

MITIGATION OF DELAY IN INDUSTRIAL CONSTRUCTION PROJECTS; CASE OF IRAN

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Abstract

Delays are one of the biggest problems construction firms face. It happens in most construction projects. Delays can lead to many negative effects such as lawsuits between owners and contractors, increased costs, loss of productivity and revenue, and contract termination. According to Bordoli and Baldwin (1998) and the World Bank (1990), for 1627 projects completed worldwide between 1974 and 1988, the overrun varied between 50% and 80%. In the United Arab Emirates, where construction contributes 14% to the gross domestic product, a study by Faridi and El-Sayegh (2006) revealed that 50% of construction projects encounter delays. In Iran many of construction projects encounter delays also.

This paper addresses two primary research questions as how do often happen delay in industrial construction projects? And how can a contractor mitigate of project delays? To achieve the above research questions, a case study approach will use in this research. The case study is selected in Iran. Data is collected through interviews and project documents.

Key words: Mitigation, Delay, industrial, construction, project, Iran.

Introduction

Delays are one of the biggest problems construction firms face. Delays can lead to many negative effects such as lawsuits between owners and contractors, increased costs, loss of productivity and revenue, and contract termination. According to Bordoli and Baldwin (1998) and the World Bank (1990), for 1627 projects completed worldwide between 1974 and 1988, the overrun varied between 50% and 80%. The problem of delays in the construction industry is a global phenomenon (Sambasivan, M. and Yau Wen Soon, 2007). Delays happen in most construction projects, whether simple or complex. In construction, delay could be defined as the time overrun either beyond the contract date or beyond the date that the parties agreed upon for delivery of a project (Assaf, S.A. and Al-Hejji S., 2006). Construction delay and overrun is a critical function in construction of public projects (Al-Momani, 2000).

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 (Al-Momani, 2000). Although the contract parties agreed upon the extra time and cost associated with delay, in many cases there were problems between the owner and contractor as to whether the contractor was entitled to claim the extra cost. Such situations, usually involved questioning the facts, causal factors and contract interpretation (Assaf SA, Al-Khalil M, Al-Hazmi M., 1995). Therefore, delays in construction projects give rise to dissatisfaction to all the parties involved and the main role of the project manager is to make sure that

the projects are completed within the budgeted time and cost (Assaf,S.A. and Al-Hejji S., 2006).

A project consists of a collection of activities. Delays can occur in any or all of these activities, and these delays can concurrently cause delays in the completion of the project. A project delay is the accumulated effect of the delays in the individual activities. Delay analysis is used to determine the cause(s) of the delay in order to ascertain whether an extension of time should be awarded. An extension of time relieves the contractor from the liability for damages (Lowsley and Linnett, 2006).

To recover the damage caused by delays, both the delays and the parties responsible for them should be identified. However, delay situations are complex in nature because multiple delays can occur concurrently and because they can be caused by more than one party, or by none of the principal parties. One delay may contribute to the formation of other delays (Arditi and Pattanakitchamroon, 2006). The analysis of these delays involves not only the calculation of the delay time but also the identification of the root causes and the responsibility for delays, Such an analysis therefore becomes a basis for the financial calculations that determine penalties or other damages to be assigned to the parties responsible for the delays.

Some causes and effects of delays in construction projects can be country-specific. In this research, it will be identify major causes of delay and categorized them as client-related, contractor- related, consultant-related, material-related, labor related, contract-related, contract relationship-related, and external factors.

Stumpf (2000) defined delay as an act or event that extends the time required to perform the tasks under a contract. It usually shows up as additional days of work or as a delayed start of an activity. He showed, in his article, that delay does matter, and that different methods for analyzing schedule delay lead to different results for the owner and contractor. Construction delays became an integral part of the project's construction life. Even with today's advanced technology, and management understanding of project management techniques, construction projects continue to suffer delays and project completion dates still get pushed back (Stumpf, 2000).

