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Identification of Causes of Non-excusable Delays of Construction Projects

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***Abstract*—One of the key characteristics of the projects, especially construction projects, is executing the scope of work in a specific amount of time. As project time overrun may have bad consequences for the project performing organization such as cost overrun, damage of company's reputation, etc. it is important to clarify between causes of excusable delays and causes of non-excusable delays. Major purpose of this paper is to identify non-excusable delays of executive companies of Mapna Group in order to improve time performance of the project by managing better these causes. The scope of the research is the projects including thermal power plant, steam and power and utility projects which are completed or being executed by these affiliated companies. In this paper top 20 causes of non-excusable delay of construction projects have been identified by a Delphi questionnaire survey and applying Mean Rank method. To determine whether there is degree of agreement among the panel of experts with respect to their ranking of the causes of non-excusable construction delays, a test of hypothesis was developed and a significant degree of agreement among the expert was verified. "Not selecting competent subcontractors" was selected as the most important cause of none-excusable construction delays.**

Keywords-non-execuable delay; construction; subcontractor; performing organization

I. INTRODUCTION

Delay is a situation in which a project due to some causes related to the contractor, client, client's consultant or other causes has not been finished in contractual or agreed period. Delays are insidious often resulting in time overrun, cost overrun, disputes, litigation, and complete abandonment of projects [1]. Few projects can be found that the fear of not completing the project on time is not the major concern of the relevant project manager. Hence time performance is one of the key measures of the project success [2] [3] [4] [5]. As some of the causes of the construction delays can be controlled during the life cycle of the project, a significant resource saving can be achieved by identifying and managing better these causes. This research is somehow a little different with other researches as in many of these researches there is no distinction between causes of excusable delays and causes of non-excusable delays. Excusable delays are those not attributable to the contractor's actions or inactions, and typically include unforeseen events. These events are beyond the contractor's control and are without fault or negligence on his/her part. Excusable delays can be further classified into excusable with compensation and excusable without compensation. On the other hand, non-excusable delays are ones that are not accepted by the client and may result some contractual liquidated damage for the performing organization.

According to this brief introduction the research objective can be defined as identification of key causes of non-excusable delays in construction projects. Research scope includes thermal power plant, steam and power, and utility projects which have been completed or being executed by executive companies MD-1, MD-2, and MD-3, performing organizations affiliated to the Mapna Group. In this regard this identification will be done from performing organization point of view.

The paper is organized as follows. First, in literature review, a clarification of construction delays is presented. Then life cycle of projects in the scope of research is posed. Research methodology is explained in the next section followed by research findings. Finally, in conclusion, the paper concludes with a brief summary of findings and proposes some solutions for the top three causes of non-excusable construction delays.

II. LITERATURE REVIEW

Assaf, Al-Khalil, and A-Hazmi [6] summarized main causes of delay in large building construction projects in Saudi Arabia. They identified approval of shop drawings, delays in payment to contractors and the resulting cash problems during construction, design changes, conflicts in work schedules of subcontractors, slow decision making and executive bureaucracy in owner's organizations, design errors, labor shortage and inadequate labor skills as the most important causes of delay. Chan and Kumaraswamy [7] conducted a research on potential delay factors in Hong Kong construction projects as seen by clients, contractor and consultants. Five principal factors are identified: poor risk management and supervision, unforeseen site conditions, slow decision making, client-initiated variations, and work variations. Mezher and Tawil [8] conducted a survey of the causes of delays in the construction industry in Lebanon from the viewpoint of owners, contractors and architectural/engineering firms. It was found that owners had more concerns with regard to financial issues; contractors regarded contractual relationship the most important, while consultants considered project management issues to be the most important causes of delays. A comprehensive classification of causes of construction delays has also been recommended by Abd. Majid and McCaffer [9]. They

