the causes are high (four of six causes are ranked more than 70%) for India. The average severity of these delays for the USA is 62.6% compared with 72.39% for India. These delays are 9.79% more severe for India than the USA. The analysis shows that a significant difference is observed in the opinions of respondents in the case of unavailability of project management crew (51.43% -the USA, 72.73% - India), which has a 21.3% relative importance index. The only cause that was ranked more severe in the USA than in India was a change in the construction contract. It is also observed that the lack of communication and coordination among all the parties (75.71% - the USA, 85.45% -India) is a very severe cause of delays. LEED certification was the least severe cause (47.14% - USA, 58.18% India). The analysis of this category shows considerable differences between the results.

Table 1. Causes of delays extracted from previous research studies

Group	Delay Causes	References														Count	Rank
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O		
Owner	Confusing requirements					x			x								2	14
	Conflicts between the owner and other parties						x			x							2	14
	Change orders	x	X	x	X	x		x	x	x	x	x	x	x	x	x	14	2
	Delay in approvals			x				x		x					x		4	12
	Failure of the owner to have the work site available to the contractor promptly								x	x							2	14
	Funding shortage					x											1	15
	High-interest rate					x											1	15
	Improper project feasibility study					x	x										2	14
	Interference with contractor's decisions					x			x					x			3	13
	Lack of capable representatives					x	x										2	14
	Lack of clear bidding process					x											1	15
	Lack of strategic management					x	x										2	14
	Owner's financial difficulties	x		x	X	x		x		x	x		x	x	x	x	11	5
	Owner's poor contract management					x						x	x				3	13
	Payment delays to thecontractor							x		x		x			x	x	5	11
	Poor coordination								x								1	15
	Slow decision making	x	X	x	X	x			x	x	x	x	x	x	x	x	13	3
	Unclear responsibility					x	x	x									3	13
	Unreasonable constraints to owner					x				x							2	14
Contractor	Contractor's financial difficulties	x	X			x		x	x	x	x	x		x	x	x	11	5
	Conflicts between the contractor and other parties		X				x			x	x						4	12
	Delay in mobilization	x								x	x						3	13
	Delays of sub-contractors	x			X			x	x	x		x	x		x	x	9	7
	Improperly allocating labor, material, and other resources on the project		X				x		x			x					4	12
	Improper monitoring and control					x		x		x		x					4	12
	Improper planning and scheduling	x	X	x	X	x	x	x	x	x	x	x	x	x	x	x	15	1
Contractor	Inaccurate cost estimating			x		x						x		x			4	12
	Inaccurate time estimating					x						x		x			3	13
	Inadequacy of site inspection	x	X			x			x		x						5	11
	Inadequate experience			x	X	x						x	x		x	x	7	9
	Inadequate modern equipment					x			x								2	14
	Inappropriate construction methods	x			X	x		x		x		x	x	x			8	8
	Incompetent project team		X			x	x			x							4	12
	Lack of competent subcontractors/suppliers				X	x		x	x	x			x			x	7	9
	Lack of necessary skills	x				x			x					x		x	5	11
	Material waste					x											1	15
	Mistakes during the construction stage				X					x		x	x				4	12
	poor communication		X							x							2	14
	Poor contract management					x							x	x		x	4	12
	Poor labor and management relations					x						x					2	14
	Poor site management	x			X	x		x	x	x		x	x	x	x		10	6
	Severe overtime					x											1	15
Consultant	Design changes	x		x			x			x	x	x			x	x	8	8
	Impractical design					x		x	x						x		4	12
	Inadequate experience	x		x		x	x			x		x					6	10
	Inadequate project management assistance					x			x							x	3	13
	Lack of involvement in theproject life					x					x					x	3	13
	Lack of responsibility					x								x			2	14
	Lack of standardization in design					x					x						2	14
	Mistakes/ errors in design and drawing documents	x	X		X		x	x	x	x	x	x		x	x	x	12	4
	Poor communication between consultant and other parties						x			x							2	14
	Preparation and approval of drawings				X					x	x	x	x		x		6	10
	Unforeseen conditions in design development													x			1	15
	Slowness in approvals	x	X		X	x			x			x	x	x			8	8
Others	Accidents during construction							x		x						x	3	13
	Ambiguous project scope					x											1	15
	Bureaucracy			x		x	x			x	x				x	x	7	9
	Excessive contractors/subcontractors	x				x											2	14
	Equipment failures	x	X					x		x	x	x	x				7	9
	Equipment shortage		X	x				x		x	x					x	6	10
	Fraudulent practices and kickbacks					x											1	15
	Improper quality assurance/control				X	x							x				3	13
	Inaccurate material estimation			x													1	15
	Inaccurate site investigation					x		x						x		x	4	12
	Inappropriate type of contracts used					x		x		x						x	4	12
	Inclement weather	x		x	X	x	x			x	x	x	x	x	x	x	12	4
	Inefficient equipment		X						x				x			x	4	12
	Labor shortage	x	X	x	x			x		x	x	x	x		x	x	11	5
	Labor productivity			x	x		x	x		x	x	x	x		x	x	10	6
	Lack of communication among parties		X		x	x	x	x	x	x		x	x			x	10	6
	Lack of comprehensive dispute resolution				x	x				x							3	13
	Lack of constructability					x											1	15
	Material shortage	x	X	x	x	x		x		x	x	x	x	x		x	12	4
	Non-value-added works					x											1	15
	Obsolete technology					x											1	15
	Pollution during construction					x											1	15
	Price fluctuations		X	x		x											3	13
	Skilled labor											x					1	15
	Slow delivery of materials	x	X							x	x	x			x	x	7	9
	Slow government permits	x	X			x				x	x	x	x		x	x	9	7
	Slow site clearance					x		x						x			3	13
	Unforeseen ground conditions	x	X		x	x		x		x	x	x	x	x	x	x	12	4
	Unrealistic imposed contract duration				x	x				x							3	13
	Unreasonable regulatory framework					x											1	15
	Unreasonable risk allocation					x											1	15
	Unsatisfactory site compensation					x								x			2	14
	Unstable regulatory framework		X			x	x				x						4	12

