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Earned Value Management of Commercial Project: A Case Study Of An LPG Bottling Plant

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Abstract
Earned Value Management (EVM) is an important project management tool that integrates cost and schedule for effective assessment of the project performance. The comprehensive literature review indicated that EVM is a widespread tool in traditional residential projects with straightforward budgets and schedules. However, commercial implementation is still underestimated. The lack of well-documented success stories and case studies of the application of EVM in commercial projects is another contribution to the hesitation of the stakeholders. Therefore, one of the primary goals of the current research is to illustrate how the EVM contributes to the accuracy of the forecast, preventive decision-making, and successful project implementation in commercial construction ventures. This research paper represents EVM analysis applied to the commercial construction project, a case study of the Liquified Petroleum Gas (LPG) bottling plant in Rasayani, Maharashtra, India. The initially planned budget was ₹87,478,725 and be implemented in 10 months. However, due to design errors, torrential rains, and inflation-induced cost increases, the project lasted for 14 months, consuming ₹101,822,725. The project was divided into 4 phases for EVM analysis: April – June 2023, July-September 2023, October 2023 – January 2024, and February – May 2024. Cost Performance Index (CPI), Schedule Performance Index (SPI), Cost Variance (CV), Schedule Variance (SV) are used to measure performance. The performed analysis identified that CPI and SPI ranged from 0.60 to 0.91 and 0.41 to 1.00, respectively, indicating cost and schedule overruns in all phases. The findings favor the wider use of EVM within commercial projects since they confirm its high effectiveness in project control and successful completion.

Keywords: Earned Value Management, Commercial Construction Project, Cost Performance Index, Schedule Performance Index, Cost Variance, Project Control.

1. Introduction

Construction is associated with uncertainty and complexity and companies strive to employ the most sophisticated approaches and tools to optimize planning and control. This issue is particularly important for the commercial sector due to its significant impact on project outcomes. Progress in planning and control theory took a major step in the 1950s with the creation of the Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT) [18]. The two methodologies presented a systematic way of scheduling & controlling project resources, which laid the foundation for further progression. Performance in construction project management is measured by cost and time, and the objective is relatively straightforward – to complete the project successfully to the needs of the client. The construction sector plays a vital role in the economy of many countries; thus, it is widely utilized because of the high level of project time and cost overrun.

In this regard, a systematic approach to managing project activities helps in achieving project goals in a set time duration, and budget. Budgeted expenses have traditionally been compared with overhead costs and may exceed the appropriate form. However, EVM offers a more complete view of future opportunities and actual achievement through the comparison of overhead expenses and a predetermined budget. EVM also serves as an early warning system, signaling the possibility of failure for executives to adopt corrective measures before doing so. EVM aids in decision-making and risk management through understanding time and cost schedules.

According to Keng and Shahdan [1], EVM is a robust tool used for integrating the scheduling, scoping, and resource monitoring and measurement to determine the overall project progress. The authors carried out a study in Malaysia and found that practitioners in the construction industry were not well-informed about EVM. The results showed that EVM was way beyond their reach because of the factors that limit EVM. Elsewhere, researchers such as Teresa *et al*. [2] purport that EVM may be used to monitor project progress, control costs, and performance measurement using the EVM metrics and interpretation models. It covers the data collection for the EVM metric to be factual. Vyas and Birajdar [3] argued that EVM monitors the project progress from the beginning to the end and helps in saving the cost associated with overpayments, timely delivery, and risk event management. Besides, the evidence showed that EVM is used in decision-making and forecasting. Khan and Reza [4] utilized EVM to manage schedule and cost variance in a construction project and supported its effectiveness as an early warning system and decision-making tool for project managers. In Sunarti *et*

