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Time Impact Analysis on Construction Projects

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Abstract: ***Time impact analysis (TIA) is a forward looking tool. This analysis takes into account a schedule that does not include a delay & one which includes delay. The difference between these two schedules is considered to be the impact of delay for time duration considerations. The research includes application of TIA on two construction projects and then finding the reasons for delays of those projects. Along with the learning's of case study, i.e. the discovered causes for delays & from the literature survey done, a questionnaire was prepared & questionnaire survey was carried out. A total of 28 causes were identified and classified under 8 major groups. The total numbers of respondents in this survey were 68, out of which 32 were clients, 12 were consultants & 24 were contractors. This questionnaire was circulated among the professionals in the industry to find the factor which contributes the most to the construction project delays. Top ten causes affecting delays the most were identified. This research would be helpful for the stakeholders to act on the critical causes & further reducing the delays.***

Keywords: Forward looking tool, TIA, Stakeholders, Questionnaire

1. Introduction

Construction industry is a vast industry involving number of participants & varied products. So along with this vastness & variations come various problems. These problems may be faced before construction (planning), during construction (execution), & post construction (in the form of maintenance).The overall effect of all these problems is project delays which the Project Management Consultants (PMC) need to tackle with. These project delays gives rise to extra resources, extra project cost (cost overruns). The main participants of the project are owner (company), project management consultants, structural consultants & the contractors. These parties keep on blaming each other for the project delays which take place during the project. There are continuous disputes between the owner & the contractors, which the PMC needs to resolve. The time allotted for the project performance is equally important for the client contractor and the consultants.

A construction projects, unlike any other project, is expected to be completed in a certain time that is planned ahead of starting the physical task of the project during the early phases. A construction project involves a considerable amount of finance that goes to staff, machinery and the capital investment therefore any delay in the completion time will result in huge losses. The impact of delay is experienced by all involved parties. Some of the main effects which occur due to the delays can be named as time overrun, cost overrun, and disputes between different parties, settlements, lawsuits, and total abandonment [9].

2. Research Methodology

The research methodology for this study contains two phases. The first phase includes collection of field data by actually being on the site. The collection of data has been done in following way- prepare schedule for the project using Microsoft Project, perform monitoring & application of TIA i.e. finding the difference between the prepared schedule & the actual tracked schedule for calculating the delays occurred. The difference represents the delay in the project. Then the activities in which delays have occurred were studied & the causes for these delays were found. Along with these causes other causes for construction project delays were also found from the literature survey done. Also responsibility analysis i.e. who was responsible for the delays in the project was found.

The second phase included the formulation of a questionnaire based on the causes found from the first phase. For this a total of 28 causes were identified & classified under 8 major groups. Then this questionnaire was circulated to the stakeholders of various projects & professionals in the industry & they were asked to rank these causes or factors in the questionnaire.

3. Data Collection

The first phase contains actual data collection from two construction sites & application of TIA i.e. difference between planned schedule & tracked schedule i.e. actual time required for the activities to complete.

1.1 Case Study 1

Project - Sugar factory expansion & construction of cogeneration plant (Boiler Section), Sangamner, Dist-Ahmednagar

Client - Sahakarmaharshi Bhausaheb Thorat Sahakari Sakhar Karkhana, Sangamner

Contractor - Pratibha Constructions, Kolhapur

This project included erection of a boiler & its other supporting machinery. Basically it was a work of industrial shed along with the erection of machinery. The project duration was of 6 months & project cost went up to 1.5 Cr. Scheduling & tracking for the project was done using Microsoft Project. The tracked schedule showing delays in the activities marked as red bar is shown in **fig 1** below:

The delay occurred in following activities

- Casting of the footings
- Shuttering for the columns
- Casting of the columns

The reasons & responsible factors for the delay were-

- The payment of contractor for concreting work was not done regularly so the casting work was stopped by the contractor. (Responsibility- Client)
- The surveyor has to perform quantity, billing works too, along with the survey works so there is delay from his side for marking of shuttering of the footing which further leads to delay in casting. (Responsibility- Contractor)
- Shuttering works for the column should have been started along with the completion of the footings, but it didn't happened so, shuttering for the columns were placed after all the footings were completed. (Responsibility- Contractor)