References: A.Nakado (1995) , B.Ogunlana *et al.* (1996), C.Kaming *et al.* (1997), D. Odeh and Battaineh (2002), E.Long *et al.* (2004), F. Iyer and Jha (2005), G. Abdul-Rahman *et al.* (2006), H.Yates and Epstein (2006), I. Assaf and Al-Hejji (2006), J. Aibinu and Odeyinka (2006), K. Faridi and El-Sayegh (2006), L. Murali and Wen (2007), M. Marzouk *et al.* (2008), N. Sweis, *et al.* (2008), O. Abd-El-Razek *et al.* (2008)

Table 2. Possible causes of delays sorted in alphabetical order

S. No	Causes of Delays
1	Accidents during construction
2	Change orders during construction by owner
3	Changes in contract
4	Changes in government regulations and laws
5	Changes in material prices
6	Conflicts between consultants and other parties involved in the project
7	Conflicts between the contractor and other parties involved in the construction
8	Conflicts between the owner and other parties involved in the construction
9	Contractor's inexperience
10	Delay in approval of the design, and drawings
11	Delay in mobilization
12	Delay in obtaining approvals from government authorities
13	Delay in progress payments by theowner to thecontractor
14	Delay in settlement of contractor's claims
15	Delay in site preparation and delivery to the contractor
16	Delays by sub-contractor
17	Delays in material delivery
18	Equipment failures
19	Financial difficulties experienced by contractor
20	Frequent changes of sub-contractors
21	Improper construction methods and rework due to errors during construction
22	Inadequate technical study by the contractor during the bidding stage
23	Ineffective equipment
24	Ineffective planning and scheduling by thecontractor
25	Inexperienced consultant and design team
26	Inexperienced technical staff
27	Lack of communication and coordination among all the parties
28	Lack of skilled workforce
29	LEED certification process and requirements
30	Mistakes, and errors in design and drawing documents
31	Owner's financial difficulties
32	Payment delays to subcontractors by themain contractor
33	Poor estimation of project duration, productivity, and resources
34	Poor performance in monitoring and tracking of work performed
35	Poor performance of the consultant
36	Severe weather conditions (snow, temperature, storms, wind)
37	Shortage of equipment
38	Shortage of materials
39	Slowness in owner's decision to approve the design
40	Too many change orders by consultant
41	Type of construction contract, project bidding, and award
42	Unavailability of theproject management crew

