

# APPLICATION OF EARNED VALUE MANAGEMENT IN PROJECT TRACKING & PERFORMANCE IMPROVEMENT THROUGH PRIMAVERA

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*Abstract:* Along with the growth, complexity and uncertainties in construction projects are also increasing day by day. As our Indian construction industry is in developing stage, there are many new challenges to face. Delay is most common phenomenon seen in almost all types of projects. Project fails to complete within time and budget, mostly due to inefficient monitoring and tracking of project progress. Project completion on time and with allocated resources is only possible with Skillful Management. Earned value management is a tool which uses project's current data to analyze and predict schedule and cost future status in a project. To compare planned progress to the actual progress on same level, Earned Value Analysis introduce new variable called Earned Value. In this paper a case study of residential building is analyzed using Earned Value Management technique. For scheduling, tracking and monitoring the primavera software is used. Use of primavera software increases the efficiency of project management. The Earned Value Management tool leads to efficient monitoring and tracking of the project. The results will aware the project manager with detailed knowledge of project performance and guides for necessary further actions.

**Index Terms – Earned Value Management, Project tracking & monitoring, Construction Management, Primavera**

## I. INTRODUCTION

Delay in project delivery is the most common phenomenon seen in almost all type of project. The profit or loss of any project will depend on planned amount to spend and actual spending. The project time also plays a major role in success of any construction project. This is where effective project management is required. For project completion within time with allocated resources and estimated budget skillfull management is imperative.

Forecasting Schedule with Cost overrun using current project data for analysis is Earned value management. To compare planned progress to the actual progress on same level, Earned Value Analysis introduce new variable called Earned Value. Earned Value is nothing but value of accomplishment.

Estimated time & higher costs are recognized by Earned Value. For complete project duration performance measurement needs to be done on combined baseline as a requirement of EVM. The variance in cost & schedule are analyzed to know the difference between actual and planned. To track the performances with respect to cost & time, Cost Performance Index & Schedule Performance Index is used.

Varieties of software are available for management of construction projects. Resource, cost & project management software Primavera P6 can enable improvement in ability to deliver projects within time and budget of organization. This software is useful for any size project across every industry to get real time visibility. Primavera P6 may be used as a scheduler or planner to keep track of a project's timetable, actual work, and work completed value and see if it's on track. With Primavera Earned Value Management, you can combine cost and schedule data into a single solution and produce statistically reliable project performance assessment.

The focus of this work is to analyze & improve the Project Performance through Tracking & Scheduling using Earned value Management and Primavera tool.

## II. EARNED VALUE MANAGEMENT

To calculate the earned value management, initially three inputs are given from project data. The input values which leads of indication of project status are Total allowed budget, actual spent cost and percentage of work completion.

Table 1 Inputs from project

Terminology	Description	Formula
Completion Budget	Planned Total Budget Project Value	----
Actual cost	Actual amount spend so far	----
Planned value	Authorized budget assigned	$PV = (BAC) * (\text{Planned \% Complete})$
Earned Value	Actual value earned by project	$EV = (BAC) * (\% \text{ of completed work})$

After the calculation of EV from inputs, next stage is to find out the deviation from actual in cost and schedules.

Table 2 Variance

Terminology	Description	Formula
Schedule Variance (SV)	SV is the status of schedule that shows lead/lag.	$SV = EV - PV$ If SV = 0, project is upon (schedule) = + ve, project is forth of (schedule) = -ve, project is beyond (schedule)
Cost Variance (CV)	CV is the status of budget i.e. the task is over/under budget.	$CV = EV - AC$ If CV = 0, project is within (budget) = +ve, project is below (budget) = -ve, project is above (budget)

CPI & SPI is used to determine Cost & Schedule performance of the project.

Table 3 Performance Index of Project

Terminology	Formula
Schedule Performance Index (SPI)	$SPI = \frac{EV}{PV}$ If SPI = 1, project is upon (schedule) = < 1, project is beyond (schedule) = > 1, project is above of (schedule)
Cost Performance Index (CPI)	$CPI = \frac{EV}{AC}$ If CPI = 1, project is upon (budget) = >1, project is below (budget) = <1, project is above (budget)

After checking the current performance the future performance is forecasted in terms of cost.

