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Factors Affecting Time Overruns in Public Construction Projects: The Case of Jordan

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Abstract

Most construction projects in developing countries are characterized by overruns in time. This research was conducted in an attempt to identify major factors for such overruns in the typical developing environment of Jordan. A descriptive study was carried out and two types of data were collected. The overrun variables were extracted from the literature and from a thorough examination of the perception of 30 engineers, and then ranked according to their Severity Index (the product of Importance Index and Frequency Index). The top ten factors causing time overruns in construction projects were identified and treated using Principal Component and Factor Analysis (PCFA). After conducting the analysis on both the secondary and primary data, results showed agreement only on one cause, weather conditions.

Keywords: time overrun, public construction sector, Jordan, principal component and factor analysis

1. Introduction

Time overrun is a very frequent phenomenon and is almost associated with nearly all projects in the construction industry. This trend is more severe in developing countries where time and cost overruns sometimes exceed 100% of the anticipated cost of the project (Kaming et al., 1997; Abd El–Razek et al., 2008; Le Hoai et al., 2008).

A construction project comprises two distinct phases: the preconstruction phase, the period between the initial conception of the project and the signing of the contract; and the construction phase, during which the contractor must complete construction subject to the conditions of the contract.

There is no particular element in any project solely responsible for time overruns however; the construction phase holds a wider proportion of major troubles. Construction time overruns are integrated parts, none of them can be divided from the other, and this is clearly seen by the costs construction time overruns leave behind.

The construction sector in Jordan is the spine of the country and plays a major role in provinding employment. Any ups or downs in this sector will immidiately be reflected in the national income. The responsibility of time overruns is distributed over several factors. The aim of this research is to answer the following question: What are the major factors causing time overruns in the Jordanian construction sector?

2. Literature review

2.1 Previous Studies Related to Time Overruns

Several studies have addressed many different factors that cause overruns in different types of construction projects. Generally; Construction delay is considered to be one of the most recurring problems in the construction industry and it has an adverse effect on project success in terms of time, cost, quality, and safety. A new type of construction projects has not escaped the overwhelming ghost of overruns. Environmentally conscious construction has become a subject of research during the last decades. Suppliers of construction materials has yet suffered from the drag of delays and cost, and multiple efforts to create a statistical model to help adjust the floats and budgets of the planning schedule have been conducted in recent studies, only to emphasize the effect overruns has on every angle of the construction project process. (Ozcan-Deniz et al., 2012; Chen et al., 2012; Mahamid, 2012; Abu Hammad et al., 2010).

In a study conducted by Ogunlana et al. (1996) comparing Thailand as a fast-growing economy country with other economies, 12 skyscrapers construction projects showed that the main reason of delays was resource supply problems in the boom-years of the construction sector. Shortage of supply of materials especially cement was the reason why projects were kept behind schedule.

The causes and effects of delay factors in construction industry vary from country to country due to environmental, topographical and technological constraints. In anticipation of the effect of globalization and the technological difference between developing and developed countries, it is necessary to identify the actual reasons of delay in order to reduce the impact of delay in any construction project (Shebob et al., 2012).

Gündüz et al. (2013) stated that in the construction industry, contractors tend to maximize their profit to increase market share. To achieve this aim, it is crucial for contractors to carefully identify the factors that affect the success of a project and estimate their impacts before the bidding stage. Construction projects may differ in size, duration, objectives, uncertainty, complexity, deadlines, and some other dimensions. Delay means no completion of the project within the specified duration agreed on in the contract.

Moreover, Al- Khalil and Al-Ghafly (1999) tackled the question of delay in water and sewage projects and on whom the responsibility falls. It was found that the majority of projects, particularly medium and large projects, had experienced delay. A whirlpool of blame showed up when the owners and consultants put the burden of delay over the contractors, while the contractors pointed their fingers against the owners. On average, the contractor is assigned most responsibility for the delay.

