

PROJECT PERFORMANCE USING EARN VALUE MANAGEMENT

¹Deepa N C, ²Rajani V Akki

¹PG Student, ²Assistant Professor
Department of civil Engineering,
East Point College of Engineering and Technology
Bangalore, India

Abstract- Most of the infrastructure projects are not complete at due cost and time. It may take over budget and more time for completion of project than estimated due to lack of project monitoring on regular basis. The majority of the mistakes and challenges that occur during the project are still fluid at the performance and monitoring phase. Earn value technique is developed to evaluate the performance of project which helps to monitor and improve the management control system of a project. In the present study, a construction of Metro Station at Bangalore airport terminal had taken as a case study. Earn value management technique was performed using Primavera P6 software. This technology helps in comparing the scheduled budgeted cost with actual cost of work. Tracking of project had been done by three times at different stages of work and named as case-1, case-2 and case-3 to know the project status. At case-1, it was behind the schedule and on budget. At case-2 period, it was behind schedule and over budget. To overcome from the cost overrun and delay in time control measures were taken after case-2 analysis. Finally, at case-3 project was restored back to keep the project, almost on schedule and near to the budgeted cost. Thus, monitoring and controlling of project using Earn Value Management improved the project performance.

Index Terms- Earn Value Management (EVM), Project Performance.

I. INTRODUCTION

Project management involves initiation, planning, execution and closing by monitoring and controlling all the works during the headway of the project. The majority of the projects in the construction industry are not completed at due cost and time. It may take more time and over budget for the completion of a project than estimated due to a lack of proper way in project monitoring. The majority of the mistakes and challenges that arise during a construction project are still fluid during the monitoring phase. This denotes that the management team still has the chance to adjust the plan. Generally, a project involves a number of tasks that expanse for a lengthy period, only after finishing the first activity we can go on to the next. So, Project monitoring makes sure that activities are done rightly and that any problem noticed can be fixed in time.

There are various project performance tools are available to project tracking. Due to the limitations of traditional project performance tools, the Earn Value Analysis technique using project management software like Microsoft Project and Primavera P6 is an effective tool for monitoring and control of construction projects. Project performance is an overall measurement of projects progress, timeline and budget. Performance is constantly evaluated in order to keep the project on track. The main aim of project performance is to maintain the project work on budget and on time. Project performance are conducted at many intervals of the period from the project starts and it is evaluated through the monitoring and control phase of project management. Earn value management is an effective technique for project performance evaluation.

EVM is a methodology that integrates the measurement of scope, cost and schedule. The earned value system focuses mainly on two variables as Schedule and cost. It is used to evaluate the project performance in the project. It provides valuable insights into the project health by measuring the planned work against actual work. It also tells the total cost of project completion. It gives warning signal.