Table 4 forecasting terminologies

Terminology	Description	Formula
Estimate at Completion (EAC)	Project total cost that is Expected.	$EAC = BAC / CPI$ $EAC = AC + (BAC - EV)$ $EAC = AC + ETC$ $EAC = AC + \left[ \frac{(BAC - EV)}{(SPI * CPI)} \right]$
Estimate to Complete (ETC)	Cost expected to finish the complete work remaining.	$ETC = EAC - AC$
Variance at Completion (VAC)	Project budget deficit or surplus when the project is finished.	$VAC = BAC - EAC$ If VAC = -ve, above budget = +ve, saved = 0, upon budget surplus

### III. LITERATURE REVIEW

To study the importance of Earned Value Management, methodology of it some literature paper have reviewed-

Amruta B. Vyas et al. (2016) centered on concept and significance of EVM with the conclusion, that following utilizing EVM is valuable in recognizing the hazard components and to figure the potential issues.

Dirga Oktrianto (2020) stated that with the EVM method, the costs and time for the project can be controlled so that the project can be completed on time and the in the budgeted cost. Case study of residential building was selected for analysis of performance.

Naderpour (2011) explores the concepts of earned value method, its methods and metrics, performance measurements and forecasting project progress using a case study of an educational center.

Rajat (2019) used Primavera P6 software for time and cost control. Factors affecting time and cost overrun were analyzed from interviews with experts. It was concluded that use of good techniques and tools for tracking and scheduling are must for proper planning.

Suchithra L(2017) used earned value management tool for tracking of case study project in Primavera software.

Mullapudi Durga Sruthi et al. (2020) analyze the cost and schedule of a case study using EVM tool. Software was stated as more efficient for EVM of a project compared with manual calculation.

Sharanabasava Patil et al. (2020) conclude the significance of project execution measuring with the help of EVM in moving forward with Project execution performance of a development project. MSP software was used for project management.

T. Subramani et al. (2014) developed software in 2008 Visual studio, 2005 SQL Server using language "C". Results were compared for selected parameters using Microsoft project 2007, Primavera P6 and developed software. The conclusion drawn was program can be utilize in a wide extend of venture for EVA calculation.

Andrew Fernans Tom (2013) performed comparison between the arranged advance of development work and genuine advance is performed utilizing Project administration program Primavera P6 moreover gets it the part of controlling & checking within the advance and opportune completion of a development Project.

Ankur Verma et al. (2014) has studied the process of monitoring & scheduling of project considering management of construction project with cost. Earned Value Management computations are done in Primavera P6 program, which proved a tool efficient in control & monitor of projects.

Kunal B Badgujar (2016) traces the fundamental standards of the EVM and its fruitful application. It was conclude that Utilization of the earned value strategy for venture control will result in way better appraisal of action time and budget prerequisites. For administration of project primavera software was used.

Sachin Nalawade et al. (2019) stated that for earn value audit various programs were designed like 2008 Visual studio , 2005 SQL server , MS project 2007 and primavera p6 and conclude that primavera P6 is best tool. Tracking gives overall idea about the cost & time of project.

Suhaas K B (2016) aimed to fix baseline by which EVA can be performed. The primavera software tool was used for analysis. The manpower was taken into accounts while materials and machinery cost was not considered. Project work can be fluently completed was concluded with the help of utilization of Program.

Tania Deena Alex (2015) used EVM technique for measurement of the progress of project & Actual cost & cost budgeted of work can be compared with its help. A multi-storey building was considered for planning, scheduling and cost management. For EVM analysis the Primavera software was used. Primavera P6 supports the conclusion that control and monitoring of a project can be made easier by EVM.

### IV. METHODOLOGY

#### 4.1 Case Study

This research is done for the purpose of analysis of capability enhancement using EVM. An ongoing residential building project is selected as a case study. The type of work is Structural Repair & Painting and Estimated Budget is 24,28,290 Rupees.

Data collection-The data collected is the estimated and ongoing budget and scheduled plans. Also the require work progress details are collected timely from the respective authority at site.

