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Causes of construction delay: traditional contracts

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Abstract

Many projects experience extensive delays and thereby exceed initial time and cost estimates. In addition to imparting the economic feasibility of capital projects, extensive delays provide a fertile ground for costly disputes and claims. This paper presents the findings of a survey aimed at identifying the most important causes of delays in construction projects with traditional type contracts from the viewpoint of construction contractors and consultants. Results of the survey indicate that contractors and consultants agreed that owner interference, inadequate contractor experience, financing and payments, labor productivity, slow decision making, improper planning, and subcontractors are among the top ten most important factors. It is hoped that these findings will guide efforts to improve the performance of the construction industry, and will be useful to international engineering and construction firms seeking a share in the Jordanian and the regional markets.

Keywords: Construction management; Construction in Jordan; Construction delays

1. Introduction

The successful execution of construction projects and keeping them within estimated cost and prescribed schedules depend on a methodology that requires sound engineering judgment [1]. To the dislike of owners, contractors and consultants, however, many rojects experience extensive delays and thereby exceed initial time and cost estimates. This problem is more evident in the traditional or adversarial type of contracts in which the contract is awarded to the lowest bidder — the awarding strategy of the majority of public projects in developing countries including Jordan.

Although the construction industry in the Middle East has suffered ever since the Gulf war, recent events in the region coupled with the restructuring of economies, joining regional and global free trade organizations, and attracting foreign investments are expected to yield an unprecedented growth in the construction activities. The region is in desperate need for development projects in many areas, especially in the fields of water collection and distribution, tourism and housing. As a result, an unprecedented number of large-scale projects are currently under construction and in the planning and contract awarding stages. In Jordan, for example, the volume of construction projects awarded in 1998 was 944 million Jordanian Dinar[1] (JD) of which 155 millions went to international contractors [2]. These projects include three dams with contract values of over 87.7 million JD. Another dam with an estimated cost of 200 million JD is in the contract award phase. A major water transport pipeline extending over 300 km with an estimated cost of 100 million JD is in the final design stage.

Unfortunately, the construction industry in Jordan is not adequately prepared for the project management problems accompanying the anticipated boom in construction activities and the increasing complexity of projects. Recent findings [3,4] revealed that delays in public projects in Jordan are extensive and warrant further investigation. It is imperative to understand the underlying causes of such delays for any corrective actions to be effective.

2. Related work

Leishman [5] presented the legal consequences of delays in construction. Herbsman et al.[6] studied the effect of delays on cost and quality. Yates [7] developed a decision support system for construction delay analysis called (DAS). The main categories of delays in DAS

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[1] 1 JD = $1.424, the rate of exchange on 1 June 2000.

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include engineering, equipment, external delays, labor, management, material, owner, subcontractors, and weather.

Ogunlana et al. [8] studied the delays in building project in Thailand, as an example of developing economies. They concluded that the problems of the construction industry in developing economies can be nested in three layers: (1) problem of shortages or inadequacies in industry infrastructure, mainly supply of resources; (2) problems caused by clients and consultants; and (3) problems caused by incompetence of contractors. Kumaraswamy et al. [9] surveyed the causes of construction delays in Hong Kong as seen by clients, contractors and consultants, and examined the factors affecting productivity. The survey revealed differences in perceptions of the relative significance of factors between the three groups, indicative of their experiences, possible prejudices and lack of effective communication. Mansfield et al. [10] studied the causes of delay and cost overrun in construction projects in Nigeria. The results showed that the most important factors are financing and payment for completed works, poor contract management, changes in site conditions, shortage of material, and improper planing.

Assaf et al. [11] studied the causes of delay in large building construction projects in Saudi Arabia. The most important causes of delay included approval of shop drawings, delays in payments to contractors and the resulting cash problems during construction, design changes, conflicts in work schedules of subcontractors, slow decision making and executive bureaucracy in the owners' organizations, design errors, labor shortage and inadequate labor skills. Mezher et al. [12] conducted a survey of the causes of delays in the construction industry in Lebanon from the viewpoint of owners, contractors and architectural/engineering firms. It was found that owners had more concerns with regard to financial issues, contractors regarded contractual relationships the most important, while consultants considered project management issues to be the most important causes of delays.

Battaineh [3] evaluated the progress reports of 164 building and 28 highway projects constructed during the period 1996–1999 in Jordan. The results indicate that delays are extensive: the average ratio of actual completion time to the planned contract duration is 160.5% for road projects and 120.3% for building projects.

