



RESEARCH ARTICLE

Evaluation of Construction Delay of Public Projects in Erbil Governorate

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ABSTRACT

Delay is one of the greatest challenges facing the implementation of construction projects. The completion project time is considered one of the measure indicators for assessing the success of any project. Delays usually have negative impacts of financial and social to all parties involved in the projects. The aim of the study is to find the most important causes of delay by evaluating the common causes of delays in terms of frequency, severity, and important indices in implementation of public construction projects in Erbil Governorate related to owners, contractors, consultants, and external factors. The data gathered through conducting a questionnaire for perception various parties involved in implementation of public construction projects. For these purpose, 104 forms of questionnaire were distributed to various parts to identify the delay causes in accordance with their opinions. It was concluded that the most significant factors causing the delay in construction of public project in Erbil Governorate related to the owner were "variation orders by owner during the construction" which came in the first rank, while the cause of delay related to the consultant that came in the first rank was "unclear and inadequate details in drawings," whereas the factor related to the contractor which came in the first rank was "selecting incompetent contractor."

Keywords: Construction projects, delay, Erbil governorate, evaluation, public project

INTRODUCTION

The construction industry is one of the main sectors that provide important ingredients for the development of an economy. The construction is the tool through which a society achieves its goals of urban and rural development. However, it is becoming more complex due to the sophistication of construction process itself and the large number of parties involved in the construction process, i.e., clients, users, designers, regulators, contractors, suppliers, subcontractors, and consultants. Modern construction projects were characterized by new standards, advanced technologies, multiparty participation, and frequent owner-desired changes. Coupled with a state, there are inherent uncertainties and complexities in the physical, financial, and economic environment in which most projects are performed. Such conditions have made completing projects on schedule and on budget a difficult task to accomplish, often leading to claims on cost compensation and time extensions.^[1]

Construction time often serves as a benchmark for assessing the performance of a project and the efficiency of the project organization. The time required to complete construction of projects is often more than the specified time in contract. These "overruns" or time extensions happen due to many reasons, such as designer changes or errors, economic conditions, resource availability, and performance of projects. Usually, majority of project delay occurs during construction phase, where unforeseen factors (environmental concerns

and restrictions, ground conditions, etc.) are always involved. Construction delays lead to increase in overall project cost, hence for the completing projects on time is beneficial to all parties involved in projects. Therefore, it is essential to identify the actual causes of delay to minimize and avoid the delays and their corresponding expenses.^[2] Project success can be defined as meeting goals and objectives as prescribed in the project plan. A successful project means that the project has accomplished its technical performance, maintained its schedule, and remained within budgetary costs.^[3]

RESEARCH OBJECTIVES

The aim of this study is to determine the most effective factors affecting the delay in public construction projects in Erbil Governorate projects. The main objectives of the study are as follows:

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Received: Sep 23, 2018

Accepted: Nov 06, 2018

Published: May 13, 2019

DOI: 10.24086/cuesj.v3n1y2019.pp18-26

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1. Identifying the main causes of delay in construction projects.
2. Evaluating the top 10 significant causes of delay in construction projects.
3. Identifying the means of minimizing delay in public construction projects.

CASE STUDY

The research focuses on construction industry of Kurdistan Region in Erbil Governorate. The surveyed construction projects include public projects of nearly most of public sectors such as local administration, municipality, road works, irrigation works, water supply, sanitary, high education, health, and religion affairs (Awqaf). The specified projects comprise schools, residential and non-residential offices, and hospitals. This study will focus on projects where the main client is the government (public construction projects).

LITERATURE REVIEW

Types of Delay

Delay in construction projects can be classified in various ways related to the parties involved in causing the delay as follows.

Excusable delay with compensation

This type of delay is caused by the clients' actions or inactions. Once contractors encounter this sort of delay, they are entitled to time extension moreover as financial compensation as a result of the delays. An example of this would be the late release of drawings from the clients' architect.^[4]

Excusable delay without compensation

This type is caused by third parties or incidents beyond the control of the client and the contractor. Examples typically include acts of God, unusual weather, strikes, fires, and acts of government in its sovereign capacity.^[5] In this case, the contractor is normally entitled to a time extension but no compensation for delay damages.

