IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Scheduling And Delay Analysis Of Construction Project With Implementation Of Earned Value Management By Microsoft Project Management

[1] Mr. Milind M. Kamble, [2] Prof. G. N. Chavan-Patil

[1]P.G. Student, [2] Assistant Professor

[1] Construction Management,

[1] Ashokrao Mane Group of Institutions Vathar Tarf Vadgaon, Dist. - Kolhapur, Maharashtra, India

Abstract: Earned Value Management (EVM) is a sophisticated project management approach that gives a complete picture of how a project is doing by looking at three main areas: scope, schedule, and cost together. Unlike older ways of tracking projects that deal with budget or time separately, EVM brings these together into one system. It measures how much work has actually been done compared to what was planned, helping managers see if a project is on track or if there are problems that need fixing.

At the heart of EVM are three main values: Planned Value (PV), which is the budget for the work that was supposed to be done; Earned Value (EV), which shows the value of the work that has actually been completed; and Actual Cost (AC), which is the real money spent on the work done. By comparing these, EVM creates metrics like the Cost Performance Index (CPI) and Schedule Performance Index (SPI). These help to show if a project is staying within budget and on schedule, and they give useful information about whether action is needed to keep things on track.

However, to make EVM work well, you need careful planning, accurate data, and a clear understanding of what the project is supposed to achieve. If you set up the baseline wrong, or if data isn't recorded properly, or if people resist using this method, it can lead to problems. So, training and good processes are important for making the most out of EVM.

EVM is used in many different fields, like construction, defense, aerospace, IT, and manufacturing, where projects are complex and need tight control over costs and timelines. The ability of EVM to integrate different parts of project performance makes it especially useful in situations where changes to the project scope and budget constraints are common.

This paper looks into the basics of EVM, showing how it turns raw data into useful performance measures.

It also talks about the challenges people face when using EVM and suggests ways to overcome them. Through examples and industry cases, the paper shows how EVM helps make projects more successful by improving delivery, reducing risks, and helping with better decision-making.

KEYWORDS: Project Progress, EVM, Schedule overruns, Cost Overruns, Schedule Variance, Cost Variance.

I. INTRODUCTION

The construction industry is a key sector both globally and nationally. It's the largest industry in India and offers a lot of jobs, playing a big role in the country's economy. One of the main issues in this industry is project delays. Earned Value

Management is a way to measure how well a plan is doing compared to its original plan. Using this method helps set a standard for evaluating how a project is progressing and also helps control time and costs by following the responsibilities outlined in the Organizational Breakdown Structure. In the past, the budgeted cost was determined by comparing the amount that was planned to be spent with the actual amount that was spent on the project.

The main emphasis was on strategy spending and actual costs. Earned Value helps identify potential future problems and tracks how much real work has been completed. Using Earned Value Management helps project managers understand potential risk areas better. This gives them a clearer picture of how the project is spending money, so they can make plans to deal with risks based on actual costs, schedule, and how much work has been done technically.

It's like an alarm for managers to spot and handle issues early, so they can take quick steps to fix them before they get out of hand. Earn value acts as an early warning system to system to help managers take fast action. Normally, traditional management tells you how much money and time a job is likely to need before it starts, and how much has been spent during the job. Earn value management does the same thing—it tells you how much money and time a job is likely to need before it starts and how much has been spent during the job.

This helps in managing a project more effectively by keeping it on moment and within fund. Earn value management isn't a particular system or collection of tools, but rather a group of guidelines that support a company's management control system.

When there are cost overruns, the project management team may implement a value engineering program to cut expenses. This could mean reducing the quality in some areas of the project or increasing the budget to handle additional costs. In cases of time delays, the team might use strategies like fast tracking or time crashing to bring the project back on track. As a result, Earned Value Management, along with accurate and timely forecasting, plays a crucial role in helping the project meet its goals. This study involves the use of Earned Value to create a forecasting EAC (Estimate at Completion) using statistical and econometric methods, as well as traditional Earned Value indicators.

II. OBJECTIVES OF STUDY

- To study scheduling methods and delay factors in construction projects.
- To collect real project data from the project manager and contractor.
- To analyze the causes of delays and their impact on project performance.
- To analyze project performance using Earned Value Management (EVM) metrics in MS Project

III. DELAY ANALYSIS

A. *General :*

Delays in construction projects can happen because of mistakes in documents, problems with contractors, things outside the project's control, issues with the project owner, or conflicts within the team.

Delay analysis looks at which activities are important versus not, whether delays are excusable or not, and whether they can be compensated for or not.

The Critical Path Method (CPM) is an important tool used to help with delay analysis and planning the project schedule effectively.

B. *Delay Analysis Techniques:*

1. As-Planned vs. As-Built:
   - Compares planned and actual timelines.
   - Simple but ignores causes and overlap of delays.
2. Impacted As-Planned:
   - Adds excusable delays to original schedule.
   - Doesn’t reflect real events or concurrent delays.
3. Collapsed As-Built :
   - Removes excusable delays from actual schedule.
   - Depends on accurate records and assumptions.

4. Window Analysis :
   - Breaks project into time "windows" (e.g., monthly).
   - Compares planned vs. actual progress within each window.
5. As-Built Method:
   - Builds schedule from actual data when original plans are missing.
6. Contemporaneous Method :
   - Analyses delays as they occur, based on progress and plan at that point.

C. *Key Delay Factors in Ratnagiri Police Quarters Project :*

1. Abnormal Rainfall (June–Oct 2019)
   - Affected plastering, waterproofing, external works.
   - Total delay impact: ~15.89% of work.
2. Labor Shortages
   - Due to floods across India; workers left or couldn't perform well.
3. Material Delay: Roman Snow Tiles
   - Vendor delay from Asian Granito (AGL) – 6 months late.
4. Pending Permissions
   - Tree cutting/transplant approval delayed site work.
5. Undefined Locations
   - Landscaping and rainwater tank work delayed due to user indecision.
6. Encroachment Issues
   - Blocked work around buildings Q3, Q4 – limited road width caused delays in laying services.

IV. EVM CALCULATION

1. General :

Earned Value Management (EVM) is a method used in project management to track how well a project is doing by comparing what was planned to be done and the budget with what has actually been completed and the money spent. It brings together the project's scope, timeline, and cost into one system, helping managers figure out:

1. Are we moving ahead or falling behind on time?
2. Are we spending less or more than we should?
3. How effectively are we using our resources?
4. What will be the total cost of the project and when is it expected to finish?

EVM uses important measures like Planned Value (PV), Earned Value (EV), and Actual Cost (AC) to give early warnings and help predict how the project will perform in the future.