#### 4.2 Planning and monitoring project using Primavera P6

The use of software simplifies the vast and complex construction projects. Primavera is one of the software used as project management tool. It has EVM function ability for tracking the project progress. The use of software is efficient compared to manual calculation of EVM. (Mullapudi Durga Sruthi et al., 2020)

- Following steps are to be considered for creation & scheduling of a project in Primavera—

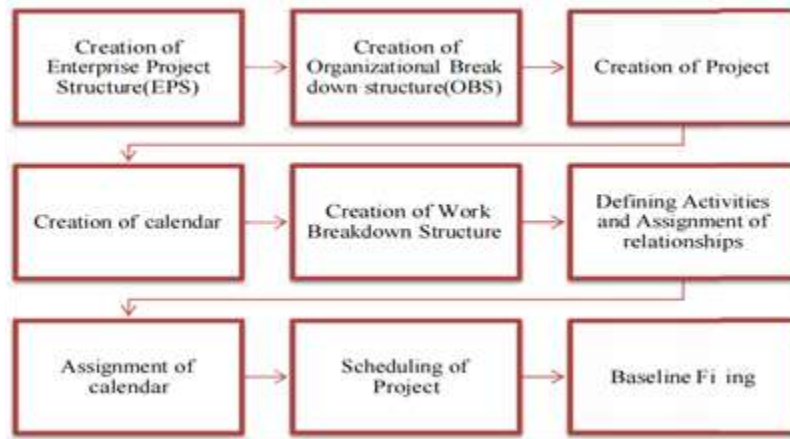


Fig. 1. Steps of creation and scheduling project in Primavera P6

- Steps to perform EVM in Primavera



Fig. 2. Steps to perform EVM of project in Primavera P6

Enterprise Project Structure (EPS) is a hierarchical representation which shows structure and levels of organization depending on project scope (Fig. 3). Organizational Breakdown Structure (OBS) is an organizational framework arrange in accordance to position of responsibilities (Fig. 4). EPS and OBS are created according to the data collected by organization of case study.