classified the factor of causes of non-excusable delays into twelve groups: material-related delays; labor-related delays; equipment-related delays; financial-related delays; improper planning; lack of control; subcontractor-related delays; poor coordination; inadequate supervision; improper construction methods; technical personnel shortages; and poor communication. Odeh and Battaineh [10] studied causes of construction delay in Jordan. Owner interference, inadequate contractor experience, financing and payments, labor productivity, slow decision making, improper planning, and subcontractors are most important factors. Long, Ogunlana, Quang, and Lam [11] studied the problems on large construction projects Vietnam. They grouped the problems in 5 major factors: incompetent designers/contractors; poor estimation and change management; social and technological issues; site related issues; and improper techniques and tools. Ogunlana, Promkuntong, and Jearkjirm [12] studied the delays in building project in Thailand. They concluded that the problems of the construction industry in developing economies can be nested in three layers: problem of shortages or inadequacies in industry infrastructure, specifically supply of resources; problems caused by clients and consultants; and problems caused by incompetence of contractors. Assaf and Al-Hejji [13] do a survey on time performance of different types of construction projects in Saudi Arabia to determine the causes of delay and their importance according to each of the project participants including the owner, consultant and the contractor. The most common cause of delay identified by all the three parties is ‘‘change order’’. The most frequent causes of delay according to contractors include delay in progress payments by owner, suspension of work by owner, late in reviewing and approving design documents by owner, change orders by owner during construction, late procurement of materials, mistakes and discrepancies in design documents, delays in producing design documents, difficulties in financing project by contractor, late in reviewing and approving design documents by consultant, slowness in decision-making process by owner. Al-Ghafly [14] discussed the delay in public water and sewage projects. Important causes identified are financial problems, changes in the design and scope, delay in making decisions and approvals by owner, difficulties in obtaining work permit, and coordination and communication problems. Kaming, Olomolaiye, Holt, and Harris [15] studied influencing factors causing delay on high-rise projects in Indonesia. The most important factors are design changes, poor labor productivity, inadequate planning, and resource shortages. Tumi, Omran, and Pakir [16] conduct a survey aimed for identifying some of the most important causes of delays in construction projects in Libya. Six main causes are improper planning, lack of effective communication, design errors, shortage of supply i.e. steel, concrete, etc, slow decision making and financial issues.

Frimpong, Oluwoye, and Crawford [17] conduct a survey to identify the significant factors contributing to delay and cost overruns in Ghana groundwater construction projects. They are monthly payment difficulties from agencies, poor contractor management, material procurement, poor technical performances, and escalation of material prices. Sambasivan and Soon [1] identified 10 most important causes of delay in construction projects. They are contractor’s improper planning, contractor’s poor site management, inadequate contractor experience, inadequate client’s finance and payments for completed work, problems with subcontractors, shortage in material, labor supply, equipment availability and failure, lack of communication between parties, and mistakes during the construction stage. A similar study in Malaysia by Alaghbari, Kadir, Salim, and Ernawati [18] indicated that clients, contractors and consultants agreed that financial problems were the main factors and coordination problems were the second most important factor causing delay in construction projects in Malaysia. Fugar and Agyakwah-Baah [19] investigate the causes of delay of building construction projects in Ghana to determine the most important according to the key project participants. All major stakeholders agreed that the top ten most important factors causing delay in Ghana are: delay in honoring payment certificates, underestimation of the cost of project, underestimation of complexity of project, difficulty in accessing bank credit, poor supervision, underestimation of time for completion of projects by contractors, shortage of materials, poor professional management, fluctuation of prices/rising cost of materials, and poor site management. Sweis G., Sweis R., Abu Hammad, and Shboul [20] studied the causes of delay in residential projects in Jordan and concluded that financial difficulties faced by the contractor and too many change orders by the owner are the leading causes of construction delay. Abd El-Razek, Bassioni, and Mobarak [21] in a similar study in Egypt found that the most important causes of delay are 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. Ayman [22] investigated the causes of delays on 130 public projects in Jordan. The projects included residential, office and administration buildings, school buildings, medical centers, and communication facilities. The results indicated that the main causes of delay in construction of public projects relate to designers, user changes, weather, site conditions, late deliveries, economic conditions, and increase in quantity.

III. Project Life Cycle

Generally there are three kinds of construction projects which have been investigated in this research: 1) thermal power plant including gas turbine, steam turbine and combined cycle; 2) steam and power plant; and 3) utility of gas refineries (such as water, air, steam and power). Life cycle of these projects has five interrelated phases:

1. Preparation: some key activities in this phase are taking over of project land, site preparation, site mobilization; kick off meeting with the project client, geotechnical studies, etc.
2. Engineering: typically includes basic design and detail design. Most of the efforts in this phase will happen at the early months of the project. Some of engineering activities which will be usually done at the late months of the projects are producing mark up drawings,

producing as built drawings, handing over project manuals, etc.