In Nigeria, Aibinu and Jagboro (2002) studied the rising dilemma of construction that Nigeria witnessed at that time and how it prevented projects to be completed on time. They conducted a survey on 61 construction projects and came out with a definition and assessment of impact of delays on the delivery of construction projects. Finally, a recipe of relief was made, in which better management procedure compound with inclusion of an appropriate contingency allowance in the pre-contract estimate were recommended as a means of minimizing the adverse effect of construction delays in Nigeria.

Chang (2002) categorized the reasons for cost and time overruns in engineering design projects as follows: those within the owner's control (for which the owner is responsible); those within the consultant's control (for which the consultant is responsible) and those beyond the control of the mation processes are relatively more complex and may be computationally cumbersome (Lord & Mannering 2010).

In addition, Ahmad et al. (2003) found that in most of the cases there is no excuse for the delay when it is caused by the contractor, while this delay could be excusable and compensable when the responsibility is on the owner or the consultant. However, when the delay is the responsibility of the government, it's always excusable and compensable.

It's noticed that almost half of the cost additions are due to unpredicted additions and balanced final field measurements. Unpredictable additions refer to items that are added to the contract, as stated within the specification, but were not included in the contract bid items because the need for the work is unknown during plan preparation. Examples include accident cleanup, repairing water main breaks, water main or service breaks, locating utilities, rock excavation (where not indicated in plans), temporary drainage facilities, and so on. Changes in this category are always germane to the contract, since provision for the work is included in the specifications (Nassar et al., 2005).

Furthermore, Algharbi et al. (2007) examined the factors behind the delay in construction projects in Malaysia. Results showed that the financial issue is the dominating factor among other factors that cause the delay of construction project in Malaysia. Coordination problems came next after the financial factor followed by materials problems.

Research has suggested that the likelihood of a cost overrun increase with contract size and complexity as well as the number of change orders (Rowland, 1981; Hinze et al., 1992). The larger the contract project, the larger the likely hood of risks. This is clearly stated out with project conducted in different zones or states. One of the most easily remembered risks that might affect such project is weather conditions.

More recently, Jaskowski and Biruk (2011) pointed out that project activities' durations are directly affected by different risk factors independently. Every activity within the project has its own time and cost estimates with different processes differentiating the type of work undertaken to accomplish these activities. All differ and affected by different risk factors that might have a major impact on one and slightly affect the other.

several studies have been conducted in deferent parts of the world that show somewhat similar results to the studies mentioned earlier (Kasimu, 2012; Tabish, 2011; Memon et al., 2012; Le–Hoai et al., 2008; Doloi et al., 2012)

One of those several studies carried out to address factors affecting time and cost overruns was conducted by

Love et al (2013) it showed two different viewpoints exist with regard to the point at which a cost overrun is determined. Within the infrastructure and transport literature, cost overruns are invariably calculated from the decision to build. In contrast, within the construction and engineering management literature, cost overruns are determined from contract award. When the decision to build is used as the reference point, reported cost overruns can be phenomenally high and alarmist to the general public. Between the decision to build and contract award a project's nature and scope can change dramatically to the extent that an entirely different facility may be commissioned, rendering cost overrun comparisons unrealistic.

In the Middle East several similar studies were carried out. Major causes of delay in Saudi Arabia were slow preparation and approval of shop drawings (Assaf et al., 1995). In Lebanon, however, the owners concerns with regard to financial issues ranked highest among the delay causes (Mezher et al., 1998). Additionally, Al Moumani (2000) identified poor design and change orders as the leading causes of delay in Jordan. While Koushki et al (2005) regarded changing orders and owner financial concerns as the top factors affecting delays in the Kuwaiti construction industry. Finally, Faridi and Al Sayegh (2006) recognized that slow preparation of drawing was a major factor affecting delay in the United Arab Emirates construction sector.