Total financial Impact due to delay

=8000 + 7200+ (10,750+3500)
=Rs 29,450 /-

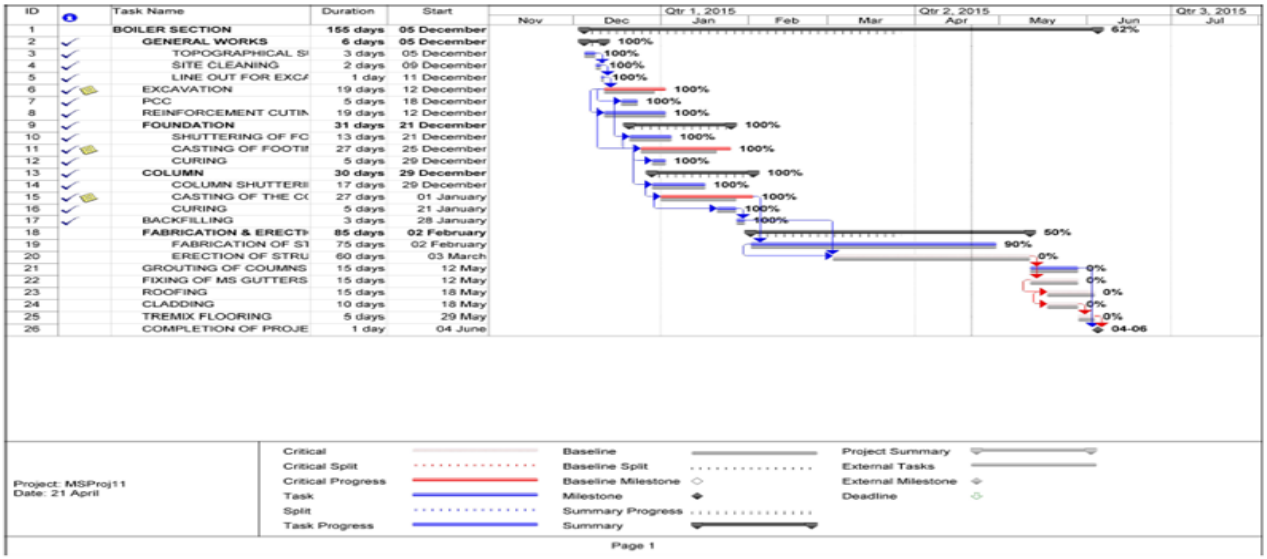

Figure 1: Tracked schedule of case study 1

1.2 Case Study 2

Project – 84 m chimney for boiler of sugar factory.Sangamner, Dist- Ahmednagar

Client – Sahakarmaharshi Bhausaheb Thorat Sahakari Sakhar Karkhana, Sangamner

Contractor – Shree Ranga Engineers Pvt Ltd, Hyderabad

This project included construction of concrete chimney of 84 m height & 3.4 m diameter using slipform technique. The project duration was of 4 months & project cost went up to 1.5 Cr. Scheduling & tracking for the project was done using Microsoft Project. The tracked schedule showing delays in the activities marked as red bar is shown in **fig 2** below.

Delay occurred in the following activities:

- Foundation of the chimney
- Setting up the slipform assembly
- Dismantling
- Mechanical ladder & platforms

The reasons or responsible factors for the delay were:

- The material was supplied by the client, due shortage of 32 mm bar diameter with the suppliers, the client asked the structural designers to make changes in the design of foundation, this took time & hence a delay of 5 days occurred. (Responsibility- Client)
- RMC plant location was a bit far away on the site so the contractor was in search of miller/transit mixer for 3 days. (Responsibility- Contractor)
- Also separate electricity & water connections were not given near this chimney site by the client. (Responsibility- Client)
- There was shut down i.e. no electricity during the setting up of assembly for 2 days(Responsibility- Client)
- The wind velocity was very high which caused problems for the labours working at height for dismantling of the slipform assembly. (Responsibility- Natural)
- The client asked the contractor to keep curing the chimney continuously even when the dismantling & mechanical ladder fitting works were going on which posed problems for the labours & work has to be stopped for some time. (Responsibility- Client)

