

Causes and Effects of Delay in Public Construction Projects in Jordan

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Abstract: One of the most significant economic sectors in Jordan is the construction sector. Time and cost overrun is one of the most serious problems suffered by this industry. The major aim of this research is to detect the major causes of delays in public projects in this country and to find the effects of this delay on the performance of these projects. The aim was accomplished through an intensive literature review and a field study used to find the perception of major parties participating in the implementation of the construction projects in Jordan. The survey which was carried out through a questionnaire has three divisions. These are the introductory part, the causes revealed by the literature review (55 causes) categorized into four groups and the effect of causes on the performance of the project. Answers were collected from (146) participants representing clients, contractors and consultants. The analysis carried out through the determination of the frequency of occurrence, severity and importance of each of the 55 causes of delay. The study presented ranking of the significant factors for each group and then the significant factors of the whole survey. In addition, the study presented the effect of the delay causes on the performance of the project.

Keywords: Jordan, public sector, construction projects, delay, time overrun.

I. INTRODUCTION

Most of construction projects suffer delays. The effects of these delays may be of considerable magnitude on the efficiency of the project. It is possible to reduce these delays through recognition of their real causes. Definitions of delays in construction can be presented in several ways. Delay could be defined as the time overrun beyond the accomplishment time in the agreement or beyond the time the contract parties agree upon for the delivery of the project [1]. Also it can be defined as the distinction between the real finish date and the estimated date [2] and [3]. Also it is defined as the period during which the project or part of it has been extended or not completed due to unexpected conditions [4]. Therefore the delay in construction project can be expressed as the time overrun or extension of time behind the date agreed upon by the contract parties.

II. AIM OF THE RESEARCH

The prime aim of this research is to survey the most significant causes of delay in public construction projects in Jordan. This research work recognizes the reasons of delay from the viewpoint of the main parties involved in any construction works. These parties are client, consultant and contractor.

III. CLASSIFICATION OF DELAY CAUSES

The classification of delay causes in construction projects can be presented in various ways. Delays may be classified into two categories. These are internal causes (related to parties within the contract) and external causes (related to reasons beyond the contract) [5].

Reference [6] categorized delay into three categories. These are excusable-non compensable, compensable delays and inexcusable. Reference [4] also classified delays into three categories. These are excusable delays (compensable and non-compensable), non-excusable and the concurrent or combination of two or independent causes.

IV. LITERATURE REVIEW

CAUSES OF DELAYS

There are many international studies (in developed and developing countries) in the field of delays in construction projects. Jordan is a developing country, and then more attention is given in this review to these countries.

Reference [7] studied the delay causes in large building projects in the Kingdom of Saudi Arabia. They examined, in their survey which included clients, consultants and contractors fifty six factors distributed in nine groups.

Another study carried out in Saudi Arabia by [1]. In this study different types of projects were taken into consideration. Total of 73 factors were identified.

In Egypt, two studies were undertaken. The first was by [8] which considered the role of consultancy to reduce the delays of major projects. The second was by [9] which are concentrated on the analysis of delay causes in construction project to minimize delays.

In Jordan, [10] investigated the causes of delay at the traditional construction contracts. The research revealed that the most significant factor is the labour productivity. The other study is carried out by [11] which considered the residential projects. The study revealed that the most significant factors suffered by contractors are financial difficulties and the large amount of changes imposed by the client.

There are many other research works related to delays in construction projects in developing countries. Among these are [12] in Thailand, [13], [14] in Indonesia, [15] and [16] in Malaysia, [17] in India, [18] in Hong Kong, [19] and [20] in Saudi Arabia.

EFFECT OF DELAY ON THE PERFORMANCE OF THE PROJECT

A research work carried out by [21] reveals six effects of delay on project performance in Nigeria. These effects are time and cost overruns, disputes, arbitration, litigation and total abandonment. In another study in Malaysia, [22] found the same effect of delays in Malaysian construction industry. In Pakistan, a study carried out by [23] concentrated the effect of delay in the construction industry. Their study revealed that the clash, claims, total abandonment and slowing down the growth of the construction industry.

The relationship between causes and effects are of two types. These are direct and indirect relationships. These relationships are studied by many authors. [24] in their study in Nepal linked the material-related causes with effects of cost and time overruns in construction projects. In their study about the large construction projects in the Kingdom of Saudi Arabia, [1] connected the causes related to contractor and causes related to labour with the time overrun of the project. The other study carried out by [10] in Jordan, they connected the causes related to contract with the disputes and negotiations occurred among the parties participating in the project.

