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Designing Guidelines to Discover Causes of Delays in Construction Projects: The Case of Lebanon

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Abstract

Construction projects in developing countries have the priority among other projects as they are considered safe investments in an unpredictable market. Due to this prioritization, it has become increasingly important that such projects are managed in accordance with internationally accepted management best practice. Project managers of construction projects in developing countries face difficulties in effectively monitoring the progress of projects they are responsible for due to many variables. The purpose of this study is to investigate the causes of delays in the construction projects that were covered in the considered literature and conduct qualitative research to investigate their relevance by interviewing project managers of actual projects in Lebanon. Based on the literature review and from the recommendations recorded during interviews, the researcher aims to create a set of guidelines that will improve the manner in which project managers can adapt to, discover and deal with project delays. These guidelines can be utilized as an early warning system concerning delays in construction projects.

Keywords: contractors, consultants, clients, delay factor categories, delay factors, project management, Lebanon

1. Introduction

Project management is considered to be a critical step in the success of any project (Abbasi et al., 2015; Masa'deh et al., 2015a, b; Orozco et al., 2015; Tarhini et al., 2015a, b) and especially in civil engineering. This is because civil engineering projects are different from each other, since each one is designed for a different purpose and for a unique structure (Hamzah et al., 2011). This is clear in relation to manufacturing facilities construction projects, where each factory has its own design that suits the objectives of the facility (Sweis, Abu Hammad, & Shboul, 2008).

In construction projects, delay could be defined as the time overrun beyond the date specified in a contract that the parties have agreed upon to deliver the project (Kazaz, Ulubeyli, & Tuncbilekli, 2012). The construction process is subjected to many unpredictable factors from many sources, thus completing projects on time is an indicator of efficiency (Assaf & Al-Hejji, 2006). However, it rarely happens that a project is completed within the specified time leading such projects to exceed initial cost estimates. Keeping construction projects within estimated cost and prescribed schedules depends on a methodology that requires engineering judgment (Sambasivan & Soon, 2007). Consolidating useful knowledge and lessons from recent projects is beneficial. Therefore, identifying significant root causes of delays and developing suitable management methods (e.g. prevention measures) are essential to effectively ensure successful project outcomes. Failure to achieve targeted time, budgeted cost and specified quality result in various unexpected negative effects on the projects. Normally, when projects are delayed, they are either extended or accelerated and therefore, incur additional cost. The time and cost of performance of a project are usually of primary importance to the investor and the contractor. Late completions of projects expose them to serious economic and financial risks such as high interest rates and loss of market opportunities (Twort & Rees, 2004). It is obvious that a very simple unforeseen event may result a costly delay to the project. This is because activities are interrelated, combined, and interdependent.

The paper is organized as follows: section 1, introduction; section 2 covers the literature review related to delays in construction projects and their impact on the success of the project and also lists these causes from varying perspectives: section 3 describes the data and methodology; section 4 presents the results of the data analysis;

section 5 discusses the main findings; section 6 presents the main conclusions and outlines future work.

2. Literature Review

In comparison with other industries the construction industry has distinct characteristics. These include one-off projects, site production, and temporary organization (Sweis et al., 2008). The planning and scheduling processes of construction projects are challenging tasks and the decisions taken in the planning stage have a major impact on the success of project execution from its early imaginary stage to the project completion stage by avoiding delays that come along the way and dealing with them in a strict and specific time frame (Sweis et al., 2008).

2.1 Type of Delays

Delay concerns are very common in construction projects. It is unrealistic to believe that all causes of delay are preventable or controllable; some delays are excusable and legitimate while others are not. Many articles and studies conducted on causes of delay in construction projects, both locally and internationally, have been reviewed. Consolidating useful knowledge from related research and lessons from recent projects are beneficial to delay management. Delayed achievement of projects is commonly caused by the reactions or inactions of the project body including the employer, contractor, subcontractors, project designers/ supervisors and other factors. Based on these causes, three major divisions of delays are commonly identified: excusable, non-excusable and compensable delays (Braimah, 2008). The employer is commonly responsible for excusable delays. Those delays are out of the control of employers, for example: unfortunate weather conditions. A compensable delay is one for which the contractor is designated to pay the cause of the delay. It is not the responsibility of the contractor. Whether a delay is excusable or compensable is a matter of the allocation of risk between the contractor and the employer (Chai & Yusof, 2013). Examples include additional work ordering variations and additional work for the contractor. The risk of delays from events over which neither party has control, for example strikes and acts of God, are usually shared. "Excusable non-compensable" delay is a type of delay in which the contractors frequently ask for extension of time but do not recover any additional payment.

"Non-excusable, non-compensable" delay is a type of delay in which its effects are within the control of the contractor, for example shortage of equipment or laborers. Delays are also differentiated between "critical" and "non-critical". Critical delays are those that cause delay to project completion dates while non- critical ones influence the progress, but not the achievement of the project. This contributes to the high importance linked to the use of critical path method (CPM) of scheduling for justifying or contradicting time relevant claims such as postponement of time and prolongation cost (De Marco et al., 2009).