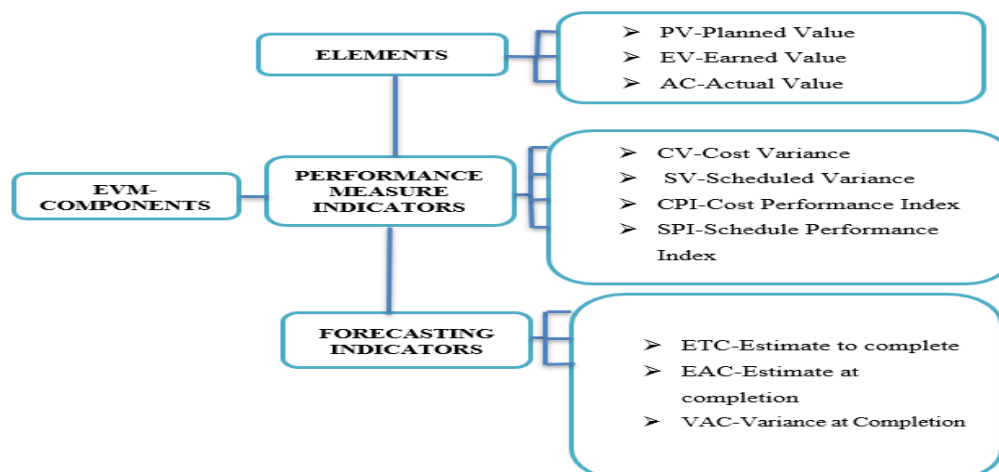


Fig 1 EVM Chart

- PLANNED VALUE (PV)- It is the amount of task that is estimated and planned to be done by a specific date.
- EARNED VALUE (EV)- It is the amount of the task that is actually completed.
- ACTUAL COST (AC)- it is the addition of the amounts which has been spent on the project so far.
- COST VARIANCE (CV) = EV – AC

Positive CV indicates under budget, Negative CV indicate over-budget, Zero CV shows that no change in the budgeted and actual cost.

- SCHEDULE VARIANCE (SV) = EV – PV

Positive SV indicates ahead of schedule, Negative SV indicates behind schedule, Zero SV indicates on schedule.

- COST PERFORMANCE INDEX(CPI) =EV/AC

CPI<1, indicate the task is over budget CPI = 1, indicate the task is on budget and CPI>1, indicate task is under budget.

- SCHEDULE PERFORMANCE INDEX(SPI)= EV/PV

SPI <1, indicate the task is behind schedule, SPI=1, indicate the task is on schedule and SPI >1, indicate ahead of schedule.

- ESTIMATE AT COMPLETION (EAC)- Expected budget at the end of the project, taking into account the variances that have already happened.

- ESTIMATE TO COMPLETE (ETC)- ETC forecasts the money needed for finishing the remaining work of a project.

- VARIANCE AT COMPLETION (VAC)- VAC is obtained by subtracting the EAC from the corresponding BAC.

OBJECTIVES:

1. To track the project to get a timely view of cost and schedule performance using EVM in Primavera P6 software.
2. To analyze the variance and performance indices calculated from earned elements and to forecast the project cost.
3. To take actions to overcome from the project's cost overrun and time delay during the progress of project.

I. LITERATURE REVIEW

1. B.S. Vinoth Kumar, C. Guru Moorthy, R. Murali (2021) in their paper entitled “Time and Cost Control using Earned Value Management” have made an attempt to compare between budgeted cost and actual cost using Earn Value Techniques. The Primavera P6 was used to track and analyses the performance of project. They have concluded that Actual Cost is higher than the Earn Value Cost for the Project. The Budget at completion is found to be Rs. 98,880/- and estimate to complete is found to be Rs. 40,861/-.

2. Sachin Nala wade, Omkar Ghode, Piyush Vaidya (2019) in their paper entitled “Earn Value Analysis of Construction Project using P6” have made an attempt to know project with budgeted cost and with time or not. The PV value is found to be Rs. Rs. 712108.06/-, EV is found to be Rs.612633.53/- and AC is found to be Rs.312633.53/-. The SPI is 0.86 hence the project is behind the schedule and CPI is 0, hence the project is on budget.

3. F Salahaldeen, W. M. Kurniaji (2020) their paper entitled “Effective Performance Evaluation to Estimate Cost and Time using Earned Value” have made on attempt to measure the performance using EV analysis, consisting of hotels, apartments and malls in Indonesia was made. The data obtained were analyzed and results of this study indicate that SPI as 0.58 and 41.48% delay. The CPI is 1.25. At the end of review period, the estimated final project costs were obtained.

II. METHODOLOGY



Fig 2 Earn Value Analysis Flow chart

III. PROJECT DESCRIPTION

The selected project for the case study was construction of Metro Station in Bangalore Airport Terminal. These are designed and built to provide a means for passengers to purchase tickets, board trains and evacuate the system in emergency. The budgeted cost of civil works was estimated as Rs. 84,82,81,200.