There are many reasons why delays occur. They may be due to strikes, rework, poor organization, material shortage, equipment failure, change orders, act of God and so on. In addition, delays are often interconnected, making the situation even more complex (Alkass S, Mazerolle M, Harris F., 1996).

Research Motivation

This work is motivated by an important problem called delay that cause overrun cost of project and have other impact on project and project parties. The

construction companies in many countries around the world experience significant delays. In the past few years, the number of claims submitted to the American Arbitration Association (AAA) reached almost 25% of the 1.7 million claims submitted over the past 74 years (Kassab et al., 2006). In the United Kingdom (U.K.), a 2001 report by the National Audit Office, entitled “Modernising Construction”, revealed that 70% of the projects undertaken by government departments and agencies were delivered late, and a recent research by Building Cost Information Service (BCIS) found that nearly 40% of all studied projects had overrun the contract period (Lowsley and Linnett, 2006). In India, a study conducted by the Infrastructure and Project Monitoring Division of the Ministry of Statistics and Programme Implementation in 2004 reported that out of 646 central sector projects costing about \$50 trillion, approximately 40% are behind schedule, with delays ranging from 1 to 252 months (Lyer and Jha, 2006).

In the United Arab Emirates (UAE), where construction contributes 14% to the gross domestic product (GDP), a study by Faridi and El-Sayegh (2006) revealed that 50% of construction projects encounter delays. 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. Delays in construction projects are common in the Jordanian construction industry (G. Sweis a, R. Sweis b, A. Abu Hammad c, A. Shboul, 2008). Construction delays are often responsible for turning profitable projects into losing ventures.

The construction sector in Malaysia, a fast developing country in South-East Asia has not escaped the problem of delays. In 2005, about 17.3% (of 417 government contract projects in Malaysia) were considered sick (more than 3 months of delay or abandoned). The Construction Sector is one of the important sectors that contribute to Malaysia’s economic growth. The sector accounted for nearly 3.3% of GDP in the year 2005 and employed about 600,000 workers including 109,000 foreign workers (MALBEX). The huge volume and complexity of projects in Malaysia’s construction sector pose a great challenge and provide a wealth of opportunities to various companies in the construction industry. The construction sector in Malaysia can be divided into four broad categories: office, retail, residential and infrastructure. This sector suffered a temporary crisis between 1997 and 2000 (ASEAN crisis) and now it has started to improve. However, the delays in the projects continue to occur. The main purpose of this study is to identify the delay factors and their impact (effect) on project completion. Earlier studies either considered the causes or the effects of project delays, separately (Sambasivan, M. and Yau Wen Soon, 2007).

As projects become increasingly ubiquitous, it is becoming more and more important that they are completed successfully within their time and cost deadlines (Banik, 2006: 1067). Delays in construction projects are inevitable; as a result claims and disputes arise among different construction parties. Different causes of delay can come into play, therefore, there is a need to identify and classify different causes of project delay. Estimation of the likelihood of delay resulting from different factors that contribute to project delay is essential to project success. Different factors that contribute to project delay affect the likelihood of project delay in different effectiveness degrees (Al-Humaidi, 2007). Due to the inherent risks and increasing complexity of modern construction projects, delays and cost overruns have become common facts in the industry (Menesi, 2007).

In Ghana, Frimpong, Y., Oluwoye, J and Crawford L. (2003) were found that 33 out of a total of 47 projects completed between 1970 and 1999 were delayed while 38 projects were overruns. Their research data indicated that 75% of the projects exceeded the original project schedule and cost whereas only 25% were completed within the budget and on time (Frimpong, Y., Oluwoye, J and Crawford L., 2003).

Recent events in the Middle East region coupled with restructuring of economies, emergence of the World Trade Organization and the rising price of oil are expected to yield an unprecedented growth in construction activities, especially in the tourism and the residential sectors. Consequently, a huge number of large-scale projects are currently under construction or in the planning and contract-awarding phase (G. Sweis a, R. Sweis b, A. Abu Hammad c, A. Shboul, 2008).