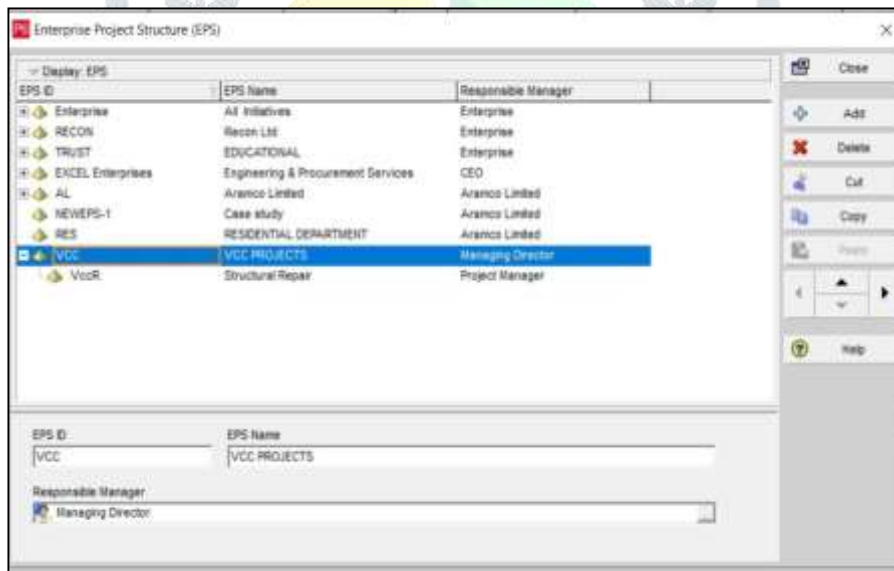


Fig. 3. Primavera P6 Structure of Project Enterprise

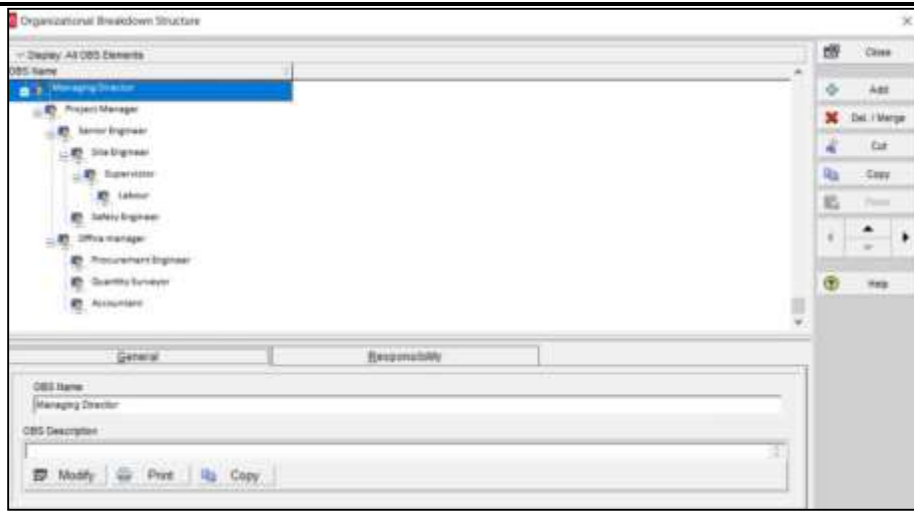


Fig. 4. Organizational Breakdown structure inside Primavera P6

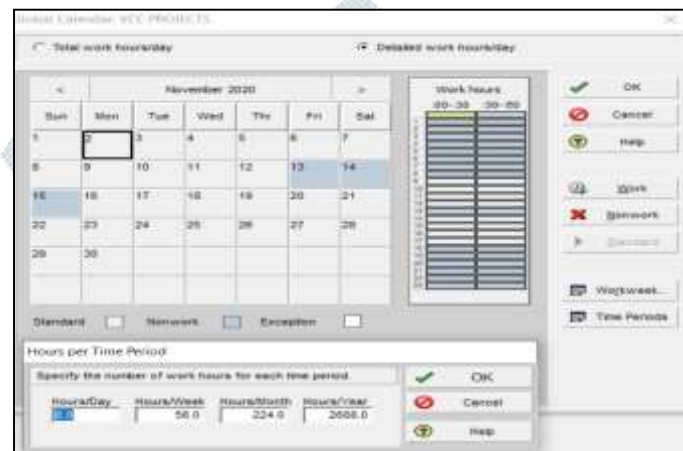


Fig. 5. Calendar

WBS Path	WBS Code	WBS Name	Start	Finish	Total Activities
VCC-1	VCC-1	On Software (incl. Theme)	20-Oct-20	25-Feb-21	43
1	VCC-1.1	INITIATION PHASE	20-Oct-20	19-Nov-20	5
1.1	VCC-1.1.1	SURVEY & TESTING	20-Oct-20	05-Nov-20	3
1.2	VCC-1.1.2	SAFETY & PROTECTION MEASURE	20-Oct-20	19-Nov-20	2
2	VCC-1.2	Treatment	04-Nov-20	07-Dec-20	15
2.1	VCC-1.2.1	STRUCTURAL TREATMENT	04-Nov-20	27-Nov-20	6
2.2	VCC-1.2.2	WATERPROOFING	09-Nov-20	07-Dec-20	9
3	VCC-1.3	PLUMBING WORKS	19-Nov-20	04-Dec-20	3
3.1	VCC-1.3.1	DRAINAGE LINE	19-Nov-20	04-Dec-20	3
3.1.2	VCC-1.3.1.2	WATER SUPPLY LINE	27-Nov-20	04-Dec-20	1
7	VCC-1.7	PLASTERING	02-Dec-20	30-Dec-20	2
4	VCC-1.4	PAINING	02-Jan-21	20-Feb-21	11
4.1	VCC-1.4.1	PREPARATION OF SURFACE	02-Jan-21	20-Feb-21	11
4.1.2	VCC-1.4.1.2	APPLICATION OF PAINT	10-Jan-21	20-Feb-21	6
5	VCC-1.5	MISCELLANEOUS	09-Feb-21	16-Feb-21	3
6	VCC-1.6	CLOSING PHASE	11-Feb-21	26-Feb-21	4

Fig. 6. Primavera P6 program Work breakdown structure

After the initial steps of EPS and OBS, project is fabricated containing projects ID, starting and ending dates, total stretch of time and responsibilities of managers. The WBS is created by dividing the projects into subparts (Fig. 6). Activities are

identified, total 43 activities created. The calendar can be used from the standard global calendar or can be customized according to requirement of organization and project. Then the calendar is assigned to the project (Fig. 5).