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al. [5] investigation of EVM in cost management within construction projects in the Klang Valley region, the authors concluded that EVM is suitable regardless of the knowledge gap and data collection complexities. Devenshu *et al.* [6] reviewed several articles on the role of EVM in project management. It was found that EVM is simple and easy to use and can monitor the cost, performance, and schedule evaluation in a project. Devanshu highlighted its application in decision-making during project overruns and the importance of software like Microsoft Project for implementation. According to Oktrianto and Susetyo [7], EVM plays a critical role in the assessment of project performance and management of delays and cost overruns in construction projects, especially when conducted in real-time and using schedule performance indicators. Barikder and Paul [8] studied the application of EVM in Indian construction projects and found that it was effective in cost performance while lacking schedule performance accuracy, especially for delayed projects. Vaibhava *et al.* [9] analyzed integrating EVM with Earned Schedule Management to track construction of residential apartments and highlighted their overlapping but unique roles in cost and schedule variance analysis. Netto et al. [10] identified EVM's implementation critical success factors in construction projects and found that team training and procedural clarity, plus management support, contributed to success through proper project performance and communication. Wenjing Xu [11] discussed EVM of construction projects in China and found that while it was helpful in cost and schedule management, it was necessary to continue improving implementation practices. Furthermore, Pavan and Kumthekar [12] used EVM to monitor and control costs and schedules of construction projects in India and presented EVM effectiveness through software applications and case study. Gaddam and Landage [13] analyzed performance in infrastructure projects using EVM and Earned Schedule and discovered that they were effective risk and uncertainty monitoring and prediction tools. Narvaez *et al.* [14] evaluated EVM on cost control and schedule compliance to construction projects in Ecuador and found that it improved due project management practices for better financial implications. Nayana and Chethan [15] used the EVM system to monitor and evaluate performance in large construction projects and develop EVM and Schedule Management integrated cost and schedule management in their case studies. Aramali *et al.* [16] developed a maturity assessment system in construction projects' EVM systems as a project success evaluation tool. Stone [17] analyzed the use of EVM for uncertain and risk management in construction projects and proposed EVM integrated approach to systemic and provisioning analysis that increases project success chances.

Overall, EVM is among the most significant project management techniques in the commercial field due to its benefits which greatly contribute to the overall success of any project. Such benefits include improved cost control, profitability analysis, client visibility, timely project completion, resource management, risk reduction, compliance, the competitive edge, stakeholder interest, market ability, and financial and investment. In this regard, this current study will contribute to an assessment of EVM in practice and show its effectiveness in the commercial field to enhance the performance of commercial projects.

2. Methodology

A case study approach was used in this study. This type of research is an empirical investigation that examines a current situation or event in a real-life context when the limits between context and phenomenon are unclear. It is exploratory consisting of quantitative data to achieve its purpose. The purpose of this research is to provide a type of generalization through specific cases to theory, an example of a basic generalization, to promote a better understanding regarding practicing EVM in a commercial construction frame. As such, a specific commercial project was explored and analyzed. Therefore, it is essential to be careful when generalizing the results due to the relatively small sample. However, the importance of the present research is that statistical tests were conducted, and their results were explained by performing in-depth qualitative research. It provides the reader with a close review of the examined topic from various perspectives. Furthermore, for data analysis, this study uses Microsoft Excel and Microsoft Project Professional (MSP) software. Therefore, by integrating statistical investigations with qualitative explanations and utilizing MSP for data analysis, this research aims to discern how to effectively implement EVM in a commercial construction project. Hence, the present findings are expected to be relevant to scientific and practical circles.

2.1 Data Collection

During the data collection process, a multifaceted approach was used, including the following three techniques:

1) Semi-structured interview technique: The use of semi-structured interviews enabled long, structured conversations with key stakeholders, which has been instrumental in analyzing their attitudes toward the implementation of the EVM in real-life commercial projects. This method provided qualitative data, which helped create an understanding of what specialists think about the subject in question.

2) The technique of monthly progress reports: Monthly reports allowed a quantitative presentation of the project's evolution through a straightforward observation of its milestones and setbacks. The method added the factor of time to the mix, and therefore the scientific method could be applied to the analysis. As a result, the data allowed the observation of trends and potential weaknesses with the passing of time.

3) The daily progress reports technique: Daily reports added another level of data acquisition where the analysis dived deep into the realm of real-time reporting. This tool helped uncover the specifics: the microstrata of the events and the reasons EVM may begin to vary in time.