So many other links can connect between other causes and items of performance. Time and cost overruns can be linked with the finance related causes and material related causes. The causes related to labour or finance can be connected with disputes and negotiation. Causes related to finance, relationship between parties, external circumstances are connected with time overrun and may abandonment of the project.

IV. RESEARCH METHODOLOGY

To achieve the aims of the research defined in the previous section, a field study based on the literature review carried out. The survey done through a questionnaire exercised to evaluate the perception of parties involve in the construction process on comparative significance of causes and effects of delay in Jordanian construction industry.

The questionnaire included three sections. The first section contained general questions about the experience, types of projects implemented by the respondents, amount of delay they experienced in their previous projects. Section two of the questionnaire concentrated on causes of delay in construction projects in Jordan. The participants in the survey were asked to point out their answer to the frequency of occurrence and degree of severity on 55 – well identified factors causing delay in construction projects. These were distributed into four groups of factors:

Group 1: included 17 factors related to clients.

Group 2: included 20 factors related to contractors.

Group 3: included 11 factors related to consultants.

Group 4: included 7 factors related to external circumstances.

The third section of the questionnaire concentrated on the effects of delay on Jordanian construction projects. From the literature review, six effects of delay were specified. These are time overrun, cost overrun, disagreement between parties, arbitration, litigation and abandonment of the project.

The questionnaire form was prepared so for every cause of delay or effect on the construction project, the participant who answers the questions will mark a figure from 1 to 5 depending on the frequency of occurrence and the severity of the cause of delay or effect on construction project. The number 1 shows non-effectiveness while 5 shows most influential.

The parties included in the survey are mainly engineers representing clients, consultants and contractors in Amman main cities in Jordan (Amman, Zarqa, Irbid and Aqaba).All the respondents were selected on the basis that they have long experience in implementation of public sector projects.

Before the approval of final form, a pilot survey carried out to check the visibility and clearness of the questions. Ten experienced engineers checked the clarity and feasibility assurance. Their notes were taken into consideration in formulating the final form of the questionnaire.

The questionnaire forms were distributed to 210 engineers representing clients, consultants and contractors. Number of forms received was 146 with a percentage of receipt of about 70%.

The answers collected through the survey were analysed. The frequency, severity and importance indices were calculated for each question within the form using the statistical techniques described in the next section. The analysis of the data collected revealed recommendations for reducing delay in construction projects.

VI. ANALYSIS OF THE COLLECTED DATA

Ranking of causes of delay was accomplished based on "Importance Index" was as specified by the participants. The formula used for this purpose is:

$$\text{Importance Index (I.I) (\%)} = [\text{F.I (\%)} * \text{S.I (\%)}] / 100 \dots\dots\dots(1)$$

Where F.I. = Frequency Index which represents the frequency of occurrence as specified by the participants of the survey. This is calculated in accordance of equation 2 below:

$$\text{Frequency Index (F.I) (\%)} = \sum a (n/N) * 100 / 5 \dots\dots\dots (2)$$

Where (a) is constant representing the weight to each answer (1, 2, 3, 4 or 5), n is the frequency of the answer and N is the total number of participants in the survey.

S.I (Severity Index) which represents the severity as specified by the people participated in the survey. This is calculated by using equation (3) below:

$$\text{Severity Index (S.I) (\%)} = \sum a (n/N) * 100 / 5 \dots\dots\dots (3)$$

VII. PRESENTATION OF THE RESULTS

GENERAL INFORMATION

Number of participants who contributed to the survey was (146) representing Clients, (50) and (44) Consultants and (52) Contractors. The average years of experience of the respondents were (18). The study included public sector projects only. The participants representing the clients working in ministries of Public Works and Housing, Education, Health, Higher education and scientific Research, Industry and Trade and Municipal Affairs in addition to Greater Amman Municipality.

CAUSES OF CLIENT RELATED FACTORS

The questionnaire included 17 client-related delay factors. The average Importance Index is 47.05. Figure (1) shows the Frequency, Severity and Importance indices for all the factors within this group. The significant delay factors related to client are those with I.I greater than the average.