Calculations of time over-runs:

The project was to be completed on 24-03-2015, but it was completed on 7-04-2015 .There was a total delay of 10 days in the project

% time overrun = (Project delay / Original project duration) x100

% time overrun = (10/106) x 100 = 9.45 %

Total Impact= 10,000+11250+22750+21000+7000+2000 =Rs74,000

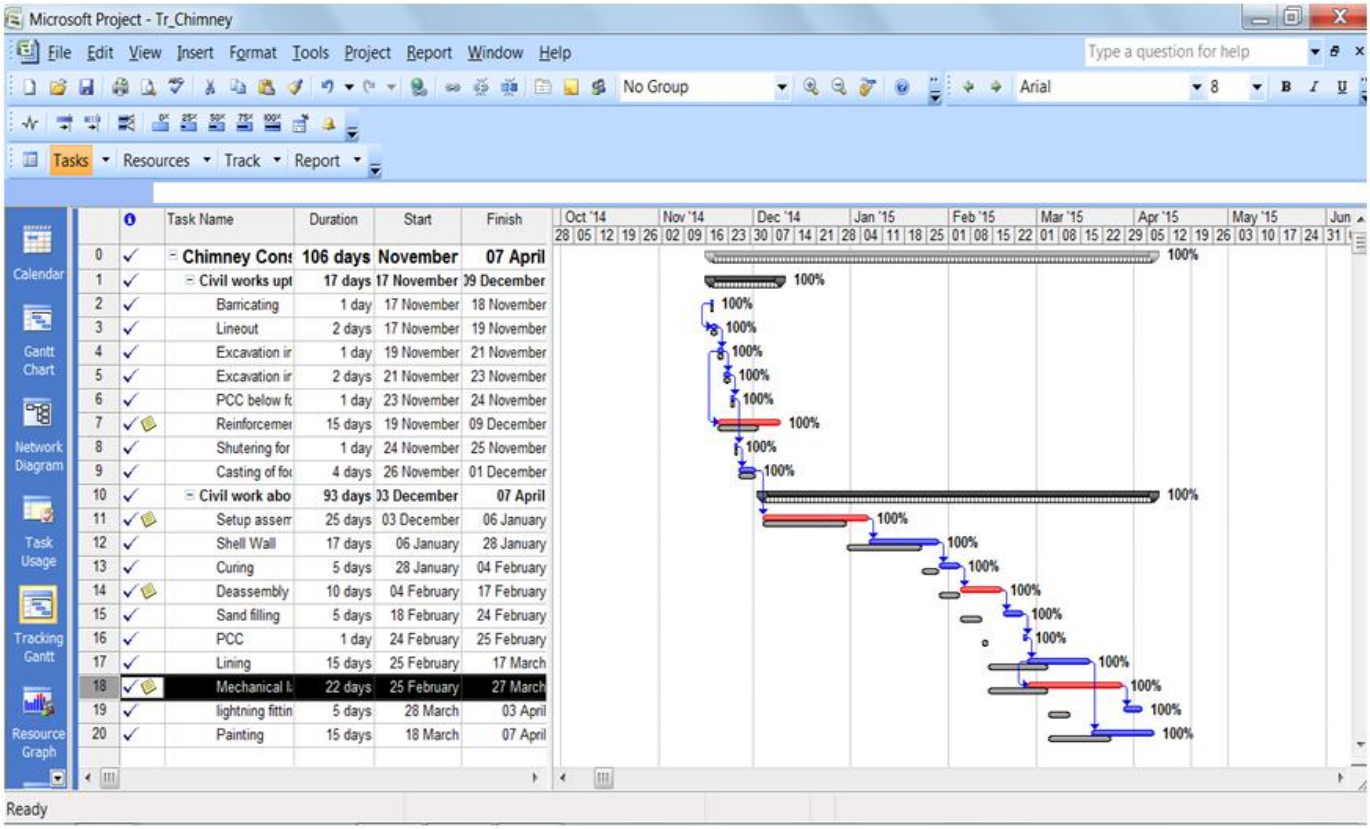

Figure 2: Tracked schedule of case study 2

4. Field Observations

From the above two case studies following observations were done

General Causes of Delays on Construction Projects are-

1. Improper site layout **(Responsibility- Contractor)**
2. Excavated & demolished material was not properly dumped (Responsibility- Contractor)
3. Improper management of labour **(Responsibility- Contractor)**
4. Site supervisor or in charge was overloaded with extra work & had to look after number of nearby sites **(Responsibility- Contractor)**
5. Personnel's on site have to also perform works other than the work allotted to them(e.g.-surveyor) **(Responsibility- Contractor)**
6. Improper management of activities **(Responsibility- Contractor)**
7. If rules & regulation set by the client not followed by contractor(Safety) **(Responsibility- Contractor)**
8. Delay in material supply is a major cause too **(Responsibility- Contractor)**
9. Change orders (Changes in design or any other specification changes by the client) **(Responsibility- Client)**
10. Improper maintenance & setup of equipments & plants(RMC) **(Responsibility- Contractor)**
11. Discontinuous & illegal supply of electricity **(Responsibility- Client)**
12. Shutdown (electricity or any other reason) **(Responsibility- Client)**
13. Delay in billing & payments of labour **(Responsibility- Contractor)**
14. Failure in investigation of type of strata before starting excavation **(Responsibility- Contractor)**
15. Fleet of equipments not managed properly(transit mixer) **(Responsibility- Contractor)**
16. Seasonal changes also affects the progress of the project **(Environmental causes)**
17. Heavy rains can stop the work completely **(Environmental causes)**
18. Cold weather hampered the setting of concrete & hence delay(Chimney site night shift) **(Environmental causes)**
19. Legal formalities & paperwork to be done for procuring materials (Responsibility- Client) **(Responsibility- Client)**