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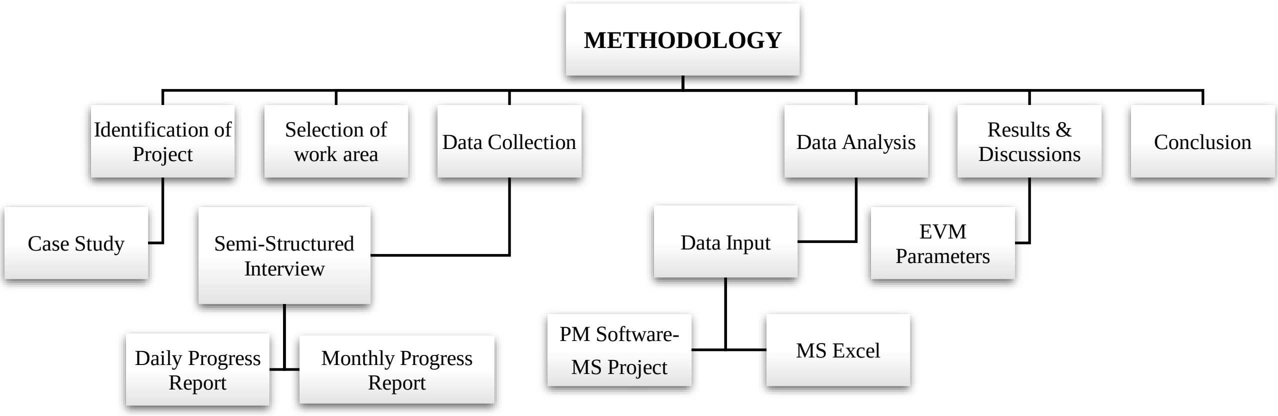

Figure 1: Methodology Chart.

2.2 Components of Earned Value Management.

EVM is a management analysis tool that integrates the project scope, schedule, and cost performance into one integrated system. It creates a common measure to assess project progress and performance, hence project managers can determine whether the project is progressing efficiently for the planned budget and within the planned timeframe. At the heart of EVM are three fundamental metrics: EV, AC, and PV.

2.2.1 EVM Fundamentals

- **Planned Value (PV)**: PV is the authorized budget assigned to the work to be accomplished by an established date. *PV = Total hours planned x Hourly Rate.*
- **Earned Value (EV)**: The value of work actually completed to date is nothing but earned value. *EV = Baseline Cost x Percentage Complete Actual.*
- **Actual Cost (AC)**: Since the beginning of the period up to date the total cost spent on work performed is the Actual Cost. *AC = Total Hours Spent x Hourly Rate.*

2.2.2 Performance Indices

- **Cost Performance Index (CPI)**: This is a measure of the cost-effectiveness of a project performed by comparing how much you have really spent with what each work was supposed to cost. *CPI = EV / AC.*
- **Schedule Performance Index (SPI):** It indicates the schedule efficiency by comparing earned value to planned and it is a ratio i,e SPI = *EV / PV.*

2.2.3 Variance Analysis

- **Cost Variance (CV)**: CV shows insight into whether the project is over or under budget by calculating the Difference between Earned Value and Actual cost. *CV = EV - AC.*
- **Schedule Variance (SV)**: If SV is positive, the project is ahead of schedule and could be prepared for an early finish. If it's negative then the project is behind the schedule. It will show by subtracting the planned value from the earned value. *SV = EV - PV.*

2.2.4 Forecasting Indicators

- **Budget at Completion (BAC):** BAC is the sum of all the financial resources that have been devoted to the completion of the project. It acts as a reference point so that the actual value of the expenditure and the value of the work done up to that point can be measured against it
- **Estimate to Complete (ETC)**: This is a projection of how much more the remaining work is likely to cost. ETC includes the work of the present point as well as the current performance and predicting any future conditions. It is vital for the preparation and monitoring/ controlling of the project.
- **Estimate at Completion (EAC)**: This indicator re-evaluates the total cost required to complete the project with existing performance metrics. To determine EAC, the BAC is divided by the CPI. This metric indicates whether it is possible to stay within the budget for the remainder of the project. It gives the revised estimate that reflects the cost-efficiency: *EAC = BAC / CPI.*
- **Variance at Completion (VAC)**: VAC shows the deviation of the projected budget. It is calculated by deducting EAC from BAC. A positive VAC means that the project will be completed under budget, and a negative VAC means that it will be over budget: *VAC = BAC – EAC.*