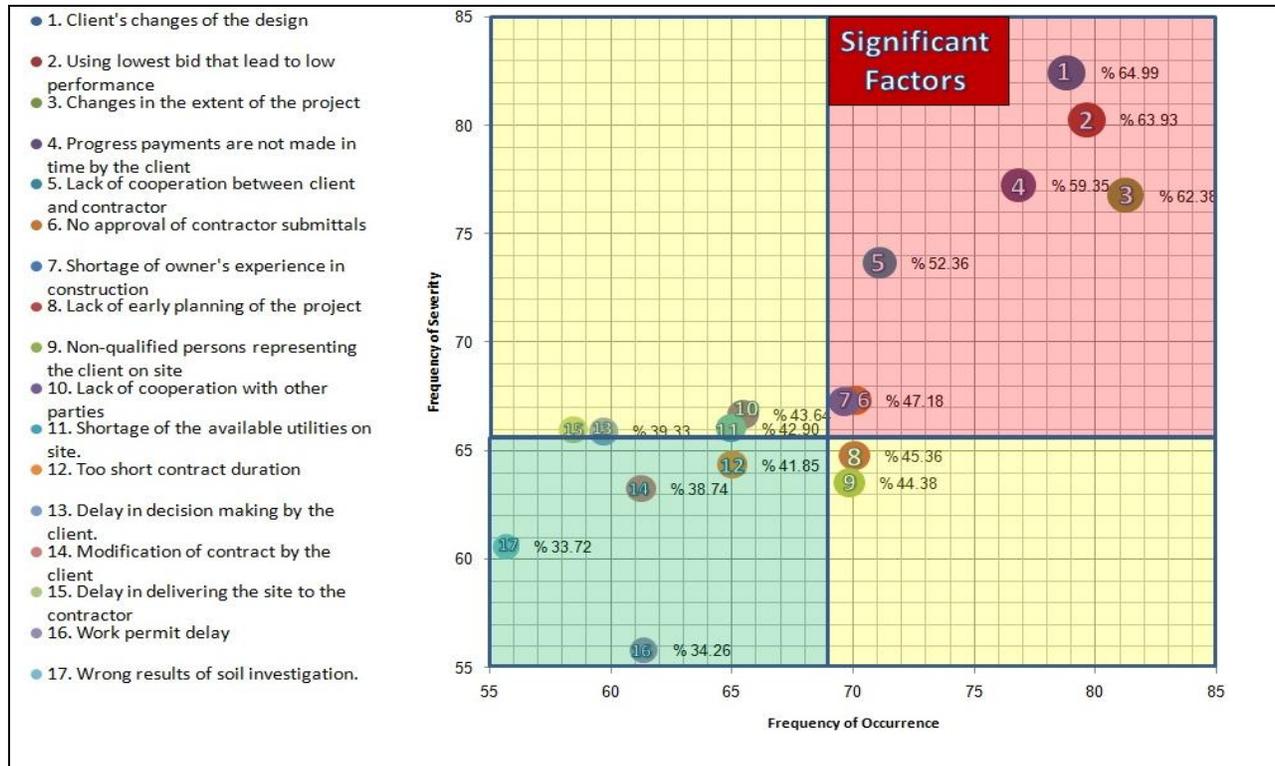


Figure (1) Ranking of significant client-related delay causes factors

CAUSES OF CONTRACTOR RELATED FACTORS

The survey included 20 factors. The average Importance Index of these factors is 47.40. Figure (2) shows the Frequency, Severity and Importance indices for all the factors within this group. The significant delay factors related to contractor are those with I.I greater than the average.