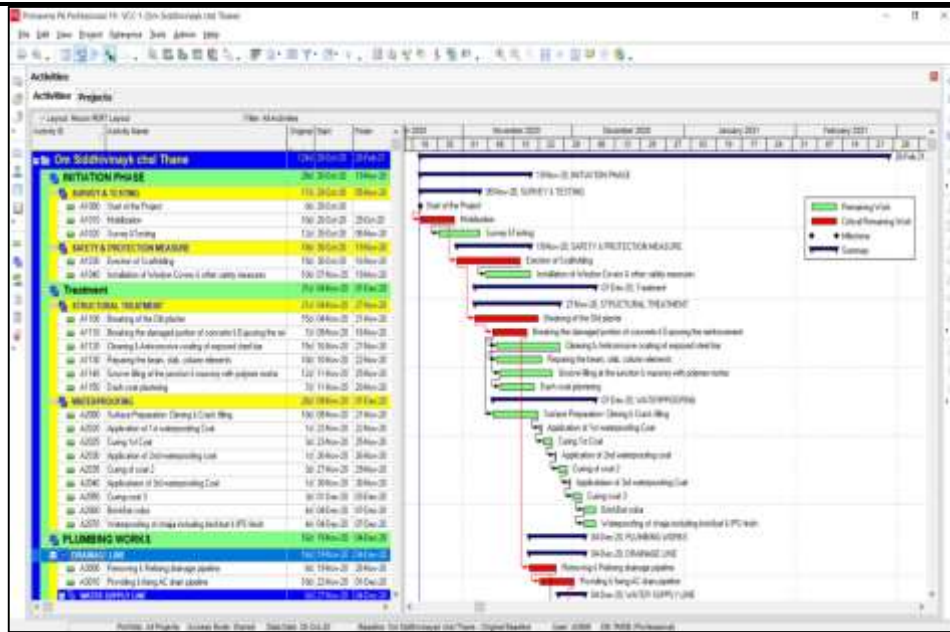


Fig. 7. Relationships & Activities (1)

The activity details given such as start and end date, type of activity, respective WBS (Fig. 7&8). The activities are linked to each other according to require activity relationships i.e. start to start, start to finish, finish to start and finish to finish.(Fig. 7&8).

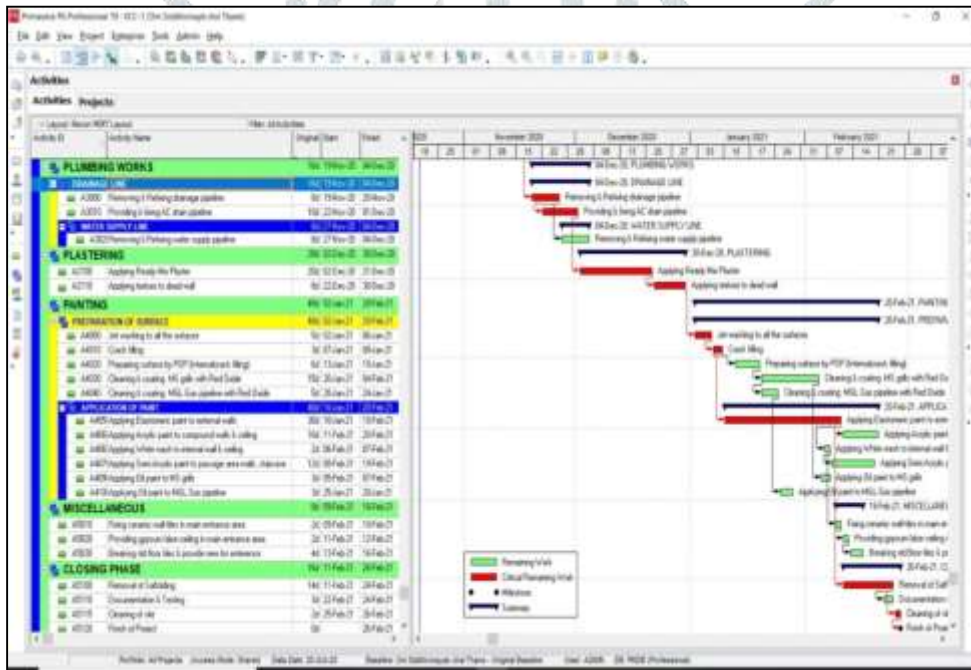


Fig.8. Activities and Relationships (2)