2.2 Time Overruns in the Jordanian Public Construction Sector

A quantitative analysis on construction delays in Jordan has been carried out by Al-Momani (2000). Results indicated that the main causes of delay in construction of public projects were related to designers, user changes, weather, site conditions, late deliveries, economic conditions and increase in quantity. Similarly, Abdalla and Battaineh(2002) conducted a survey aimed to identify major causes of delays in construction projects with traditional types of contracts from the viewpoint of construction contractors and consultants. Results of the survey had shown agreement among contractors and consultants that owner interference, inadequate contractor experience, financing and payments, labor productivity, slow decision making, improper planning, and subcontractors were among the top ten most important factors.

Project delays in Jordan constitute a major issue in the construction management field. Besides, dearth of research in this field is the major reason behind this study in which factors influencing time overruns in the Jordanian construction sector will be identified and ranked by professionals in the field.

3. Methodology

Two types of data were collected, secondary data from the Ministry of Public Works and Housing, and primary data using a survey conducted with engineers from the Ministry.

Secondary data was collected from 57 public construction projects. A final evaluation report of each project was studied. A spread sheet was created to summarize the data and conduct further descriptive analysis.

After An extensive literature review, a number of delay factors were extracted, followed by forming the questionnaire based on the compiled list of causes. The process of collecting primary data was launched by the distribution of the formed questionnaires to a purposive sample consisting of 30 engineers of different levels of work experience at the Ministry of Public Works and Housing and the Association of Construction Contractors who were willing to participate. The second phase consisted of analyzing the data using Principal Component and Factor Analysis (PCFA).

To calculate the weighted indexes for importance and frequency of overrun variables, the research employed the methodology used by Abd El-Razek et al. (2008) and Le-Hoai et al. (2008). The overrun variables were ranked according to their Severity Index (the product of Importance Index and Frequency Index).

$$\text{Importance Index (I.I.)} = \frac{\sum_0^4 a*n}{4N} \quad (1)$$

$$\text{Frequency Index (F.I.)} = \frac{\sum_0^4 a*n}{4N} \quad (2)$$

$$\text{Severity Index (S.I.)} = \text{I.I} * \text{F.I} \quad (3)$$

- *a* = constant represents weight assigned to the scale (ranges from 4 for Extremely Significant/Continual to 0 for Not Significant/Rarely)
- *n* = the frequency of each response.
- *N* = the total number of responses.

4. Data Analysis

The top ten factors were analyzed using the PCFA technique to arrive to the top three factors contributing to the overall time overrun. Table 1 shows the importance, frequency and severity index ranks of time overrun factors. The top time overrun variable was too many change orders from owner with a severity index of 0.55, followed by poor planning and scheduling of the project by the contractor, ambiguities and mistakes in specifications and drawings, slow decision making from owner and poor qualification of consultant engineers' staff assigned to the project. The top five variables have severity index greater than 0.40. The next thirteen variables have severity indexes that ranged from 0.30 to 0.37. The lowest severity index was 0.14 of unforeseen site conditions.