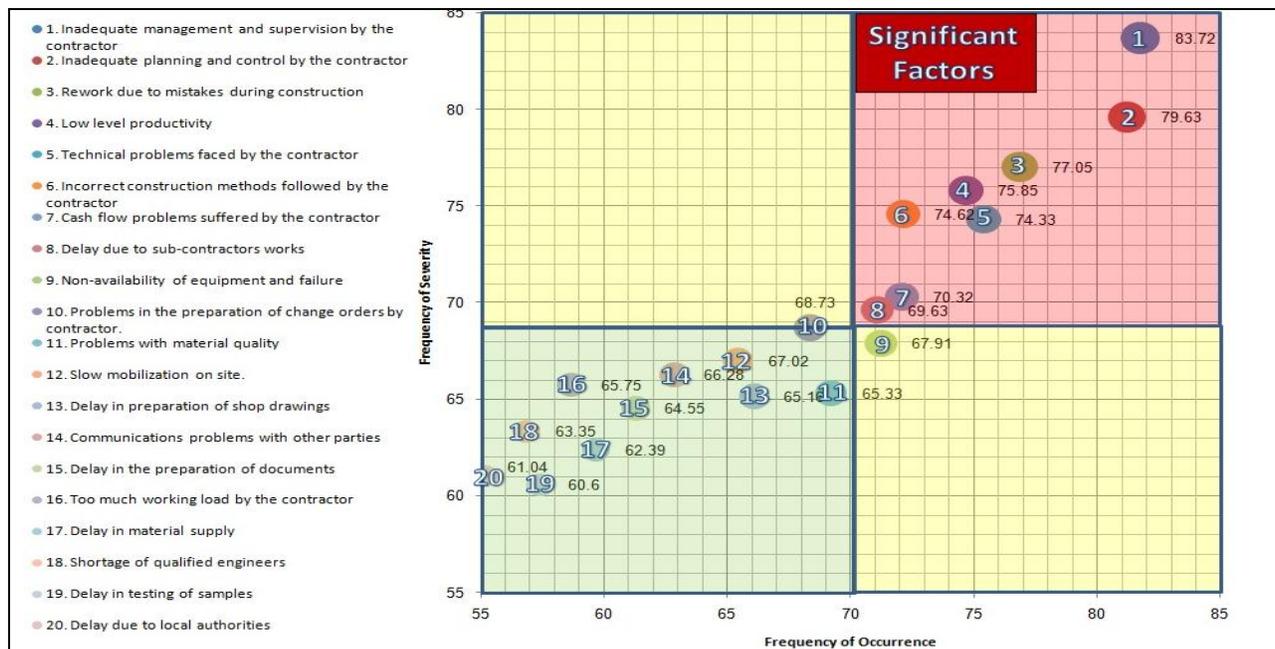


Figure (2) Ranking of significant contractor-related delay causes factors

CAUSES OF CONSULTANT RELATED FACTORS

The survey included 11 delay factors related to this group. It can be noticed from figure (3) that shows the Frequency, Severity and Importance indices for all the factors within this group. The significant delay factors related to contractor are those with I.I greater than the average (44.13).

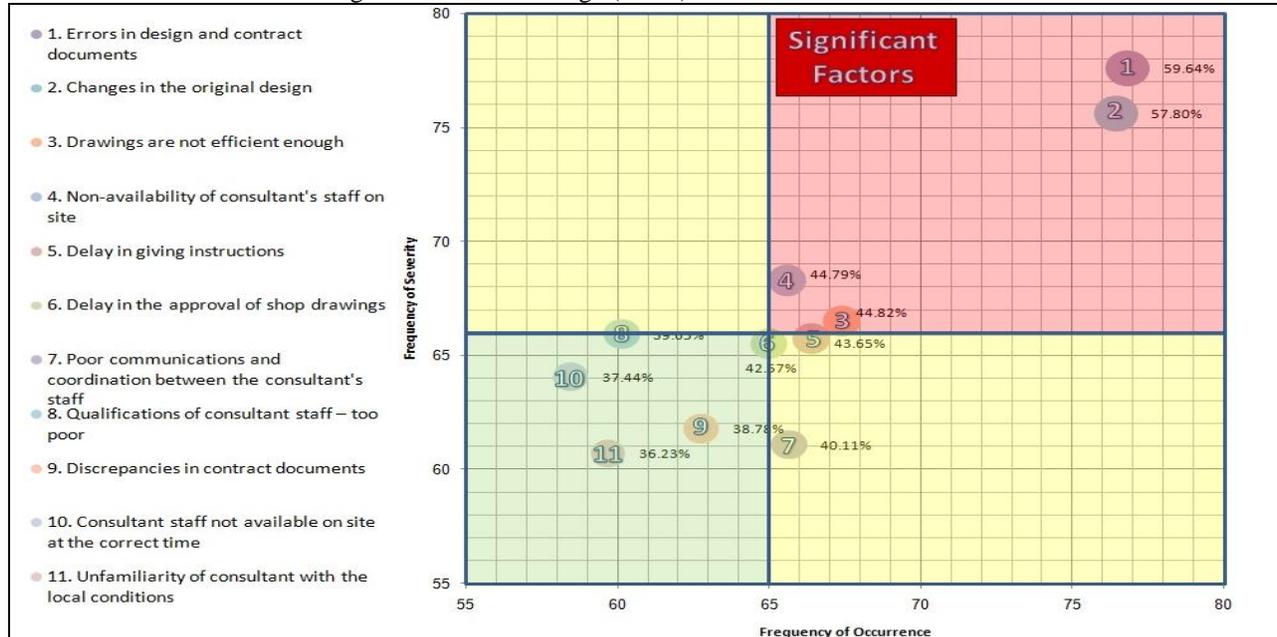


Figure (3) Ranking of significant consultant-related delay causes factors

CAUSES OF DELAYS DUE TO EXTERNAL FACTORS

The average delay factor of this group is 38.65. Number of factors which have significant effect is four out of seven factors included in this group. Figure (4) shows the Frequency, Severity and Importance indices for all the factors within this group. The significant delay factors related to contractor are those with I.I greater than the average.