Table 3. Number of recipients and respondents of the research survey

Description	USA	India	Total
Questionnaire sent	171	124	295
Responses received	16 (9.4%)	11 (8.9%)	27 (9.1%)

Table 4. RII, and severity ranks of all the delay causes for the USA and India sorted in alphabetical order

Category	Causes of Delays	USA		India	
		RII	Rank	RII	Rank
General delays	Changes in contract	71.43	11	63.64	32
	Lack of communication and coordination among all the parties	75.71	4	85.45	1
	LEED certification process and requirements	47.14	42	58.18	38
	Poor estimation of project duration, productivity, and resources	65.71	23	74.55	12
	Type of construction contract, project bidding, and award	64.29	27	72	17
	Unavailability of the project management crew	51.43	40	72.73	16
Contractor-related delays	Conflicts between the contractor and other parties involved in the construction	73.33	6	71.11	19
	Contractor's inexperience	58.67	33	62.22	33
	Delay in mobilization	57.33	36	66.67	26
	Delays by sub-contractor	70.67	15	73.33	14
	Financial difficulties experienced by the contractor	52	39	64.44	30
	Frequent changes of sub-contractors	61.33	30	66.67	28
	Improper construction methods and rework due to errors during construction	66.67	22	85	2
	Inadequate technical study by the contractor during the bidding stage	65.33	25	66.67	27
	Ineffective planning and scheduling by thecontractor	70.67	13	80	7
	Inexperienced technical and administrative staff	68	20	82.22	4
	Payment delays to subcontractors by the main contractor	60	32	71.11	18
	Poor performance in monitoring and tracking of work performed	70.67	14	82.22	5

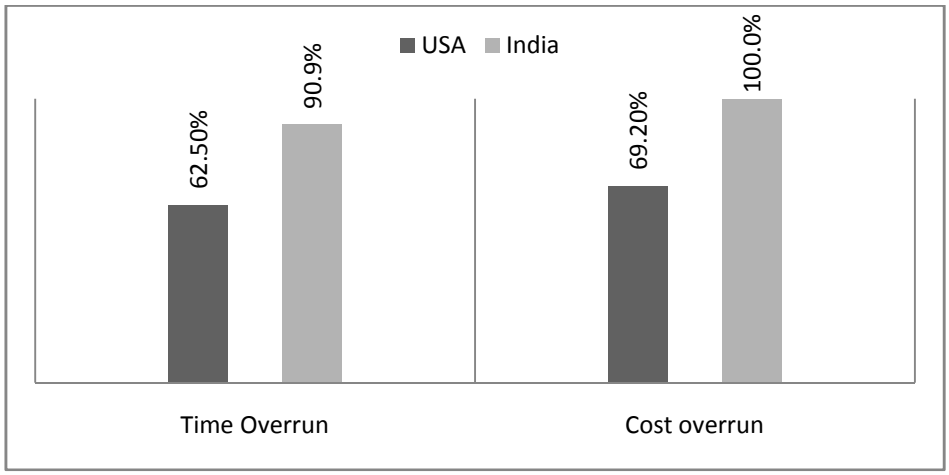


Figure 1: Relationship between time and cost overrun for the projects.