The terms "concurrent delays", "independent delays" and "serial delays" are also used to illustrate delays based on the interrelation of the above delay types with respect to their time of occurrence and duration. On the other hand, serial delays occur consecutively in sequence and do not overlap with each other on an appropriate network line while independent delays are delays that arise in isolation or without other successive or concurrent delays. "Concurrent delays" are type of delays in which two or more delays occur or effects overlap. Chai and Yusof (2013) defined concurrent delays as the position in which two or more delays happen at the same time. Each of the delays must separately influence the critical path. Concurrent delay is also used to refer to the existence of two or more delay activities at distinctive times but when their outcomes are perceived at the same time. Figure 1 allocates the different types of delays based on their different aspects.

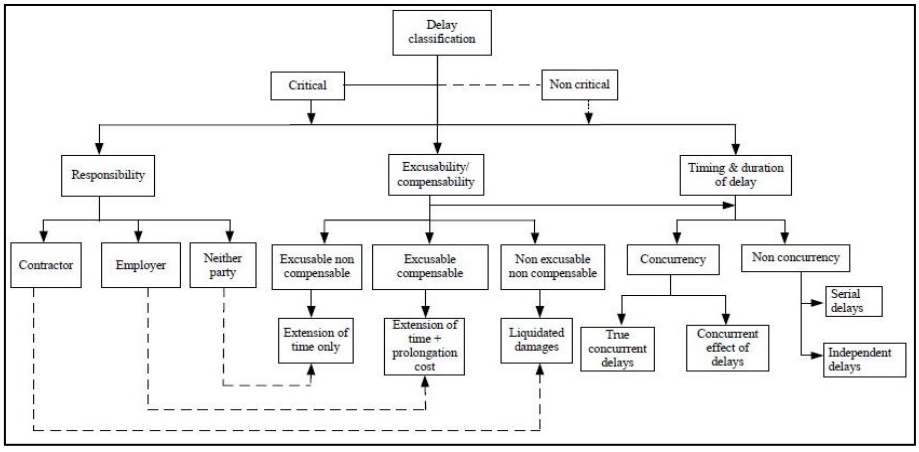

Figure 1. Construction delay and disruption analysis methodologies (Braimah, 2008)

2.2 Overview of Delays in Construction Projects

Most delays might affect the reputation of contractors and thus it's important to determine the significant delay causes so that relevant management efforts can be made to control such affected projects (Alhomadi et al., 2011). Moreover, in many cases the root causes for delays might be common and controllable by effective risk management and knowledge-based planning with specific arrangements.

Assaf and Al-Hejji (2006) outlined 56 main causes of delay in large construction projects. He assembled the delay factors into nine major groups with different levels of importance to different parties. The most important causes of delay conducted in large construction buildings were delays in payments to contractors, design changes, delay for approval for the shop drawings, conflicts in work schedules of subcontractors, slow decision making, inadequate labor skills. Al-Shahrani (2009) classified and identified sixty causes in public water and sewage projects delays. He concluded the following: delays occur frequently in medium and large size projects, and are considered severe in small projects.

Chan and Kumaraswamy (1997) evaluated 83 potential delay factors in Hong Kong construction projects and found five principal factors: client-initiated variations, unforeseen site conditions, slow decision making, poor risk management and supervision, and work variations. Kikwasi (2013) found out influencing factors on 31 high-rise projects in Tanzania. The major factors influencing cost overrun are material cost increase due to inflation, inaccurate material estimation and degree of complexity. While in time overrun, the most important factors causing delays are design changes, poor labor productivity, inadequate planning, and resource shortages.

Abd El-Razek et al. (2008) mentioned that delays can be caused by all parties involved in a project when he investigated the causes of delays in highway construction in Thailand. However the main causes come from inadequacy of sub-contractors, insufficient resources, incomplete and unclear drawings and differences/misunderstandings between consultants and contractors. The study suggested that delay can be minimized by discussions that lead to understanding.

A study by Al-Momani (2000) investigated the causes of delay in 130 public projects in Jordan. The main causes were related to designer, user changes, weather, site conditions, late deliveries, economic conditions and increase in quantity. Al-Barak (1993) discussed the main causes of failure in the construction industry in Saudi Arabia. The prevalent factors were lack of experience, poor estimation practices, poor contract management, shortage of material, improper planning and changes in site conditions.

A study about delays in building projects by Ogunlana et al. (2006) in Thailand concluded that the problems of the construction industry can be stratified in 3 layers, 1) problems caused by clients and consultants, 2) problems caused by incompetence of contractors and 3) problems of inadequacy in industry infrastructure, mainly supply of resources.

From the viewpoint of owners, contractors and architectural/engineering firms the causes of delays in the construction industry in Lebanon (Mezher & Tawil, 1998) were that owners were more concerned with financial issues. While consultants considered project management issues to be the most important of causes of delays, contractors regarded contractual relationships as the most important. The investigations of Faridi and El-Sayegh (2006) in the UAE construction industry revealed specific causes of delays such as: preparation and approval of drawings, inadequate pre-project planning, slowness of the owners decision-making process, shortage of manpower, poor supervision, poor site management, productivity of man power, skill of manpower, non-availability of materials, obtaining permit and/or approvals, municipality/different government authorities and financing by contractors during construction. The discovered delay factors in the literatures are presented in Table 1.

