

EFFECTIVE TIME AND COST MANAGEMENT TECHNIQUES IN CONSTRUCTION OF A COMMERCIAL BUILDING USING PRIMAVERA

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Abstract - Project management techniques such as planning and scheduling using tools and devices are helpful in comparing a project's stipulated cost, time and quality. Every Project is unique on its own and it is very important to manage the project to meet a greater efficiency of work. Project management is the practice of initiating, planning, executing, controlling and closing the work of a team to achieve specific goals and meet specific success criteria at the specified time. This study deals with an ongoing construction project of a Commercial Building (B+G+3) "Dream City Mall" at Kasaragod, Kerala and collect relevant data related to the project from the concerned agencies and track the process of the work deeply, with the use of a project management software named Primavera P6 which is a tool to plan a project and to track the progress of work time to time. Time and Cost Effectiveness is focused in this project. The study covers mainly the process of planning, scheduling the activities and monitoring. A comparison of the actual and original time and cost is performed in this study using project management software Primavera.

Key Words: Cost Effectiveness, Time Control, Primavera P6, Construction projects, Commercial Building

1. INTRODUCTION

Construction industry is a fundamental part of a country's foundation and the growth of industry. In spite of being the second largest industry in India, its development has been distinctive across the nation. Time and cost is fundamental in planning, designing and developing a construction project. It is the key criteria for success of project throughout the life cycle of the project. Even though various obtainment procedures have been introduced to handle the construction projects successfully, very rarely projects are finished within estimated budget and time. It requires sound plans, correct practices, and precise judgment to keep these projects within estimated cost and schedule. Hence effective time and cost management has a vital role in construction projects.

1.1 Few of the most common causes of Cost Overruns in the construction projects

1. Imprecise Project Estimates

If there are mistakes in the schedule and budgets of the project to start it, there would be overrun from initial stage itself causing imprecise project estimates. So it is important in the initial stage itself for the project to be accurate and realistic about its deadline and costs from the contractors and architects. A better planning leads to better documentation process reducing confusion which in turn will reduce the expenses in future.

2. Significant Project Design Errors

If there is fault in the design plans, it will automatically lead to cost overrun in the construction projects, no matter we provide correct time and resources in the pre construction stage. Deficiency in the design is the poorly made designs which are not proper and incomplete ones. These kind of problems can be avoided in the design phase itself by using the software which will reduce the risk of errors.

3. Management Errors

If the project management is not up to the speed of project progress it will lead to cost overruns. The best to it is to provide the management team with right equipment and tools. This could include the project management software that will play the role of multiple managers and will help in running the project smoothly.

4. Bad Site Management

When there is a sudden change in the project site unexpectedly there will be clash between the people. Using construction software the on-site communication can be improved that will reduce the issues related to site management. Digital calculations are done and the designs created by software can be trusted and decisions can be made based on it. It will lead to faster communication which will also help in making better decisions.

1.2 The major causes for delays in construction projects

1. Altered Project Scope

Change in the project scope could be because of the poor project scope in the initial stage, improper calculation of risks and all which will lead to variation in the product of the project, it's budget and entire team. Hence the entire project has to be revised that will take more time to complete the work. So in the initial planning phase itself it is important to find out the key factor in relation with the client and perform well accordingly.

2. Project Difficulty

Complication in project can be a major reason for time delay and cost overrun. This is based on the scale of the project. This will cause a change in the rate of materials and inflation such that the initially proposed budget needs to be increased to complete the project. This will increase the overall cost and in turn lead to delay in the overall time of the construction project. For this we need a good and honest team with great interest for the success of the project to achieve this.

3. Insufficient Planning

Planning a project means to find out the tasks to be done in order to obtain the expected result in minimum time and cost. In construction projects, planning includes calculation of all the materials, tools, equipment, suppliers, human resources, time and cost required to complete the work. A planner should have enough knowledge about the various aspects of construction. Insufficient planning will result in poor outcome. Hence it is the responsibility of the team to do the project accurately for timely completion

4. Inappropriate Project Schedule

Scheduling is a process in which all the activities of a particular work are arranged in a proper logical order to achieve the project within the given time frame. The most common type of scheduling is Bar chart, which is nowadays generated in computers using different software. Improper project scheduling will lead to diversion of resources to the activities that are not critical and thus the critical activities will suffer more from this and lead to delay in the construction time. To solve this problem scheduler should have great knowledge related to the project and also should have good experience in a variety of advanced project management software. Knowledge of Oracle Primavera P6 is preferred as it is being used in most industries as an efficient project management tool.