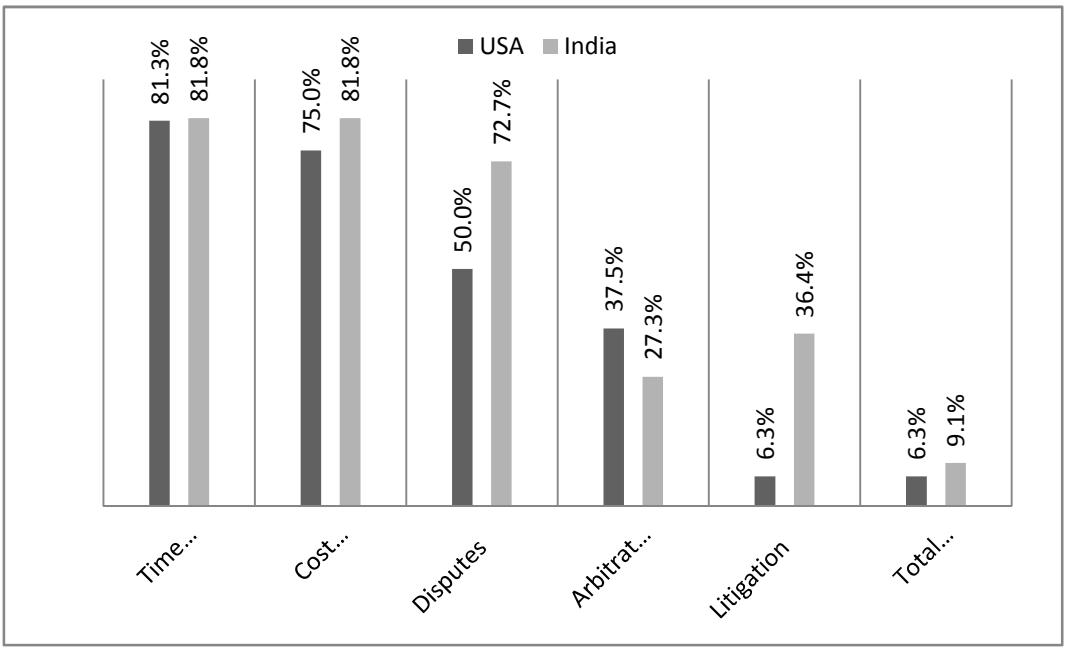


Figure 2. Severe effects of construction delays