The surveys revealed that delay occur frequently in construction projects in developing countries in general, especially in long-duration projects. It is therefore important that thorough analysis be carried out to help in efficient project management, to reduce delay.

Research questions and objectives

This study addresses the following three primary research questions associated with the three subjects discussed in the previous section: What are causes of delays in Iran? And How can a contractor mitigate effect of construction projects delays?

The main objectives of this study include the following: To identify the causes of delays in construction in Iran, and to study on reducing impact of delay on contractor.

Research Methodology

To achieve the above research objectives, case study approach are using in this research. The case studies considered from a developing countries as Iran. Cases choose to depict different organizational and construction contexts but with the common focus on projects. Cases are thus similar in terms of the project focus, but different in terms of construction and industry, to enable cross case comparisons and the discovery of project common features across organizations.

Data collected through strategic planning organization reports and some project documents. The organizations and companies visited several times to follow up on project progress and interviews conducted in each organization/companies. Main issues discussed during interviews will project progress and experiences at each point in time. Issues on environmental impact are thus not the only issue on which data collect but as environmental aspects come up in the discussion, further questions will ask and the issue explores more in depth. A questionnaire was developed in order to identify occurrence, severity and importance of the identified causes. Project information was collected from Contractors Company and from the lists of contractors from literature.

Literature review

Chan and Kumaraswamy (1997) studied delays in Hong Kong construction industry. They emphasized that timely delivery of projects within budget and to the level of quality standard specified by the client is an index of successful project delivery. Normally, when the projects are delayed, they are either extended or accelerated and therefore, incur additional cost.

Al-Ghafly (1995) discussed the delay in public water and sewage projects. Sixty causes were identified and classified. Al-Ghafly (1995) concluded the following: the delay occurred frequently in medium and large size projects, and considered severe in small projects. There are many important causes of delay related to owner involvement, contractor performance, and the early planning and design of the project.

Important causes are financial problems, changes in the design and scope, delay in making decisions and approvals by owner, difficulties in obtaining work permit, and coordination and communication problems.

Ogunlana and Olomolaiye (1989) remarked that contractors handling projects in a developing industry face three major problems (Table 1). First they have to contend with problems imposed by the industry's infrastructure, e.g. training, plant availability, materials supply and communication. The second are problems of inaccurate information and frequent changes in instructions and failure to meet

obligations on the part of clients and consultants. The third are problems imposed by their own shortcomings. This survey shows that their observations are true in the case of Thailand.



Table 2. Problems causing delays in construction projects

Since Olomolaiye and Ogunlana's (1989) study was conducted in an economy facing similar problems as in Thailand, i.e. an economy in a period of receding boom, a relevant question to ask is "are these the characteristics of construction projects in developing countries?" A detailed examination of studies of construction delays will help in answering the question. To answer the question posed above, data from four previous studies were assembled for comparative analysis (Ogunlana SO, Promkuntong K., 1996).

Arditi et al., (1985), Sullivan and Harris (1986), Okpala and Aniekwu, (1988) and Dlakwa, (1990) have studied construction delays in the UK and UK colonies, Turkey and Nigeria. The data assembled from the studies are shown in Table 3. A close examination of the data from the five studies (including this survey) may provide evidence to justify or refute the assertions made by Ogunlana and Olomolaiye (1989). Although the purpose and methods of the surveys differ, the results are useful for understanding the problems of project management in developing countries.

Chan and Kumaraswamy (1997) conducted a survey to evaluate the relative importance of 83 potential delay factors in Hong Kong construction projects and found five principal factors: poor risk management and supervision, unforeseen site conditions, slow decision making, client-initiated variations, and work variations.