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- **Percentage Completed Planned**: It is the measure of the work actually scheduled to be completed as of today up to a certain date divided by the budget actually to be spent on scheduled work by the same date. It quantifies the amount of work done as scheduled work as opposed to current spending on scheduled work. Furthermore, this is obtained by accruing the planned value. Since the value already planned has been quantified the percentage progress made throughout the work so far is obtained, *% Completed Planned = PV / BAC.*
- **Percentage Completed Actual**: This shows the total work planned as compared to the actual work until that reporting date. This thus provides the values from which the overall progress of work so far can be derived as per the value up to the reporting date. *% Completed Actual = AC / EAC.*

2.3 Earned Value Analysis Using Microsoft Project Software:

Construction project management requires accurate and organized schedules to facilitate efficient coordination and planning. MSP is an established application that supports the preparation, tracking, and optimization of construction schedules. The scheduling process with MSP was detailed. The project scheduling process was meticulously executed using MSP. With the help of features such as task dependencies, critical path analysis, and resource allocation, a full plan was prepared to guide the planning and implementation of project phases. Monitoring the plan in real-time facilitated timely response mechanisms to deviations or shortcomings in the set timelines and objectives. This regular check ensured proper coordination and management of the project towards meeting the agreed timelines and milestones, culminating in the successful completion of the project.

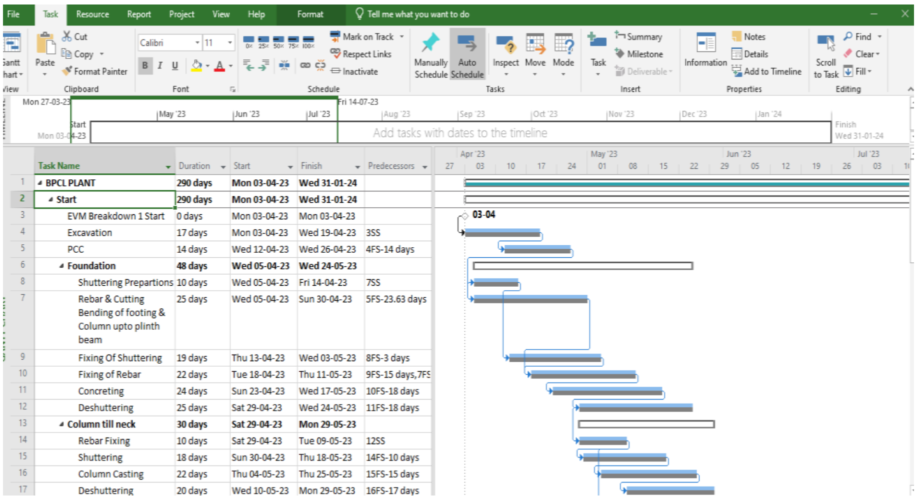

Figure 2: MSP - Defining Relationships.