3. Methodology

This research aims to identify the causes of delays in construction projects in order to create a set of guidelines that can be used to monitor construction projects more effectively and time efficiently.

3.1 Research Approach

This project is divided into phases and each one of these stages has two objectives. The detailed explanation of each phase and its objectives are explained in the following sections.

3.1.1 Exploratory Phase

This phase can be considered as the secondary research in this study, in which the first objective in this project, which concerns conducting an advanced research and literature review in order to identify the issues, and delay causes that face construction projects, is completed. This advanced research is based on information from

literature investigating this phenomenon. The literature review aims to analyze previous scientific journal articles covering the topic of delays and their causes in construction engineering. This task uses key words such as:

- Delays in construction in projects;
- Lateness in construction projects.

Subsequently the factors identified in each related paper were recorded in order to be used later during the interviews with construction project managers. The remainder of the literature review considers the solutions for discovering delays in construction projects suggested by the authors of the scientific papers related to the topic. Again, these discovered techniques are investigated during the interviews. The key words for this part of the research are:

- Construction project performance monitoring;
- Monitoring and evaluating the construction projects progress;
- Predicting delays in construction projects.

3.2 Data Collection Phase

In this phase, a mix of case study and qualitative research methods was used to gather the required data about the question in study. Qualitative methods were used to conduct on-site interviews with project managers as it enables the researcher to record their points of view regarding the discovered causes of delays and the available solutions in the literature. Also, it also helped in understanding their own project monitoring in the construction projects as well as eliciting their recommendations regarding how to improve the process, procedures and techniques of monitoring. Among all different types of interviews, including, structured interviews, unstructured interviews and semi-structured interviews (Guion, Diehl, & McDonald, 2011; Myers & Newman, 2007; Alenezi et al., 2015, Tarhini et al., 2015c,d, El-Masri et al., 2015), the latter was used to collect the required data from the interviewees for this study. The length of each interview was about 60 minutes. Each interview was divided into three parts. The first part recorded participants' point of views regarding the importance of the delay factors. The second part measured the effectiveness of the solution suggested by the authors. The last part provided the interviewee with the opportunity to present his\her own observations about how to discover and reduce the causes of delays.

3.3 Data Analysis and Framework Designing Phase

The data analysis starts with coding, in which the researcher determines the data's subject and decides the categories of data and names and labels them. Also, thematic analysis was used to identify patterns and themes in the analyzed data. Moreover, Semiotic study was used to identify the hidden meanings and specific details in the analyzed interviews. Finally, the narrative analysis was done, where the researchers rephrased the interviewees' sentences in an easier way (Liamputtong, 2009).

Interviews contents were recorded in the form of written transcripts. The essential information of the interviews was extracted manually in harmony with content analysis rules where content analysis is a method of analyzing written, verbal or visual communication messages (Cole, 1988). Content analysis is used to analyze qualitative data, which is the method used to conduct this research (Elo & Kyngas, 2008). Texts can be defined broadly as interviews and occurrence of communicative language. To complete the content analysis, the interview text is detailed, into convenient categories with different levels, word, sentence, meaning, phrase or theme and then examined using relational analysis. According to (Gavanagh, 1997), words and phrases that are classified into the same category, share the same meaning. One advantage of the content analysis is that it discovers relations in the texts or transcripts, and as a result discovers the central aspect of social interaction and allows for qualitative operations.

There are two approaches to conducting content analysis, the inductive and deductive approach. The deductive method is the one used during this project, as the structure of analysis was operationalized, based on previous knowledge (Elo & Kyngas, 2008). The previous knowledge mentioned here that is relevant to current research was gained through literature review, mentioned earlier in the exploratory phase. The causes of delays and solutions discovered in the literature and the origins of delay identified from the content analysis of the data collected from the interviews was compared and discussed. This helped in developing the framework or guidelines relevant to the aim of this research.

4. Data Analysis

The interviews were conducted with 9 Project managers and 15 site engineers. The project managers surveyed have an average experience of about 14 years, while site engineers have an average project management

practical experience of approximately 9 years. During the interviews, the researcher asked the participants to provide an estimation of importance for each delay factor. The options were:

- Not important at all;
- Not important;
- Neutral;
- Important;
- Very important.

Table 1 presents the analysis for the data collected from those interviews, as explained previously. The numbers in the last five columns of the table show how many interviewees agreed on the same option from the list above. In this way, the researcher was able to discover the order of importance for each factor.