Non-excusable delay

Caused solely by the contractor or his suppliers, the contractor is generally not entitled to relief and must either make up the lost time through acceleration or compensate the owner.^[4]

Many studies and researches conducted on the subject of delay in the completion time of construction projects; therefore, this part of literature review classified the studies carried out locally, regionally, and neighbor countries as follows:

Local Studies

Ewadh *et al.*^[6] studied the most effective causes of delays in execution and delivering of construction projects in specified time in Karbala Governorate. Within 78 probable causes of delay, the most occurrence causes were delay in testing materials, awarding contracts to the lowest cost bidder, contractor's financial difficulties, sudden rise in prices of materials, and incorrect of estimation of contract duration.

Muhammad^[7] studied the causes of delay from the point of view of owners, engineers, and contractors. There are many causes of delay in construction projects in Erbil Governorate

including Inadequate contractor experience, waiting time for approval of tests and inspection, poor estimate of project duration by the contractor, poor technical staff qualification, financial difficulties of contractor, problems with subcontractors, unclear and inadequate details in drawings, slow payment of completed works, poor site management, and poor communication and coordination by the contractor with others.

Jahager^[8] studied the causes of construction delay in Baghdad city. He specified the most important causes of delay in construction project through a field survey of a questionnaire contained 58 causes of delay according to group of owners, contractors, and consultants. The study showed that the most important cause of delay is mistakes and discrepancies in design documents, ineffective planning and scheduling of project by contractor, poor site management and supervision by contractor, poor qualification of the contractor's technical staff, unclear and inadequate details in drawings, inadequate design-team experience, insufficient data collection and survey before design, difficulties in financing project by contractor, obsolete or unsuitable construction methods, and unqualified workforce.

Bekr^[9] studied the most important causes of delay in public projects in Iraq through an intensive literature review and a survey which included a questionnaire used to assess the perceptions of the main participants involved in the construction of the projects. The 65 causes compiled through the literature review and the pilot study were classified into four groups: Client related, contractor related, consultant related, and external factors. He concluded that the most effective delay factors affecting the time overrun in the public projects in Iraq were security measures, government change of regulations and bureaucracy, official and non-official holidays, low performance of lowest bidder contractors in government tendering system, design and changes by owner, design changes by consultants, delay in progress payments by the owner, problems with local community, owner's lack of experience in construction, and economic local and global conditions.

Regional Studies

Several studies in neighbor countries and abroad have been reviewed. In Jordan, Sweis *et al.*^[10] evaluated the most common causes of delays in projects using a survey distributed to consultant engineers, contractors, and owners, and interviews with senior professionals in the field. Most correspondents agreed that financial difficulties faced by the contractor and too many change orders by the owner are the leading causes of construction delay. Severe weather conditions and changes in government regulations and laws ranked among the least important causes.

Samarah and Bekr^[11] studied the effects of delay on project's performance. The study 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 covered (146) participants representing clients, contractors, and consultants. The study presented ranking of the significant factors for each group and then the significant factors of the whole survey. Top ten factors causing delays for public sector projects in Jordan were (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.

A research survey on time performance of different types of construction projects in Saudi Arabia was conducted to determine the causes of delay and their importance according to each of the project participants, i.e., the owner, consultant, and contractor. 73 causes of delay were identified during this research. 76% of the contractors and 56% of the consultants indicated that average of time overrun is between 10% and 30% of the original duration. The most common cause of delay identified by all the three parties is the “change order.” Furthermore, the study concluded that 70% of projects experienced time overrun and found that 45 of 76 (about 60%) projects were delayed.^[12]

A study of time delays and cost increases associated with construction of private residential projects in the state of Kuwait was conducted. A survey response of 450 respondents was selected in 27 districts in metropolitan Kuwait showed that time-delays and cost increases are the main causes of delays. The three main causes of time delays included changing orders, owners’ financial constraints, and owners’ lack of experience in the construction industry.^[13]

Causes of delays in construction projects in Turkey were studied by Kazaz *et al.*^[14] by applying a questionnaire to 71 companies working in Turkey. The study showed that, of 34 factors affecting project duration, design and material change was found to be the most important predominant factor, delay of payments, and cash flow problems.