IV. PROJECT IMPLEMENTATION

1. Login to Primavera P6 software.
2. Create a new EPS (Enterprise Project Structure).
3. Create a Project: Under metro station EPS, a new project named Metro station -March was created. The plan starts and finish for the project were also added and saved.
4. Create a calendar for activity.
5. Create WBS (Work Break Down Structure).
6. Define activity with duration and assign the relation between the activities.
7. Schedule the project: Scheduling was done using either schedule button or simply pressing the F9 button to get the critical path and critical duration.
8. Budget allocation: The budgeted cost of the project had been obtained by assigning the resources to each activity.
9. Baseline Creation: The baseline was created using maintain baseline option and the created baseline had been linked with the corresponding project using assign option.

CASE -1

The project was started on March 10th 2022. The first tracking of project in order to know the project performance made on 20th April 2022.

1. Update Schedule Progress: The project was tracked on 20th April 2022 by using update schedule progress option. The tracking date was entered as a new date in update progress dialogue box schedule and scheduled planned percentage of work was obtained. As of this date, this project had a scheduled progress of 61.26% and the corresponding planned Value as Rs. 52,21,35,400/-.
2. Actual progress: The actual progress of each activity that was completed at the site were collected and entered in the percentage activity complete column. If cost utilized has variance with earned cost, then actual cost details would have collected and entered. In case 1 actual cost is same as earned cost.
3. Earn Value analysis: After the completion of all the input parameters, Primavera P6 automatically calculates the EVM elements, Variances performance and forecasting indicators of the project. Reports and S-curves were generated after completion of EVA.

CASE-2

Only 20% of work was accomplished by the end of 20th April 2022. The project was halted for few months due to some delays like financial sanction, heavy rainfall and restarted on December 1st 2022. Therefore, project was rescheduled and tracked for project performance.

1. Reschedule the project: December 1st 2022 was entered as current start date in schedule dialogue box and scheduled.
2. New Baseline Creation: New baseline was created using maintain baseline option and it had been assigned to the reschedule project.
3. Update Schedule Progress: The project was tracked on 26th December 2022 by using update schedule progress. The tracking date was entered as a new date in update progress dialogue box schedule and scheduled planned percentage of work was obtained. As of this date, this project had a Scheduled percentage Complete of 92.04%. and the corresponding planned value as Rs. 78,07,43,240/-.
4. Actual progress: The actual progress of each activity that was completed at the site were collected and entered in the percentage activity complete column. The actual cost of work accomplished had also been entered in case-2.
5. Earn Value Analysis: After the completion of all the input parameters, Primavera P6 automatically calculates the EVM elements, Variances, performance and forecasting indicators of the project. Reports and S-curves were generated after completion of EVA

CASE – 3

Case 3 is the tracking of the project after the control measures were applied after Case-2 Earn value analysis. Tracking was made on 20th January 2023.

1. Update Schedule Progress: The project was tracked on 20th January 2023 by using update schedule progress. The tracking date was entered as a new date in update progress dialogue box schedule and scheduled planned percentage of work was obtained. As of this date, this project had a Scheduled progress of 99.95% and the corresponding Planned Value as Rs. 84,78,80,800/-.
2. Actual progress: The actual progress of each activity that was completed at the site were collected and entered in the percentage activity complete column.
3. Earn Value Analysis: After the completion of all the input parameters, Primavera P6 automatically calculates the EVM metrics, Variances, performance and forecasting indicators of the project. Reports and S-curves were generated after completion of Earn value analysis.