Table 1. Agreement among participants on the importance of the factors

1st column= Not Important at All 2nd column= Not important 3rd column= Neutral 4th column= Important 5th column= Very Important						
*B1.Client Related Factors (*Odeh & Battaineh, 2002; Sambasivan & Soon, 2007) *Total interviewee=24*						
1	Finance and payments of completed work	0	0	1	5	18
2	Owner interference	0	0	9	9	6
3	Slow decision making	0	0	10	11	3
4	Unrealistic contract duration imposed by owners	0	3	2	10	9
5	Client-initiated variations	0	0	9	13	2
B2. Contractor Related Factors (Odeh & Battaineh, 2002; Assaf & Al-Hejji 2006; Hamzah, Khoiry, Arshad, Tawil & Che Ani, 2011; Doloi, Sawhney, Iyer, & Rentala, 2012; Kazaz, Ulubeyli, & Tuncbilekli, 2012)						
6	Conflicts in sub-contractors schedule in execution of project Contractor	0	0	10	9	5
7	Delays in sub-contractors work	0	3	3	12	6
8	Poor qualification of the contractor technical staff	3	3	9	1	6
9	Site management	0	0	5	10	9
10	Inadequate contractor experience	0	0	8	10	6
11	Lack of contractor's administrative personnel	0	4	11	6	3
12	Shortage of technical professionals in the contractor's organization	0	0	7	14	3
13	Insufficient coordination among the parties by the contractor	0	5	0	13	6
14	Delay to furnish and deliver the site to the contractor by the owner	0	0	9	11	4
15	Delay in mobilization 14 Safety rules and regulations are not followed within the contractor's organization	0	5	4	12	3
16	Incompetent technical staff assigned to the project	0	0	13	5	6
17	Improper technical studies by the contractor during the bidding stage	0	8	4	6	6
18	Poor planning and scheduling of the project by the contractor	2	4	0	10	5
19	Improper handling of the project progress by the contractor	0	0	9	9	6
20	Ineffective quality control by the contractor	0	3	9	8	4
21	Use of unacceptable construction techniques by the contractor	4	2	3	12	3
22	Bureaucracy	0	0	8	11	5
23	Financial difficulties faced by the contractor	0	1	8	12	3

24	Delays in contractor's payments to subcontractors Owner	0	4	5	6	9
25	Delay in contractor's claims settlements	0	4	8	5	7
26	Work suspensions by the owner	0	2	2	9	11
27	Too many change orders from owner	0	0	3	6	15
28	Slow decisions making from owner	0	0	1	17	6
29	Inference by the owner in the construction operations	0	0	0	21	3
30	Financial constraints faced by the owner	0	0	0	16	8
31	Insufficient coordination among the parties by the Owner	0	4	0	17	3
32	Rework due errors during construction	0	0	5	11	8
33	Improper construction methods implemented by contractor	0	4	2	11	7
34	Staffing problems	0	0	10	12	2
35	Change orders	0	0	12	5	7
36	Late project commencement	0	0	10	8	6
B3. Consultant Related Factors (Source: Odeh & Battaineh, 2002; Sweis, Abu Hammad & Shboul, 2008; Hamzah, Khoiry, Arshad, Tawil & Che Ani, 2011)						
37	Contract management	0	0	6	12	6
38	Late revising and approving the design documents by the owner	0	0	4	11	9
39	Quality assurance	0	5	4	12	3
40	Ambiguities and mistakes in specifications and drawings	0	0	7	15	2
41	Delay to furnish and deliver the site to the contractor	0	1	5	15	3
42	Change orders by the owner during the construction	0	0	6	12	6
43	Conflicts between joint-ownership of the project	0	0	9	9	6
44	Unavailability of incentives for contractor for finishing ahead of schedule	0	8	4	9	3
45	Suspension of work	0	1	11	6	6
46	Late in reviewing and approving design documents by consultant	0	0	5	10	9
47	Conflicts between consultant and design engineer	0	0	1	20	3
48	Inadequate experience of the consultant	0	0	6	9	9
49	Financial problems (delayed payments, financial difficulties, economic problems)	0	0	6	15	3
50	Contract modifications (replace and add new works to the project, change in specifications)	0	0	3	9	12
51	Lack of coordination with contractor	0	0	3	15	6
52	Lack of working knowledge	3	0	9	12	0
53	Supervision too late and slowness in making decisions	0	0	8	10	6
54	Slow to give instructions	0	0	13	8	3
55	Lack of consultant's experience	0	2	10	9	3
56	Incomplete documents	0	0	3	17	4
57	Lack of consultant's site staff experience (managerial and supervisory personnel)	0	1	8	12	3
58	Absence of consultant's site staff	0	0	14	7	3
59	Poor qualifications of consultant engineer's staff assigned to the project	0	4	0	20	0
60	Delay in the approval of contractor submissions by the engineer	0	0	10	11	3
61	Poor communication and coordination between parties	0	0	3	15	6
62	Slow responses by the consultant engineer regarding testing and inspection	0	0	8	15	1
63	Slow responses by the consultant engineer to contractor inquiries	0	0	5	19	0