Kaming et al. (1997) studied influencing factors on 31 high-rise projects in Indonesia and found out that cost overruns occur more frequently and are more severe problem than time overruns. They pointed out that the major factors influencing cost overrun are material cost increase due to inflation, inaccurate material estimation and degree of complexity. While in time overrun, the most

important factors causing delays are design changes, poor labor productivity, inadequate planning, and resource shortages.

Kumaraswamy and Chan (1998) studied the causes of construction delays in Hong Kong. They found that there was a difference in perceptions as to causes of delays by different groups of participants in building and civil engineering works. They suggested that biases of different industry groups might direct blame for delays to other groups.

Noulmanee et al. (1999) investigated causes of delays in highway construction in Thailand and concluded that delays can be caused by all parties involved in projects; however, main causes come from inadequacy of sub-contractors, organization that lacks of sufficient resources, incomplete and unclear drawings and deficiencies between consultants and contractors. The study suggested that delay can be minimized by discussions that lead to understanding.

Al-Momani (2000) investigated causes of delay in 130 public projects in Jordan. The main causes of delay were related to designer, user changes, weather, site conditions, late deliveries, economic conditions and increase in quantity. The study suggested that special attention to factors will help industry practitioners in minimizing contract disputes. Delays have strong relationship with failure and ineffective performance of contractors.

Ubaid discussed the performance of contractors as one of the major causes of delay. Thirteen (13) major measures were considered. These measures are related to contractor resources and capabilities (Assaf,S.A. and Al-Hejji S., 2006). Al-Barak discussed the main causes of failure in Construction industry in Saudi Arabia by surveying 68 contractors and about 34 different causes of failure. The study concluded that lack of experience, poor estimation practices, bad decisions in regulating company's policy, and national slump in the economy are the severe factors (Assaf,S.A. and Al-Hejji S., 2006).

The studies compared

The studies used for comparison need to be put in proper perspective. Sullivan and Harris' (1986) study is based on interviews and responses to questionnaire surveys conducted on construction clients (n = 3), consultants (n = 4) and top UK contractors (n = 13). Overseas contracts in the study are mainly projects in which British contractors were involved. Such contracts are mostly in former British colonies which are mainly developing countries. The study by Arditi et al. was based on responses to questionnaires received from public organizations (n = 44) and contractors (n = 34) in Ankara and Istanbul, Turkey. The study was made when the economy in Turkey was moving towards recession (personal communication with Arditi). Aniekwu and Okpala 8 received responses to questionnaires from engineers (n =58), architects (n = 52) and quantity surveyors (n = 46) in three cities in southwest Nigeria. They replicated a study of delays in

construction projects in America made in 1970. Judging by the publications from the study, Ogunlana SO and Promkuntong K. (1996) concluded that it was undertaken when the Nigerian economy was moving towards recession. Dlakwa and Culpin's study 9 is based on questionnaires returned by public agencies (n = 94), contractors (n = 34) and consultants (n = 47) in Nigeria.

At the time of the study, the Nigerian economy was in recession. It should be understood that while the studies of Sullivan and Harris (1986) and Arditi et al. (1985) focussed on delays, Okpala and Aniekwu (1988) and Dlakwa and Culpin (1990) concerned delays as well as cost and time overruns. In addition, the measures used in the studies are not the same but an effort has been made to find common denominators for the studies. Sullivan and Harris (1986), Okpala and Aniekwu (1988) and this study used percentage responses while Arditi et al. (1985) used average relative weight (max. = 20.0) and Dlakwa (1990) used mean score (max. = 4.0).