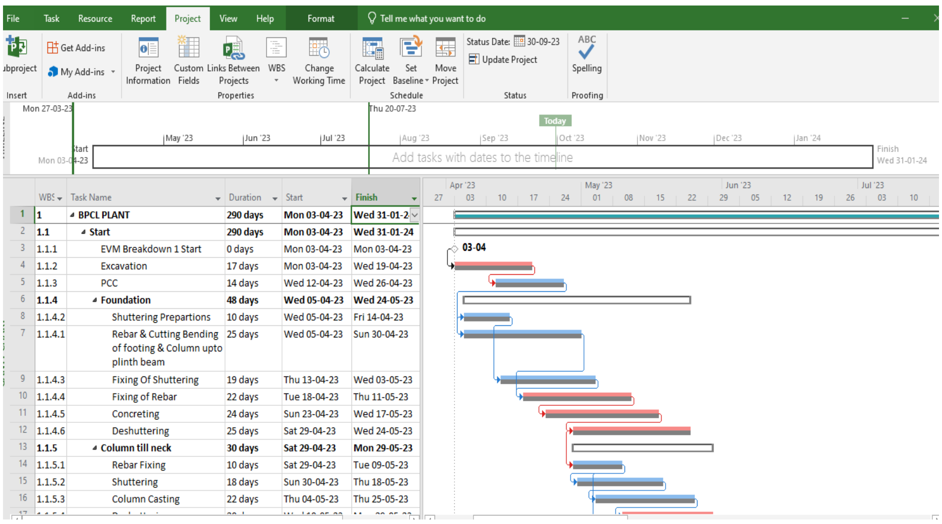

Figure 3: MSP - Critical Path.

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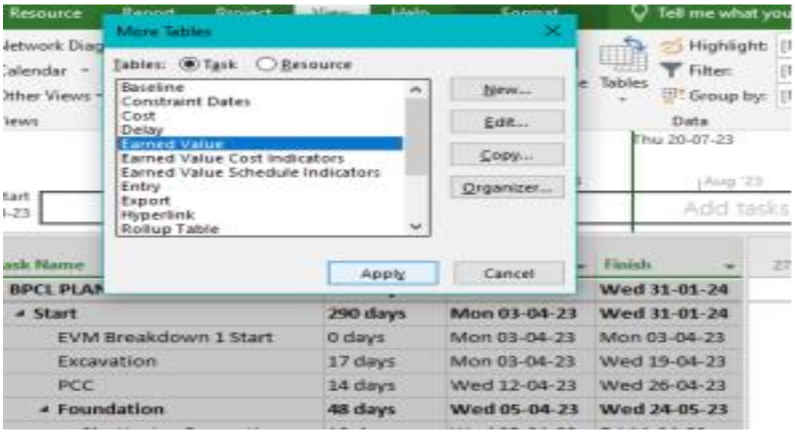

Figure 4: MSP - Earned Value

2.4 Hypothetical Application of EVM

This study is based on the hypothetical application of EVM to a commercial construction project. The LPG bottling plant at Rasayani in Raigad, Maharashtra, India, was the project of interest in this study. The project is under the commercial industry, and it involved constructing a Pre-Engineered Building with a total built-up area of 1620 square meters. The actual cost incurred for the project is Rs 10,18,22,725 /-. The project was planned to last months, but due to several challenges, including design errors, torrential rains, and increased costs due to inflation, it went up to 14 months. The first part of the analysis was breaking down the project into four phases: April to June 2023, July to September 2023, October 2023 to January 2024, and February to May 2024 for detailed EVM analysis.

3. Results and Discussion

3.1 Cost Estimation and Performance Analysis

The project's BAC was ₹87,478,725, while AC reached ₹101,822,725, indicating significant budget overruns. The EVM analysis for each period is as follows:

a) Timeline: April to June 2023

Analysis: Design errors have prolonged the project and caused budget overruns. A cost overrun has an equivalent to a CPI of 0.91, and a schedule overrun equals an SPI of 0.64. These issues stem from EVM non-usage that could have detected and corrected design errors at an early stage, and provided for better resource allocation and communication; therefore, they could have been easily mitigated.

Table 1: Indices for Timeline 1.