Abd El-Razek *et al.*^[15] studied the causes of delay in building construction projects in Egypt. The study revealed that the most important causes were financing by contractor during construction, delays in contractor’s payment by owner, design changes by owner or his agent during construction, partial payments during construction, and non-utilization of professional construction/contractual management.

Khoshgoftar *et al.*^[16] studied the causes of delay in Iranian projects. The study showed that the main causes of delay are financial and payments of completed works, improper planning, site management, contract management, and lack of communication between parties.

RESEARCH METHODOLOGY

The data collection for the purpose of this study was conducted by the preparation of questionnaire including a list of 37

proposed causes of delay in construction projects. A hand-delivered questionnaire method was used to obtain the opinion of respondents. A questionnaire was divided into three main parts. The first part was a clarification of the idea and the purpose of the survey as well as the definition of the interested area of the study. In the second part, the profile of the respondent was requested such as graduate year, number of years working in construction industry, number of projects supervised and/or executed, and the role kinds (site engineer, project manager, or any other duties) during working in construction. The third part concerned the delay causes in construction project in the form of clear statement. Delay factors are classified into four categories relating to main participants: Owner, consultants, contractors, and other externals. For each factor, two measures were used, frequency and severity. For each measure, the respondents have four options in the form of digits ranking from 1 to 4 as shown in Table 1.

The questionnaires submitted to respondents working in public project in Erbil Governorate who directly participated in construction of projects consisting of project managers, site engineer, and supervisors.

DATA ANALYSIS

The author used various factors related to project delay. The data was analyzed by using frequency and severity indices.

Frequency Index

The following equation was applied to analyze the causes of delay based on frequency occurrence identified by respondents.

$$\text{Frequency index (\%)} = \left[\frac{\sum f_i x_i}{4 \sum x_i} \right] \times 100 \tag{1}$$

Where,

x_i is constant expressing weight (scale) given to i^{th} response: 1, 2, 3, 4

f_i is variable expressing frequency of i^{th} response

i is response category index of 1, 2, 3, 4.

Severity Index

The following equation was used to analyze the severity index in the manner of frequency index:

$$\text{Severity index (\%)} = \left[\frac{\sum s_i x_i}{4 \sum x_i} \right] \times 100$$

Where,

s_i is variable expressing severity of i^{th} response.

Table 1: Frequency and severity measurements of delay factors

Delay causes statements	Frequency				Severity			
	1	2	3	4	1	2	3	4
Delay scale x_i	1	2	3	4	1	2	3	4
Scale	Rarely happens	Sometimes happens	Often happens	Always happens	Little	Moderate	Great	Extreme
Factors	f_1	f_2	f_3	f_4	S_1	S_2	S_3	S_4

Important Index

The important index (I.I) of each cause was calculated using the following equation:

RESEARCH FINDINGS AND DISCUSSIONS

General Characteristics of Respondents' Profile

The respondents include experienced engineers executed and supervised the public projects in governorate institution of most services; local administration, works and housing, municipality, roads, irrigations, water supply, sewage, electricity, religions affairs (Awqaf), and health. The respondent's year of experience ranges from 1 year to >25 years as shown in Figure 1. The number of executed and supervised projects by respondents ranging between 1 and >50 projects is illustrated in Figure 2. The percentage

distribution of types of project ranges from 2% to 20% as shown in Figure 3.

Analyzing the Ranks of Delay Causes

Table 2 shows the causes of the delay which are related to owner, consultant, contractor, and external in terms of frequencies, severities.