2. Calculation Steps For EVM :

A. EVM Terms & Formulas :

1. **Planned Value (PV) or Budgeted Cost of Work Scheduled (BCWS) :** is the budget that has been approved for the produce that is supposed to be finished by a certain date in the project.
2. **Earned Value (EV) or Budgeted Cost of Work Performed (BCWP) :** Earned Value is the value of the work that has actually been finished up to a certain point in time, and it is measured based on the agreed-upon budget for the project.

$$EV = BAC \times \% \text{ Complete}$$

3. **Actual Cost (AC) or Actual Cost of Work Performed (ACWP) :** Actual Cost refers to the total amount of money spent on the work done up to a certain time. It covers all the expenses like wages for workers, cost of materials, equipment usage, overheads, and other direct or indirect costs involved in completing the work.
4. **Budget at Completion (BAC) :** This is the total fund planned for the whole plan, based on the original plan.

B. Variance Metrics :

1. **Cost Variance (CV) =** EV – AC
   A positive cost variance shows the project is spending less than planned, and a negative cost variance means it's spending more than expected.
2. **Schedule Variance (SV) =** EV – PV
   A positive SV means the project is moving faster than planned, and a negative SV shows it is falling behind the schedule.
3. **Cost Variance Percentage (CV%) =** CV% = (CV / EV) X 100 or (CV / BCWP) X 100
4. **Schedule Variance Percentage (SV%) =** SV% = (SV / PV) X 100 or (SV / BCWS) X 100

C. Performance Indexes :

1. **Cost Performance Index (CPI) =** EV / AC
   If the CPI is above 1, the project is considered cost-efficient. If it's below 1, the project is over budget..
2. **Schedule Performance Index (SPI) =** SPI = EV / PV
   If the SPI is greater than 1, the project is moving faster than planned; if it's below 1, the project is falling behind schedule.

D. Forecasting & Completion Metrics :

1. **Estimate at Completion (EAC) :** EAC uses current information like how much has already been spent and how the project is progressing to guess what the total cost will be at the end.
   EAC = BAC / CPI
2. **Variance at Completion (VAC) =** VAC = BAC – EAC
   A positive VAC indicates the project is spending less than planned, whereas a negative VAC means it is spending more than
   expected..
3. **Estimate to Complete (ETC) =** ETC = EAC – AC
4. **To-Complete Performance Index (TCPI) :** This demonstrates how quickly the remaining work needs to be done to stick to the initial fund or a new cost estimate.
   TCPI = (BAC – EV) / (BAC – AC)

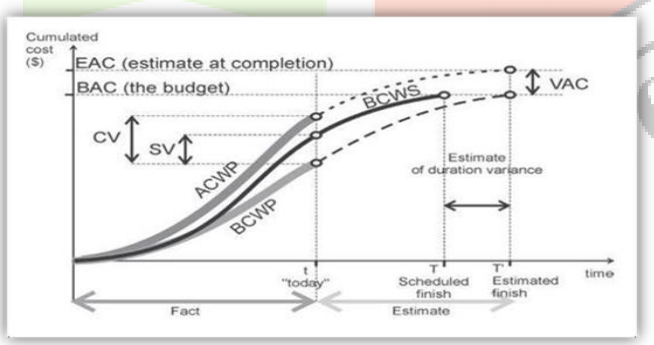


Figure : Earned Value Curves

3. Example :

- BCWS (PV) at the end of Month 3: Rs 30,000
- BCWP (EV) at Month 3: Rs 25,000
- ACWP (AC): Rs 28,000
- BAC: Rs 60,000

Sr. No.	Metric	Formula	Value	Interpretation
1.	CV	EV - AC	-3,000	Over Budget
2.	SV	EV - PV	-5,000	Behind Schedule
3.	COI	EV / AC	0.89	Cost Inefficient
4.	SPI	EV / PV	0.83	Behind Schedule

5.	EAC	BAC / CPI	67,415	Forecasted total cost if inefficiency continues
6.	VAC	BAC - EAC	-7,415	Overrun Expected

4. *Details Of Construction Project :*

Project : DSP Office with Police Head Quarters Project
Owner : DSP of office, Ratnagiri .
Developer : Maharashtra State Police Housing and Welfare Corporation, Worli, Mumbai.
Contractor : Nirman Infrastructure, Office No. 6 and 7, First Floor Indradhanu Behind Chhatrapati Shivaji Maharaj Stadium,
SV Road, Hindu Colony, Abhyudhya Nagar, Ratnagiri, Maharashtra – 415 612 .
Contract Value : Rs. 121,47,29,718.00
Planned Value : PV = Rs.151,34,40,323.67
Earned Value : EV = Rs. 151,34,40,323.67
Actual Cost : AC = Rs. 121,47,29,718.00

Cost of Activities involved in project (After completion of Project)

The Construction 360 Quarters for Ratnagiri project is lagging behind for 70 to 80% of scheduled time because most of the time SPI value is less than one. Project is over Budgeted from start to end. CPI value is less than one.

- Extended Time – 31 Days Extended
- Cost - 6,11,84,993.33

1. Cost of Activities in Project :

Sr No.	Activities	Planned Value - PV (BCWS)	Earned Value – EV (BCWP)	Actual Cost – AC
BUILDING WORK		**94,83,77,606.67**	**94,83,77,606.67**	**99,17,48,270.00**
1.	Reinforced Cement Concrete (include OHWT)	64,68,79,584.50	64,68,79,584.50	66,00,36,684.50
2.	AAC Block Masonry (including Parapet wall)	3,81,80,000.00	3,81,80,000.00	4,23,95,000.00
3.	Door Frame fixing	34,26,780.00	34,26,780.00	37,37,180.00
4.	Electrical wall conduiting	27,43,200.00	27,43,200.00	45,76,500.00
5.	External Plater work	84,56,200.00	84,56,200.00	1,28,80,900.00
6.	Internal Gypsum work	2,29,14,900.00	2,29,14,900.00	2,44,08,400.00
7.	Internal Plumbing work	1,35,95,413.00	1,35,95,413.00	1,40,71,413.00
8.	Toilet waterproofing	58,84,710.00	58,84,710.00	69,32,220.00
9.	Tiling work	2,76,70,464.00	2,76,70,464.00	2,98,50,964.00
10.	Door Shutters	1,20,48,160.00	1,20,48,160.00	1,24,25,440.00
11.	Iron works (MS grill and Railing)	47,31,800.00	47,31,800.00	49,76,000.00
12.	Aluminium work	2,60,23,050.00	2,60,23,050.00	2,58,89,050.00
13.	Internal wiring, Board and DB fitting	2,37,48,876.67	2,37,48,876.67	2,44,96,560.00
14.	Electrical fitting and fixtures	1,24,71,080.00	1,24,71,080.00	1,26,89,480.00