EARNED VALUE MANAGEMENT PARAMETERS/INDICES										
TIMELINE - APRIL TO JUNE 2023										
Sr. NO	ACTIVITY	ACWP (AC)	BCWP (EV)	BCWS (PV)	CPI	CV	SPI	SV	EAC	VAC
1	Excavation	₹ 9,29,250	₹ 9,29,250	₹ 9,29,250						
2	PCC	₹ 7,20,000	₹ 7,20,000	₹ 7,20,000						
3	Foundation	₹ 69,77,000	₹ 69,77,000	₹ 69,77,000						
4	Column till neck	₹ 21,34,000	₹ 19,20,600	₹ 21,34,000						
5	Plinth beam	₹ 44,83,500	₹ 38,16,800	₹ 47,71,000						
6	Flooring	₹ 32,43,240	₹ 24,55,596	₹ 33,82,236						
7	Column	₹ -	₹ -	₹ 52,58,000	0.91	₹ -16,67,744	0.64	₹ -92,77,240	₹9,61,52,843	₹ -86,74,118
8	Fabrication	₹ -	₹ -	₹ 19,25,000						
9	Roof Sheeting	₹ -	₹ -	₹ -						
10	RCC Flooring	₹ -	₹ -	₹ -						
TOTAL TO DATE		₹ 1,84,86,990	₹ 1,68,19,246	₹ 2,60,96,486						

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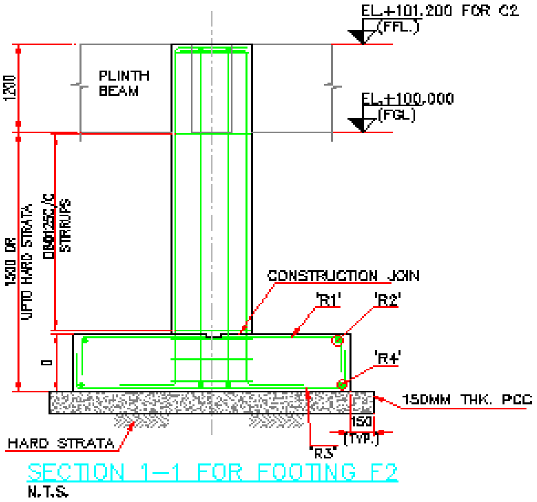

Figure 5: Design Error with no Column Capitals.

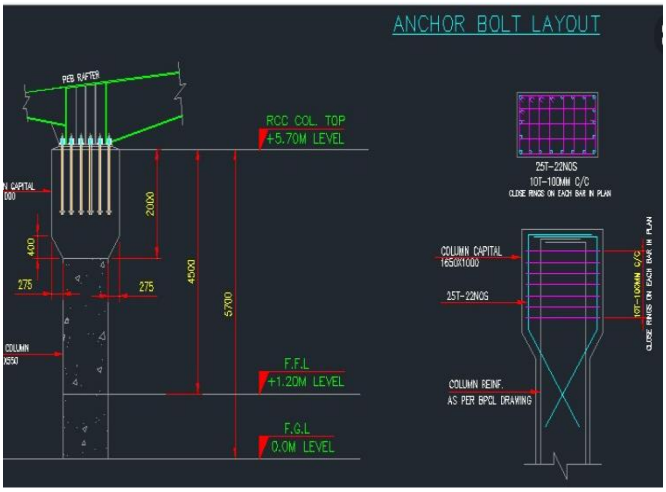

Figure 6: Revised design with column capitals.

b) Timeline: July to September 2023

Analysis: Torrential rains and site closures led to further delays and cost issues. A CPI of 0.78 and an SPI of 0.56 reflect severe inefficiencies. EVM could have guided measures like the development of contingency plans for weather disruptions, rescheduling critical activities, and flexible work schedules could have been crucial.

Table 2 : Indices for Timeline 2.

TIMELINE - JULY TO SEPTEMBER 2023										
Sr. NO	ACTIVITY	ACWP (AC)	BCWP (EV)	BCWS (PV)	CPI	CV	SPI	SV	EAC	VAC
1	Excavation	₹ 9,29,250	₹ 9,29,250	₹ 9,29,250						
2	PCC	₹ 7,20,000	₹ 7,20,000	₹ 7,20,000						
3	Foundation	₹ 69,77,000	₹ 69,77,000	₹ 69,77,000						
4	Column till neck	₹ 21,34,000	₹ 21,34,000	₹ 21,34,000						
5	Plinth beam	₹ 47,13,500	₹ 45,32,450	₹ 47,71,000						
6	Flooring	₹ 44,47,872	₹ 41,69,880	₹ 46,33,200						
7	Column	₹ -	₹ -	₹ 75,58,000	0.78	₹ -79,84,042	0.56	₹ -2,28,89,870	₹11,14,90,135	₹ -2,40,11,410
8	Fabrication	₹ 1,71,50,000	₹ 96,25,000	₹ 2,42,55,000						
9	Roof Sheeting	₹ -	₹ -	₹ -						
10	RCC Flooring	₹ -	₹ -	₹ -						
TOTAL TO DATE		₹ 3,70,71,622	₹ 2,90,87,580	₹ 5,19,77,450						

c) Timeline: October 2023 to January 2024

Table 3: Indices for Timeline 3.