Description	UK %	Overseas %	Turkey rel. wt.	Nig. 1 %	Nig. 2 mean	Thai. %
Waiting for information	51	32		47		75.0
Change orders	49	40	3.54	71	2	41.7
Ground problems/site inspection	21	9	3.94	52	1.3	33.3
Bad weather	19	4	0.6	52		
Design complexity	19	14				
M & E Subcontractors	17	17				
Obstructions	14	9				
M & E plant procurement	14	26				
Materials procurement	13	35	17.46	93	1.7	91.7
Statutory undertakers	9	9				
Industrial relations	7	4		65		
Civil subcontractors	7	6		55		
Claims/disputes	6	11		55		
Labourers/tradesmen shortages	5	17	6.11	65	1.2	75.0
Construction plant shortages	5	12			1.3	58.3
Breakdowns	5	8			1.3	25.0
Senior staff shortages	4	8				
Foremen shortages	2.5	10	4.74			
Company coordination	0.3	4				
Monthly payment difficulties			10.67	92	3.9	
Contractor's financial difficulties			10.59		3.3	33.3
Deficiencies in client's organisation			6.3		2	33.7
Additional work			5.39	79	1.8	
Design delays			4.57		1.7	66.7
Planning and scheduling deficiencies			4.54		2.3	58.3
Contract negotiations			48			
Unrealistic time imposed by client			2.68	71	1.9	
Difficulties in obtaining energy			2.46			
Disagreement on contract clauses			1.28	67	1.4	
Construction permits			0.77			
Disagreements on specifications			0.48		1.4	25.0
Transportation problems			0.31	54		
Poor contractor management			8.25	86	2.5	75.0
Imported materials				73		
Mistakes during construction				57		
Approval of materials/samples				46		
Low bid					1.6	
Unexpected natural/social events					1.9	
Escalation of materials prices				90	3.4	16.7
Inspection and testing of work				38	1.3	
Others			2.55		0.9	

UK and overseas = Sullivan and Harris⁷; Turkey = Arditi *et al.*⁸; Nig. 1 = Okpala and Aniekwu⁴; Nig. 2 = Dlakwa and Culpin⁹ and Thai. = this survey.

Table 4. Factors responsible for delay (Ogunlana SO, Promkuntong K., 1996)

Causes of Delays

Odeh and Battaineh identified 28 construction delay factors that Sambasivan, M. and Yau Wen Soon. (2007) have categorized them into the following eight major groups:

1. Client related factors: finance and payments of completed work, owner interference, slow decision making and unrealistic contract duration imposed by owners.
2. Contractor related factors: delays caused by subcontractor, site management, improper construction methods, improper planning and errors during construction, and inadequate contractor experience.
3. Consultant related factors: contract management, preparation and approval of drawings, quality assurance and waiting time for approval of test and inspection.
4. Material related factors: quality of material and shortage in material.
5. Labor and equipment related factors: labor supply, labor productivity and equipment availability and failure.
6. Contract related factors: change orders and mistakes or discrepancies in contract document.
7. Contract relationship related factors: major disputes and negotiations, inappropriate overall organizational structure linking to the project and lack of communication between the parties.
8. External factors: weather condition, regulatory changes, problem with neighbors and unforeseen site condition.

Table 3 shows the most important causes of delay according to the owners, contractors and consultants. The importance index of each cause is calculated as a product of both frequency and severity indices. Only one cause of delay is common between all parties, which is “change orders by owner during construction”. There are many causes which are common between two parties, such as delay in progress payments by owner, ineffective planning and scheduling of project by contractor, poor site management and supervision by contractor, shortage of labors and difficulties in financing project by contractor. All three parties agree that the following delay causes are the least important: Changes in government regulations and laws, Traffic control and restrictions at job site, Effect of social and cultural factors, Accidents during construction.