2. SCOPE OF THIS STUDY

1. The scope of this project is the Time and Cost Effectiveness.
2. It mainly focuses on how to administer the Time and Budgeted cost validly without any delay and cost overrun.

2.1 OBJECTIVES OF THIS STUDY

1. To give the significance and basis of monitoring the construction work.
2. To conclude the work in estimated cost and prescribed time.
3. For the analysis of the management, of construction projects,(Primavera, M.S.Project, etc.) the techniques and tools are surveyed.
4. The causes are pointed out which lead to cost overrun and to assess their respective importance.
5. To discover the critical activities that leads to major project delays originally from the point of view of the client and also generally from a broader point of view.
6. In order to achieve the goals to complete a project on time and within the budgeted value the existing planning, tools and techniques are inspected.

3. MATERIALS

Learning the software Primavera P6 and collecting the project details from the site office.

3.1 METHODOLOGY

1. Collection of the project data.
2. Project planning and scheduling by using Primavera P6.
3. Finding Critical path and Critical activity.
4. Costing of the project.
5. Monitoring the activities time to time.
6. Complete observation of the project.
7. Comparing the Actual cost and Budgeted cost and the Planned date and Actual date.

3.2 AREA STATEMENT OF DREAM CITY MALL

DREAM CITY MALL is an upcoming project by Arun Associates at Kasaragod, Kerala. It is consisting of Basement parking, G + 3 floors.

Carpet Area of each floor - 18041 Sq.ft

Total Carpet Area - 90205 Sq.ft

Built Up Area of each floor - 22551 Sq.ft

Total Built Up Area - 112755 Sq.ft

Rate per Sq.ft - Rs 1500

3.3 PROJECT DETAILS IN SEQUENTIAL ORDER IN PRIMAVERA P6

1. Enterprise Project Structure (EPS)

Table 3.1: EPS Details

EPS Code	CON2
EPS Name	COMBUILDING
Project Code	NP05-7
Project Name	MALL05
OBS	Civil Engineer
Planned Start Date	09-October-2017
Planned Finish Date	26-August-2020

2. Project Calender

Global Calender named NP03 is assigned to the project. Workweek is set for 6 days from Monday to Saturday. Sunday is holiday.

All the public holidays are also set in the calender.

Total work hours/ day = 8 hrs/ day

The work hours = 9.00am - 6.00pm

Lunch break time = 1.00pm - 2.00pm

The calender is assigned to the project from October 2017 since the project started on this year. Initially it was set till August 2020 and later on it is extended till July 2022 after the final updation of the project.

3. Work Breakdown Structure (WBS)

In this project the WBS consists of 23 project elements. They are Planning and Design, Approval, Foundation, Sub-Structure Envelope, Shell, Superstructure : Ground.Floor, First.Floor, Second Floor, Third Floor, Shell Exterior Closure, Interior Construction, Interior Finishes, Flooring, Elevators, Staircase, Escalator, Shell Enclouse Roof, Exterior Glazing, Exterior Doors, Plumbing, HVAC, Air Distribution System, Fire Protection System, Electrical, Painting, Furnishing and Building Site work.

4. Create Activities

There is a total of 108 activities in this project beginning from Architectural Programming to Finish Project. These activities are set with their respective duration starting from 09 October 2017. In General tab ;

Activity Type - Task dependent

Duration Type - Fixed duration units

% Complete Type - Duration

Activity Calender - NP03

Responsible Manager - Civil Engineer

5. Assign Relationship

After creating the activities, relationship is assigned to each of them on their predecessor and successor columns. The relationship provided are Finish to Start (FS), Start to Start (SS), Start to Finish (SF), Finish to Finish (FF).

6. Budgeting and Allocation of Resources

There are 39 resources created here. Out of it ;

Labour resources = 19

Material resources = 18

Non-Labour resources = 2

The Calender assigned to each resources is NP03

The Default units/ time = 10/ day

For each resources Maximum units/ time is set with their Standard rates.