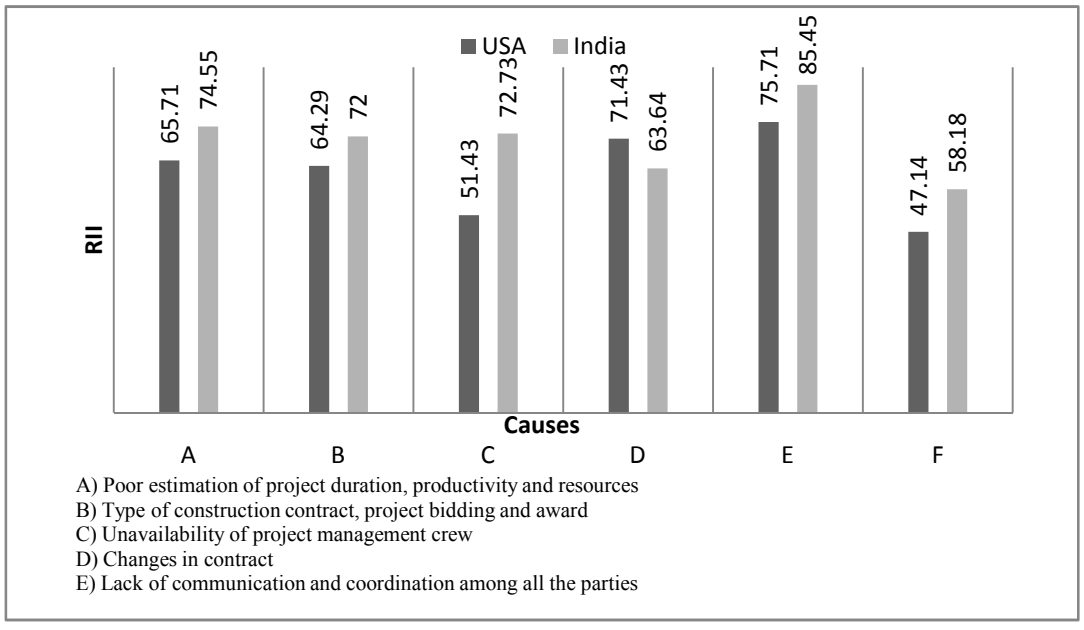
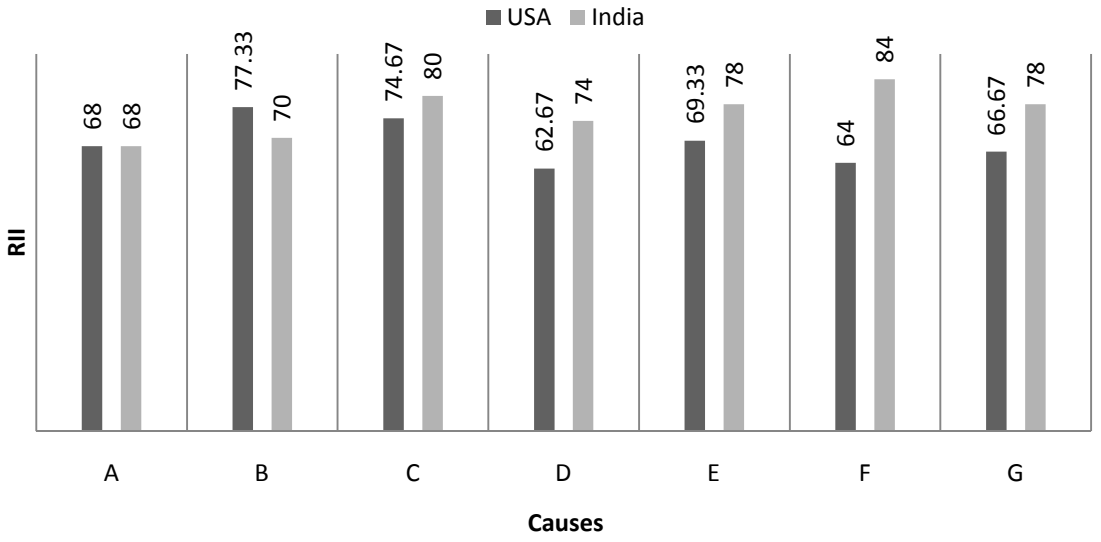
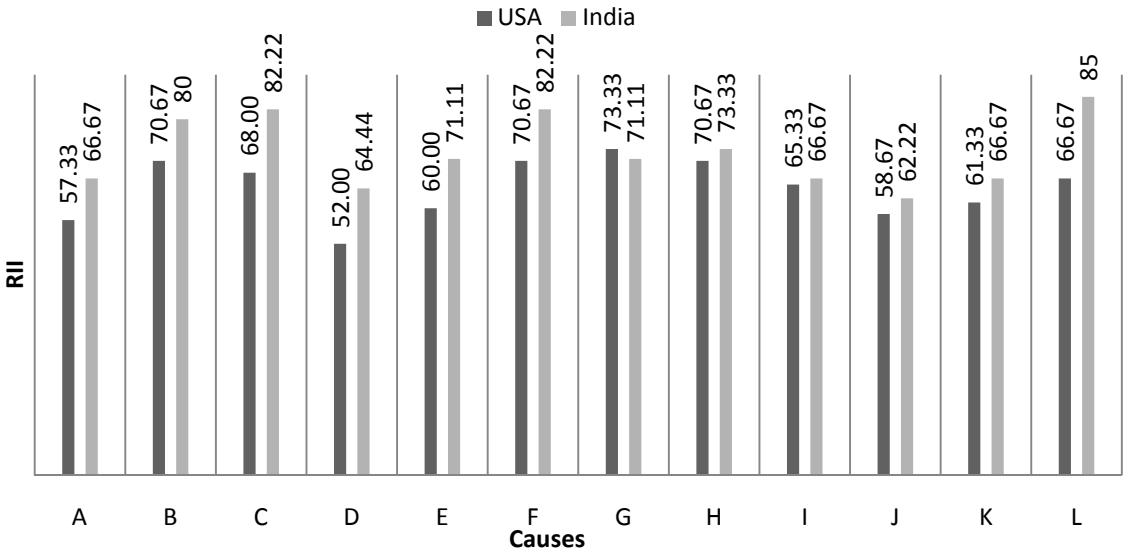