B4. Material Related Factors (Odeh & Battaineh, 2002; Sweis, Abu Hammad& Shboul, 2008)						
64	Quality of material	0	4	5	4	11
65	Shortage of construction materials in market	0	0	5	7	12
66	Delay in materials delivery	0	4	2	12	6
67	Materials price fluctuations	0	3	8	10	3
68	Modifications in materials specifications	0	0	2	20	2
B5. Labor and Equipment Related Factors (Odeh & Battaineh , 2002; Sweis, Abu Hammad& Shboul, 2008; Hamzah, Khoiry, Arshad, Tawil & Che Ani 2011)						
69	Labour supply	0	0	4	4	16
70	Equipment availability and failure	0	0	1	9	14
71	Shortage of manpower (skilled, semi-skilled, unskilled labour)	0	0	3	10	11
72	Shortage of equipment	0	0	1	11	12
73	Insufficient equipment	0	0	7	5	12
74	Damage of sorted material while they are needed urgently	0	3	9	6	6
75	Delay in manufacturing special building materials	3	2	0	10	8
76	Late procurement of materials	0	3	8	10	3
77	Late in selection of finishing materials due to availability of many types in market	0	3	7	9	5
B6. Contract Related Factors (Odeh & Battaineh, 2002; Kazaz, Ulubeyli, & Tuncbilekli, 2012)						
78	Change orders and mistakes	0	1	2	12	9
79	Discrepancies in contract document	0	0	3	21	0
80	Late drawings and specifications delivery	0	0	2	19	3
81	Wrong data provided by client	0	0	6	9	9
82	Quantity change	0	0	5	13	6
83	Contract documents errors, omissions or inconsistency	0	1	6	11	6
84	Project commencement later than notice to proceed	0	0	13	2	9
85	Late site liberation by client	0	1	6	12	5
86	Slow inspection by client's representative	0	3	6	14	1
87	Major disputes and negotiations	0	0	12	12	0
88	Inappropriate overall organizational structure linking to the project	0	0	8	10	6
89	Lack of communication between the parties	0	0	7	14	3
B8. External Factors (Sambasivan & Soon, 2007; Assaf, & Al-Hejji, 2006; Sambasivan & Soon, 2007; Sweis, Abu Hammad & Shboul, 2008; Hamzah, Khoiry, Arshad, Tawil & Che Ani , 2011; Kazaz, Ulubeyli, & Tuncbilekli, 2012)						
90	Problem with neighbors	0	1	8	12	3
91	Unforeseen site condition	0	2	3	13	6
92	Severe weather conditions on the job site	0	0	6	10	8
93	Government regulations	0	4	5	12	3
94	Difficulties in obtaining work permits	0	0	3	10	11
95	Changes in Government regulations and laws	3	0	3	9	9
96	Labour strike	3	2	4	7	8
97	War, rebellion or insurrection	0	3	6	0	15
98	Resistance by residents	0	3	9	0	12
99	Infectious disease	3	3	5	4	9

100	Equipment breakdowns	0	2	10	9	3
101	Shortage of equipment	0	1	8	12	3
102	Low level of equipment-operator's skill	0	0	3	18	3
103	Low productivity and efficiency of equipment	0	0	3	16	5
104	Lack of high-technology mechanical equipment	0	3	0	12	9
105	Shortage of labours	0	0	4	14	6
106	Unqualified workforce	0	6	4	5	9
107	Nationality of labours	3	3	3	6	9
108	Low productivity level of labours	0	3	4	13	6
109	Personal conflicts among labours	0	4	9	8	3
110	Effects of subsurface conditions (e.g., soil, high water table, etc.)	0	5	7	6	6
111	Delay in obtaining permits from municipality	0	3	5	7	9
112	Hot weather effect on construction activities	0	0	18	3	3
113	Rain effect on construction activities	0	1	11	9	3
114	Unavailability of utilities in site (such as, water, electricity, telephone, etc.)	0	5	0	17	3
115	Effect of social and cultural factors	0	6	8	10	0
116	Traffic control and restriction at job site	0	4	14	0	6
117	Accident during construction	0	8	4	3	9
118	Differing site (ground) conditions	0	3	6	9	6
119	Changes in government regulations and laws	0	6	6	6	6
120	Delay in providing services from utilities (such as water, electricity)	0	0	5	13	6
121	Delay in performing final inspection and certification by a third party	0	3	4	11	6
B9. Owner Related Factors (Sweis, Abu Hammad & Shboul, 2008; Sweis, Abu Hammad & Shboul, 2008; Hamzah, Khoiry, Arshad, Tawil & Che Ani , 2011)						
122	Delay in progress payments by owner	0	1	8	12	3
123	Delay to furnish and deliver the site to the contractor by the owner	0	0	8	10	6
124	Change orders by owner during construction	0	0	9	11	4
125	Late in revising and approving design documents by owner	0	0	9	15	0
126	Delay in approving shop drawings and sample materials	0	0	7	17	0
127	Poor communication and coordination by owner and other parties	0	0	1	11	12
128	Slowness in decision making process by owner	0	0	7	14	3
129	Conflicts between joint-ownership of the project	0	0	3	15	6
130	Unavailability of incentives for contractor for finishing ahead of schedule	0	8	4	9	3
131	Suspension of work by owner	0	4	1	7	12

Again, the same type of questions and analysis was completed to measure the interviewees' consensus on the importance of the solutions explored during the literature review carried out in the previous section. Table 2 shows the results of the analysis for the data collected from those interviews, as explained previously, in which, the numbers in the last five columns of the table show how many interviewees agreed on the same option. In this way, the researcher was able to discover the order of importance for each solution.