After creating the resources they have to be assigned to each activities with the required Budgeted units/ time. This shows their Budgeted cost and Budgeted units. Also Primary resource in each activities is shown in General tab. The Estimated Budget at Completion = Rs 169132500.20
Expected Project Finish Date = 26 August 2020

7. Create Baseline

Baseline is created and assigned to the project after budgeting and allocation of resources. It shows the Planned Start and Finish dates of the project with their planned duration.

BL Project Start = 09 October 2017

BL Project Finish = 26 August 2020

Baseline is represented by thin yellow colored bar

8. Project Updating and Scheduling

After creating the baseline, project has to be updated as per the Actual date. After updating the project, project scheduling has to be done. This helps us to compare the Planned project finish with Actual project finish clearly.

9. Critical Path and Critical Activities

In this project there are few critical path activities which are represented by red coloured bars and relationships. Their total float is zero.

10. Project Tracking

After scheduling the project, check the project progress using Tracking option from Enterprise menu.

11. Earned Value Analysis and Earned Value Curve

Earned Value compares the Budgeted cost and Actual cost of the project. It requires three basic elements for its calculations :

Planned Value (PV)

Earned Value (EV)

Actual Costs (AC)

The EV curve measures how much value has been earned at the current time depending on the work that has been done till now.

12. Project Issues

There are so many problems emerged at the site while executing the work of the project. These are the project issues and they are mentioned in each activities which has faced them.

4. RESULT AND DISCUSSION

4.1 PROJECT TIME MANAGEMENT

The expected project finish date is supposed to be 26th August 2020. But as the project got delayed the actual project finish date came to 16th July 2022. Hence the planned original duration which was 687 days is increased to 1139 days with a remaining duration of 294 days. The percentage in project delay is 65.79%.

Table 4.1: Planned and Actual Duration Details

WBS	Planned Original Duration	Actual Original Duration	Days Delayed	% Increase d
Foundati on	42	80	38	90.48
Shell Superstru cture	126	180	54	42.85
Interior Finishes	49	95	46	93.87
Flooring	50	100	50	100
Elevators	35	36	1	2.85

4.2 PROJECT COST MANAGEMENT

The below table shows the cost overrun in each WBS until which the work is completed.

Table 4.2: Budgeted and Actual Total Cost Details

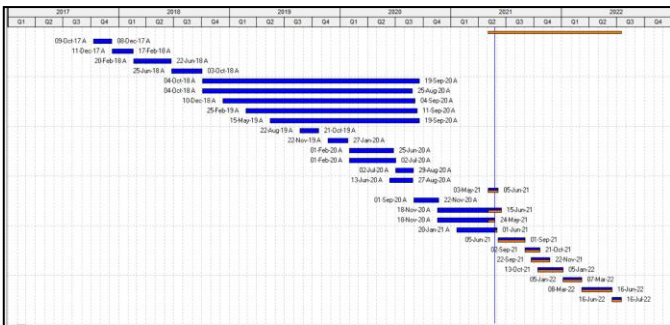
WBS	Budgeted Total Cost (Rs)	Actual Total Cost (Rs)	% Increased
Planning and Design	151,100.00	154,250.00	2.09
Approval	210,050.00	212,460.00	1.16
Foundation	20,990,500.00	20,994,780.00	0.02
Shell Superstructure	89,527,900.00	89,770,550.00	0.27
Shell Exterior Closure	186,900.00	188,100.00	1.00
Interior Construction	479,700.00	482,320.00	1.00
Interior Finishes	505,250.00	510,060.00	1.00
Flooring	676,000.00	683,685.00	1.14
Elevators	2,591,050.00	2,659,175.00	2.63
Shell Encluse Roof	690,900.00	695,640.00	1.00
Exterior Glazing	2,042,250.00	2,213,800.00	8.40
Exterior Doors	92,400.00	109,605.00	18.62
Plumbing	4,361,550.00	4,399,520.00	1.00

1. Earned Value Analysis

The Budgeted Total Cost of the project is Rs 169,132,500.20. The Actual Total Cost of the project at this stage is Rs 141,990,745.00. The Duration % complete of the project is 74.18%. The project is almost at the completion stage as only 25.82% is remaining. The Estimated Budget at the project conclusion is said to be Rs 174,177,217.82, hence the % cost increased is 3%.

