

THE EFFECT OF CONSTRAINTS IN COST AND SCHEDULE CONTROL BY USING PRIMAVERA: A COMMERCIAL BUILDING PROJECT CASE STUDY

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ABSTRACT

Constraints in any project are evitable during planning, scheduling and tracking procedures. Constraints can be with respect to procurement, cash flow, skilled resource availability, contractors and sub-contractors etc. Constraints are conditions which are generally associated with activities and its relationships directly or with respect to the start and end dates. This paper presents a case study from the construction industry. Multiple semi-structured interviews and project documents have been used as sources of data. TOC Thinking Process logic tools and mainly the site knowledge were used to identify the core constraints that are affecting the progress of the cost.

KEYWORDS: Constraints, Commercial Project, Theory of Constraint, Flexible and Non-Flexible Constraints, Construction, Construction Management

INTRODUCTION

All the projects are the goal oriented; these constraints are the restriction to achieve the goal or target of the project. These constraints will lead to time overrun, cost overruns due to this the construction process will get delay and to inadequate quality because of the rushing up of work for the completion of the project within time. For making the project as a successful one, the constraints have to be identify and reduce it. In construction industry the cost and time are the two factors which decides that the project is successful are not. The time and cost are interdependent factors. The time delay of a project is also leads to increase in the cost of the project. The more delays in the construction activities will cause cost overrun in the project which finally leads to the failure of the project. Therefore, the delays and cost has to be monitored and controlled during the progress of the project. For these, the constraint affecting the project has to be identified and study it. The constraints affecting the time of a project has to be carefully noticed. There are several constraints which are responsible for the time delay of the projects. The constraints involved in the construction may differ according to the type of construction and the situation in which the construction progress is going to take place. There are several reasons for the construction constraints. Some of the studies are included which gives clear idea about the reasons of the constraints. Hamzah N, et al.1 gives a theoretical framework on the causes of delay in construction. In this, the construction delay causes were classified into excusable, non-excusable and concurrent. The excusable delays are compensable and it is caused by owner/consultant. Non-excusable delays are caused by contractor.

Concurrent delays are non-compensable and they are caused by act of god and by third parties. SK. Nagaraj et al.2 shows a comprehensive framework for resource management particularly related to manpower as resource element in construction domain. Murali Sambasivan et al.3 identified the delay factors and their effect on project completion and also established an empirical relationship between each cause and effect. Shu-Shun L., et al.6 study shows the importance of resources in the profit maximization of a project. Shu-Shun Liu et al.4 presented an optimization model using constraint programming (CP) for project selection and scheduling problems with time-dependent resource constraints. The proposed model allows planners to determine an optimal portfolio with specified resource constraints according to various time intervals, and benefits decision making for project selection and scheduling.

METHODOLOGY

The methodology is divided into the following steps

- Study area characteristics.
- Identifying the critical areas (constraints) in the project.
- Applying the parameters in the software.
- Evaluate the changes.
- Analyse the results and generate the report.

Study Area Characteristics

An on-going commercial hotel interior fixing project has taken for the study. The hotel consists of G+20 levels with 280 luxury rooms. The interior work has started in 5/08/2016 and the first review of the project is done on 21/12/2016 according to this review the planned progress should be 30% but the actual progress is 10%. The second review is done on 25/01/2017 according to this review the planned progress is 45% but the actual progress is 20%. The project is delayed due to the constraints.

Identifying the Critical Areas (Constraints) in the Project

Identified the constraints in the project

- MATERIAL CONSTRAINT: All the interior work materials and furniture are supposed to be shipped from Muscat.
- SHIPMENT CONSTRAINT: The delivery of the panels from the Muscat is in the form of compact bundle, this bundle includes the materials required for only 4 levels.
- The MEP and HVAC agencies which have to follow the baseline of this project.
- Skilled labour constraints.
- Design constraints.
- Schedule constraints.
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Above are the constraints which are delaying the project. In material and shipment constraints all the materials have to be imported from Muscat and that too it will come by batches, one batch consists of the materials required for the 4 levels (floors) and this has to come from sea so it requires more time to reach India. In MEP constraints the closure of the ceiling and wall panels requires the clearance from the MEP contractor because the electrical, plumbing and HVAC lines are passing in between the wall panels and in the ceiling panels. In skilled labour constraints, to complete the delaying activities within the schedule we have to increase the number of skilled labours, but the availability of the skilled labours in the company is limited so managing the available skilled labours is the big challenge. In design constraints, there is the chance that the architect will change the design as per the client's satisfaction, so this will lead to rework or waiting this will delay the project. In schedule constraints, the entire project is scheduled to finish by December 2017; in this schedule they had given the float of 2 weeks in between all the levels (floors), so we have to maintain the float.

Applying The Parameters in the Software

- After identifying the constraints we have to incorporate these constraints in Primavera P6 software. In Primavera there is a set of inbuilt constraints they are
 - Primary constraints
 - Secondary constraints

PRIMARY CONSTRAINTS

In primary constraints means you should stick on date to start or complete the task. The lists of primary constraints are

- Start on
- Finish on
- Mandatory finish
- Mandatory start

2. Secondary Constraints

- Start on or before
- Start on or after
- Finish on or before
- Finish on or after

By using these constraint types we had successfully incorporated the identified constraints in the Primavera P6 software.