Table 2. Results of the collected data

1= Not Effective at All						
2= Not Effective						
3= Neutral						
4= Effective						
5= Very Effective						
1	Fast tracking techniques	0	0	4	8	12
2	Acceleration of subsequent site activities	0	0	1	9	14
3	Contingency allowance	0	0	9	11	4
4	Deterministic methods (earned value and its extensions)	0	0	4	20	0
5	Key Performance Indicators (KPIs)	0	0	6	15	3
6	Geotechnical Instrumentation Monitoring System (GIMS)	0	4	8	12	0
7	Geotechnical Integrator (GINT)	0	5	7	12	0
8	Environmental Management System (EMS)	0	5	10	9	0
9	primavera expedition software	0	4	6	11	3
10	Work Breakdown Structure (WBS)	0	1	11	6	6
11	critical-path method CPM schedule that determines the “nominal schedule”	0	3	6	5	1
12	Obtain the daily weather data for the construction site from the National Climatic Data Centre (NCDC)	0	4	8	12	0

The collected data illustrates the fact that the project managers are not familiar with some solutions and techniques presented by authorities in the field.

Also, a content analysis was undertaken for the content of the of the interviewees’ answers regarding their recommendations on how to improve the process of projects monitoring. Similarly, a content analysis was completed for the main findings related to the advanced solutions discovered in the literature review which the project and site managers were not familiar with, such as:

- Fuzzy fault tree analysis (FTA);
- Project Performance Monitoring System (PPMS);
- Digitalising Construction Monitoring (DCM).

5. Findings and Discussion

5.1 Ranking of the Delay Factor

The five ranking indices were used to rank delay causes from the viewpoints of the engineers (Project managers and site engineers). Table 3 shows the ranking of the delay causes in descending order of frequency. It presents the 20 most important delay factors according to project managers and site engineers. It can be observed that most commonly delays occur due to non-payment for completed work.

Table 3. The 20 most important delay causes

First column= Not Important at All						
2nd column= Not Important						
3rd column= Neutral						
4th column= Important						
5th column= Very Important						
Ranking the delay factors from the highly important to the less important						
Total interviewees=24						
1	Finance and payments of completed work	0	0	1	5	18
2	Equipment availability and failure	0	0	1	9	14
3	Late revising and approving the design documents by the owner	0	0	4	11	9
4	Poor communication and coordination by owner and other parties	0	0	1	11	12
5	Shortage of equipment	0	0	1	11	12
6	Financial constraints faced by the owner	0	0	0	16	8
7	Too many change orders from owner	0	0	3	6	15
8	Slow decisions making from owner	0	0	1	17	6
9	Lack of coordination with contractor	0	0	3	15	6
10	Inference by the owner in the construction operations	0	0	0	21	3
11	Conflicts between consultant and design engineer	0	0	1	20	3
12	Late drawings and specifications delivery	0	0	2	19	3
13	Low level of equipment-operator's skill	0	0	3	18	3
14	Insufficient coordination among the parties by the contractor	0	5	0	13	6
15	Delay in contractor’s claims settlements	0	4	8	5	7
16	Insufficient coordination among the parties by the Owner	0	4	0	17	3
17	Financial problems (delayed payments, financial difficulties, economic problems)	0	0	6	15	3
18	Poor qualifications of consultant engineer’s staff assigned to the project	0	4	0	20	0
19	Slow responses by the consultant engineer to contractor inquiries	0	0	15	9	0
20	Shortage of construction materials in market	0	0	5	7	12

5.2 Ranking of the Techniques to Reduce Delays

Again, based on the information acquired during the interviews, Table 4 lists (in a descending order of effectiveness) the ranking of techniques and solutions aimed at tracking and reducing delays.

Table 4. 3 Most important proposed techniques

1= Not Effective at All						
2= Not Effective						
3= Neutral						
4= Effective						
5= Very Effective						
1	Acceleration of subsequent site activities	0	0	1	10	13
2	Fast tracking techniques	0	0	5	8	11
3	Deterministic methods (earned value and its extensions)	0		4	17	3

5.3 Explanation of the Guidelines

Depending on the previous analyses, on the recommendations given by the interviewees and on the techniques that were discovered in the literature review, the following explains the most important techniques that project managers can use to discover and reduce delays in construction projects. The following techniques can play the role of the guidelines aimed by this study.

5.3.1 Acceleration of Subsequent Site Activities

Acceleration of subsequent site activities is used to decrease or if possible to eliminate time overrun. In cases of delay of an activity on site, subsequent site activities are often accelerated but this frequently fails to compensate for time lost. At the beginning of the acceleration process there usually appears to be advancement. However, due to inadequacy of the project management process at the client's end, the fundamental reasons for delays persist, whereupon any acceleration is frustrated and rendered inefficient. A major source of inefficiency identified as significantly responsible for this is clients' continuous requests for design information and variations.