Figure 4.1: Earned Value Details

Chart 4.1: Earned Value Gantt Chart

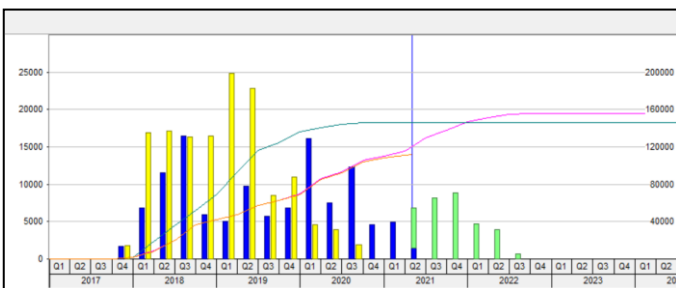


From the Earned Value Gantt Chart, the actual progress of the project is obtained which is shown along with the dates. The project is started on 09-Oct-2017. All the completed activities are depicted in blue bars. The blue line is showing the date till which the project is updated and scheduled i.e. 03-May-2021. The orange bar is showing the activities which are yet to be completed. Those are the ongoing activities. The activities which are depicted in blue bars with little orange bars towards the end are the partially completed ones. The activities which are not yet started are the ones that comes after the blue line which are depicted in both blue and orange bars. It is expected to be completed on 16-July-2022.

2. Earned Value Curve

Earned Value Curve gives the detailed information about the Project Tracking and Earned Value Analysis. The Earned Value Curve in pink represents the Estimate at Completion - labour. The curve in orange represents the Earned Value Labour and the curve in light blue represents the Planned Value Labour. The Actual Labour, Remaining Labour and BL Project Labour are represented in dark blue, green and yellow colours.

Chart 4.2: Earned Value Curve



- In Planning and Design, the activities were supposed to finish by 05th December 2017, but there was a delay of two days due to which it got over on 8th December 2017.
- In Approval, the activities which were to be completed by 6th February 2018, got completed on

13th February 2018. Since these are the initial stages of project the main reasons for delay here were the delay in approvals and poor planning and that in turn led to the delay in submission of drawings and starting the project.

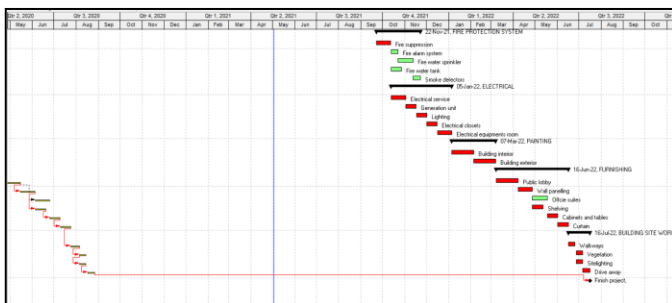
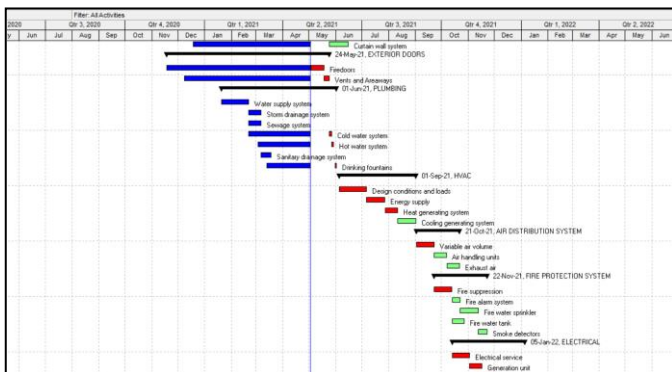
- In Foundation, the activities were supposed to finish by 31st March 2018, but as the project started little late, it was completed by 22nd June 2018. In Substructure Envelope, the activities were to be finished by 5th July 2018, but got completed on 3rd October 2018. The reason here was shortage of finances and the lack of labours available for construction. It is one of the biggest challenges faced in construction field these days. As a result many labours have to work overtime and many have to manage two or three different works at the same time.
- In Shell Superstructure, all the activities which were to be completed by 29th December 2108 got finished on 19th September 2020 as there was a long delay in project. This further delayed all the upcoming activities. The main reason for a long delay in project here is the pandemic that hit our country in the worst possible way due to which the entire nation was under lockdown and that in turn also reduced the number of labours as many of them were from different states.
- In Shell Exterior Closure, the activities which were to be finished by 20th February 2019 got completed on 21st October 2019.
- In Interior Construction, the activities which were to be finished by 06th February 2019 got completed on 30st November 2019.
- In Interior Finishes, the activities were supposed to finish by 17th May 2017, but there was a delay in project due to which it got over on 02nd March 2020.
- In Flooring, the activities were supposed to finish by 17th June 2019, but it got completed on 02nd July 2020.
- In Elevators, the activities were supposed to finish by 18th June 2019, but it got completed on 29th August 2020.
- In Staircase, the activities were supposed to finish by 03rd April 2019, but it got completed on 27th August 2020.
- In Shell Enclose Roof, the activities were supposed to finish by 23rd March 2019, but it got completed on 22nd November 2020.
- From the above scenario we could tell that the main reasons for delay in project are poor planning by the management, delay in the approval from management which kept the entire project from moving forward as there was no proper coordinating actions taken place between the management team. This in turn led to delay in the submission of plans and drawings. Then there were shortage in finances which further delayed the project as it also caused the unavailability of labours for work as many of them