V. RESULTS AND DISCUSSIONS

Case-1: Earn Value Analysis Report

METROSTATION-MARCH		Classic Schedule Layout										04-Jul-23 13:53
Activity ID	Activity Name	Planned Value Cost	Earned Value Cost	Actual Cost	Cost Variance	Schedule Variance	Cost Performance Index	Schedule Performance Index	Budget At Completion	Estimate To Complete	Estimate At Completion Cost	Variance At Completion
PROJ-1	METROSTATION-MARCH	Rs522,135,400.00	Rs391,132,120.00	Rs391,132,120.00	Rs0.00	(Rs131,003,280.00)	1.00	0.75	Rs848,281,200.00	Rs457,149,080.00	Rs848,281,200.00	Rs0.00
PROJ-1.1	AIRPORT TERMINAL ME	Rs522,135,400.00	Rs391,132,120.00	Rs391,132,120.00	Rs0.00	(Rs131,003,280.00)	1.00	0.75	Rs848,281,200.00	Rs457,149,080.00	Rs848,281,200.00	Rs0.00
PROJ-1.1.1	TVF ROOMS	Rs64,282,000.00	Rs63,779,200.00	Rs63,779,200.00	Rs0.00	(Rs502,800.00)	1.00	0.99	Rs66,588,600.00	Rs22,809,400.00	Rs66,588,600.00	Rs0.00
PROJ-1.1.2	LOADING DOCK	Rs30,576,000.00	Rs30,576,000.00	Rs30,576,000.00	Rs0.00	Rs0.00	1.00	1.00	Rs30,576,000.00	Rs0.00	Rs30,576,000.00	Rs0.00
PROJ-1.1.3	UNDERCROFT LEVEL	Rs0.00	Rs0.00	Rs0.00	Rs0.00	Rs0.00	0.00	0.00	Rs2,544,400.00	Rs2,544,400.00	Rs2,544,400.00	Rs0.00
PROJ-1.1.4	RAIL LEVEL	Rs2,940,000.00	Rs806,500.00	Rs806,500.00	Rs0.00	(Rs2,033,500.00)	1.00	0.31	Rs21,831,000.00	Rs20,924,500.00	Rs21,831,000.00	Rs0.00
PROJ-1.1.5	ZERO LEVEL	Rs101,895,600.00	Rs75,187,460.00	Rs75,187,460.00	Rs0.00	(Rs26,708,140.00)	1.00	0.74	Rs183,752,800.00	Rs108,565,340.00	Rs183,752,800.00	Rs0.00
PROJ-1.1.6	CONCOURSE LEVEL SLAB	Rs322,254,800.00	Rs220,572,960.00	Rs220,572,960.00	Rs0.00	(Rs101,681,840.00)	1.00	0.68	Rs520,031,400.00	Rs299,458,440.00	Rs520,031,400.00	Rs0.00
PROJ-1.1.7	INSTALLATION OF EXPANSIC	Rs187,000.00	Rs110,000.00	Rs110,000.00	Rs0.00	(Rs77,000.00)	1.00	0.59	Rs2,957,000.00	Rs2,847,000.00	Rs2,957,000.00	Rs0.00