Figure 3: Comparative analysis of general delays



A) Delay in site preparation and delivery to contractor
B) Change orders during construction by owner
C) Slowness in owner's decision to approve design
D) Delay in settlement of contractor's claims
E) Owner's financial difficulties
F) Delay in progress payments by owner to contractor
G) Conflicts between owner and other parties involved in construction

Figure 4. Comparative analysis of owner related delays



A) Delay in mobilization
B) Ineffective planning and scheduling by contractor
C) Inexperienced technical and administrative staff
D) Financial difficulties experienced by contractor
E) Payment delays to subcontractors by main contractor
F) Poor performance in monitoring and tracking of work performed
G) Conflicts between contractor and other parties involved in construction
H) Delays by sub-contractor
I) Inadequate technical study by the contractor during the bidding stage
J) Contractor's inexperience
K) Frequent changes of sub-contractors

Figure 5. Comparative analysis of contractor related delays

These delays are more critical for Indian construction projects than the USA projects. All the delays in this category are more severe for India than the USA, except for delays by sub-contractors where the difference is not remarkable. The average value of severity of all the delay causes for the USA is 64.56%, whereas it is 72.63% for India. The difference in RII is 8.07%. The most severe delays for India in this category are ineffective planning and scheduling by the contractor (80.0%), poor performance in monitoring and tracking of work performed (82.22%), inexperienced technical and adminis trative staff (82.22%), and improper construction methods and rework due to errors during construction (85.0%). These are ranked more severe and equal to 80%, yet none of the delays are ranked more than 80% for the USA. Four out of the twelve delays are ranked more than 70% for the USA, whereas seven delays are ranked more than 70% for India. The study showed that, the causes with significant differences in the results are improper construction methods and rework due to errors during construction (66.67% - the USA, 85% - India), inexperienced technical and administrative staff (68% - the USA, 82.22% - India), and financial difficulties experienced by the contractor (52% - USA, 64.4% - India). The differences in RII values are 18.33%, 14.22%, 12.44%, respectively. The least severe delay for the USA is financial difficulties experienced by the contractor (52%), while India's contractor's inexperience ranks least (62.22%). Figures 4 and 5 shows the comparative analysis of owner and contractor related delays respectively. Table 4 depicts the RII, and severity ranks of all the delay cause for the USA and India.