3. Procurement: there are three main steps for procuring materials and equipment for the project: 1) bidding as per the vendor list approved by the client and contract awarding with the winner, 2) manufacturing or purchasing as per the contract conditions, and finally 3) forwarding the goods and material to the project site.
4. Construction: it includes civil activities such as foundation works, building, road making, etc., installation and precommissioning, and commissioning.
5. Delivery and closing: it consists of delivery of commissioned equipment and system to the client, closing of the subcontractors' contracts, defect clearance, finalizing claim and delay, releasing project guarantees, releasing project resources, and closing of client contract as per the closing conditions.

IV. Research Methodology

A third-round Delphi questionnaire survey was applied as the research method. As the MD-1, MD-2, MD-3 use matrix structure for managing their projects, middle and top matrix managers, some discipline engineers in planning, engineering, and procurement, and project managers of these organizations in addition to some other experts from other affiliated companies of Mapna Group were selected as the statistical population. Based on literature review and organizational experience in executing construction projects, an initial list of 40 causes of non-excusable construction delays was developed. Causes of excusable delays and some of the causes of non-excusable delays in which performing organizations do not have any control over them, were deleted from the list.

The questionnaire was reviewed by 5 experts to establish the validity (do the questionnaire items appear to measure what the instrument purports to measure?). The purpose of a review is to improve the questions, format, and the scales [23]. At the first round it was distributed to the 110 people by email accompany with a cover letter explaining the research objective. It was followed up via telephone and email. The respondents were asked to what extent they agree to the causes of non-excusable construction delays on a five-point Likert scale where 1: totally disagree, 2: partially disagree, 3: indifferent, 4: partially agree and 5: totally agree. In addition they were asked to propose any other causes of non-excusable construction delays which they believe that they are missed, to the end of the list. A total of 47 respondents returned the questionnaires for the first round, giving a response rate of 43%. After the first round, 37 new causes of non-excusable construction delays were suggested by the panel of experts. After revising, combining, and deleting similar causes, a total of 12 causes of non-excusable construction delays were added to the initial list for the second round. The second round questionnaire, with the same Likert scale, was distributed for a portion of the statistical population in which replied in the first round. A total of 20 respondents out of 47 returned the questionnaire for the second round, giving a response rate of 43%. Top 20 causes of non-excusable construction delays having an average score greater than 3, were selected for the third round. The third round questionnaire was distributed for 110 people. In this round the respondents were supposed to represent the degree of significant of each cause of non-excusable construction delays by giving a number between 0 (not important) to 10 (very important). A total of 39 respondents returned the questionnaire for the third round, giving a response rate of 35%.

V. Research Findings

Mean rank method was applied for ranking 20 causes of non-excusable construction delays. Research findings are shown in Table 1.

TABLE I. Ranked Top 20 Causes of Non-excusable construction delays

Rank	Non-excusable causes of construction delay	Mean Rank
1	Not selecting competent subcontractors	15.92
2	Poor management of the project changes	12.96
3	Lack of mechanism for recording, analyzing, and transferring project lessons learned	12.94
4	Delay in forwarding material and equipment to the site	12.21
5	Delay in awarding subcontractors' contracts	12.06
6	Lack of effective managing and controlling subcontractors	11.46
7	Delay in detail design by project engineer subcontractor	11.27
8	Delay in supplying shortage of the equipment	11.14
9	Poor management of project site	10.73
10	Poor management of project contract	10.47
11	Issues on recruiting, attaining, and promoting expert and experienced project team	10.24
12	Lack of effective communication and coordination with project stakeholders specially with the client/client's consultant	10.21
13	Delay in obtaining technical information from subcontractors	9.71
14	Conflicts among performing organization, client and client's consultant	9.41
15	Slow decision making by project manager	9.15
16	Detail design errors by project engineer subcontractor	8.56
17	Delay in basic design by performing organization	8.13
18	Lack of applying contractual tools (liquidated damage or acceleration of work) against subcontractor	8.12
19	Delay in basic design by project engineer subcontractor	7.97
20	Conflicts in work schedules of the subcontractors	7.33

Here by performing organizations we mean MD-1, MD-2, and MD-3 and by subcontractors we mean contractors who have a contract with the performing organizations to do some specific portion of the project.