15.	Duct wiring and Meter cabin	52,25,700.00	52,25,700.00	58,84,700.00
16.	Internal Painting	5,50,52,500.00	5,50,52,500.00	5,68,58,500.00
17.	Internal Furniture	1,12,38,600.00	1,12,38,600.00	1,22,93,250.00
18.	External Plumbing (All down takes, All rising Mains)	25,16,488.50	25,16,488.50	36,47,488.50
19.	External Painting works	1,07,90,000.00	1,07,90,000.00	1,53,98,000.00
20.	Solar down take works	8,05,950.00	8,05,950.00	13,44,150.00
21.	Terrace waterproofing	1,17,48,000.00	1,17,48,000.00	1,34,37,600.00
22.	Polycarbonate sheet roofing work	8,24,400.00	8,24,400.00	14,91,000.00
23.	Terrace Looping	9,16,750.00	9,16,750.00	13,42,990.00
24.	Solar system	4,85,000.00	4,85,000.00	6,84,800.00
BUILDING SERVICES		**4,08,29,470.00**	**4,08,29,470.00**	**4,23,39,570.00**
25.	Lifts	1,13,78,000.00	1,13,78,000.00	1,19,91,200.00
26.	Fire Fighting Work (Building)	2,58,75,000.00	2,58,75,000.00	2,66,52,000.00
27.	Garbage Chute	17,04,000.00	17,04,000.00	20,31,600.00
28.	L.V. Room	18,72,470.00	18,72,470.00	16,64,770.00
DEVELOPMENT		16,42,33,247.50	16,42,33,247.50	18,06,41,877.50
29.	Underground Water Tank (UGWT)	1,02,61,350.00	1,02,61,350.00	1,45,87,670.00
30.	Flushing Tanks	30,77,987.50	30,77,987.50	49,13,337.50
31.	Services (Sewer line, Raw water pipe, Electrical pipes, SWD line)	1,89,41,800.00	1,89,41,800.00	2,26,41,100.00
32.	Fire Fighting System (Courtyard)	7,04,08,000.00	7,04,08,000.00	7,13,41,300.00
33.	Sewage treatment plant	62,02,537.50	62,02,537.50	80,93,687.50
34.	Pump room, Distribution board and panels	19,55,000.00	19,55,000.00	31,59,500.00
35.	RCC Road Work	3,21,19,500.00	3,21,19,500.00	3,27,86,900.00
36.	Street Light	4,56,700.00	4,56,700.00	8,86,360.00
37.	Paver Marking	28,61,050.00	28,61,050.00	30,00,490.00
38.	D.G. Set	5,54,750.00	5,54,750.00	10,10,430.00
39.	Horticultural work (Landscaping)	14,07,350.00	14,07,350.00	19,84,850.00
40.	Organic Waste Management System	10,20,600.00	10,20,600.00	16,56,510.00
41.	Testing and Commissioning	50,000.00	50,000.00	50,000.00
42.	Rain Water Harvesting Tank (RWHT)	40,34,072.50	40,34,072.50	50,84,072.50
43.	Expansion Joint	33,01,000.00	33,01,000.00	3,69,600.00
44.	D.I. Lines and GI lines	49,65,000.00	49,65,000.00	61,50,000.00
45.	Recharge Pits	21,16,550.00	21,16,550.00	24,06,350.00
46.	Finishing, Cleaning	1,04,400.00	1,04,400.00	19,720.00
47.	Obtaining OCC	5,00,000.00	5,00,000.00	5,00,000.00

Table : Cost of Activities involved in Project

2. Variance Calculation of Activities involved in Project (After Project Completion) :

Sr No.	Activities	CV	SV	CV%	SV%
BUILDING WORK		**-43370663**	**0**	**-4.06%**	**0%**
1.	Reinforced Cement Concrete (include OHWT)	-13157100	0	-2.03%	0%
2.	AAC Block Masonry (including Parapet wall)	-4215000	0	-11.04%	0%
3.	Door Frame fixing	-310400	0	-9.06%	0%
4.	Electrical wall conduiting	-1833300	0	-66.83%	0%
5.	External Plater work	-4424700	0	-52.32%	0%
6.	Internal Gypsum work	-1493500	0	-6.52%	0%
7.	Internal Plumbing work	-476000	0	-3.50%	0%
8.	Toilet waterproofing	-1047510	0	-17.80%	0%
9.	Tiling work	-2180500	0	-7.88%	0%
10.	Door Shutters	-377280	0	-3.13%	0%
11.	Iron works (MS grill and Railing)	-244200	0	-5.16%	0%
12.	Aluminum work	134000	0	0.51%	0%
13.	Internal wiring, Board and DB fitting	-747683.33	0	-3.15%	0%
14.	Electrical fitting and fixtures	-218400	0	-1.75%	0%
15.	Duct wiring and Meter cabin	-659000	0	-12.61%	0%
16.	Internal Painting	-1806000	0	-3.28%	0%
17.	Internal Furniture	-1054650	0	-9.38%	0%
18.	External Plumbing (All down takes, All rising Mains)	-1131000	0	-44.94%	0%
19.	External Painting works	-4608000	0	-42.71%	0%
20.	Solar down take works	-538200	0	-66.78%	0%
21.	Terrace waterproofing	-1689600	0	-14.38%	0%
22.	Polycarbonate sheet roofing work	-666600	0	-80.86%	0%
23.	Terrace Looping	-426240	0	-46.49%	0%
24.	Solar system	-199800	0	-41.20%	0%
BUILDING SERVICES		**-1510100**	**0**	**-3.70%**	**0%**
25.	Lifts	-613200	0	-5.39%	0%
26.	Fire Fighting Work (Building)	-777000	0	-3%	0%
27.	Garbage Chute	-327600	0	-19.23%	0%
28.	L.V. Room	207700	0	11.09%	0%
DEVELOPMENT		**-16408630**	**0**	**-9.99%**	**0%**
29.	Underground Water Tank (UGWT)	-4326320	0	-42.16%	0%
30.	Flushing Tanks	-1835350	0	-59.63%	0%
31.	Services (Sewer line, Raw water pipe, Electrical pipes, SWD line)	-3699300	0	-19.53%	0%
32.	Fire Fighting System (Courtyard)	-933300	0	-1.33%	0%
33.	Sewage treatment plant	-1891150	0	-30.49%	0%
34.	Pump room, Distribution board and panels	-1204500	0	-61.61%	0%
35.	RCC Road Work	-667400	0	-2.08%	0%
36.	Street Light	-429660	0	-94.08%	0%
37.	Paver Marking	-139440	0	-4.87%	0%