TIMELINE - OCTOBER 2023 TO JANUARY 2024										
Sr. NO	ACTIVITY	ACWP (AC)	BCWP (EV)	BCWS (PV)	CPI	CV	SPI	SV	EAC	VAC
1	Excavation	₹ 9,29,250	₹ 9,29,250	₹ 9,29,250						
2	PCC	₹ 7,20,000	₹ 7,20,000	₹ 7,20,000						
3	Foundation	₹ 69,77,000	₹ 69,77,000	₹ 69,77,000						
4	Column till neck	₹ 21,34,000	₹ 21,34,000	₹ 21,34,000						
5	Plinth beam	₹ 47,71,000	₹ 47,71,000	₹ 47,71,000						
6	Flooring	₹ 45,86,868	₹ 41,69,880	₹ 46,33,200						
7	Column	₹ -	₹ -	₹ 75,58,000	0.60	₹ -2,34,46,988	0.41	₹ -5,16,07,595	₹14,46,58,764	₹ -5,71,80,039
8	Fabrication	₹ 3,92,00,000	₹ 1,61,70,000	₹ 3,85,00,000						
9	Roof Sheeting	₹ -	₹ -	₹ 88,00,000						
10	RCC Flooring	₹ -	₹ -	₹ 1,24,56,275						
TOTAL TO DATE		₹ 5,93,18,118	₹ 3,58,71,130	₹ 8,74,78,725						

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Analysis: Inflation and accumulated issues caused severe cost inefficiencies and delays. A CPI of 0.60 and SPI of 0.41 highlight the compounded nature of project delays and cost overruns. EVM could have prioritized high-impact activities, negotiated bulk purchasing agreements, and increased workforce and shifts to regain schedule momentum.

d) Timeline: February to May 2024:

Figure 7: A picture of the site showcasing ongoing work in Phase 4.

Analysis: The project stabilized, achieving an SPI of 1.00, indicating it was on schedule, but a CPI of 0.86 still shows budget overruns. EVM would have helped continue close monitoring and control of costs, optimized resource allocation, and implemented lessons from previous phases.

Table 4: Indices for Timeline 4.

TIMELINE - FEBRUARY TO MAY 2024										
Sr. NO	**ACTIVITY**	**ACWP (AC)**	**BCWP (EV)**	**BCWS (PV)**	**CPI**	**CV**	**SPI**	**SV**	**EAC**	**VAC**
1	Excavation	₹ 9,29,250	₹ 9,29,250	₹ 9,29,250						
2	PCC	₹ 7,20,000	₹ 7,20,000	₹ 7,20,000						
3	Foundation	₹ 69,77,000	₹ 69,77,000	₹ 69,77,000						
4	Column till neck	₹ 21,34,000	₹ 21,34,000	₹ 21,34,000						
5	Plinth beam	₹ 47,71,000	₹ 47,71,000	₹ 47,71,000						
6	Flooring	₹ 46,33,200	₹ 46,33,200	₹ 46,33,200						
7	Column	₹ 90,02,000	₹ 75,58,000	₹ 75,58,000	**0.86**	**₹ -1,43,44,000**	**1.00**	**₹ -**	**₹10,18,22,725**	**₹ -1,43,44,000**
8	Fabrication	₹ 4,90,00,000	₹ 3,85,00,000	₹ 3,85,00,000						
9	Roof Sheeting	₹ 1,12,00,000	₹ 88,00,000	₹ 88,00,000						
10	RCC Flooring	₹ 1,24,56,275	₹ 1,24,56,275	₹ 1,24,56,275						
TOTAL TO DATE		**₹ 10,18,22,725**	**₹ 8,74,78,725**	**₹ 8,74,78,725**						