To determine whether there is degree of agreement among the panel of experts with respect to their ranking of the causes of non-excusable construction delay, Kendall's Coefficient of Concordance was used. The Kendall's Coefficient of Concordance says that the degree of agreement on a zero to one scale is:

$$W = \frac{12U - 3n(n-1)^2m^2}{n(n-1)^2m^2} \quad (1)$$

Where:

$$U = \sum_{j=1}^{n}(\sum_{i=1}^{m} R_{ij})^2 \quad (2)$$

And:

n = Number of causes of non-excusable delays (equals to 20)
m = Number of respondents in third round (equals to 39)
R_{ij} = Significant degree allocated for j^{th} causes of non-excusable delays by i^{th} expert
W = Kendall's coefficient of concordance

The calculated Kendall's Coefficient of concordance for project success criteria W = 0.135. In order to know whether there is disagreement or agreement among the panel of experts on ranking the causes of non-excusable construction delays, a test of hypothesis is needed.

- Null hypothesis: H_0: Disagreement in ranking of causes of non-excusable construction delay among the panel of experts.
- Alternative hypothesis: H_1: Agreement in ranking of causes of non-excusable construction delays among the panel of experts.

Since $n = 20$ is too large for the table of critical values of Kendall's, chi-square approximation of the sampling distribution of W is computed with the following equation:

$$\chi^2 = m(n-1)W \quad (3)$$

Therefore, $\chi^2 = 100.356$ and using a χ^2critical table for $n = 20$ and $\alpha = 0.05$, the $\chi^{2(n-1)}_{0.05} = \chi^{2(19)}_{0.05} = 30.14$. Since computed value $\chi^2$is greater than critical table $\chi^{2(19)}_{0.05}$ null hypothesis H_0 is rejected and alternative hypothesis H_1 is accepted. Therefore, concluded that there is a significant degree of agreement among the panel of experts with respect to how they rank the causes of non-excusable construction delay.

VI. Conclusion and Disscussion

In this paper the key causes of non-excusable construction delays have been identified through a questionnaire survey. By an effective management and control of these causes, the time of non-executable delay of the project can be decreased. Extension of contract duration, if it is due to poor management of the project, regardless of contractual liquidated damage, can increase site indirect cost and reputation damage of the performing organization. As it is shown in the Table 1, 3 out of 5 top causes have roots in procurement process. The most important cause of non-executable delay, at least in the scope of this research, is "not selecting competent subcontractors". We present some recommendations for the top three causes in order to improve time performance of the project.

Not selecting competent subcontractors: As the Mapna Group approach in executing project is to break scope of the client's contract to some subcontracts and manage subcontractors, special attention is paid to procurement process. The kind of these subcontracts is combination of engineering, procurement and construction. Bidding will be held as per the common list of vendor list attached to the client contract and vendor list of Mapna Group. In this regard "not selecting competent subcontractors" can be rooted in the vendor list or in the evaluation process. The present evaluation method consists of two parts: technical evaluation and price evaluation. Price evaluation which has been done only for the proposal which have been passed technically is nothing except to choose the one with minimum price. The problem is that there is no technical score for this part and the technically accepted proposals will enter to price evaluation with the same weight. This will cause that the proposal with minimum required qualification may win the bid if it has the lowest price. It can bring some side effects for the project such as increased claim notice by the subcontractor, extension of subcontract performance period because the subcontractor is not so qualified and increased claim notice from other subcontractors which have interface with this one. The evaluation process can be improved by using a comprehensive evaluation system. In this method a weight factor will be allocated to the technical and price evaluation. A technical score should be assigned to the proposals after the technical evaluation is finished. For obtaining a score for the price evaluation, a base price should be defined as per the past experience of the performing organization or by applying a price engineering process.

Poor management of the project changes: One of the inherent characteristics of the project is change. Those changes which can affect time, cost, or scope of the project required special attention and should be managed. Traditional method of change evaluation was limited to the cost dimension. As projects consist of interrelated and complex activities, any ignorance in investigation of time impact of the change can have inconsequence's for the project. This can cause non-excusable delays. In this regard one of the key processes of A Guide to the Project Management Body of Knowledge is "Integrated Change

Control". Management of the project changes can be improved by applying an integrated change control (ICC) system or other similar system which pay attention of time evaluation of the changes. By getting approval of the client for the changes which has been evaluated not only in cost dimension but also in time dimension, you can convert non-excusable delay to the excusable delay.

Lack of mechanism for recording, analyzing, and transferring project lessons learned: Usually lessons learned should be transferred from the past similar projects to the present project. Project works can be divided into two parts: 1) project management work such as preparing work breakdown structure, change management and risk management and 2) product production work such as civil, erection, and commissioning work. Lessons can be learned from both parts and be transferred to the project team in order to repeat success experiences and avoid failure experiences. Designing and applying a collecting, evaluating, and distributing project lessons learned can facilitate project work.

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