Al-Momani [4] conducted a quantitative analysis of construction delays by examining the records of 130 public building projects constructed in Jordan during the period of 1990–1997. The researcher presented regression models of the relationship between actual and planned project duration for different types of building facilities. The analysis also included the reported frequencies of time extensions for the different causes of delays. The researcher concluded that the main causes of delay in construction projects relate to designers, user changes, weather, site conditions, late deliveries, economic conditions, and increase in quantities. However, such conclusion can be misleading. First, they included causes which are limited to those for which contractors are entitled to time extension. The analysis does not cover causes of delay for which the contractor is responsible, such as those related to labor and equipment, planning and site management, construction methods, adequacy and capability of contractor. Second, they are based on the reported number of time extensions not on the extent of delay attributed to the different causes of delay. Despite the moderate weather in Jordan, for example, it was figured among the major causes of delay because a time extension was granted for all public projects under construction in the winter of 1991 as a result of an unprecedented severe storm that had a very low probability of occurrence. Third, they are drawn from records of public building projects and one would question their validity to other types of construction projects such as industrial facilities, water collection treatment and distribution, and highway construction.

3. Research design and objectives

The objective of this research is to identify the major causes of delay in the construction industry and to assess the relative importance of these causes for the traditional adversarial type of contracts from the viewpoint of construction contractors and consultants. First, a survey questionnaire was developed to assess the perceptions of contractors and consultants of the relative importance of construction delay causes. Second, the questionnaire was distributed to a random sample of contractors and consultants working on large projects in Jordan. Responses to the questionnaire were then collected and analyzed. The analysis included ranking the different causes according to the relative importance indexes for both contractors and consultants responses. The Spearman's rank correlation coefficient was then used to test association between the contractors and consultants ranking.

4. Causes of delay

The survey is based on 28 well recognized causes of delay to which participants were asked to indicate their level of importance of each cause. These causes were categorized into the following 8 major groups:

1. Client related factors include finance and payments of completed work, owner interference, slow decision making and unrealistic contract duration imposed by owners.
2. Contractor related factors include site management, improper planning, inadequate contractor

experience, mistakes during construction, improper construction methods and delays caused by subcontractors. Delays caused by subcontractors are included among the contractor's factors because the latter is fully responsible for the delays caused by his subcontractors.

3. Consultant related factors include contract management, preparation and approval of drawings, quality assurance/control, and long waiting time for approval of tests and inspections.
4. Material factors include quality and shortage.
5. Labor and equipment factors include labor supply, labor productivity, and equipment availability and failure.
6. Contract factors include changed orders and mistakes and discrepancies in contract documents.
7. Contractual relationships factors include major disputes and negotiations during construction, inappropriate organizational structure linking all parties involved in the project, and lack of communication between these parties.
8. External factors include weather conditions, changes in regulations, problems with neighbors and site conditions.

Other significant issues of concern such as political, socio-economical and religious factors are dismissed because it is felt that people in this part of the world are very sensitive to these issues to a degree that might prejudice their responses.

5. Survey methodology

The scope of the research included large public and private buildings, roads, and water and sewer projects in Jordan. Given this scope, the questionnaire was distributed to a random sample of 100 contractors and 50 consultants representing the different specialization of contractors and consultants working on large projects (contract value > 1 million JD). Tables 1 and 2 show the distribution of the population, sample, and respondents among the different specializations of contractors and consultants classified by the Ministry of Public Works and Housing to take on 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.

The respondents were asked to express their perception of the relative importance of each of the 28 causes of delays as either: extreme, very, moderate, slight, or not important. The questionnaire was personally handed over to respondents, and an interviewer was available to answer questions about the questionnaire and to ensure that the questionnaire is administered by VPs or project managers. This mode of follow-up communication led to the return of 82 completed questionnaires: 63 contractors and 19 consultants.

6. Analysis of responses

To determine the ranking of different causes from the point of view of contractors and of consultants, the *relative importance index* (I) was computed as:

$$I = \frac{\sum_{i=1}^{5} W_i X_i}{\sum_{i=1}^{5} X_i}$$

where:

i = response category index = 1, 2, 3, 4, and 5 for not-, slightly-, moderately-, very-, and extremely-important, respectively.
W_i = the weight assigned to the ith response = 0, 1, 2, 3, 4, respectively.
X_i = frequency of the ith response given as percentage of the total responses for each cause.