20. Failure of equipments (e.g. chimney site-mixer) **(Responsibility- Contractor)**
21. Slow decision making from client side **(Responsibility- Client)**

22. If timely promotions & increment of the employees is not done, they may be discouraged towards their work resulting in delays too. **(Responsibility- Contractor)**
23. Clearances not given from client side to start work e.g.- clearing power cables or underground conditions **(Responsibility- Client)**

1.3 Responsibility Analysis

The above causes were studied & analysis was done to find out who was responsible for the delays whether it was the client, contractor or environmental causes or others. Based upon the observation following analysis was done as shown in Figure 3.

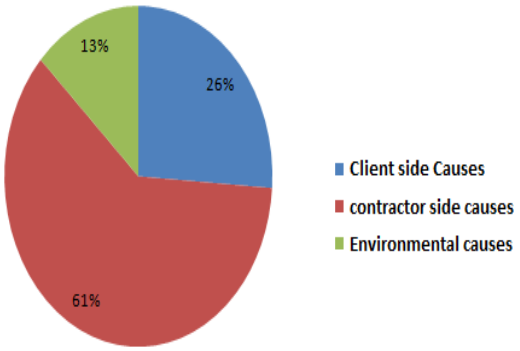

Figure 3: Pie diagram representing responsibility analysis

The results were as follows-
Client side causes - 26%
Contractor side causes - 61%
Environmental & other causes -13%

5. Questionnaire

Second phase consisted of preparation of questionnaire. By taking into consideration above 23 causes from on field observations & other causes identified from the literature survey done, a total of 28 causes were finalised & classified into 8 groups. The questionnaire was circulated to around 80 professionals from civil industry from the categories client, consultants, and contractors, out of which 68 professionals responded to the questionnaire. So the response rate is (68/80 * 100) **85 %**, which is considered a good rate for such surveys.

1.4 Data Analysis Approach

The data analysis was carried out using Statistical Package for the Social Sciences (SPSS). SPSS was used to generate the frequency (fi) of the response category index for the delay causing factors. The relative importance index **(RII)** for each factor was calculated using the frequency data for each response categories generated from SPSS. The RII is the calculation of the mean frequency of each responses category index for the probability [5]. It is calculated using equation (1) given below:

$$RII = \frac{\sum_{i=1}^{n} w_i f_i}{\sum_{i=1}^{n} f_i} \quad (1)$$

Where fi is the frequency of the i^{th} response and wi is the weight assigned to the i^{th} response.