38.	D.G. Set	-455680	0	-82.14%	0%
39.	Horticultural work (Landscaping)	-577500	0	-41.03%	0%
40.	Organic Waste Management System	-635910	0	-62.31%	0%
41.	Testing and Commissioning	0	0	0%	0%
42.	Rain Water Harvesting Tank (RWHT)	-1050000	0	-26.03%	0%
43.	Expansion Joint	2931400	0	88.80%	0%
44.	D.I. Lines and GI lines	-1185000	0	-23.87%	0%
45.	Recharge Pits	-289800	0	-13.69%	0%
46.	Finishing, Cleaning	84680	0	81.11%	0%
47.	Obtaining OCC	0	0	0%	0%

Table : Variances Calculations of Activities involved in Project

3. Performance Indices Calculations (After Project Completion) :

Sr No.	Activities	CPI	CPI Results	SPI	SPI Results
BUILDING WORK		**0.956**	Over Budget	**1**	Project is Ahead of Schedule
1.	Reinforced Cement Concrete (include OHWT)	0.98	Over Budget	1	
2.	AAC Block Masonry (including Parapet wall)	0.901	Over Budget	1	
3.	Door Frame fixing	0.917	Over Budget	1	
4.	Electrical wall conduiting	0.599	Over Budget	1	
5.	External Plater work	0.656	Over Budget	1	
6.	Internal Gypsum work	0.939	Over Budget	1	
7.	Internal Plumbing work	0.966	Over Budget	1	
8.	Toilet waterproofing	0.849	Over Budget	1	
9.	Tiling work	0.927	Over Budget	1	
10.	Door Shutters	0.97	Over Budget	1	
11.	Iron works (MS grill and Railing)	0.951	Over Budget	1	
12.	Aluminium work	1.005	Cost - Efficient	1	
13.	Internal wiring, Board and DB fitting	0.969	Over Budget	1	
14.	Electrical fitting and fixtures	0.983	Over Budget	1	
15.	Duct wiring and Meter cabin	0.888	Over Budget	1	
16.	Internal Painting	0.968	Over Budget	1	
17.	Internal Furniture	0.914	Over Budget	1	
18.	External Plumbing (All down takes, All rising Mains)	0.69	Over Budget	1	
19.	External Painting works	0.701	Over Budget	1	
20.	Solar down take works	0.6	Over Budget	1	
21.	Terrace waterproofing	0.874	Over Budget	1	
22.	Polycarbonate sheet roofing work	0.553	Over Budget	1	
23.	Terrace Looping	0.683	Over Budget	1	
24.	Solar system	0.708	Over Budget	1	
BUILDING SERVICES		**0.964**	Over Budget	**1**	
25.	Lifts	0.949	Over Budget	1	

26.	Fire Fighting Work (Building)	0.971	Over Budget	1	
27.	Garbage Chute	0.839	Over Budget	1	
28.	L.V. Room	1.125	Cost - Efficient	1	
DEVELOPMENT		**0.909**	Over Budget	**1**	
29.	Underground Water Tank (UGWT)	0.703	Over Budget	1	
30.	Flushing Tanks	0.626	Over Budget	1	
31.	Services (Sewer line, Raw water pipe, Electrical pipes, SWD line)	0.837	Over Budget	1	
32.	Fire Fighting System (Courtyard)	0.987	Over Budget	1	
33.	Sewage treatment plant	0.766	Over Budget	1	
34.	Pump room, Distribution board and panels	0.619	Over Budget	1	
35.	RCC Road Work	0.98	Over Budget	1	
36.	Street Light	0.515	Over Budget	1	Project is Ahead of Schedule
37.	Paver Marking	0.954	Over Budget	1	
38.	D.G. Set	0.549	Over Budget	1	
39.	Horticultural work (Landscaping)	0.709	Over Budget	1	
40.	Organic Waste Management System	0.616	Over Budget	1	
41.	Testing and Commissioning	1	Cost - Efficient	1	
42.	Rain Water Harvesting Tank (RWHT)	0.793	Over Budget	1	
43.	Expansion Joint	8.931	Cost - Efficient	1	
44.	D.I. Lines and GI lines	0.807	Over Budget	1	
45.	Recharge Pits	0.88	Over Budget	1	
46.	Finishing, Cleaning	5.294	Cost - Efficient	1	
47.	Obtaining OCC	1	Cost - Efficient	1	

Table : Performance Indices Calculations

4. Cost of Forecasting and Completion of activities involved in Project (After Completion Project) :

Sr No.	Activities	EAC	VAC	ETC	TCPI
BUILDING WORK		**1,27,02,81,044.14**	**-5,55,51,326.04**	**27,85,32,774.14**	**1.195**
1.	Reinforced Cement Concrete (include OHWT)	1,23,94,36,511.69	-2,47,06,793.59	57,93,99,827.19	1.024
2.	AAC Block Masonry (including Parapet wall)	1,34,88,33,588.24	-13,41,03,870.14	1,30,64,38,588.24	1.004
3.	Door Frame fixing	1,32,47,60,739.79	-11,00,31,021.69	1,32,10,23,559.79	1
4.	Electrical wall conduiting	2,02,65,42,197.03	-81,18,12,478.93	2,02,19,65,697.03	1.002
5.	External Plater work	1,85,03,36,087.83	-63,56,06,369.73	1,83,74,55,187.83	1.004
6.	Internal Gypsum work	1,29,39,00,861.50	-7,91,71,143.40	1,26,94,92,461.50	1.001