Table 1. Ranks of time overrun factors

	Importance		Frequency		Severity	
	Index	**Rank**	**Index**	**Rank**	**Index**	**Rank**
Too many change orders from owner	0.72	2	0.77	1	0.55	1
Poor planning and scheduling of the project by the contractor	0.67	12	0.70	2	0.47	2
Ambiguities and mistakes in specifications and drawings	0.69	4	0.67	3	0.46	3
Slow decision making from owner	0.66	18	0.65	4	0.43	4
Poor qualification of consultants, engineers and staff assigned to the project	0.67	12	0.61	5	0.41	5
Improper technical study by the contractor during the bidding stage	0.71	3	0.52	12	0.37	6
Delay in progress payments by the owner	0.65	19	0.56	7	0.36	7
Severe weather conditions on the job site	0.67	12	0.54	8	0.36	8
Presence of unskilled labors	0.68	7	0.52	12	0.35	9
Shortage of technical professionals in the contractors organization	0.68	7	0.52	12	0.35	9
Slow response by the consultant's engineers to contractor inquires	0.58	30	0.59	6	0.35	11
Financial difficulties faced by the contractor	0.67	12	0.51	16	0.34	12
Delays in contractors claims settlements	0.62	22	0.54	8	0.33	13
Poor coordination by the consultants engineers with the parties involved	0.60	26	0.54	8	0.33	14
Insufficient coordination among the parties by the contractor	0.59	28	0.53	11	0.31	15
Delay in mobilization	0.60	26	0.52	12	0.31	16
Financial constraints faced by the owner	0.69	4	0.43	23	0.30	17
Work suspension by the owner	0.59	28	0.50	18	0.30	18
Delays in site preparation	0.63	21	0.46	21	0.29	19
Delay in the approval of contractor submissions by the engineer	0.61	25	0.48	19	0.29	20
Improper handling of the project progress by the contractor	0.69	4	0.42	25	0.29	21
Slow response by the consultants engineers regarding testing and inspections	0.57	32	0.51	16	0.29	22
Shortage of manpower	0.68	10	0.41	27	0.28	23
Modification in material specifications	0.62	22	0.44	22	0.27	24
Shortage of equipment	0.73	1	0.33	31	0.24	25
Delay in materials delivery	0.58	31	0.42	25	0.24	26
Incompetent technical staff assigned to the project	0.68	10	0.35	29	0.24	27
Delays by the contractor payments to subcontractors	0.48	36	0.48	19	0.23	28
Shortage of materials	0.68	7	0.33	31	0.23	29
Insufficient coordination among the parties by the owner	0.52	35	0.43	24	0.22	30
Ineffective quality control by the contractor	0.67	12	0.33	34	0.22	31
Interference by owner in the construction operation	0.62	22	0.33	31	0.21	32
Difficulties in obtaining work permits	0.67	12	0.31	35	0.21	32

Materials price regulations	0.55	33	0.34	30	0.19	34
Failure of equipment	0.64	20	0.29	36	0.19	35
Safety rules and regulations are not followed within the contractors regulations	0.48	36	0.36	28	0.17	36
Unforeseen site conditions	0.53	34	0.28	37	0.14	37

4.1 Principal Component and Factor Analysis (PCFA)

PCFA is a reduction technique used to classify and reduce the number of variables. It was applied on the top ten factors according to index ranking. A test for the suitability of data has been conducted before starting the analysis. The test is based on Kaiser-Meyer-Olkin measure of sampling. A KMO value >0.5 indicates that the sample is suitable for the analysis. The KMO value for time overrun sample was 0.659. This value indicates that the sample is suited for analysis. Tables 2 and 3 show some descriptive statistics of the sample and factor loading of time overrun factors, respectively.

Table 2. Descriptive statistics of the top ten times overrun variables

	Mean	**Std. Deviation**	**Analysis N**	**Missing N**
Presence of unskilled labors	3.400	1.1626	30	0
Shortage of technical professionals in the contractors organization	3.400	.7701	30	0
Improper technical study by the contractor during the bedding stage	3.450	.8545	30	0
Poor planning and scheduling of the project by the contractor	3.733	.8976	30	0
Too many change orders from owner	3.967	.9463	30	0
Slow decision making from owner	3.617	1.0478	30	0
Delay in progress payments by the owner	3.417	.9656	30	0
Ambiguities and mistakes in specifications and drawings	3.717	1.0229	30	0
Poor qualification of consultants, engineers and staff assigned to the project	3.550	.8645	30	0
Severe weather conditions on the job site	3.417	1.2871	30	0

Table 3. Factor loading of time overrun variables

	Component		
	DF1	**DF2**	**DF3**
Presence of unskilled labors		.738	
Shortage of technical professionals in the contractors organization	.774		
Improper technical study by the contractor during the bedding stage	.662		
Poor planning and scheduling of the project by the contractor			.866
Too many change orders from owner		.668	
Slow decision making from owner		.790	
Delay in progress payments by the owner			.796
Ambiguities and mistakes in specifications and drawings	.758		
Poor qualification of consultants, engineers and staff assigned to the project.	.906		
Severe weather conditions on the job site		.817	

From table 3, we can see that 3 factors have been extracted:

- Poor qualification of consultants, engineers and staff assigned to the project.
- Poor planning and scheduling of the project by the contractor.
- Severe weather conditions on the job site.