were from different states. And then came the unexpected pandemic situation which hit the country in the worst possible way and all the works had to be paused for a long time. Since the project is not completed on time, it led to cost overrun in the project. Many activities are partially completed in this project, since the second wave of Covid - 19 hit the country off late

3. Critical Path and Critical Activities

Critical Path and Critical Activities are depicted in red bars and red arrow marks. Floor Construction, Ground, First, Second, Third Floor Walls, Roof Construction, Fire doors, Vents and Area ways, Cold Water System, Hot Water System, Drinking Fountains, Design Conditions and Loads, Energy Supply, Heat Generating System, Variable Air Volume, Fire Suppression, Electrical Service, Generation Unit, Lighting, Electrical Closets, Electrical Equipment Room, Building Interior, Building Exterior, Public Lobby, Wall Panelling, Shelving, Cabinets and Cables, Curtain, Walkways, Vegetation, Site lighting and Drive away are the critical activities. They have to be completed in given time. If not it will further extend the project dates and cause a delay in the project.

Figure 4.2 and 4.3: Critical Activities after Scheduling



In the beginning, few critical activities starting from Floor Construction on Ground Floor till Roof Construction had been delayed which caused a delay in the entire project dates. Activities like Fire doors, Vents and Area ways, Cold Water System, Hot Water System and Drinking Fountains are partially completed. Since they are not going to be

finished on time as they were started late it caused further delay in the project dates.

5. CONCLUSIONS

The present study concludes the following

1. 74.18% of the work is completed in this project.
2. The project is delayed by 65.79%
 - The delay in approval of the project from management team is a reason which normally causes delay in starting the project. It is the role of project manager to take decisions that keep the projects going. Coordinating actions and quick approval of items can keep the construction jobs on time and in some cases, under budget.
 - Delay in approval of project also leads to delay in submission of plans and drawings. So it is important that every actions should be coordinated and done accordingly.
 - The availability of labours is also another important factor in construction projects. Because labour challenges is one of the main problem faced by the construction industries. When they are not properly available, lots of works will be delayed. And sometimes one person itself will have to do two or three different works at the same time. This is caused due to the shortage of finances.
3. The cost of the project is increased by 3%.
 - The longer the time project takes to complete, the costs may vary. If the project is completed on time, it will reduce the cost of the project. For the project to be completed on time, it requires proper planning which is the first and foremost step in construction or any other projects.
4. Critical path and Critical activities are found using Primavera. This would help in reducing the time delay and cost overrun in the project. Delay in these activities have led to delay in the project and cost overrun.
5. Another main reason for project delay is the pandemic that hit the country off late in the worst possible manner due to which the entire country was under lockdown. All the works had come to halt due to Covid - 19 situation. And resumed after a period of one or two months which again led to the shortage of workers and equipment and the budget too.

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