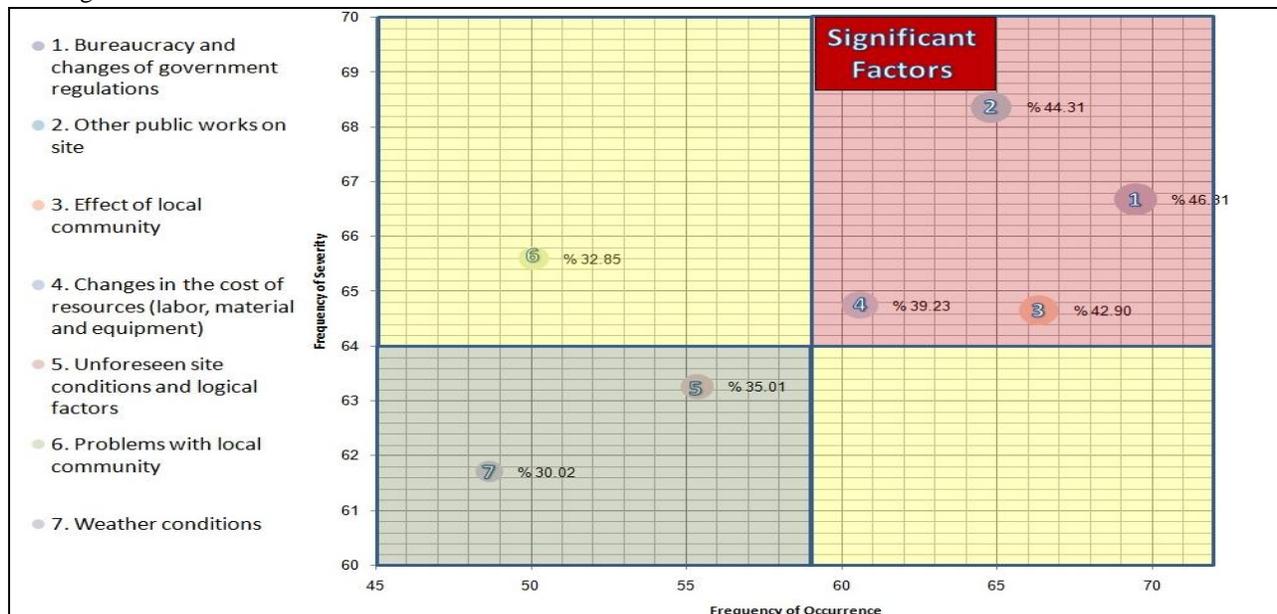


Figure (4) Ranking of significant delay causes factors due to external factors

RANKING OF THE MOST SIGNIFICANT FACTORS

Table (1) presents ranking of the 22 significant factors based on the results of the survey brought in tables 1, 2, 3 and 4. It can be noticed that among the top 10 factors causing delays on construction sites in Jordan, 8 out of the ten are related to client and contractor (four for each). Only two factors among the top 10 are related to consultant (the 6th and the 9th). The top 10 factors are: (1) inadequate management and supervision by the contractor, (2) client's changes of the design, (3) inadequate planning and control by the contractor, (4) using lowest bid that lead to low performance, (5) Changes in the extent of the project, (6) errors in design and contract documents, (7) progress payments are not made in time by the client, (8) Rework due to mistakes during construction, (9) changes in the original design and (10) Low level productivity.