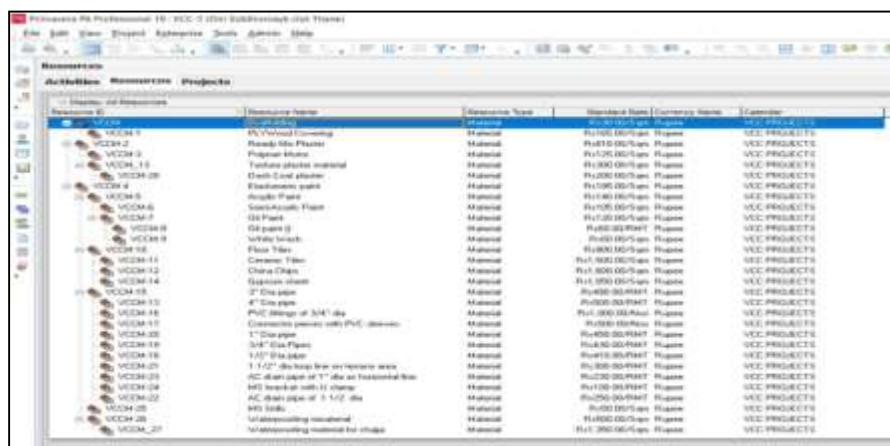


Fig. 9. Resources

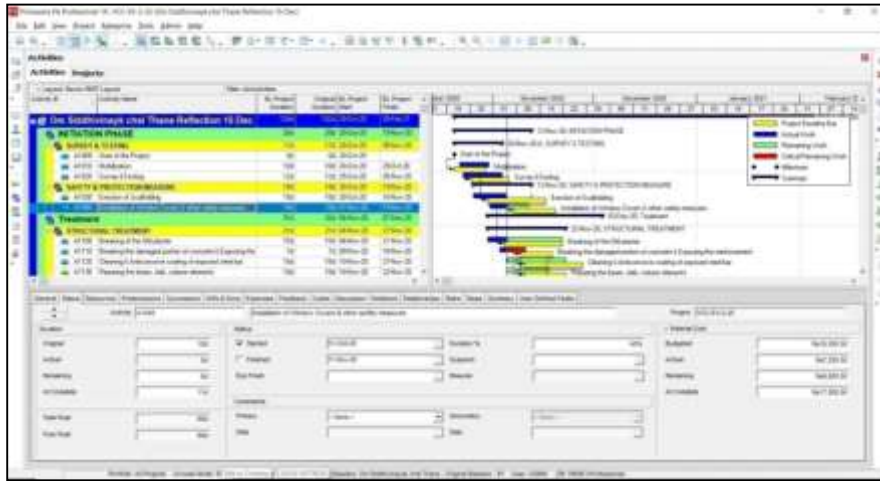


Fig. 10. Tracking Progress

The detailed resources with detail as resource type, standard rate, currency, assigned calendar are created (Fig. 9).required resources are assigned to the activities (Fig. 9). Baseline fixing is storing copy of original planning for reference and it is followed by Scheduling the project. The project is updated according to its progress on site (Fig.10). By adding required columns, the results of EVM can be analysed.

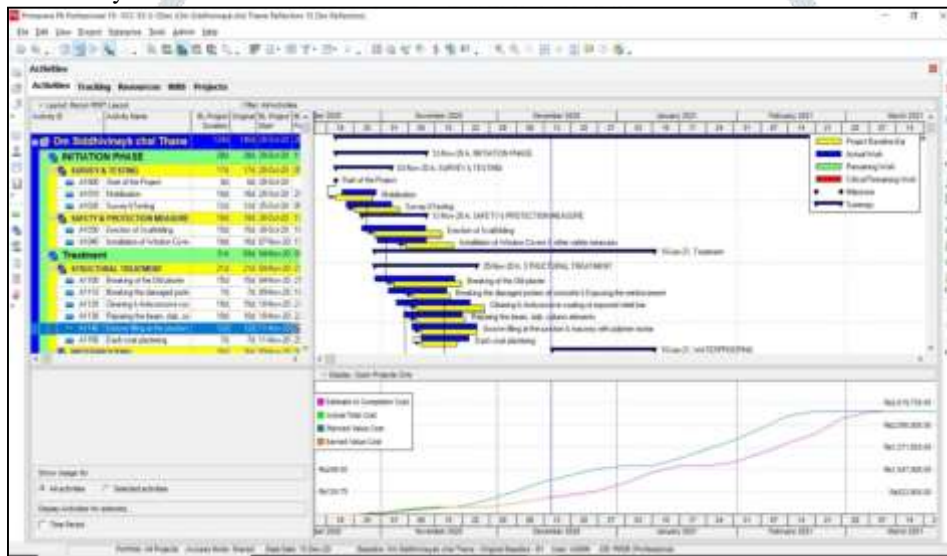


Fig. 11. Analysis

**V. RESULTS**

The continuous project progress is tracked to gain the knowledge of project status. In initial month of project is has CPI equals to 0.98 indicating the under budget status. The SPI is found out to be 1.3 indicating leading schedule. On November End, the project was still under budget with the CPI equals to 0.95 but slightly lagging in schedule with the SPI of 0.6. In the mid of December the value of CPI came out to be 1 .The SPI equals to 0.5 showing delay (lag) in schedule equals to 0.5.