FIG 3 CASE 1-EVM REPORT

Case-1: S-Curve

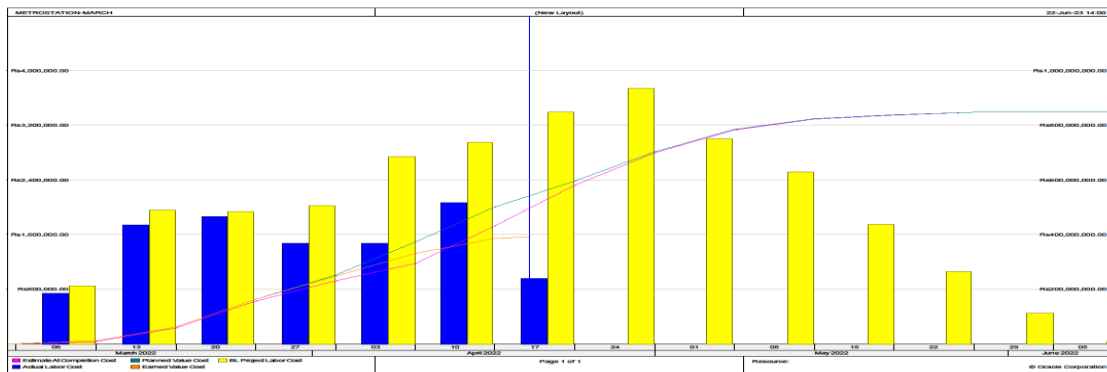


FIG 4 CASE 1- S CURVE

Case-2: Earn Value Analysis Report

METROSTATION-DEC		Classic Schedule Layout										04-Jul-23
Activity ID	Activity Name	Planned Value Cost	Earned Value Cost	Actual Cost	Cost Variance	Schedule Variance	Cost Performance Index	Schedule Performance Index	Budget At Completion	Estimate To Complete	Estimate At Completion Cost	Variance At Completion
PROJ-2	METROSTATION-DEC	Rs780,743,240.00	Rs700,608,400.00	Rs781,180,040.00	Rs80,571,640.00	(Rs80,134,840.00)	0.90	0.90	Rs848,281,200.00	Rs158,988,930.98	Rs940,168,970.98	Rs1,887,770.98
PROJ-2.1	AIRPORT TERMINAL ME	Rs780,743,240.00	Rs700,608,400.00	Rs781,180,040.00	Rs80,571,640.00	(Rs80,134,840.00)	0.90	0.90	Rs848,281,200.00	Rs158,988,930.98	Rs940,168,970.98	Rs1,887,770.98
PROJ-2.1.1	TVF ROOMS	Rs79,163,600.00	Rs70,544,000.00	Rs79,250,400.00	Rs8,706,400.00	(Rs8,619,600.00)	0.89	0.89	Rs66,588,600.00	Rs24,528,428.57	Rs103,778,828.57	Rs1,190,228.57
PROJ-2.1.2	LOADING DOCK	Rs30,576,000.00	Rs30,576,000.00	Rs30,576,000.00	Rs0.00	Rs0.00	1.00	1.00	Rs30,576,000.00	Rs0.00	Rs30,576,000.00	Rs0.00
PROJ-2.1.3	UNDERCROFT LEVEL	Rs2,544,400.00	Rs1,272,200.00	Rs2,556,400.00	Rs1,284,200.00	(Rs1,272,200.00)	0.50	0.50	Rs2,544,400.00	Rs2,556,400.00	Rs5,112,800.00	Rs2,568,400.00
PROJ-2.1.4	RAIL LEVEL	Rs9,065,000.00	Rs9,065,000.00	Rs9,065,000.00	Rs0.00	Rs0.00	1.00	1.00	Rs21,831,000.00	Rs12,766,000.00	Rs21,831,000.00	Rs0.00
PROJ-2.1.5	ZERO LEVEL	Rs180,564,840.00	Rs180,391,840.00	Rs180,730,040.00	Rs338,200.00	(Rs173,000.00)	1.00	1.00	Rs183,752,800.00	Rs3,838,000.00	Rs184,568,040.00	Rs815,240.00
PROJ-2.1.6	CONCOURSE LEVEL SLAB	Rs477,394,000.00	Rs407,615,960.00	Rs477,491,600.00	Rs69,875,640.00	(Rs69,778,040.00)	0.85	0.85	Rs520,031,400.00	Rs113,414,251.43	Rs690,905,851.43	Rs7,874,451.43
PROJ-2.1.7	INSTALLATION OF EXPANSIC	Rs1,435,400.00	Rs1,143,400.00	Rs1,510,600.00	Rs367,200.00	(Rs292,000.00)	0.76	0.80	Rs2,957,000.00	Rs1,885,850.98	Rs3,396,450.98	Rs439,450.98