The indexes were then ranked, and the results are shown in Table 3. Calculating the average indexes of the causes in each group gives the relative importance index of the mean groups. The mean indexes and the ranking of all groups are shown in Table 4. The Spearman's correlation coefficients of the ranking of contractors and consultants for all the causes and for the main

Table 1
Distribution of population, sample and respondents of the different specializations of contractors

	Specialization of contractors			
	Buildings	Roads	Water and sewer	Total
Population	222	141	80	265
Sample	50	32	18	100
Respondents	39	27	16	82

Table 2
Distribution of population, sample and respondents of the different specializations of consultants

	Specialization of consultants			
	Buildings	Roads	Water and Sewer	Total
Population	42	22	16	80
Sample	26	14	10	50
Respondents	9	5	5	19

Table 3
Relative importance index and ranking of delay factors

Category	Factor	Contractors		Consultants	
		Index	Rank	Index	Rank
Client	Finance and payments of completed work	3.30	4	3.32	2
	Owner interference	3.51	2	3.21	4
	Slow decision-making by owners	3.24	8	3.16	5
	Unrealistic imposed contract duration	3.08	13	3.11	6
Contractor	Subcontractors	3.21	9	3.26	3
	Site management	3.29	5	2.58	13
	Construction methods	3.29	5	2.37	17
	Improper planning	3.14	10	2.95	8
	Mistakes during construction	2.56	17	2.74	11
	Inadequate contractor experience	3.37	3	3.37	1
Consultant	Contract management	3.10	12	3.00	7
	Preparation and approval of drawings	2.32	21	2.21	19
	Quality assurance/control	2.06	25	2.11	21
	Waiting time for approval of tests and inspections	2.46	18	2.47	15
Material	Quality of material	1.75	26	2.00	23
	Shortage in material	3.11	11	2.79	10
Labor and equipment	Labor supply	2.63	16	2.63	12
	Labor productivity	3.60	1	2.89	9
	Equipment availability and failure	3.25	7	2.42	16
Contract	Change orders	2.40	19	1.79	26
	Mistakes and discrepancies in contract documents	3.05	14	2.05	22
Contractual relationships	Major disputes and negotiations	2.94	15	2.16	20
	Inappropriate overall organizational structure linking all parties to the project	2.27	22	2.26	18
	Lack of communication between the parties	2.38	20	2.53	14
External factors	Weather condition	2.19	23	1.95	24
	Regulatory changes and building Code	1.70	27	1.16	28
	Problems with neighbors	1.59	28	1.58	27
	Unforeseen ground conditions	2.10	24	1.84	25

categories of delays are 0.789 and 0.762, respectively. These correlation coefficients are calculated for the ranking shown in Tables 3 and 4 using the following equation [13]:

$$r_S = 1 - \frac{6\sum d^2}{N(N^2-1)}$$

where:

r_S = Spearman's rank correlation coefficient.
d = the difference in ranking between the contractors and the consultants, and
N = the number of variables, equals to 28 and 8 for all the causes and for the main categories of causes of delay, respectively.

The somewhat high values of rank correlation coefficients indicate strong agreement between contractors and consultants on the ranking of all the factors and of the main groups of factors. This association between the ranking of contractors and consultants is verified by a hypothesis testing at 95% significance where $Z = r_S\sqrt{N-1}$

Table 4
Importance index and ranking of major delay categories

Category	Contractors		Consultants	
	Index	Rank	Index	Rank
Client	3.28	1	3.20	1
Contractor	3.14	3	2.88	2
Consultant	2.48	6	2.45	4
Material	2.43	7	2.39	5
Labor and equipment	3.16	2	2.65	3
Contract	2.72	4	1.92	7
Contractual relationships	2.53	5	2.32	6
External factors	1.89	8	1.63	8

7. Discussion of results

The ranking of the relative importance of the delay factors, Table 3, shows that owner interference, inadequate contractor experience, and financing and payments of completed work made the top five significant factors for both contractors and consultants. Moreover, labor productivity, site management, slow decision making, construction methods, improper planning and subcontractors are among the top ten ranked factors of both groups.

The following is a brief discussion of the ranking of the relative importance of the groups of delay factors, as deducted from Tables 3 and 4.

7.1. Client

The client related group of delay factors was the most important group to both contractors and consultants. This is mainly due to financing issues and owner interference, which are considered very important by both parties. It was interesting to find out that slow decision by owners and unrealistic contract duration are of more importance to consultants than to contractors. This is because contractors considered operational issues, such as labor productivity and equipment availability and failure, of more importance. Unlike contractors, however, consultants considered the client related factors to be more important than operational ones.

7.2. Contractor

Both contractors and consultants ranked this group of causes very high. It is worth noticing that consultants are mainly concerned with technical factors such as inadequate contractors experience, delays caused by subcontractors, and improper planning, while contractors are more concerned with managerial and operational factors such as site management and construction methods.

Inadequate contractor experience was the most important factor in this group. This can be attributed to the contract awarding procedure where most projects are awarded to the lowest bidder. Moreover, local contractors, solely or through joint ventures, are being awarded large and complex projects in which they have little experience because such projects were virtually limited to international contractors in the past.

Delays caused by subcontractors are also of high importance to consultants. This can be attributed to inadequate experience of subcontractors, the bid shopping practice of general contractors, and to improper planning and coordination.