Table (1) Ranking of most significant factors of delay

Cause of Delay	Rank	Importance Index	Group
Inadequate management and supervision by the contractor	1	68.45	Contractor
Client's changes of the design	2	64.99	Client
Inadequate planning and control by the contractor	3	64.67	Contractor
Using lowest bid that lead to low performance	4	63.93	Client
Changes in the extent of the project	5	62.38	Client
Errors in design and contract documents	6	59.63	Consultant
Progress payments are not made in time by the client	7	59.35	Client
Rework due to mistakes during construction	8	59.21	Contractor
Changes in the original design	9	57.80	Consultant
Low level productivity	10	56.63	Contractor
Technical problems faced by the contractor	11	56.04	Contractor
Incorrect construction methods followed by the contractor	12	53.81	Contractor
Lack of cooperation between client and contractor	13	52.36	Client
Cash flow problems suffered by the contractor	14	50.68	Contractor
Delay due to sub-contractors works	15	49.48	Contractor
No approval of contractor submittals	16	47.18	Client
Bureaucracy and changes of government regulations	17	46.31	External
Drawings are not efficient enough	18	44.82	Consultant
Non-availability of consultant's staff on site	19	44.79	Consultant
Other public works on site	20	44.30	External
Effect of local community	21	42.89	External
Changes in the cost of resources (labor, material and equipment)	22	39.22	External

EFFECT OF DELAY ON PROJECT DELIVERY

Table (2) below shows the frequency of occurrence of the effects of construction delays on project delivery revealed by the field study.

Table (2) Effect of delay on project delivery

Cause of delay	Rank	Frequency of occurrence
Time overrun	1	94.62
Cost overrun	2	88.50
Disputes	3	73.37
Arbitration	4	64.33
Total abandonment	5	58.21
Litigation	6	55.67

RELIABILITY OF FACTOR ANALYSIS

To examine the reliability of the factors, Cronbach's alpha ($C\alpha$) test was carried out on each group of factors to view if they were integrated. The values of Cronbach's alpha should have a range between 0 and 1. The lower values represent lower internal consistency and larger values represent greater internal consistency. The criteria introduced by [25] for the interpretation of this coefficient was considered to evaluate the results of the analysis. $C\alpha > 0.8$, 'Excellent'; $0.8 > C\alpha > 0.7$ 'Good'; $0.7 > C\alpha > 0.5$ 'Satisfactory' and $C\alpha < 0.5$ 'Poor'. Table(3) shows that the results of Cronbach alpha for all the groups.

Table (3) Reliability analysis

factors	Cronbach alpha	Result
Client related	0.751	Good
Contractor related	0.687	Satisfactory
Consultant related	0.852	Excellent
Effect of external factors	0.696	Satisfactory
All factors	0.776	Good

CORRELATION ANALYSIS

Correlation analysis is a good way to evaluate the relationship between variables that have interval data. The correlation analysis was carried out to evaluate the empirical relationship between the categories of causes and effects. Table (4) presents the results of the analysis.

Table (4) Correlation between items and effects of delays

Effects	Causes of delay			
	client	contractor	consultant	External
Time overrun	0.564	0.457	0.682	0.778
Cost overrun	0.224	0.548	0.604	- 0.109
Disputes	0.408	- 0.184	0.587	0.144
Arbitration	0.689	0.788	0.479	0.784
Total abandonment	0.384	0.483	0.487	0.847
Litigation	0.759	0.207	0.507	0.754

VIII. Conclusions

The aims of the study were to recognize the major causes of delay that influence the performance of public works in Jordan. A comprehensive literature review was carried out to identify the causes of delay specified in the literature. The literature review and the pilot study revealed 55 delay causes distributed over four categories.

The questionnaire sets were distributed to the three main parties involve in the construction process. Number of participants responded to the survey were 50 clients, 52 contractors and 44 consultants.

The paper presented the most significant factors causing the delay to the four groups. This is bases on the importance indices for the delay factors. Number of factors that showed significant effect on the performance of the projects is: six factors are related to client's group, eight factors are related to contractor's group, four factors are related to consultant' group and four factors are due to external factors.

Total of 22 out of 55 delay factors showed that they are of significant effect. Ranking of these factors was made according to the Importance Indices in the four groups.

Top ten factors causing delays for public sector projects in Jordan are: (1) inadequate management and supervision by the contractor, (2) client's changes of the design, (3) inadequate planning and control by the contractor, (4) using lowest bid that lead to low performance, (5) changes in the extent of the project, (6) errors in design and contract documents, (7) progress payments are not made in time by the client, (8) Rework due to mistakes during construction, (9) Changes in the original design and (10) Low level productivity.

The research revealed that the delay of projects will cause time overrun, cost overrun, disputes, arbitration, litigation and total abandonment. These results are based on frequency of occurrence.

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