Frequency Occurrence of Top 10 Delay Causes

The frequency occurrences of top 10 highest delay causes are listed in Table 3, showing that the most causes related to the contractor are "selecting incompetent contractors," "not selecting competent subcontractors," "contractor's financial difficulties," "ineffective planning and scheduling of project by contractor," "the required skilled

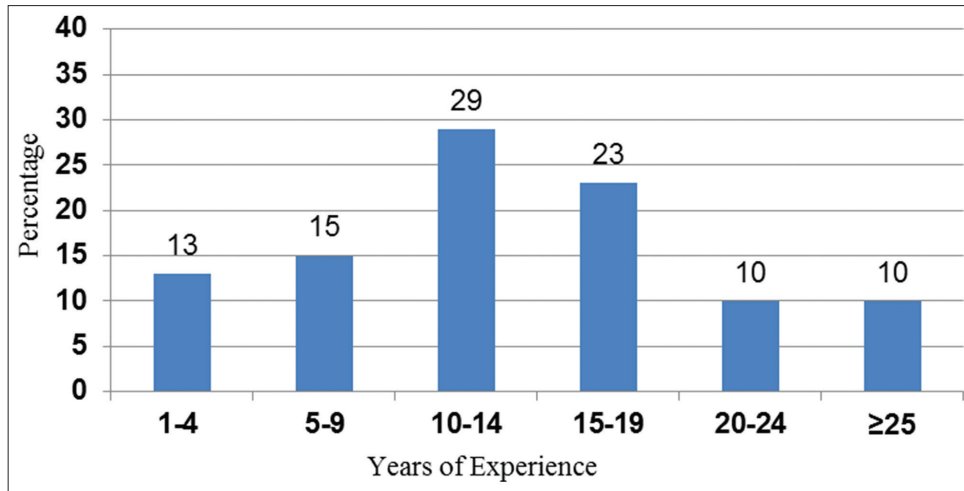


Figure 1: Respondent's year of experience

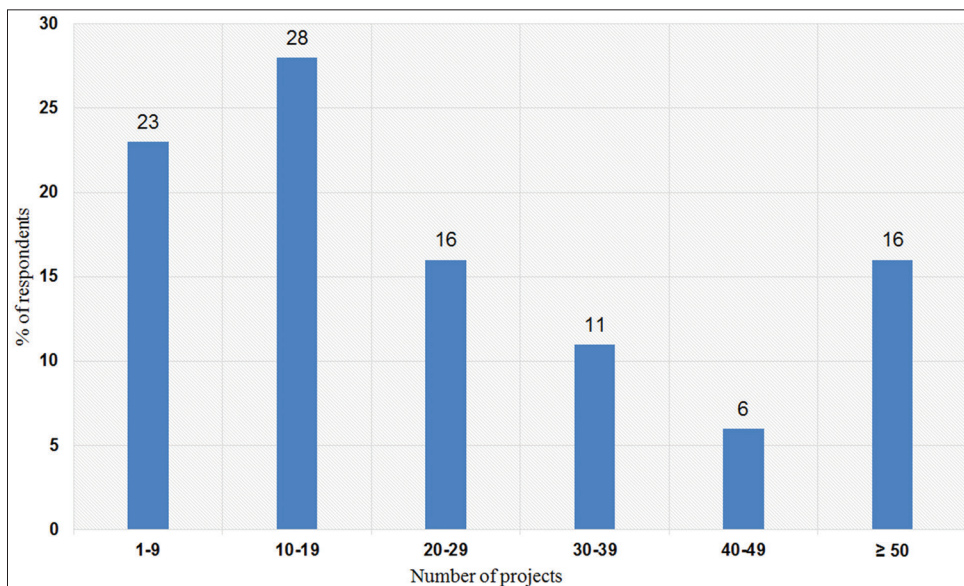


Figure 2: Number of projects executed and supervised by the respondents

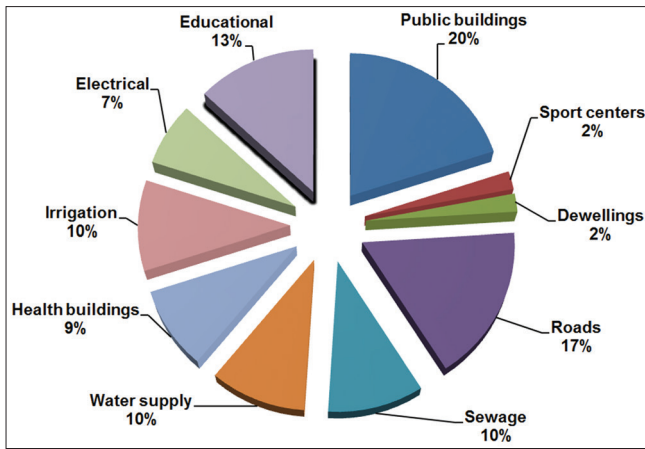


Figure 3: Types of projects executed by the respondents

labor is not available,” “differing site conditions,” and “the required equipment and tools are not available.” The highest causes related to the owner are “variation orders by owner during construction,” and “delays in contractor’s payment by owner.” The “weather conditions” also listed within the highest 10 delay causes related to the external conditions.

Severity occurrence of top 10 delay causes

The most severe causes of delay are due to contractor relating to his experience and capacity, subcontractors, and financial difficulties, while the causes related to owner are only variation order and delaying payments. Only weather conditions are related to external conditions. The overall causes sorting from high to lower severity are “selecting incompetent contractors,” “variation order(s) by owner during construction,” contractor’s

Table 2: The important index and ranking of delay causes

Delay causes statements	Frequency of occurrence		Severity of occurrence		Importance index	
	Index	Rank	Index	Rank	Index	Rank