S. no.	Owners	Contractors	Consultants
1	Shortage of labors	Delay in progress payments by owner	Type of project bidding and award
2	Unqualified work force	Late in reviewing and approving design documents by owner	Shortage of labors
3	Ineffective planning and scheduling of project by contractor	Change orders by owner during construction	Delay in progress payments by owner
4	Low productivity level of labors	Delays in producing design documents	Ineffective planning and scheduling of project by contractor
5	Hot weather effect on construction activities	Late in reviewing and approving design documents by consultant	Change orders by owner during construction
6	Conflicts encountered with sub-contractors' schedule in project execution	Difficulties in financing project by contractor	Low productivity level of labors
7	Poor site management and supervision by contractor	Mistakes and discrepancies in design documents	Difficulties in financing project by contractor
8	Inadequate contractor's experience	Late procurement of materials	Poor site management and supervision by contractor
9	Effects of subsurface conditions (soil, existing of utilities, high water table, etc)	Inflexibility (rigidity) of consultant	Poor qualification of the contractor's technical staff
10	Change orders by owner during construction	Slowness in decision making process by owner	Delay in material delivery

Table 5.Importance of delay causes

Lo et al. (2006) summarized some of the studies that took place from 1971 to 2000 (Table 1).

Researchers	Country	Major causes of delay
Baldwin et al. (1971)	United States	- inclement weather - shortages of labour supply - subcontracting system
Arditi et al. (1985)	Turkey	- shortages of resources - financial difficulties faced by public agencies and contractors - organizational deficiencies - delays in design work - frequent changes in orders/design - considerable additional work
Okpala and Aniekwu (1988)	Nigeria	- shortages of materials - failure to pay for completed work - poor contract management
Dlakwa and Culpin (1990)	Nigeria	- delays in payment by agencies to contractors - fluctuations in materials, labour and plant costs
Mansfield et al. (1994)	Nigeria	- improper financial and payment arrangements - poor contract management - shortages of materials - inaccurate cost estimates - fluctuations in cost
Semple et al. (1994)	Canada	- increases in the scope of the work - inclement weather - restricted access
Assaf et al. (1995)	Saudi Arabia	- slow preparation and approval of shop drawings - delays in payments to contractors - changes in design/design error - shortages of labour supply - poor workmanship

Table 6.Summary of Previous Studies of the Causes of Delays in Construction Projects

Ogunlana et al. (1996)	Thailand	<ul style="list-style-type: none"> - shortages of materials - changes of design - liaison problems among the contracting parties
Chan and Kumaraswamy (1996)	Hong Kong	<ul style="list-style-type: none"> - unforeseen ground conditions - poor site management and supervision - slow decision making by project teams - client-initiated variations
Al-Khal and Al-Ghafly (1999)	Saudi Arabia	<ul style="list-style-type: none"> - cash flow problems/financial difficulties - difficulties in obtaining permits - "lowest bid wins" system
Al-Momani (2000)	Jordan	<ul style="list-style-type: none"> - poor design - changes in orders/design - inclement weather - unforeseen site conditions - late deliveries
Lo et al. (2006)	Hong Kong	<ul style="list-style-type: none"> - inadequate resources - unforeseen ground conditions - exceptionally low bids - inexperienced contractor - work in conflict with existing utilities - poor site management and supervision - unrealistic contract duration
Faridi and El-Sayegh (2006)	UAE	<ul style="list-style-type: none"> - slow preparation and approval of drawings - inadequate early planning of the project - slowness of owner's decision making - shortage of manpower - poor site management and supervision - low productivity of manpower
Assaf and Al-Hejji (2006)	Saudi Arabia	<ul style="list-style-type: none"> - change in orders by the owner during construction - delay in progress payment - ineffective planning and scheduling - shortage of labor - difficulties in financing on the part of the contractor

Table 7. Summary of Previous Studies of the Causes of Delays in Construction Projects

The research shows these factors have most important causality for delay in Iran projects: delay in earth delivery, delay in produce and delivery of plan to contractor in production and operation projects, delay in confirmation or approval of contractor plan in designing project, security and preparation of product and operation (EPC), Presence of an opponent in contracted earth or in some parts of it, change in programs or in operational activities while the project is doing , by contractor or communication of new preferred works to contractor at the same time, delay in materials and building tools delivery or preparation of some products by contractor, delay in confirmation or payment of on time inventory and undoing of some financial undertakes by contractor, unparalleled volume of implicating operations with improvement validities that would be prepared (it is

the basic reason for timing delay in projects that is reported as deficiency in validities) (M.E.Sepasgozar, Samad; M.Shirazi, Sasan, 2008).