5.3.2 Fast Tracking Techniques

Shortening time-to-market is one of the most critical factors contributing to the success of businesses in many industries. The increasing desire of project owners and managers to fast-track construction explains the reputation of the coexisting advancement in construction. Fast tracking techniques and phased construction were basically established as part of the Professional Construction Management (PCM) approach to meet the challenges and accelerate the project phases (Huovila et al., 1997). A simple explanation of fast tracking is the action of overlapping sequential tasks or activities in parallel to condense the project schedule (Duncan, 1996). Huovila et al. (1997) stated that fast tracking is a project delivery method built on useful basis without considering a firm theoretical basis. The Fast-Track Manual's broad definition (Rasta, 2013) of fast-tracking is the "reduction of the schedule to the minimum practicable as a principal driving force for one or more stages of the project".

5.3.3 Earned Value Management

Earned Value Management (EVM) technique used to track the Progress and Status of a Project. This technique enables both the owner and contractors to examine detailed schedule and information. It provides for the identifying of early warning signs of performance problems. The essential features of EVM are:

- A quantified project plan;
- A valuation of planned work (PV);
- Pre-defined metrics to quantify the actual accomplishment of work (earned value);
- Earned value (EV) of activities as they are completed are compared to planned cost (Panned value) to determine performance and trends.

5.3.4 Contingency Allowance

A contingency is a predetermined amount or the percentage of a contract held aside for unpredicted changes in the project. A contingency is a helpful risk management tool that insures owners financially for addressing risk within a project. If managed correctly, a contingency can afford sufficient protection to designers, contractors, and owners to complete the project within budget.

The Architect's Handbook of Professional Practice describes contingency allowance as the amount, or percentage, included in the project budget to cover unpredictable changes in the work or terms of work. For example, it is not unusual for a contractor to need to move a wall or an opening or to otherwise modify plans. The construction contingency allows for flexibility, and therefore the owner should not view it as a financial loss but as a tool for completing the project within the set budget.

5.3.5 Additional Techniques Suggested by Interviewees

- The use of trend analysis to forecast delays;
- Initiating effective tracking and control system, like control logs that can be oriented based on the expected delay causes;
- Graphical tracking techniques.

5.3.6 Fuzzy Fault Tree Analysis (FTA)

The fuzzy fault tree analysis (FTA) is a tool which assesses the likelihood of project delay. Managers and

construction planners can employ this tool at early project stages. Since project schedules can be very complex, and the effect of different components on the system as a whole is difficult to evaluate without an analytical tool, the FTA seeks to identify all of the failure methods that can cause a system failure as described by Deshpande (2011). FTA aims at identifying systematically all possible modes of occurrence of project delay. The structure of the fault tree is as follows; undesired event (project delay) is on the top of the fault tree, whereas the links that lead to the undesired event are logically on branches using standard "AND" and "OR" gates. Furthermore, this tool provides diagram that gives the logical and causal relationship among different contributing causes (Al-Humaidi & Hadipriono, 2010).

5.3.7 Project Performance Monitoring System (PPMS)

The aim of Project Performance Monitoring System (PPMS) is to help project managers in exercising construction project control. This system differentiates performance measures such as People, Cost, Time, Quality, Safety and Health, Environment, Client Satisfaction, and Communication (Jin & Li; 2014, Mas'deh et al., 2015b, c). For each of these measures, performance indicators and their measurements are also established. Also, PPMS aims at reducing the time needed for data collection and dissemination of collated data. Organizations' needs can be reflected by adding or reducing performance measures. Another use of PPMS is to facilitate instant graphical presentation of performance data. Therefore, by focusing on these issues, further development might be achieved (Cheung, Suen, & Cheung, 2004).

5.3.8 Digitalising Construction Monitoring (DCM)

DCM prototype system helps integrate the information from construction drawings and digital images of construction sites. For example, this system explains CAD drawings of buildings and extracts structural components data and stores it in a database. Also, DCM prototype system extracts engineering information from digital images. Combining these two databases enables the percentage of progress to be calculated and viewed in Microsoft Project automatically. For monitoring purposes, the application of DCM system enables project management teams to better track and control the productivity and quality of construction projects. This could help resident engineers, construction managers and site engineers to monitor and evaluate project performance, and therefore, improve decision-making processes and provides an improved mechanism for advanced project management. This system could help project managers to develop progress reports of projects with speed, within time and accurate in order to convince clients of successful completion of construction work (Jin & Li, 2014).

6. Summary, Contributions, Recommendations, Limitation and Future Research

6.1 Summary of the Research

Construction projects in developing countries have the priority among other projects as they are considered safe investments in an unpredictable market. Due to this prioritization, it has become increasingly important that such projects are managed in accordance with internationally accepted management best practice. Project managers of construction projects in developing countries face difficulties in effectively monitoring the progress of projects they are responsible for due to many variables.