Causes related to the owner						
Variation order (s) by owner during construction	71.53	2	62.85	2	44.95	4
Late in revising and approving design documents	53.13	15	52.11	19	27.68	17
Delay in approving shop drawing and sample materials	55.56	11	52.78	17	29.32	12
Poor communication and coordination	45.14	26	45.71	30	20.63	27
Slowness in decision-making process	53.29	14	53.96	13	28.76	15
Conflicts between joint-ownership of the project	44.01	27	46.83	27	20.61	28
Delays in contractor’s payment by owner	64.2	7	62.67	7	40.26	7
Design changes by owner or his agent during construction	51.07	20	53.99	14	27.57	18
Partial payment during construction	47.83	23	43.75	31	20.92	26
Owner interference	51.39	19	48.26	24	24.80	21
Quality assurance – control	55.00	13	52.86	16	29.07	13
Bureaucracy	43.01	30	46.07	29	19.82	30
Causes related to the consultant						
Change in design by engineer or consultant	52.90	16	51.09	21	27.02	19
Conflict between contract documents	39.55	35	39.34	36	15.56	36
Inflexibility (rigidity) of consultant	42.25	32	43.08	33	18.20	32
Poor communication and coordination by consultant with other parties	39.39	36	42.80	34	16.86	35
Inadequate experience of designer	43.38	28	48.41	23	21.04	25
Mistakes and discrepancies in design documents	49.15	21	50.00	22	24.58	22
Design complexity	40.30	34	43.56	32	17.55	34
Unclear and inadequate details in drawings	51.49	18	54.23	12	27.92	16
Lack of consultant’s knowledge of available materials and equipment	45.52	25	47.76	25	21.74	24
Causes related to the contractor						
Differing site conditions	56.52	9	54.04	15	30.55	11
Selecting incompetent contractors	73.57	1	71.74	1	52.78	1
Not selecting competent subcontractors	68.28	3	66.67	5	45.52	2

(Contd...)