Deficiency in validities has been reported as the reason for a 40.1 percentage of delays in improvement-national projects and a 67.7 percentage of delays in delayed state projects since 1379 to 1383. In a consideration of timing delay reason in 1385, the validity problems is 38.9, deficit in validity and allocation and deficiency in payment are respectively 16.1, 19.4 and 3.4. Weakness of contractor and operational system is 11.1 of delay reason in improvement-national projects and 11.3 of delay reason improvement- state projects during 1379-83. In 1385, 8.6 percentage of delay reason is termed of weakness in operational system. Contractor’s weakness is caused 5.7 percentage of delay reason in improvement-national projects and 4.7 of delay reason improvement-state projects during 1379-83. In 1385, contractor difficulties are 3.6 percentage of delay reason. Also in this year the maximum of delay reasons in improvement-national projects are unforeseen weather change, flood-water, earthquake and in public natural problems. Delay on attention to claims and additional costs termed from primitive delays by contractor.

Types of Delays

Delays are classified into two different types according to liability: excusable and inexcusable (Fig. 2.1). When the contractor is responsible for the cause of the delay, it is called an inexcusable delay. Examples include failure to coordinate work, too few workers, and low productivity. The contractor cannot obtain a time extension for inexcusable delays. The contractor is also liable for damages incurred by the owner as a result of the inexcusable delay.

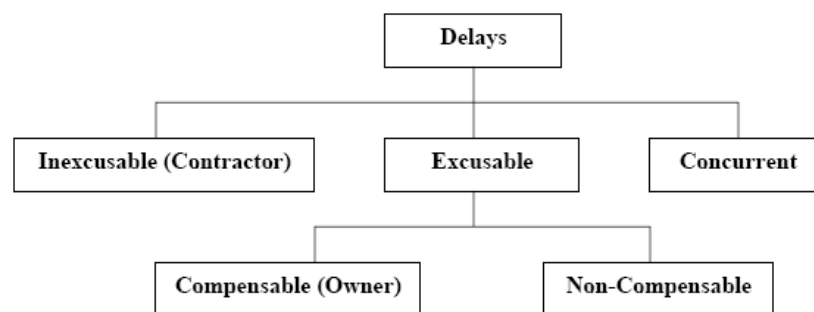


Table 8.Types of Delays

The second type of delays, excusable delays, can be farther broken down into compensable and non-compensable delays. Compensation is required when the owner is the major cause of the delay. Examples include changes in the scope of work and the owner’s failure to grant site access. When neither the owner nor the contractor is responsible for the delay, it is called excusable-non-compensable delay. Examples include severe weather and acts of God. The contractor is entitled to a time extension if this type of delay increases the overall project duration.

When more than one type of delay happens at the same time and both, either together or independently, impact the project's critical path, a concurrent delay occurs (Arditi and Robinson 1995; Ostrowski and Midgette, 2006). Concurrent delays add more complexity to the delay analysis. Mohan and Al-Gahtani (2006) indicated that the three major difficulties in calculating concurrent delay are as follows:

1. It is difficult to agree on the concurrency period of two or more delay events. The concurrent delay events may occur with respect to two or more concurrent activities which have different start and finish dates; thus only portions of these activities are concurrent.
2. New critical paths could be formed because of consuming the total floats for noncritical activities.
3. If the concurrent delays are on critical paths, and if the owner delays the critical path, the contractor can decelerate his work on the parallel critical paths in order to be critical.

Conclusion

We identified main causes of delay and ten most important causes were: (1) contractor's improper planning, (2) contractor's poor site management, (3) inadequate contractor experience, (4) inadequate client's finance and payments for completed work, (5) problems with subcontractors, (6) shortage in material, (7) labor supply, (8) equipment availability and failure, (9) lack of communication between parties, and (10) mistakes during the construction stage.