Conclusions and Recommendation

Construction delays are very significant since they cause losses to the owners, builders and influence the economics of the construction industry. Prior knowledge of possible delays during construction save money, time, and energy, and is essential for the construction of high rise buildings. The investments in these projects are very high, and the possibilities of delays are relatively common because of the complexity of the construction. This research study is intended to identify the causes of probable delays and their severity for the high-rise building construction industry. Additionally, this study investigates all possible delays and their severity through a structured questionnaire survey administered all over the USA and India. The survey results of the two countries were subjected to analysis, and the severities of the delays were calculated using the relative important index. The research study has collected sixteen (16) responses from the USA and eleven (11) from India. The analysis of the study shows that the results are dissimilar for the USA and India. The top ten severe delay causes for the USA are: change orders during construction by the owner (77.33%), severe weather conditions (77.14%), mistakes and errors in design and drawing documents (76.0%), lack of communication and coordination among all the parties (75.71%), slowness in owner's decision to approve design (74.67%), conflicts between contractor and other parties involved in construction (73.33%), delay in approval of design and drawings by consultants (73.33%), and delays in material delivery (72.0%).For India, the top ten severe delay causes are: lack of communication and coordination among all the parties involved in construction (85.45%), improper construction methods (85.0%), payment delays by the owner (84.0%), inexperienced technical and administrative staff (82.22%), poor performance in tracking performed work (82.22%), slowness in owner's decision to approve design (80.0%), ineffective planning and scheduling by contractors (80.0%), and others. The comparative analysis of the study shows that there are wide differences between the results of the two countries in many situations. The presence of time delays and cost escalations are more severe for India than the USA. The Indian participants indicated that cost escalations are evident every time along with overall time delays, whereas the American participants indicated that 69.2% of the projects experienced cost escalations as the effect of overall time delay. All the participants of the two nations agreed that time and cost overruns are the critical effects of construction delays, followed by disputes and arbitration. The study demonstrates that the delays related to owners, contractors, resources and other general delays are more severe for India than the USA, whereas the miscellaneous and consultant related delays, are more severe for the USA than India. Most of the severe delays are ranked more than 80% for India, and none of the delays are ranked more severe than 80% for the USA. However, the results depict the difference between geographical locations, economy, and the use of project management systems between the USA and India. At the end of this study, several recommendations are listed by the participants to help minimize construction delays and their severe effects.

REFERENCES

Abd El-Razek, M. E., Bassioni, H. A. and Mobarak, A. M. 2008. "Causes of Delays in Building Construction Projects in Egypt." *Journal of Construction Engineering and Management*, vol. 134, no. 11, pp. 831-841.

Abdul-Rahman, H., Berawi, M. A., 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*, vol. 132, no. 2, pp. 125-133.

Aibinu, A. A. and Jagboro, G. O. 2002. "The Effects of Construction Delays on Project Delivery in Nigerian Construction Industry." *International Journal of Project Management*, vol. 20, no. 8, pp. 593-599.

Aibinu, A.A. and Odeyinka, H.A. 2006. "Construction Delays and Their Causative Factors in Nigeria." *Journal of Construction Engineering and Management*, vol. 132, no. 7, pp. 667-677.

Al-Khalil, M. I. and Al-Ghafly, M. A. 1999. "Delay in public utility projects in Saudi Arabia." *International Journal of Project Management*, vol. 17, no. 2, pp. 101-106.

Al-Momani, A.H. 2000. "Construction Delay: a Quantitative Analysis." *International Journal of Project Management*, vol. 18, no. 1, pp. 51-59.

Assaf, S.A. and Al-Hejji, S. 2006. "Causes of Delay in Large Building Construction Projects." *International Journal of Project Management*, vol. 24, no. 4, pp. 349-357.

Assaf, S.A., Alkhalil, M. and Al-Hazmi, M. 1995. "Causes of delay in large building construction projects." *Journal of Management in Engineering,* vol. 11, no. 2, pp. 45-50.

Chan, A.P.C, Scott, D. and Chan, A.P.L. 2004. "Factors Affecting the Success of a Construction Project." *Journal of Construction Engineering and Management*, vol. 130, no. 1, pp. 153-155.

Chan, D.W.M. and Kumaraswamy, M.M. 1996. "An Evaluation of Construction Time Performance in the Building Industry." *Building and Environment*, vol. 31, no. 6, pp. 569-578.

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*, vol. 15, no. 1, pp. 55-63.

Chan, D.W.M. and Kumaraswamy, M.M. 2002. "Compressing Construction Durations: Lessons Learned from HongKong Building Projects." *International Journal of Project Management*, vol. 20, pp. 23-35.

Crosthwaite, D. 2000a. "The Global Construction Market: a Cross-sectional Analysis."*Construction Management and Economics*, 18, 619–27.

Crosthwaite, D. 2000b. "The international performance of British Construction Companies 1990–1996". *Building Research & Information*, 28(4), 280–90.