Table 2: (Continued)

Delay causes statements	Frequency of occurrence		Severity of occurrence		Importance index	
	Index	Rank	Index	Rank	Index	Rank
Poor management of project site	55.36	12	59.00	8	32.66	9
Poor management of project contract	47.43	24	51.45	20	24.40	23
Conflicts in work schedule of the subcontractors	48.91	22	52.61	18	25.73	20
Contractor's financial difficulties	66.79	4	68.12	3	45.49	3
Rework due to errors during construction	51.84	17	56.15	10	29.11	14
Site accidents	43.18	29	46.43	28	20.05	29
The required skilled labor is not available	58.21	8	57.97	9	33.74	8
The required equipment and tools are not available	56.44	10	54.55	11	30.79	10
Ineffective planning and scheduling of project by contractor	64.45	6	64.02	6	41.26	6
Causes related to external conditions						
New government regulations	42.65	31	42.42	35	18.09	33
Strikes	31.25	37	37.86	37	11.83	37
Political influence	40.67	33	47.39	26	19.27	31
Weather conditions	65.94	5	67.75	4	44.68	5

Table 3: Frequency of top 10 highest delay causes

Causes of delay	Frequency (%)	Rank	Source
Selecting incompetents contractors	73.6	1	Contractor
Variation order (s) by owner during construction	71.5	2	Owner
Not selecting competent subcontractors	68.3	3	Contractor
Contractor's financial difficulties	66.8	4	Contractor
Weather conditions	65.9	5	External conditions
Ineffective planning and scheduling of project by contractor	64.5	6	Contractor
Delays in contractor's payment by owner	64.2	7	Owner
The required skilled labors are not available	58.2	8	Contractor
Differing site conditions	56.5	9	Contractor
The required equipment and tools are not available	56.4	10	Contractor

financial difficulties,” “whether condition,” “not selecting competent subcontractors,” “ineffective planning and scheduling of project by contractor,” “delays in contractor's payment by owner,” “poor management of project site,” “the

required skilled labors are not available,” and “rework due to errors during construction” as shown in Table 4.

Important index of top 10 delay causes

The important indices of top 10 delay causes are listed in Table 5. The most causes of delay are related to contractor. The first three high ranked causes included “selecting incompetent contractors” with important index of 52.78% and 45.5% important index for both “not select competent subcontractors” and “contractor's financial difficulties.” The most managers of projects are suffering from incompetent contractors and subcontractors with problem of financial and technical difficulties. The other causes are related to the owner comprising “variation order(s) by owner during construction” and “delays in contractor's payment by owner” which are the most common cause in other neighbor countries with important indices of 45% and 40.3%, respectively. The latter cause is the “weather conditions” related to external condition with important indices of 45%. The last remained causes of delay are related to contractors such as the required labor skill, poor management, and the unavailability of equipment and tools. The most of these causes of delay and their important indices are approximately similar to those mentioned by Bekr, 2015.^[9] and And a study by (Assaf and Al-Hejji, 2006)^[12] as mentioned previously in literature review.

Ranking of Delay Sources

The causes of delay sources as previously mentioned are related owner, contractor, consultant, and external conditions. The ranking of the frequency of occurrence, severity, and importance index is as follows.

Ranking of delay causes related to the owner

The frequency, severity, and importance index of delay related to the owner are listed in Table 6. The highest frequency is

Table 4: Severity occurrence of top 10 delay causes

Causes of delay	Severity (%)	Rank	Source
Selecting incompetents' contractors	71.7	1	Contractor
Variation order (s) by owner during construction	68.2	2	Owner
Contractor's financial difficulties	68.1	3	Contractor
Whether condition	67.8	4	External condition
Not selecting competent subcontractors	66.7	5	Contractor
Ineffective planning and scheduling of project by contractor	64.0	6	Contractor
Delays in contractor's payment by owner	62.7	7	Owner
Poor management of project site	59	8	Contractor
The required skilled labors are not available	58	9	Contractor
Rework due to errors during construction	56.2	10	Contractor