We identified main effects of delay and they were: (1) time overrun, (2) cost overrun, (3) disputes, (4) arbitration, (5) litigation, and (6) total abandonment. As an important contribution, we also studied the empirical relationships between the causes and effects of delays. We isolated the causes of delay for each of the six effects. We believe that the results of this study can be of immense help to the practitioners (clients, contractors and consultants) and academicians.

The practitioners can better understand the dynamics of project management and make efforts to reduce the incidences of delays. The academicians can conduct similar studies in other parts of world and identify causes and effects of delays. As mentioned earlier, some causes and effects may be unique to certain countries.

Delays in construction projects can be reduced through the joint efforts of participants in the construction industry. Owner associations, designers, contractors, suppliers, finance houses, educational institutions, manufacturers

and the government should cooperate to provide the infrastructure necessary for efficient project management. A means of achieving this is to formulate and execute a participatory programme for the development of the construction industry through a national agency dedicated to the industry. This should be followed by clients and consultants giving adequate support to contractors to execute efficiently the projects for which they are contracted. On their part, national contractors need to put their houses in order and train themselves to become better suppliers of the services for which their countries rely on them. (Ogunlana SO, Promkuntong K., 1996)

Identification of causes and effects alone does not help the project managers to take appropriate remedial or preventive steps. The project managers need to understand, for example, what causes or factors result in time overrun or cost overrun. Once these factors become clear, the managers can take proactive steps to avoid such situations. For example, if it is known that time overruns are predominantly caused by client-related factors, the project manager can: (1) make sure that payments for the completed work are paid on time, (2) reduce owner interference, (3) speed up the decision-making process, and (4) avoid unrealistic contract duration and requirements. Therefore, the link between causes and effects of delays need to be established.

According to the contractors and consultants, monthly payments difficulties from agencies was the most important delay and cost factor, while owners ranked poor contractor management as the most important factor. Despite some difference in viewpoint held by the three groups (contractors, owners and consultants) surveyed, there is a high degree of agreement among them with respect to their ranking of the factors. The overall ranking results indicates that the three groups felt that the major factors that can cause excessive project overruns in developing countries are poor contractor management, monthly payment difficulties from agencies, material procurement, poor technical performances, escalation of material prices according to their degree of influence.

The following points can be recommended by all parties in order to minimize and control delays in construction projects:

Owners should give special attention to the following factors:

1. Pay progress payment to the contractor on time because it impairs the contractors ability to finance the work.
2. Minimize change orders during construction to avoid delays.
3. Avoid delay in reviewing and approving of design documents than the anticipated.
4. Check for resources and capabilities, before awarding the contract to the lowest bidder.

Contractors should consider the following factors:

1. Shortage and low productivity of labor: enough number of labors should be assigned and be motivated to improve productivity.
2. Financial and cash flow problems: contractor should manage his financial resources and plan cash flow by utilizing progress payment.
3. Planning and scheduling: they are continuing processes during construction and match with the resources and time to develop the work to avoid cost overrun and disputes.
4. Site management and supervision: administrative and technical staff should be assigned as soon as project is awarded to make arrangements to achieve completion within specified time with the required quality, and estimated cost.

Consultants should look to the following points:

1. Reviewing and approving design documents: any delay caused by the consultant engineer in checking, reviewing and approving the design submittals prior to construction phase, could delay the progress of the work;
2. Inflexibility: Consultants should be flexible in evaluating contractor works. Compromising between the cost and high quality should be considered.

Finally; Architect/design engineer should focus on the following issues:

1. Producing design documents on time: A/E should set a schedule to complete design documents on time, otherwise result in a delay of work completion.
2. Mistakes and discrepancies in design documents: They are common reasons for redoing designs and drawings and may take a long time to make necessary corrections.

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