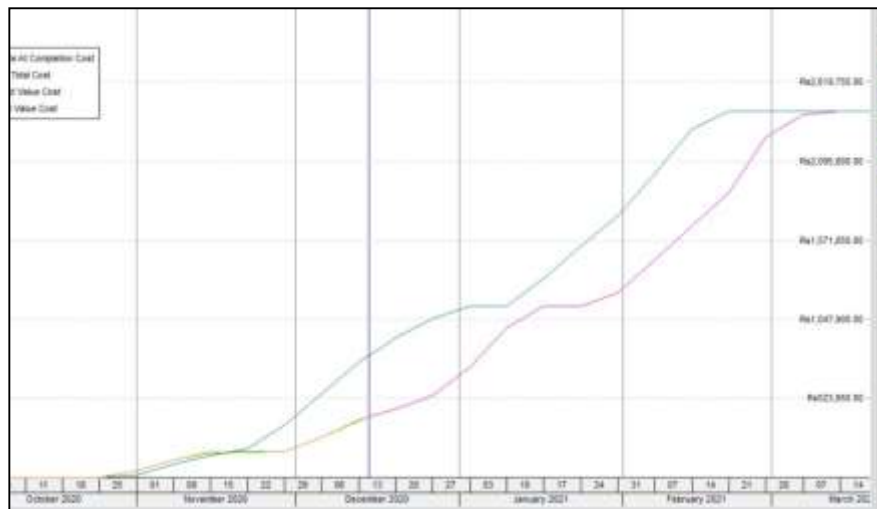


Fig.12. EVM graph in Primavera

The activity wise tracking shows the detail analysis. 50% of activities are on budget, 33% are under budget and only 17% activities are over budget. 83% of activities are on schedule and 17% activities are leading.

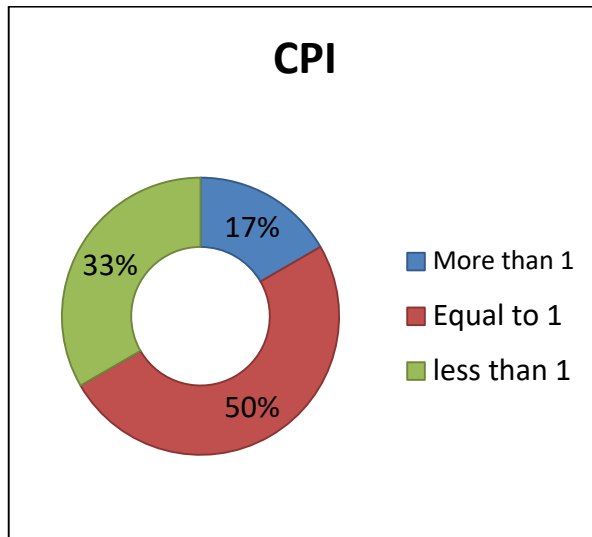


Fig. 13 Activity wise CPI

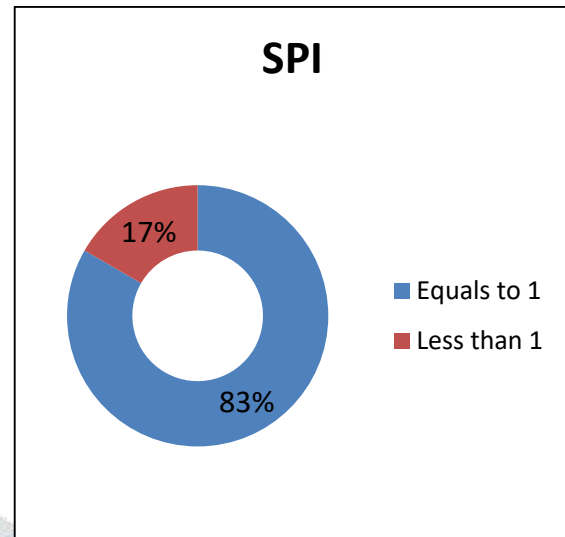


Fig. 14 Activity wise SPI

Table 5 Tracking and forecasting details of project

Tracking & Forecasting of project (15 Dec)		
Parameters	Value	Remark
Actual Cost	Rs. 4,05,980	
Earned Value	Rs. 4,04,441	
Cost Variance	Rs. -1,538	
SPI	0.5	Behind the Schedule
CPI	1	On budget
Budget at Completion	Rs. 24,28,290	
Estimate to complete	Rs. 20,20,514	
Variance at completion	Rs. 1,796	