Table 5: The important index of top 10 delay causes

Causes of delay	Important index (%)	Rank	Source
Selecting incompetents contractors	52.78	1	Contractor
Not selecting competent subcontractors	45.5	2	Contractor
Contractor's financial difficulties	45.5	3	Contractor
Variation order (s) by owner during construction	45	4	Owner
Weather conditions	44.7	5	External conditions
Ineffective planning and scheduling of project by contractor	41.3	6	Contractors
Delays in contractor's payment by owner	40.3	7	Owner
The required skilled labors are not available	33.7	8	Contractor
Poor management of project site	32.7	9	Contractor
The required equipment and tools are not available	30.8	10	Contractor

due to "variation orders" and "delay in contractor's payment by owner" at 71.53% and 64.24%, respectively. The following causes are due to "delay in approving shop drawing and sample materials," "quality assurance – control," "slowness in decision-making process," "late in revising and approving design documents," "owner interference," and "design changes by owner or his agent during construction" with frequency ranging between 51.07% and 55.56%. The remaining owner-related causes of delay included "partial payment during

construction," "poor communication and coordination," "conflicts between joint-ownership of the project," and "bureaucracy" ranging between 43.01% and 47.83%. The ranking of importance index of causes of delay is in the order as of their frequency of occurrences. Regarding the important indices of delay cause, the highest two causes are "variation order(s)" and "delays in contractor's payment" with important indices of 44.95% and 40.26%, respectively. The other causes of delay were between 20% and 29.32%.

Ranking of delay causes related to the consultants

The ranking of delay causes related to consultants listed in Table 7 shows that the highest ranked delay cause is "unclear and inadequate details in drawings," "mistakes and discrepancies in design documents," "lack of consultant's knowledge of available materials and equipment," and "inadequate experience of designer" at important indices of 27.92%, 24.58%, 21.74%, and 21.02% respectively. Other causes are less effective at important indices <20% which are "inflexibility (rigidity) of consultant," "design complexity," "conflict between contract documents," and "poor communication and coordination by consultant with other parties."

Ranking of delay causes related to the contractor

The ranking delay causes related to contractor are shown in Table 8, indicating that owner, consultant and external conditions ranked high in causing the delay. Therefore, selecting incompetent contractors (52.78%) have significant effects on delay of projects. The latter group of causes of delay consisting of subcontractors selecting, financial difficulties, and ineffective planning and scheduling have relatively effects on the delay of project with important indices between 40% and 50%. The other group of causes lowers the effects on delay. The important indices ranged between more than 30% to <34% which deals with labor experience, site conditions, and site management having their effects on the delay of project. The last set of causes of delay was less than 30%. They are reworking due to errors in construction, conflicts between subcontractor's scheduling, poor management of contract, and site accidents.

Ranking delay related to external conditions

The only four causes of delay related to external conditions rather than participants' owner, consultant, and contractor are shown in Table 9. The effective cause in this group of delay related to external causes is "weather conditions" which is not excusable as per Iraqi Conditions of Contract of Civil Engineering Works (1987) with importance index of 44.68%.

CONCLUSION

The study focused on identifying and ranking in terms of frequency, severity, and importance of the factors of delay in construction of executed public projects. The study revealed that the top 10 delays from highest to lowest are Selecting incompetents contractors, incompetent subcontractors, contractor's financial difficulties, variation order(s) by owner, weather conditions, ineffective planning and scheduling of project by contractor, delays in contractor's payment, the unavailability of skilled labor, poor management, finally, the unavailability of equipment and tools.

Table 6: Ranking of frequency of delay causes related to the owner

Causes of delay	Frequency of occurrence		Severity of occurrence		Importance Index	
	Index	Rank	Index	Rank	Index	Rank
Variation order (s) by owner during construction	71.53	1	62.85	1	44.95	1
Delays in contractor's payment by owner	64.24	2	62.67	2	40.26	2
Delay in approving shop drawing and sample materials	55.56	3	52.78	6	29.32	3
Quality assurance – control	55	4	52.86	5	29.07	4
Slowness in decision-making process	53.29	5	53.96	4	28.76	5
Late in revising and approving design documents	53.13	6	52.11	7	27.68	6
Owner interference	51.39	7	48.26	8	24.8	8
Design changes by owner or his agent during construction.	51.07	8	53.99	3	27.57	7
Partial payment during construction	47.83	9	43.75	12	20.92	9
Poor communication and coordination	45.14	10	45.71	11	20.63	10
Conflicts between joint-ownership of the project	44.01	11	46.83	9	20.61	11
Bureaucracy	43.01	12	46.07	10	19.82	12