7.	Internal Plumbing work	1,25,72,59,602.69	-4,25,29,884.59	1,24,31,88,189.69	1
8.	Toilet waterproofing	1,43,09,58,134.96	-21,62,28,416.86	1,42,40,25,914.96	1.001
9.	Tiling work	1,31,04,53,380.35	-9,57,23,662.25	1,28,06,02,416.35	1.002
10.	Door Shutters	1,25,27,68,159.49	-3,80,38,441.39	1,24,03,42,719.49	1
11.	Iron works (MS grill and Railing)	1,27,74,19,814.29	-6,26,90,096.19	1,27,24,43,814.29	1
12.	Aluminium work	1,20,84,74,733.30	62,54,984.80	1,18,25,85,683.30	1
13.	Internal wiring, Board and DB fitting	1,25,29,72,923.17	-3,82,43,205.07	1,22,84,76,363.17	1.001
14.	Electrical fitting and fixtures	1,23,60,02,692.89	-2,12,72,974.79	1,22,33,13,212.89	1
15.	Duct wiring and Meter cabin	1,36,79,16,254.68	-15,31,86,536.58	1,36,20,31,554.68	1.001
16.	Internal Painting	1,25,45,78,986.91	-3,98,49,268.81	1,19,77,20,486.91	1.002
17.	Internal Furniture	1,32,87,22,092.35	-11,39,92,374.25	1,31,64,28,842.35	1.001
18.	External Plumbing (All down takes, All rising Mains)	1,76,06,72,730.03	-54,59,43,011.93	1,75,70,25,241.53	1.001
19.	External Painting works	1,73,34,94,735.80	-51,87,65,017.70	1,71,80,96,735.80	1.004
20.	Solar down take works	2,02,59,06,012.26	-81,11,76,294.16	2,02,45,61,862.26	1
21.	Terrace waterproofing	1,38,94,32,419.13	-17,47,02,701.03	1,37,59,94,819.13	1.001
22.	Polycarbonate sheet roofing work	2,19,69,45,669.20	-98,22,15,951.10	2,19,54,54,669.20	1.001
23.	Terrace Looping	1,77,95,14,441.35	-56,47,84,723.25	1,77,81,71,451.35	1
24.	Solar system	1,71,51,48,270.01	-50,04,18,551.91	1,71,44,63,470.01	1
BUILDING SERVICES		**1,25,96,57,152.80**	**-4,49,27,434.70**	**1,21,73,17,582.80**	**1.001**
25.	Lifts	1,28,01,95,728.22	-6,54,66,010.12	1,26,82,04,528.22	1.001
26.	Fire Fighting Work (Building)	1,25,12,06,819.20	-3,64,77,101.10	1,22,45,54,819.20	1.001
27.	Garbage Chute	1,44,82,65,783.62	-23,35,36,065.52	1,44,62,34,183.62	1
28.	L.V. Room	1,07,99,88,246.97	13,47,41,471.13	1,07,83,23,476.97	1
DEVELOPMENT		**1,33,60,94,002.12**	**-12,13,64,284.02**	**1,15,54,52,124.62**	**1.016**
29.	Underground Water Tank (UGWT)	1,72,68,75,729.49	-51,21,46,011.39	1,71,22,88,059.49	1.004
30.	Flushing Tanks	1,93,90,51,759.08	-72,43,22,040.98	1,93,41,38,421.58	1.002
31.	Services (Sewer line, Raw water pipe, Electrical pipes, SWD line)	1,45,19,64,281.14	-23,72,34,563.04	1,42,93,23,181.14	1.003
32.	Fire Fighting System (Courtyard)	1,23,08,31,684.44	-1,61,01,966.34	1,15,94,90,384.44	1.001
33.	Sewage treatment plant	1,58,51,00,087.71	-37,03,70,369.61	1,57,70,06,400.21	1.002
34.	Pump room, Distribution board and panels	1,96,31,39,920.38	-74,84,10,202.28	1,95,99,80,420.38	1.001
35.	RCC Road Work	1,23,99,70,167.48	-2,52,40,449.38	1,20,71,83,267.48	1.001

36.	Street Light	2,35,75,38,499.97	-1,14,28,08,781.87	2,35,66,52,139.97	1
37.	Paver Marking	1,27,39,32,427.56	-5,92,02,709.46	1,27,09,31,937.56	1
38.	D.G. Set	2,21,25,26,992.45	-99,77,97,274.35	2,21,15,16,562.45	1
39.	Horticultural work (Landscaping)	1,71,31,88,816.55	-49,84,59,098.45	1,71,12,03,966.55	1
40.	Organic Waste Management System	1,97,15,97,026.58	-75,68,67,308.48	1,96,99,40,516.58	1.001
41.	Testing and Commissioning	1,21,47,29,718.10	0	1,21,46,79,718.10	1
42.	Rain Water Harvesting Tank (RWHT)	1,53,09,03,065.01	-31,61,73,346.91	1,52,58,18,992.51	1.001
43.	Expansion Joint	13,60,08,513.73	1,07,87,21,204.37	13,56,38,913.73	0.998
44.	D.I. Lines and GI lines	1,50,46,50,103.99	-28,99,20,385.89	1,49,85,00,103.99	1.001
45.	Recharge Pits	1,38,10,51,644.02	-16,63,21,925.92	1,37,86,45,294.02	1
46.	Finishing, Cleaning	22,94,48,946.75	98,52,80,771.35	22,94,29,226.75	1
47.	Obtaining OCC	1,21,47,29,718.10	0	1,21,42,29,718.10	1

Table : Cost Forecasting of Activities involved in Project

V. MSP SOFTWARE USES

Start by opening Microsoft Project and making a new file. Set the start date of the project and choose the working calendar. In the Gantt Chart view, add your tasks, set their durations, group them into different phases, and include milestones. Connect tasks with dependencies and modify lead or lag times if necessary. Add resources such as people, equipment, and materials through the Resource Sheet, and link them to the relevant tasks. Assign costs to resources or set fixed costs for tasks. After the planning is done, create a baseline to keep track of how the project is performing.

While the project is in progress, update the actual dates, percentage completion, and progress in the Tracking Gantt view. Use the built- in reports to check the project's status, address problems like delays or overused resources, and make changes to the plan as required.

Once everything is finalized, save the project and export it to PDF or Excel for sharing or reporting purposes.