4.2 Secondary Data

Figure 1 shows the different types of projects that were analyzed in our sample. 40% of the projects were mainly schools in different cities in Jordan, other projects included General (Utility buildings… etc.) 24%, Health 4% (Hospitals and clinics), Residential 2%, Municipality 14% and Sports and Youth projects 16%.

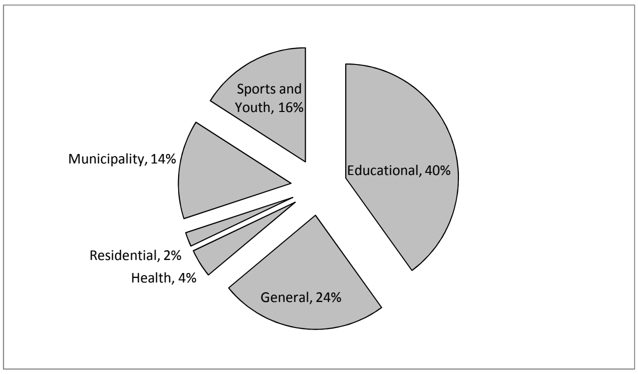

Figure 1. Project type percentages in data sample

The percentages of projects with time overruns were calculated. It was found that 65% of projects had time overrun and only 35% of projects were on time as shown in Figure 2.

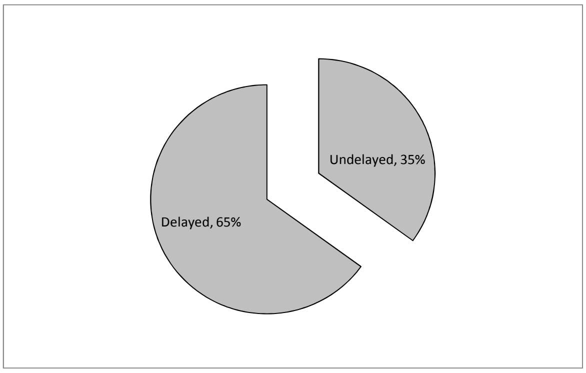

Figure 2. Percentage of projects with time overrun

The time overrun factors documented in the final project report were summarized. Figure 3 represents the percentage of each factor to the total time overrun in our sample. It shows that the top factor of time overrun in public construction was governmental delay 32% (mainly the slow process of decision making on the part of the owner/government), followed by severe weather conditions 23%, and 18% for design changes. These three factors contribute to 73% of time overrun.

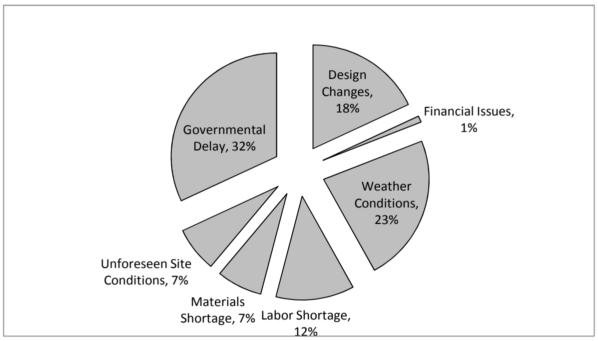

Figure 3. Top time-overrun factors documented in actual data sample

The average time overrun for each sector was calculated. A comparison between the different sectors of the study is shown on Figure 4. The top sector contributing for time overrun is municipality with a percentage of 30% of the total time overrun, followed by educational sector with 26%.