Faridi, A.S. and El-Sayegh, S.M. 2006. "Significant Factors Causing Delay in the UAE Construction Industry." *Construction Management and Economics,* vol. 24, no. 11, pp. 1167 – 1176.

Ireland, V. 1985. "The Role of Managerial Actions in the Cost, Time and Quality Performance of High-Rise Commercial Building Projects." *Journal of Construction Management and Economics,* vol. 3, pp. 59-87.

Iyer, K.C. and Jha, K.N. 2005. "Factors Affecting Cost Performance: Evidence from Indian Construction Projects." *International Journal of Project Management*, Vol. 23, no. 4, pp. 283-295.

Kaming, P.F., Olomolaiye, P.O., Holt, G.D. and Harris, F.C. 1997. "Factors Influencing Construction Time and Cost Overruns on High-Rise Projects in Indonesia." *Journal of Construction Management and Economics,* vol. 15, no.1, pp. 83-94.

Long, N.D., Ogunlana, S.O., Quang, T. and Lam, K.C. 2004. "Large Construction Projects in Developing Countries: a Case Study from Vietnam." *International Journal of Project Management*, vol. 22, no. 7, pp. 553-561.

Marzouk, M., El-Dokhmasey, A. and El-Said, M. 2008. "Assessing Construction Engineering-Related Delays: Egyptian Perspective." *Journal of Professional Issues in Engineering Education and Practice*, Vol. 134, no. 3, pp. 315-326.

Murali, S. and Wen, Y.S. 2007. "Causes and Effects of Delays in Malaysian Construction Industry." *International Journal of Project Management*, Vol.25, no. 5, pp. 517-526.

Nkado, R.N., (1995). "Construction Time-Influencing Factors: the Contractor's Perspective." *Construction Management and Economics*, vol.13, no. 1, pp. 81 – 89.

Odeh, A.M. and Battaineh, H.T. 2002. Causes of Construction Delay: Traditional Contracts." *International Journal of Project Management*, vol. 20, no. 1, pp. 67-73.

Ofori, G. 1990. The Construction Industry: Aspects of its Management and Economics, Singapore University Press, Singapore, pp. 236. ISBN: 9971-69-148-5.

Ogunlana, S.O., Promkuntong, K. and Jearkjirm, V. 1996. "Construction Delays in a Fast-Growing Economy: Comparing Thailand with Other Economies." *International Journal of Project Management*, vol. 14, no.1, pp. 37-45.

Powl, A. and Skitmore, M. 2005. "Factors hindering the performance of construction project managers," *Construction Innovation: Information, Process, Managemen*t, Vol. 5 (1), pp.41 – 51.

Sanvido, V., Grobler, F., Parfitt, K., Guvenis, M. and Coyle, M. 1992. "Critical Success Factors for Construction Projects." *Journal of Construction Engineering Management*, vol. 118, no. 1, pp. 94-111.

Song, J. R., Zhong, S. and Guo, Y.H., 2006. "Model for Bidding and Tendering with Bill of Quantities Based on Bid Winning Estimate at Reasonable Low Price," *Journal of Southwest Jiaotong Universit*y, 14(4), pp. 387-393.

Sweis, G., Sweis, R., Abu Hammad, A. and Shboul, A. 2008. "Delays in Construction Projects: The Case of Jordan." *International Journal of Project Management*, vol. 26, no. 6, pp. 665-674.

Tse, R.Y.C. and Ganesan, S. 1997. Causal Relationship Between Construction Flows and GDP: Evidence from Hong Kong, Construction Management, and Economics, 15(4), pp. 371-376.

Yates, J. K. and Epstein, A. 2006. "Avoiding and Minimizing Construction Delay Claim Disputes in Relational Contracting." *Journal of professional issues in engineering education and practice*, vol. 132, no. 2, pp. 168-179.

Ye, K., Shen, L. and Zuo, J. 2013. "Utilizing the Linkage Between Domestic Demand and the Ability to Export to Achieve Sustainable Growth of Construction Industry in Developing Countries." *Habitat International*, vol. 38, pp.135-142.

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