1. Set Calendar :

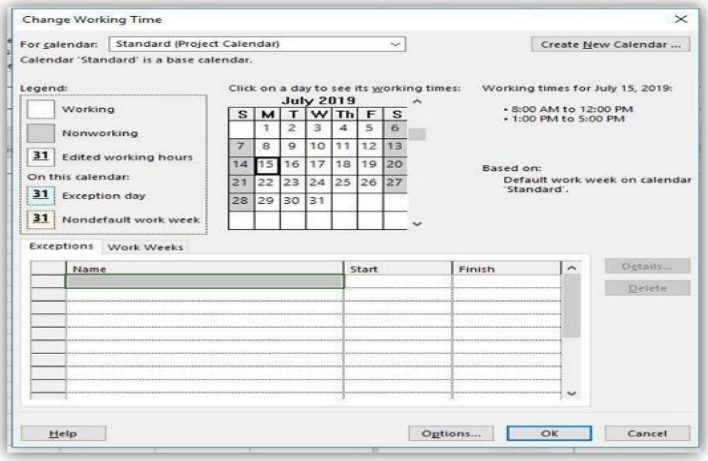


Figure : Standard Base Calendar

2. Assign Task :

	Task Mode	WBS	Task Name	Start	Finish	Predecessors	Resource Names	Duration	Cost
1	✓	1	Building	Sat 1/6/18	Thu 2/27/20			783 days	₹1,214,729,718.10
2	✓	1.1	Reinforced Cement Concrete (including OHWT)	Sat 1/6/18	Fri 9/27/19		Exicutive Director, Project Manager, Sinor Engineer[2],Bill	630 days	₹660,036,684.50
3	✓	1.2	AAC Block Masonary (including parapet wall)	Sat 3/17/18	Mon 9/2/19	2SS+70 days	Site Engineer, Junior Engineer, Supervisor[2], Junior Electricision,T	535 days	₹42,395,000.00
4	✓	1.3	Door Frame Fixing	Sun 5/13/18	Tue 8/27/19	3SS+10 days	Door fixing Skilled[3]	472 days	₹3,737,180.00
5	✓	1.4	Electrical Wall Conduting	Fri 5/11/18	Sat 9/21/19	4SS-2 days	Junior Engineer, Supervisor[2],Junior	499 days	₹4,576,500.00
6	✓	1.5	External Plaster Work	Thu 5/3/18	Wed 10/30/19	3SS+47 days	Supervisor, Block Work / Plaster	546 days	₹12,880,900.00
7	✓	1.6	Internal Gypsum Plaster	Mon 8/13/18	Mon 10/14/19	5SS+94 days	Supervisor, Gypsum Work	428 days	₹24,408,400.00
8	✓	1.7	Internal Plumbing	Sat 9/29/18	Sat 10/19/19	7SS+47 days	Plumbing Work Skille	386 days	₹14,071,413.00
9	✓	1.8	Toilet waterproofing	Sun 10/14/18	Sat 10/19/19	7SS+62 days	Quality Engineer, Junior Engineer,Supe	371 days	₹6,932,220.00
10	✓	1.9	Tilling Work	Thu 11/22/18	Mon 10/21/19	9SS+39 days,8SS	Supervisor[2],Tiles W	334 days	₹29,850,964.60
11	✓	1.10	Door Shutters	Tue 12/18/18	Wed 10/30/19	10SS+26 days	Door fixing Skilled[5]	317 days	₹12,425,440.00
12	✓	1.11	Iron Works (M.S. Grills & Railling)	Thu 11/15/18	Sun 10/20/19	10SS-7 days	Supervisor, Fabrication Work	340 days	₹4,976,000.00
13	✓	1.12	Aluminium Work	Thu 1/24/19	Thu 10/31/19	11SS+37 days	Aluminum Work Skill	281 days	₹25,889,050.00
14	✓	1.13	Internal Wiring, Board &	Wed 1/23/19	Sat 11/30/19	13SS-1 day	Junior Electricision,	312 days	₹24,496,560.00

Figure : Entry table with dates and Predecessors

3. Gant Chart :

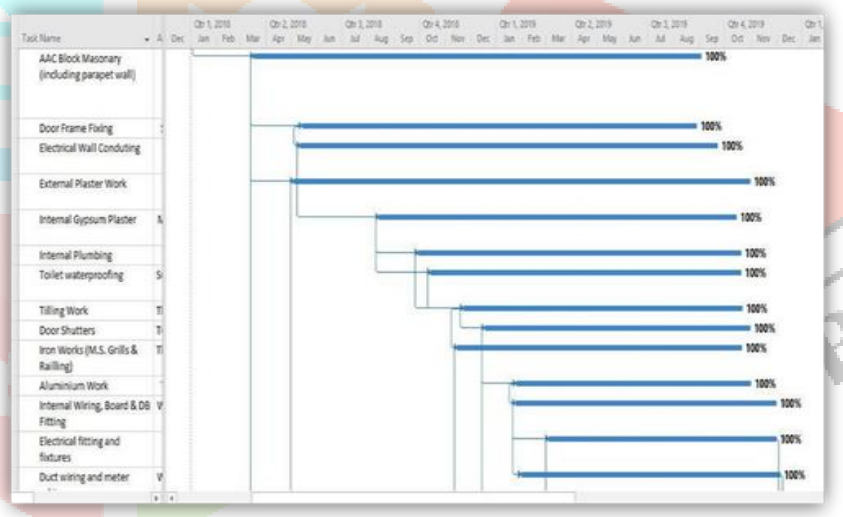
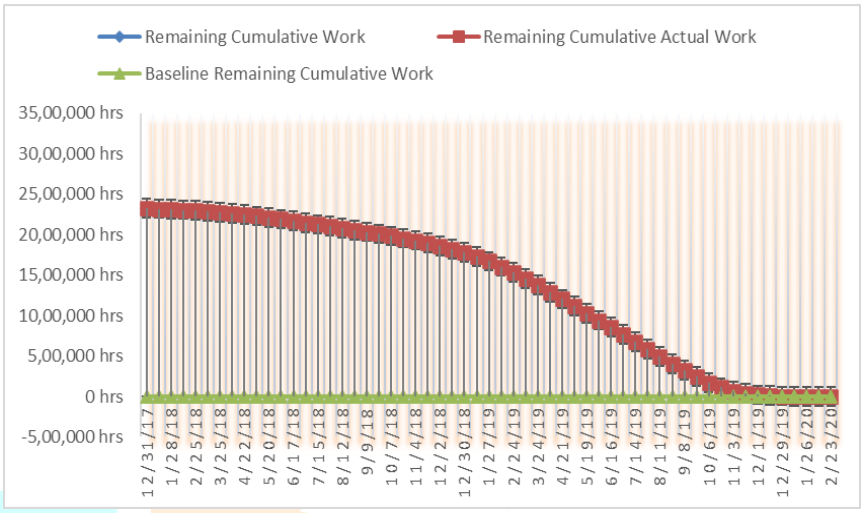