Improper planning is also troublesome to contractors and consultants. Local contractors are reluctant to use scheduling techniques and to update schedules on a regular basis. Despite the fact that contractors are required to provide work schedules on most projects, the schedule is often a summary schedule that is hardly updated during construction. This is substantiated by the fact that only 8 of the 63 sampled contractors responded positively to updating schedules on their projects.

Delays caused by improper construction methods are more important to contractors than to consultants. Fluctuation in the construction market and the seasonal nature of the industry has forced many contractors towards diversity. As a result, they do not focus on one line-of-work and try to adopt advanced methods and techniques.

Site management is another important cause of delay to contractors. This is due to the reluctance of contractors to invest in planning and control and to the lack of professional construction managers. The majority of site managers are civil engineers with a good work experience but little training or education in management.

7.3. Consultants

Neither contractors nor consultants ranked this group of factors high among the major groups of delay causing factors. Contrary to what is expected, consultants consistently ranked each of these causes higher than contractors. The highest ranked factor among these causes was contract management. This could be attributed to the lack of authority the owners are willing to delegate to consultants enabling them to manage the contract effectively. This finding is consistent with the high ranking of owner interference and the low ranking of factors over which the consultants are usually granted authority. The latter factors include preparation and approval of drawings, quality assurance/control, and approval of tests and inspections.

7.4. Material

The group of material related causes received low ranking by both contractors and consultants. Quality of material was among the least important causes because most of the available material is local with little variation in quality, especially for cement, steel, and asphalt that are produced by a limited number of producers. Shortage of material received higher ranking than quality. This is particularly true for imported material that may take a considerable time to procure.

7.5. Labor and equipment

This group of causes were ranked high, second by contractors and third by consultants. As expected, this group of causes is more important to contractors than to consultants. This was true for labor productivity and for equipment availability and failure. While labor supply is not that important considering the relatively inexpensive flux of foreign and local laborers, the productivity of the labor forces was the top ranked factor for contractors. This may be attributed to lack of

incentives for higher productivity, lack of or improper training, and absence of trade unions or associations that regulate, train, and classify construction trades.

The high ranking of contractors of equipment availability and failure indicate problems associated with ownership of new equipment, maintenance and repair, and availability and reliability of the rental option.

7.6. External factors

External factors were the lowest ranked group of factors by both parties. It seems that all parties are familiar with these factors and are able to deal with them effectively without causing any major delays. Of course, the moderate weather conditions in Jordan coupled with low levels of water tables in addition to well established regulations and building code contribute to this low ranking.

7.7. Contract

This group of causes had more difference in ranking than any other group. While it was considered important and ranked fourth by contractors, it was unimportant and ranked only seventh by consultants. Contrary to contractors, consultants who are usually empowered to issue changed orders and to correct mistakes and discrepancies in contract documents are less critical of their role in causing such delays.

7.8. Contractual relationships

This group of causes was ranked low by contractors and consultants. Relatively, factors relating to organization and communication were more important to consultants than to contractors. Delays caused by disputes and negotiations were more important to contractors, especially for public projects in Jordan where arbitration is not allowed and where legal recourse through courts takes a considerable time.

8. Conclusions and recommendations

According to contractors, labor productivity was the most important delay factor. Inadequate contractor experience, however, was the most important delay factor to consultants. All parties generally agreed on the ranking of the individual delay factors. They agreed that inadequate contractor experience, owner interference, and financing of work were among the top five most important factors. Moreover, delays caused by subcontractors, slow decision making by owners, improper planning, and labor productivity were among the top ten most important factors for both parties.

Operational factors such as labor productivity, construction methods, site management, and equipment availability and failure were more important to contractors than to consultants. Contractors were also more concerned with factors related to contract clauses that may alter their contractual obligations and rights.

These factors include changed orders, mistakes and discrepancies in contract documents and major disputes and negotiations. However, factors dealing with subcontracting, planning, organizing and communicating were more important to consultants than to contractors.

Delays are costly and often result in disputes and claims, impair the feasibility for project owners, and retard the development of the construction industry. To improve the situation, the findings of this research must be addressed by a joint effort of all participants in the construction industry. This calls for:

1. Enforcing liquidated damage clauses and offering incentives for early completion.
2. Developing human resources in the construction industry through proper training and classifying of craftsmen. This calls for providing incentives such as offering a tax deduction on money spent on training, and for authorizing trade unions or other agencies to regulate, follow-up on training, and classify trades. Developing human resources also applies to construction engineers who usually lack adequate managerial skills. There is an urgent need for offering training courses in scheduling, time and cost control, information systems, and management of human resources.
3. Adopting a new approach to contract award procedure by giving less weight to prices and more weight to the capabilities and past performance of contractors.
4. Adopting new approaches to contracting, such as design-build and construction management (CM) types of contracts. Such contracts reduce delays by limiting owner interference, improving the design, and improving the contractual relationships among all parties to the project.

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