Table 7: Ranking of delay related to the consultant

Causes of delay	Frequency of occurrence		Severity of occurrence		Importance Index	
	Index	Rank	Index	Rank	Index	Rank
Unclear and inadequate details in drawings	51.49	1	54.23	1	27.92	1
Mistakes and discrepancies in design documents	49.15	2	50.00	2	24.58	2
Lack of consultant's knowledge of available materials and equipment	45.52	3	47.76	4	21.74	3
Inadequate experience of designer	43.389	4	48.41	3	21.04	4
Inflexibility (rigidity) of consultant	42.25	5	43.08	6	18.20	5
Design complexity	40.3	6	43.56	5	17.55	6
Conflict between contract documents	39.55	7	39.34	8	15.56	8
Poor communication and co-ordination by consultant with other parties	39.39	8	42.80	7	16.86	7

Table 8: Ranking of delay related to the contractor

Causes of delay	Frequency of occurrence		Severity of occurrence		Importance Index	
	Index	Rank	Index	Rank	Index	Rank
Selecting incompetents contractors	73.57	1	71.74	1	52.78	1
Not selecting competent subcontractors	68.28	2	66.67	3	45.52	2
Contractor's financial difficulties	66.79	3	68.12	2	45.49	3
Ineffective planning and scheduling of project by contractor	64.45	4	64.02	4	41.26	4
The required skilled labors are not available	58.21	5	57.97	6	33.74	5
Differing site conditions	56.52	6	54.04	9	30.55	8
The required equipment and tools are not available	56.44	7	54.55	8	30.79	7
Poor management of project site	55.36	8	59.00	5	32.66	6
Rework due to errors during construction	51.84	9	56.15	7	29.11	9
Conflicts in work schedule of the subcontractors	48.91	10	52.61	10	25.73	10
Poor management of project contract	47.43	11	51.45	11	24.40	11
Site accidents	43.18	12	46.43	12	20.05	12

Of these 10 factors, 7 of them are related to contractor. The only two factors "variation order(s) by owner during construction," and "delays in contractor's payment by owner." The weather conditions are related to external conditions.

The ranking of delay factors related to owner listed from high importance index to lower (44.95–24.8%) is "variation order(s) by owner during construction," "delays in contractor's payment by owner," "delay in approving shop drawing and

Table 9: Ranking of delay related to external conditions

Causes of delay	Frequency of occurrence		Severity of occurrence		Importance Index	
	Index	Rank	Index	Rank	Index	Rank
Weather conditions	65.94	1	67.75	1	44.68	1
New government regulations	42.65	2	42.42	3	18.09	3
Political influence	40.67	3	47.39	2	19.27	2
Strikes	31.25	4	37.86	4	11.83	4

sample materials,” “quality assurance – control,” “slowness in decision-making process,” “late in revising and approving design documents,” “design changes by owner or his agent during construction,” and “owner interference.”

Consultant-related factors based on importance index from high importance index to lower (27.92–21.04%) are “unclear and inadequate details in drawings,” “mistakes and discrepancies in design documents,” “lack of consultant’s knowledge of available materials and equipment,” and “inadequate experience of designer.”

The contractor related factors of delay causes which are the most effective factors from high to lower importance index (52.78–32.66%) are “selecting incompetents contractors,” “not selecting competent subcontractors,” “contractor’s financial difficulties,” “ineffective planning and scheduling of project by contractor,” “the required labor skill are not available,” “differing site conditions,” “the required equipment and tools are not available,” and “poor management of project site.”

The last source of delay related to external conditions was weather conditions 44.68%.

For avoiding and minimizing the delays in construction of public projects, it is recommended to impose regulations more strict in selecting contractors and subcontractors, time payments and financial controlling, planning and scheduling and revising them, site management, more accurate initial cost estimate, and frequent progress meetings of various parties involved in construction of public projects.

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