Fig 5 Case 2-EVM Report

Case-2: S-Curve

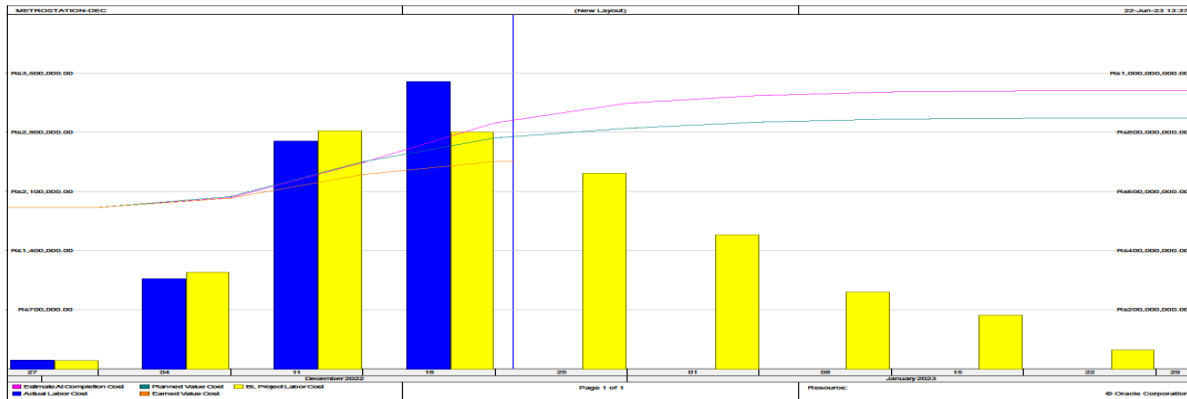


Fig 6 Case-2 S Curve

Case-3: Earn Value Analysis Report

Activity ID	Activity Name	Planned Value Cost	Earned Value Cost	Actual Cost	Cost Variance	Schedule Variance	Cost Performance Index	Schedule Performance Index	Budget At Completion	Estimate To Complete	Estimate At Completion Cost	Variance At Completion
PROJ-3	METROSTATION-JAN	Rs947,880,880.00	Rs946,631,260.00	Rs946,908,460.00	(Rs277,200.00)	(Rs1,249,620.00)	1.00	1.00	Rs948,281,200.00	Rs1,649,940.00	Rs948,558,400.00	(Rs277,200.00)
PROJ-3.1	AIRPORT TERMINAL ME	Rs947,880,880.00	Rs946,631,260.00	Rs946,908,460.00	(Rs277,200.00)	(Rs1,249,620.00)	1.00	1.00	Rs948,281,200.00	Rs1,649,940.00	Rs948,558,400.00	(Rs277,200.00)
PROJ-3.1.1	TVF ROOMS	Rs86,588,600.00	Rs85,271,000.00	Rs85,299,800.00	(Rs28,800.00)	(Rs1,317,600.00)	1.00	0.98	Rs86,588,600.00	Rs1,317,600.00	Rs86,617,400.00	(Rs28,800.00)
PROJ-3.1.2	LOADING DOCK	Rs30,576,000.00	Rs30,576,000.00	Rs30,576,000.00	Rs0.00	Rs0.00	1.00	1.00	Rs30,576,000.00	Rs0.00	Rs30,576,000.00	Rs0.00
PROJ-3.1.3	UNDERCROFT LEVEL	Rs2,544,400.00	Rs2,544,400.00	Rs2,544,400.00	Rs0.00	Rs0.00	1.00	1.00	Rs2,544,400.00	Rs0.00	Rs2,544,400.00	Rs0.00
PROJ-3.1.4	RAIL LEVEL	Rs21,770,280.00	Rs21,803,400.00	Rs21,803,400.00	Rs0.00	Rs33,120.00	1.00	1.00	Rs21,831,000.00	Rs27,600.00	Rs21,831,000.00	Rs0.00
PROJ-3.1.5	ZERO LEVEL	Rs183,752,800.00	Rs183,752,800.00	Rs183,905,200.00	(Rs162,400.00)	Rs0.00	1.00	1.00	Rs183,752,800.00	Rs0.00	Rs183,905,200.00	(Rs152,400.00)
PROJ-3.1.6	CONCOURSE LEVEL SLAB	Rs519,918,600.00	Rs519,906,660.00	Rs520,002,660.00	(Rs86,000.00)	(Rs11,940.00)	1.00	1.00	Rs520,031,400.00	Rs124,740.00	Rs520,127,400.00	(Rs86,000.00)
PROJ-3.1.7	INSTALLATION OF EXPANSIC	Rs2,730,200.00	Rs2,777,000.00	Rs2,777,000.00	Rs0.00	Rs46,800.00	1.00	1.02	Rs2,957,000.00	Rs180,000.00	Rs2,957,000.00	Rs0.00