Figure: The Gantt Chart

VI. GRAPH AND REPORT

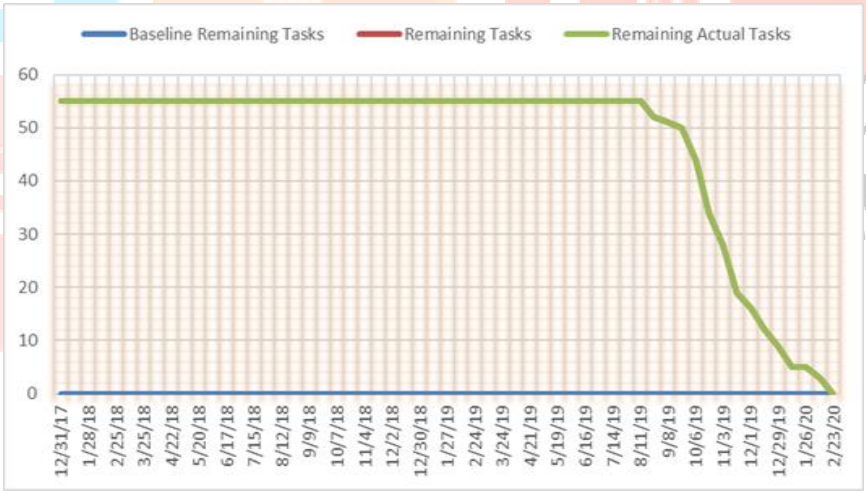
1. Work Burndown : Burndown (Actual Work Hours – 2327524 Hrs.) : (Project Duration - Mon 01/01/2018 to 27/2/2020)

Work Burndown - This shows how much work has been done on the project and how much is still left. If the line showing the remaining work is steeper, it means the project is behind schedule.



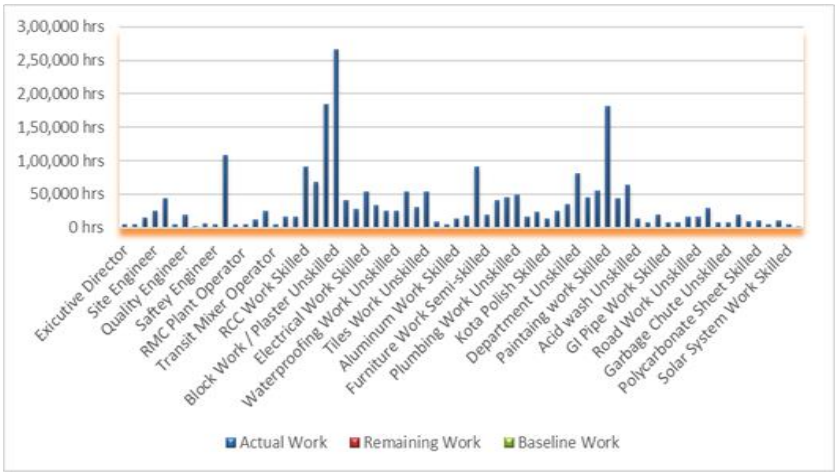
Graph : Work Burndown

2. Task Burndown - This shows how many tasks have been completed and how many are still remaining in the project. If the line showing the remaining tasks is steeper, it means the project is late.



Graph : Task Burndown

3. Resource Report :



Graph : Work status for all resources

Graph : Percentages Work done by all the resources

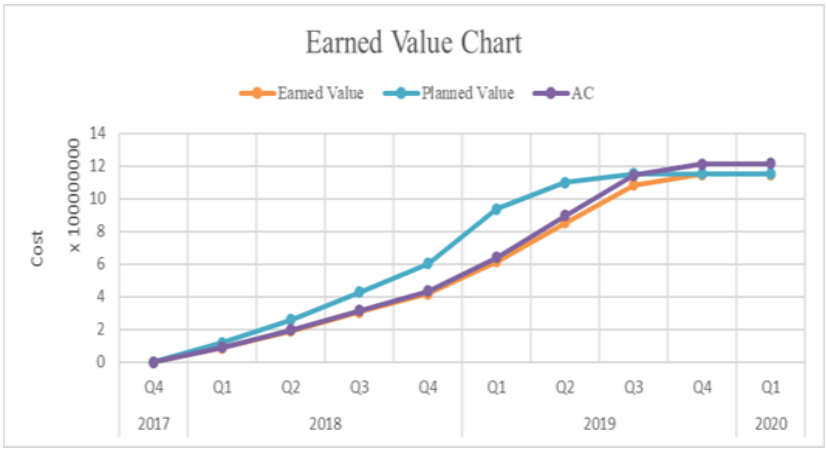
4. Cash Flow Report :

1. Actual Cost = Rs. 121,47,29,718.00
2. Remaining Cost = Rs. 0.00
3. Budgeted Cost at Work Performed = Rs.115,34,40,323.67
4. Budgeted Cost at Work Scheduled = Rs.115,34,40,323.67
5. Cost Variance = Rs. 6,12,89,391.33

Graph : Cash Flow

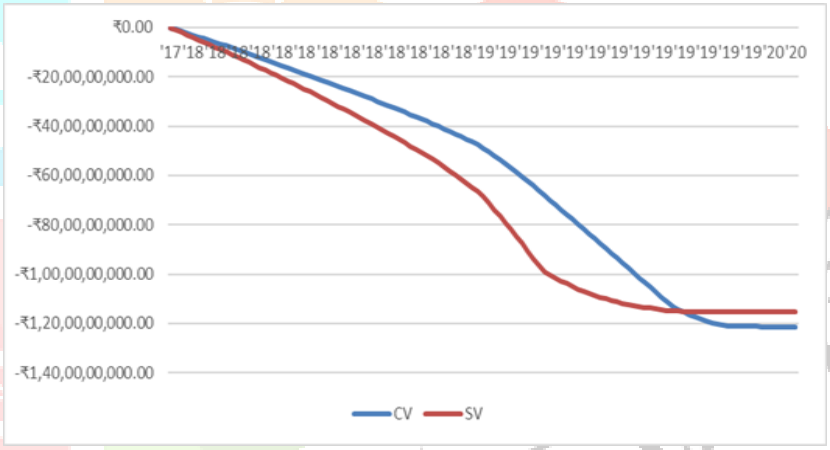
The Graph shows the project's cumulative cost and the cost per quarter.

5. Earned Value Report : Earned value management helps measure how well a project is performing. It compares actual costs and progress against the planned baseline to see if the project is on track.