The starting date of project is 20 Due to the time constraint the results until 15 December 2020 are presented. In this span, it is seen that the status is constantly changing. Initially leading schedule started in the second month of project. The unavailability of material due to post covid-19 circumstances is the reason of delay in project. The necessary actions taken such as scheduling the activities in parallel and increase in the workforce will help to cope up this delay in its initial stage only.

## VI. CONCLUSION

- Even though the case study project is behind the schedule and within the budget, necessary actions can prevent the delay and cost overrun.
- The results confirm that, the Earned Value Management tool leads to efficient monitoring and tracking of the project.
- The results are aware to the project manager with detailed knowledge of project performance and guides for necessary actions.
- The Earned Value management in primavera increases efficiency of project performance.

## VII. ACKNOWLEDGMENT

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## REFERENCES

- [1] Amruta B. Vyas and B. V. Birajdar, "Tracking of Construction Projects by Earned Value Management", International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181, Vol. 5 Issue 03, March-2016.
- [2] Andrew Fernans Tom, Sachin Paul, "Project Monitoring and Control using Primavera", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 2, Issue 3, March 2013.
- [3] Ankur Verma, K.K. Pathak and R K Dixit, "Earned Value Analysis of Construction Project at Rashtriya Sanskrit Sansthan, Bhopal", International Journal of Innovative Research in Science, Engineering and Technology Vol. 3, Issue 4, April 2014.
- [4] Dirga Oktrianto and Budi Susetyo, "Productivity Analysis for Performance Measurement by (Earned Value Management) EVM in High-Level Building Projects", International Journal of Engineering Research and Advanced Technology (IJERAT) , Volume.6, Issue 7 July -2020.
- [5] Kunal B Badgular1, B A Konnur, "EVM Analysis with Primavera", International Research Journal of Engineering and Technology (IRJET), Volume: 03 Issue: 06, June 2016.
- [6] Mullapudi Durga Sruthi and Achuthan Aravindan, "Performance measurement of schedule and cost analysis by using earned value management for a residential building", Elsevier, Materials Today: Proceedings, 2214-7853, 2020.
- [7] Naderpour and m. Mofid, "Improving Construction Management of an Educational Center by Applying Earned Value Technique", Elsevier, Procedia Engineering 14 (2011) 1945–1952.
- [8] Rajat and Masoom Reza, "Time and Cost Control using Primavera P6 in Construction of Buildings", International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 Vol. 8 Issue 11, November-2019.
- [9] Sachin Nalawade, Omkar Ghode, Piyush Vaidya, "Earn value analysis of construction project using primavera p6", Cikitusi Journal for Multidisciplinary Research, ISSN NO: 0975-6876, Volume 6, Issue 5, May 2019.
- [10] Sharanabasava Patil, Ramya Kavuru and Md Ruhina Begum, "Analysis of Construction Project Using Earned Value - A Case Study", Journal of critical reviews Issn- 2394-5125 vol 7, issue 04, 2020.
- [11] Suchithra L, Anne Ligorina S, "Tracking and management of construction projects using primavera", International Research Journal of Engineering and Technology (IRJET), Volume: 04 Issue: 07, July -2017.
- [12] Suhas K B and Vijay K, "Base Line Fixing and Earned Value Analysis in Construction Industry using Primavera", International Journal of Engineering Research & Technology, Vol. 5 Issue 08, August-2016.
- [13] T. Subramani1, D. S. Stephan Jabasingh2 and J. Jayalakshmi, "Analysis of Cost Controlling In Construction Industries by Earned Value Method Using Primavera", Int. Journal of Engineering Research and Applications ISSN: 2248- 9622, Vol. 4, Issue 6 (Version 1), June 2014, pp.145-153.
- [14] Tania Deena Alex and Sahimol Eldhose, "Forecasting Project Performance using Earned Value Analysis", International Journal of Innovations in Engineering and Technology (IJIET), Volume 5 February 2015.