Fig 7 Case-3 EVM Report

Case-3: S-Curve

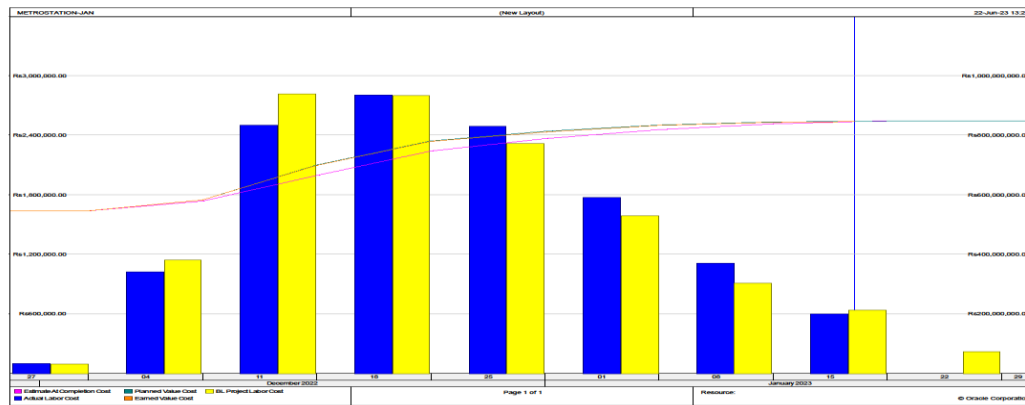


Fig 8 Case-3 S-Curve

(A) SUMMARY OF RESULTS

Table 1 Summary of Results

Sl. No	EVA Parameter	Case-1	Case-2	Case-3
1	Tracking Date	20 th April 2022	26 th December 2022	20 th January 2023
2	Planned value	52,21,35,400	78,07,43,240	84,78,80,800
3	Earned Value	39,11,32,120	70,06,08,400	84,66,31,260
4	Actual Cost	39,11,32,120	78,11,80,040	84,69,08,460

Sl. No	EVA Parameter	Case-1	Case-2	Case-3
5	Schedule Variance	-13,10,03,280	-8,05,71,640	-12,49,620
6	Cost Variance	0	-8,01,34,840	-2,77,200
7	Schedule Performance Index	0.75	0.9	1
8	Cost Performance index	1	0.9	1
9	Budgeted At cost	84,82,81,200	84,82,81,200	84,82,81,200
10	Estimate To Complete	45,71,49,080	15,89,88,930	16,49,940
11	Estimate At completion	84,82,81,200	94,01,68,970	84,85,58,400

(B) PERFORMANCE INDICES INTREPRETATION

Table 2 Performance Indices Interpretation

Sl. No	Performance Indicator	Case-1	Case-2	Case-3
1	SPI	0.75	0.9	1
2	Status	Behind Schedule	Behind Schedule	On Schedule
3	CPI	1	0.9	1
4	Status	On Budget	Over Budget	On Budget