6. Results and Findings

After the analysis done using SPSS, ranking to the causes were given based responses given by the three categories i.e. client, contractor, consultant.

The top ten factors based on the RII by considering all the categories together are tabulated in Table no 1 below

Table 1: Ranking of all categories together

FACTORS /CAUSES	RII	RANK
DELAYED PAYMENTS & BILLS	0.782	1
POLITICAL ISSUES	0.776	2
LACK OF COORDINATION IN VARIOUS DEPARTMENTS	0.767	3
LAND ACQUISITION	0.752	4
IMPROPER COMMUNICATION	0.747	5
BUILDING PERMITS & APPROVAL	0.717	6
SHOP DRAWING APPROVAL	0.691	7
MATERIAL PROCUREMENT & PRICE VARIATION	0.673	8
RAINS	0.652	9
CHANGE ORDERS	0.641	10

The top ten factors based on the RII by considering the responses of clients only, are tabulated in Table no 2 below.

Table 2: Ranking of factors by the clients

FACTORS /CAUSES	RII	RANK
POLITICAL ISSUES	0.775	1
LAND ACQUISITION	0.768	2
LACK OF COORDINATION IN VARIOUS DEPARTMENTS	0.725	3
DELAYED PAYMENTS & BILLS	0.718	4
SHOP DRAWING APPROVAL	0.712	5
POOR FINANCIAL MANAGEMENT & CONTROL	0.706	6
BUILDING PERMITS & APPROVAL	0.693	7
IMPROPER COMMUNICATION	0.687	8
DECISION MAKING IN DEVELOPMENT STAGES	0.650	9
MATERIAL PROCUREMENT & PRICE VARIATION	0.606	10

The top ten factors based on the RII by considering the responses of contractors only, are tabulated in Table no 3 below.

Table 3: Ranking of factors by the contractors

Factors /causes	*RII*	*Rank*
Delayed payments & bills	0.825	1
improper communication	0.775	2
change orders	0.766	3
lack of coordination in various departments	0.741	4
Political issues	0.733	5
material procurement & price variation	0.708	6
building permits & approval	0.700	7
land acquisition	0.675	8
rains	0.666	9
shop drawing approval	0.641	10

The top ten factors based on the RII by considering the responses of consultants only, are tabulated in Table no 4 below.

Table 4: Ranking of factors by the consultants

Factors /causes	**RII**	**Rank**
land acquisition	0.866	1
lack of coordination in various departments	0.850	2
Delayed payments & bills	0.816	3
Political issues	0.800	4
improper communication	0.783	5
site layout changes	0.750	6
building permits & approval	0.750	7
change orders	0.733	8
shop drawing approval	0.733	9
material procurement & price variation	0.733	10

7. Summary of Findings

The objective of the research was to find the in general the causes & the responsible category for the delays of the construction projects. The results were as follows- Client side causes were 26% Contractor side causes were 61% Environmental & other causes were 13%. The top ten factors responsible for delays based on responses from all the categories of respondents were as follows - delayed payments & bills, political issues, lack of coordination in various departments, land acquisition, improper communication, building permits & approval, shop drawing approval, material procurement & price variation, rains & change orders.

8. Remedial Measures

From the above analysis done, following are the measures which could be implemented to reduce the major delays:

i. There should be proper financial management, the contractors must submit the bill as suggested by the client & the client should see that the bills are cleared as early as possible once the bill is submitted.
ii. For proper coordination between various departments centrally located server with access to all departments as well to all the stakeholders of the project should be provided for smooth functioning.
iii. The policies for land acquisition should be such prepared that there is no injustice made to the land owners & they get proper values for their land. There should be proper negotiations between the stakeholders so the land acquisition becomes easy.
iv. The stakeholders should have clear idea about the project. Meetings & other modern communication tools like video conferencing, social networking sites should be used for improved communication.
v. The lengthy documentation process should either be reduced or digitalisation of this process should take place so a person need no to go the offices for approvals all the time.
vi. The shop drawing approvals should be fast, there should be proper communication between the contractor & the structural consultants so that the drawing is handed over to contractor on time.
vii. Inventory management should be followed along with application of techniques like ABC analysis for. The client should have an alternative material supplier for avoiding delays & price escalation.

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