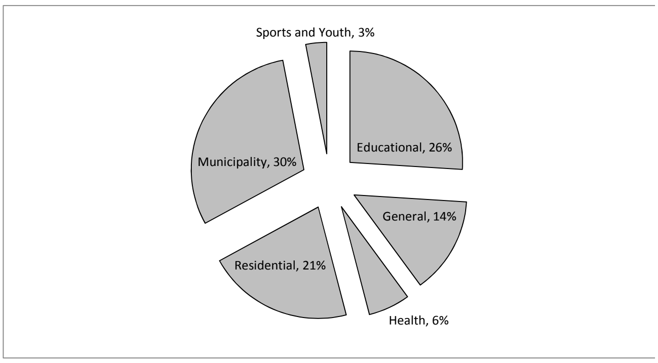

Figure 4. Percentage of time overrun contribution for different public sectors

5. Conclusion

This paper was conducted to determine factors leading to time overruns in Jordanian construction projects through examining the perceptions of 30 engineers with different work experience levels working at the Ministry of Public Works and Housing and the Association of Construction Contractors. After a careful literature review, several factors affecting time overruns were identified and ranked by the study sample. Furthermore, the top ten factors causing time overruns in construction projects were identified and treated using PCFA analysis. Three factors causing time overruns were extracted, namely, poor qualification of consultants, engineers and staff assigned to the project; poor planning and scheduling of the project by the contractor and severe weather conditions on the job site.

Analysis of secondary data relating to actual public projects at the Ministry of Housing and Public Works revealed that three factors are responsible for 73% of all delays in the Jordanian public construction, namely, government delay, design changes, and weather conditions.

After conducting the analysis on both the secondary and primary data, results showed agreement only on one cause, weather conditions. While disagreement was found on factors such as poor qualifications of consultants, engineers and staff assigned to the project, poor planning and scheduling of the project on one hand, and government delay and design changes on the other.

The findings show consensus of opinion among the sample members that poor qualifications of consultants, engineers and staff as well as poor planning and scheduling served as main factors contributing to public projects time overrun. Taking into account that most staff members working on public projects in Jordan acquire their skills through informal means with their own competencies and not formally tested nor certified, it is therefore not surprising that poor qualifications and poor planning and scheduling were ranked high by the sample as a main factor contributing to time overrun. Due to this emerging issue mentoring consultants, engineers and staff members will help minimize the bullwhip effect of the lack of qualified consultants on time overruns in construction projects.

Furthermore, in comparison to other similar studies conducted in Asian and developing countries, results of this paper showed agreement with Sweis et al., (2008) regarding the time overrun cause "too many changes and slow decision making from the owner". While other studies showed factors such as changed site conditions (Acharya et al., 2006), inadequate early planning Faridi, 2006), financial constraints (Koushki, 2005), poor contract management (Frimpong, 2003) and client's cash flow problems (Aibinu, 2006).

According to the results showed previously, it is clear that a variety of causes for time overruns exist in public construction projects. It is vitally important to note that major factors causing time overruns differ greatly among countries. Each country possesses its own divine characteristics and its own construction projects environment which indicates that the impact of each of the previously listed factors differ greatly between countries. Results of this particular study illustrated that although most developing and Asian countries possess similar characteristics in their construction environment, they still hold opposing views regarding factors affecting time overruns.

6. Implications

The goal behind this research was to identify the factors that are responsible for increasing the time of a public project thereby, weakening the public construction in Jordan.

As the results indicated one of the major factors causing construction projects time overrun was governmental delays and design changes, due to this, systematic steps must be taken, and can be illustrated by reforms and change of regulations required to accelerate the approval process of the government. Moreover more attention should be given during the design phase to minimize the probability of change orders.

As has been discussed earlier, there is also a need to embark on a long term and effective training program in Jordanian public construction that would aid in the evolution of effective workforce and extract the benefits of mentoring.

Further similar studies are recommended to be conducted in other developing countries. The relatively small sample size used in this study may limit the ability to generalize the findings. Future studies could be performed to replicate the results of this study using a larger sample size.

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