Graph : Earned Value over Time

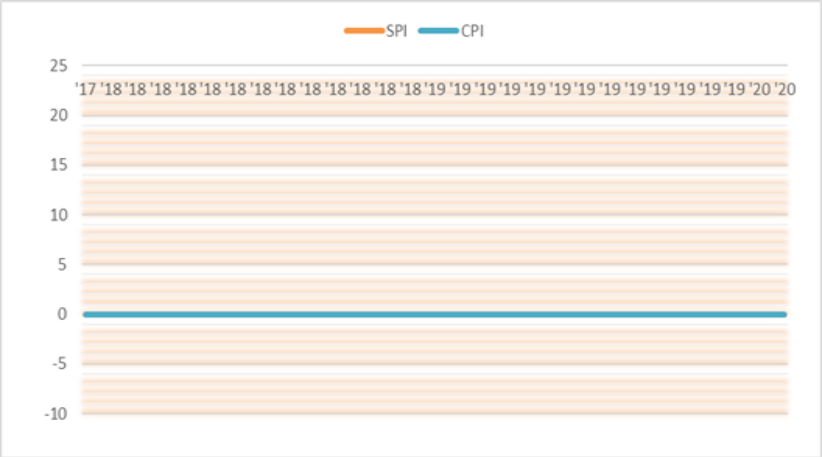
Based on the current project status date, the cost variance is negative, which means the project is spending more than planned. The schedule variance is also negative, indicating the project is behind schedule by half of the planned time and will likely finish later than originally scheduled.



Graph : The variances have been tracked over time

The cost and schedule performance indices for the project as of the latest update show how well the project is doing in terms of time and money. A higher index means the project is progressing better than planned, saving both time and money. Since the project was finished on time, the schedule performance index (SPI) is 1.

However, the cost performance index (CPI) is less than 1, which means the project ended up costing more than planned.



Graph : The Indices have been tracked over time

6. Cost Distribution :

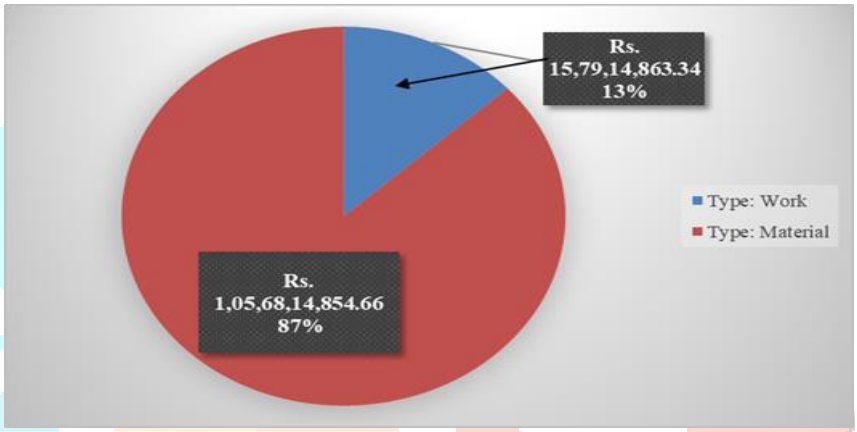


Chart : Cost Distribution

VII. CONCLUSION

Time and cost are important parts of the project. Along with keeping an eye on cost factors, it also focuses on managing changes to the original cost plan. The main advantage of Earned Value is that it helps identify differences and reduce risks, and allows for planning corrective and preventive steps.

1. In this project, Earned Value Analysis proved to be an effective tool for keeping the project on schedule and within budget. It consistently shows when the project is delayed and over budget.
2. It was noticed that in the early stages, up to 30% to 35% of the work completed, the construction project was slow and behind schedule. Between 30% to 70% of the work, the project was on track. However, at the end, it slowed down again.
3. Compared to traditional project tracking methods, Earned Value Analysis can help reduce both the time and cost of construction projects.
4. Earned Value Analysis helps prevent project failures, and this tool can be a key and important factor in managing projects effectively.

VIII. REFERENCES

1. Ming-Fung Siu et al. (2011) “Studied scheduling simulation- based techniques for earned value management on resource- constrained schedules under delayed scenarios” in Automation in Construction, pp. 504-512.
2. Mohamed Elsaid et al. (2022) “Reviewed earned value management methods for monitoring and controlling project schedule performance using an AHP approach” in the International Journal of Construction Management, pp. 1-17.
3. Deng Jie et al. (2022) “Proposed estimating construction project duration and costs using Monte Carlo simulations and improved earned value management” in the Journal of Construction Engineering and Management, article 04022086.

4. Mohammad Azim Eirgash (2019) "Analysed earned value for construction projects using project management scheduling engine" in the International Journal of Civil Engineering and Technology, pp. 2300-2310.
5. Akash Pati et al. (2021) "Demonstrated management of residential buildings using earned value analysis with Microsoft Project" in the International Journal of Innovative Technology and Exploring Engineering, pp. 1150-1155.
6. Amhara Waterworks Construction Enterprise (2020) "Evaluated construction project performance using earned value management system" in the Journal of Engineering and Applied Sciences, pp. 56-65.
7. Prof. Shelke et al. (2015) "Tracked construction projects by earned value management" in the International Journal of Engineering Research and Applications, pp. 24-30.
8. Hong Long Chen et al. (2014) "Applied earned value analysis for project performance tracking" in the International Journal of Project Management, pp. 765-772.
9. John-Paris Pantouvakis et al. (2015) "Studied earned value management systems in the construction industry" in the International Journal of Project Management, pp. 123-134.
10. Girish Ambadas Gaddam et al. (2022) "Reviewed earned value management and earned schedule methods for construction projects" in the International Journal of Construction Management, pp. 1-11.
11. Lokesh, Y. and Mahendra, S.P. (2018) "Discussed planning, scheduling, and tracking of a bridge construction project using Primavera software and EVM technique" in the International Journal of Applied Engineering Research, 13(7), pp. 209-214.
12. Rudresh, L. and Vanakudari, S.U. (2017) "Applied earned value method and delay analysis to analyze cost and schedule in construction projects" (journal and pages not specified).
13. Mishakova, A., Vakhrushkina, A., Murgul, V., and Sazonova T. (2016) "Studied project control using PERT and earned value management methods" in Procedia Engineering, 165, pp. 1812-1817.
14. Dodson, M., Defavari, G., and de Carvalho, V. (2015) "Explored quality as the third element of earned value management" in Procedia Computer Science, 64, pp. 932- 939.
15. Mohammed, I.A., Sarhan, D.F.M., and Sameer, D. (2014) "Evaluated infrastructure project performance using earned value management" in the International Journal of Civil Engineering & Technology, 5(9), pp. 145-155.
16. Czemplik, A. (2014) "Applied the earned value method to progress control of construction projects" in Procedia Engineering, 91, pp. 424-428.
17. Bhosekar, S.K. and Vyas, G. (2012) "Analysed cost controlling using earned value analysis in construction industries" in the International Journal of Engineering and Innovative Technology, 1(4), pp. 324-332.
18. Naeni, L.M., Shadrokh, S., and Salehipour, A. (2011) proposed a fuzzy approach for earned value management in the International Journal of Project Management, 29(6), pp. 764-772.