Construction delay is a critical issue in construction projects. The use of inadequate project controls affects the delivery of projects on time and within budget. The management and control of changes is fundamental to the success of projects. If changes are not recognized and monitored effectively, then the control of the project costs and schedule is affected. Adequate planning; coordination; and proper monitoring of the construction projects by experienced and qualified professionals reduce the impact of delay. The findings of this research are discussed below emphasizing the most important delay causes.

In the construction industry it can be shown that most of the problems are human and managerial. These problems will continue to necessitate the consideration of managers and decision makers in the construction industry for years to come. A rapid solution to these nontechnical problems would minimize delay and cost overruns. It is essential that effective decisions on design specifications, project financing, contractual systems, and methods of construction are all taken at the preliminary stage of the project.

The delay in construction projects is discussed in the field survey. It studied frequency, severity and importance of the causes of delay and the techniques used to reduce those delays. 131 causes of delay were identified through research. The identified causes are combined into nine groups (Client Related Factors, Contractor Related Factors, Consultant Related Factors, Material Related Factors, Labor and Equipment Related Factors, Contract Related Factors, Contract Relationship Related Factors, External Factors, Owner Related Factors). The survey included 3 Project managers and 5 site engineers. Study indicated that finance and payment for completed work is the highest frequent factor of delay, factor considered severe by contractors (related to owners).

Only one cause of delay is common to all parties, which is ‘‘changing orders by owner during construction’’. Many causes are common to two parties, such as: insufficient coordination among the parties; poor site management and supervision by contractor; ineffective planning and scheduling; delay in progress payments; shortage of laborers and difficulties in financing by contractor. All parties agreed that the following causes are the most important: finance and payments for completed work; equipment availability and failure; late revising and approving the design documents by the owner; poor communication and coordination by owner and other parties; shortage of equipment; financial constraints faced by the owner; too many changing orders from owner; lack of coordination with contractor; slow decision making from owner; and interference by the owner in the construction operations. Delays in construction projects can be reduced through the joint efforts of participants in the construction industry. This could reduce the incidence of delays in construction projects. Similarly the effects of these delays are time overrun, cost overrun, disputes, arbitration and litigation. It is therefore recommended that adequate construction budget, timely issuing of information, finalization of design and project management skills should be the main target of the parties in any construction project. It is hoped that the arguments and findings presented in this study contribute good guidance for managerial intervention, and provide some guidelines and information that project managers can utilize to manage their projects. In brief, this study summarized some reasons behind the delay caused in these construction projects and operations and proposes some recommendation, which might facilitate competitiveness for effective project delivery and client satisfaction within the stipulated time schedule.

6.2 Research Contribution

This research provides a set of guidelines and a collection of techniques that could prove effective in discovering causes of delay as early as possible and in reducing their negative impact. Many papers or journal articles have studied the causes of delays that accompany construction projects progress in developing countries; however, very few have studied the solutions that might be used to accomplish the aforementioned aim. This paper provides a comprehensive analysis of the origins of the delays from many scientific articles concerned with this topic as well as the solutions offered by these authorities in the field. In addition, this study investigates project managers in Lebanon’s perspectives regarding how to achieve improved projects’ monitoring. As a result, this work can be considered the most comprehensive study to date in this field.

6.3 Recommendations

The following points can be recommended in order to minimize and control delays in construction projects. These points are grouped according to the concerned stakeholders:

The factors that the owners can consider are:

- Owners should make progressive payments to the contractor on time.
- Owners should minimize changing orders during construction to avoid delays.
- Owners should avoid delay in reviewing and approving of design documents.

The factors that the contractor can consider are:

- Contractors should have competent site-managers to ensure the smooth execution of work
- Contractors should establish an efficient materials management system for a given construction project.
- Contractors should better manage the number of laborers and their productivity.
- Contractors should plan their work efficiently and effectively and provide the entire schedule to the clients.
- Contractors should manage their financial resources and plan cash flow payment.
- Contractors should not take up projects for which they lack expertise.

The factors that the client can consider are:

- Clients should not interfere frequently during the execution and keep making major changes to the requirements.
- Clients should have the finances in time to pay the contractors after completion of work.
- Clients should make quick decisions to solve any problems that arise during the execution.
- Clients should allow sufficient time to prepare project briefs and other feasibility studies.

The factors that the client can consider are:

- Consultants should prepare and approve drawings on time.

- Consultants should monitor the work closely by making inspections at appropriate times.

6.4 Research Limitations and Future Work

This research provides a set of guidelines that can help the managers of construction projects to monitor the progress in the projects more effectively. However, this study has suffered from some limitations that affected its quality. The main restriction was not being able to validate the proposed guidelines or the suggested techniques in a real life construction project. Therefore, it can be further improved by conducting a field research project in a real life context case study to evaluate the findings and the results in this paper. Moreover, similar studies can be performed for specific types of construction projects, such as utility projects, highways construction projects, dam construction projects, etc. Detailed studies can be done to evaluate the involvement and the effect of specific parties or construction project resources on time overrun occurring in such projects.

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