(C) FORECASTING INDICATORS INTREPRETATION

Table 3 Forecasting Indicators Interpretation

Sl. No	EVA Parameter	Case-1	Case-2	Case-3
1	BAC	84,82,81,200	84,82,81,200	84,82,81,200
2	ETC	45,71,49,080	15,89,88,930	16,49,940
3	EAC	84,82,81,200	94,01,68,970	84,85,58,400
4	VAC=EAC-BAC	0	9,18,87,770	2,77,200
5	STATUS	No difference between EAC & BAC.	Contractor will be on cost overrun.	Contractor will have less cost overrun than Case-2

VI. CONCLUSION

The Earn Value Analysis for the performance measurement of infrastructure project was successfully tested on the above case study. The EVA provides a clear insight into the project progress. It facilitates the project team to carry out in depth assessment of project status and predicts future performance as well.

This project can be concluded on the following parameters:

- Based on the inputs provided by the client, performed the Earned Value Management to further improve on the work progress percentage and also to have functional process in place.
- The EVA also helps the management to effectively utilize resources and to organize so as to cause untimely delay.
- Micro level management becomes easier when EVA is monitored at the activity level for effective project management.

Thus, suggest the management to implement the above suggestions to avoid similar delays in their future projects thus satisfying the objectives of the project.

VII. FUTURE ENHANCEMENT

- The outcome of EVA in this project can also be used as input for Decision Tree Analysis for various functionalities within the project.
- Return on Investment (ROI) plans can be generated using EVA so as to monitor good financial status of the project and keeping the investors profitable.
- Role of EVM in projects with incorporating Risk and Delay analysis can be carried out and analyses the changes or saving in cost and time as per planned cost and schedule

REFERENCES:

- [1] Akshay R Manohar and Rakshith Kumar Shetty, "Project Performance Evaluation through Earned Value Analysis IJRSET, Volume 05, Issue 09, August 2019.

- [2] B.S. Vinoth Kumar, C. Guru Moorthy and R. Murali, "Time and Cost Control using Earned Value Management" IRJET, Volume 08, Issue 03, March 2021.
- [3] F. Salahaldeen and W. M. Kurniaji, "Effective Performance Evaluation to Estimate Cost and Time using Earned Value" IOP Conference Series: Material Science and Engineering- 771 0120051, 2020.
- [4] I.Suaad Khaleel, Al-Fadhli and Shahlaa Hikmat Al-BazazAtul, "Applying Earn value to construction Projects" IOP Conference Series: Material Science and Engineering- 737 0120041, 2020.
- [5] Mohammad Irfandio Kurniawan, Diah Ayu Restuti Wulandar and Julistyana Tistogondo, "Evaluation of Construction Project Time and Cost Control based on Earned Value and Crash Project Method" Volume 21, Number 01, July 2021.
- [6] P. Sundara Kumar and M. Sharun, "Study and Analysis on Earned Value Management System in Construction Industry" IJCIET, Volume 09, Issue 03, pp. 332-338, March2018.
- [7] Rakibul Hasan, Showaib Ahmed Chowdhury and Jhumana Akter, "Construction Project Monitoring: The Cost and Schedule Control by Earned Value Method" JIMB, ISSN: 2289-7224, Volume 08, Issue 01, 2021.
- [8] S.P. Mahendra, Yateen Lokesh and P. Suvarna, "Planning, Scheduling and Tracking of ongoing Bridge Construction Project using Primavera Software and EVM Technique" IJAER, ISSN: 0973-4562, Volume 13, Issue 07, pp. 209-214, 2018.
- [9] Sachin Nalawade, Omkar Ghode and Piyush Vaidya, "Earn Value Analysis of Construction Project using P6" CJMR, ISSN No:0975-6876, Volume 06, Issue 05, May 2019.
- [10] Sharan Basava Patil, Ramya Kavuru and Md. Ruhina Begum, "Analysis of Construction Project Using Earned Value - A Case Study" JCR, ISSN: 2394-5125, Volume 07, Issue 04, 2020.