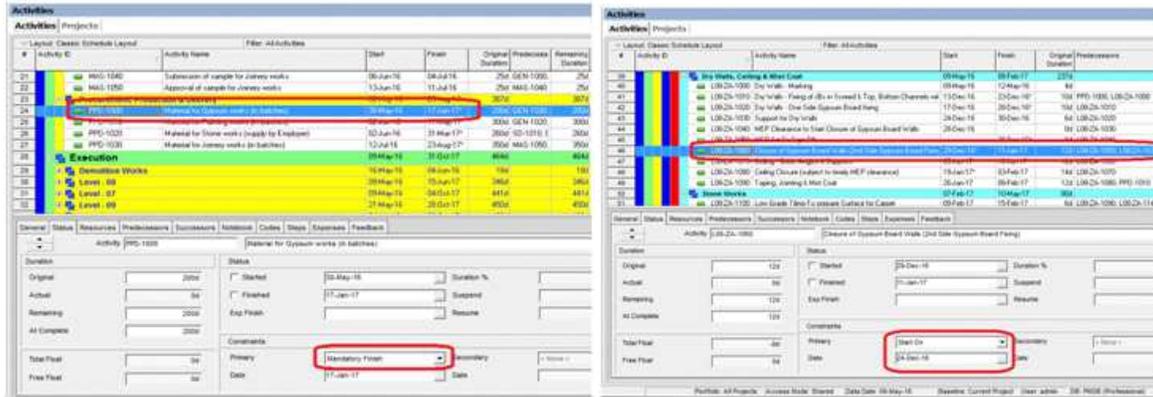


Figure 1: Real Time Site Constraints Incorporated in Primavera P6

Evaluate the Changes

As per the baseline the duration of the project is 444 days. After applying the constraints to the baseline schedule the entire schedule has changed, during the 1st review (21/12/2016) the project duration has changed to 534 days then in second review (25/01/2017) the duration of the project has changed to 543 days.in the 3rd review we had noted the activities those start date is on or after 25/01/2017 and finish date is on or after 20/02/2017 and studied those activities thoroughly, then by comparing with the baseline schedule we had assigned the non-flexible constraints i.e. mandatory start and mandatory finish for those activities, then the duration of the project has reduced to 542 days.

RESULTS AND DISCUSSIONS

- During the 3rd review effort was made to reduce the duration of the project with the marginal increment in cost as baseline finish was given priority.
- The PMC decided to source additional skilled labours to control the duration.
- Including the above data it was proposed that project duration could reduce to 88 days.

Table 1: Modified Activities List

Activity Id	Activity Name	Previous Constraint As Per 2 nd Review	Constraints Type Applied to Reduce the Duration of Project
L08-ZA-1080	Ceiling Closure (subject to timely MEP clearance)	Start on 10/01/2017	Mandatory start 19/08/2016
L08-ZD-1090	Taping, Jointing & Mist Coat	NA	Finish on 20/02/2017
L08-ZD-1160	Joinery-First Fix Works	NA	Mandatory start 01/12/2016
L07-ZA-1080	Ceiling Closure (subject to timely MEP clearance)	NA	Mandatory start 22/08/2016
L07-ZC-1060	Closure of Gypsum Board Walls (2nd Side Gypsum Board Fixing)	NA	Mandatory finish 14/01/2017
L07-ZC-1160	Joinery-First Fix Works	NA	Mandatory start 03/02/2017
L07-ZD-1060	Closure of Gypsum Board Walls (2nd Side Gypsum Board Fixing)	Start on 14/01/2017	Finish on 14/01/2017
L09-ZC-1060	Closure of Gypsum Board Walls	Start on	Mandatory start

	(2nd Side Gypsum Board Fixing)	31/12/2016	03/01/2014
L09-ZC-1080	Ceiling Closure (subject to timely MEP clearance)	Start on 24/01/2017	Mandatory start 02/01/2017
L05-ZC-1080	Ceiling Closure (subject to timely MEP clearance)	Start on 26/01/2017	Start on 03/01/2017

- The effect of real time constraint in term of cost and schedule could be reduced by cost Rs 5,15,911 3% and duration by 11 days 3%

Table 2: Overview of the Project

	Baseline Duration	Change in Duration	Delay	Finish Date	Budgeted Cost	Change in Cost
REVIEW 1 21/12/2016	444 days	534 days	90 days	20/01/2018	11, 64,000 Rs	15, 89,853Rs
REVIEW 2 25/01/2017	444 days	543 days	99 days	31/01/2018	1, 90, 67,650Rs	2, 54, 67,260Rs
REVIEW 3 20/02/2017	444 days	532 days	88 days	18/01/2018	1, 90, 67,650Rs	2,49,51,709Rs

Table 3: Outcome of the Project

	Baseline	Reduced by	% Reduced by
DURATION	444 days	2 weeks	3%
COST	Rs 1, 90, 67,650	Rs 5,15,911	3%

CONCLUSIONS

- If the proposed schedule is followed, they can able reduce the cost by 3%.
- As per the client requirement, the project should finish by 31/12/2017, they can able to finish the project on 18/01/2018 only if they follow the revised schedule and maintain the same work progress.
- In the current work done at 5 levels (floors) for interior we have recorded the reason for the delay and ensure that it does not repeat in the next subsequent floors.as a result the work can be done at a much faster rate.
- By considering 60% of current proposed changes the project can be completed on time and on budget.
- As we have covered the major constraints the Future constraints during execution can be easily monitored.

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