3.2 Detailed Discussion

a) Early Warning Signals for Cost and Schedule Variances:
The continuous application of Earned Value Management would have signaled cost and schedule changes at the earliest stages of the project. For instance, in April-June 2023, a CPI of 0.91 and SPI 0.64 indicate cost overrun and extensive Schedule derailments due to design flaws. Introducing EVM would have allowed immediate action, such as re-designing and re-allocation of resources, to prevent cost overruns and other related issues.

b) Proactive Risk Management:
Since EVM can be employed at the beginning of the project, one can argue that it can help prevent risks before they occur. As an example, severe weather in July-September 2023 caused CPI and SPI of 0.78, and 0.56, respectively, leading to cost inefficiencies and scheduled derailments. EVM early introduction would help outline the project risks and build preventative measures, such as alternative work schedules and rescheduling, to avoid adverse effects on the project due to certain events.

c) Optimized Resource Allocation:
The project EVM allows for optimized resource allocation throughout the project life cycle. By monitoring EV, PV, and AC, resource deployment becomes more efficient. From October 2023 to January 2024, the cost performance index and

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schedule performance index were 0.60 and 0.41 due to inflation and accumulated problems. However, with strategic resource management such as bulk purchases negotiations and workforce adjustments, the cost of the schedule could have recuperated and maintained momentum.

d) Improved Communication and Coordination:
EVM enables improved communication and coordination through systematic reporting. It defines performance metrics that enable all stakeholders to be clear on the project outcome. Although the schedule performance indicator from February to May 2024 was 1.00, and the cost of performance index was 0.86, the budget overrun was still ongoing. Therefore, EVM reporting would have helped all stakeholders to discuss and decide based on the information whether the remaining cost overrun could have been solved and projects completed within the revised estimations.

e) Enhanced Project Governance:
EVM improves project governance structurally, systematic monitoring and reporting standardized performance assessment, and data-driven decisions. In this manner, project resilience becomes enhanced, and stakeholder confidence across the project life.

4. Conclusion

The EVM application in the commercial construction project seems to be a promising and strong project management tool. Based on the EVM principles, the project team can manage to foresee and address issues that can, in the end, guarantee that the work will be finished on time and meet the original budget. The examination of four phases of the project proves EVM's ability to extrapolate outcomes by finding design failures, managing weather delays, and alleviating cost over-curves because of inflation. The use of a systematic approach could promote not only the integration between these methods but also the implementation of a number of management strategies.

4.1 Key Findings

1) Impact of EVM on Project Cost Management and Schedule Management:
EVM cost and schedule variance analyses were instrumental in detecting budgetary overruns and delays at each stage of the project. The initial miscalculations of the first phase (April to June 2023) error was due to design phase errors, weather delays in the second phase (July to September 2023), and inflationary cost increases during the third stage(October 2023 to January 2024) — all that could have been identified earlier with EVM and allowed for better adjustment budgets. The cost control processes would have been more entrenched by the end phase. The SPI also showed schedule delays, which the organization should have been able to capture and respond to by reallocating resources or adjusting schedules further validating EVM's role in sustaining on-time performance.

2) Proactive Decision-Making and Strategic Management Insights Facilitated by EVM:
EVM enabled timely corrective action at each phase with good upfront decision-making based on early identified issues. Management could have acted proactively by monitoring cost and schedule performance daily, perfecting emerging design errors, weather disruptions, or inflation throughout the construction. These insights should have encouraged the implementation of contingency plans and improved control would have been a clear example of EVM's ability to process strategic management and long-term planning.

3) Enhanced Forecasting Capabilities of EVM thereby promoting the Adoption of EVM in Commercial Construction Projects:
Applying EVM proved it to be an extremely accurate method for forecasting project results, both in cost and schedule. Likewise, alarms going off about the budget being blown in the first quarter (Apr-21 to June 2023) would have called for corrections preventing an escalation in further quarters. In the same way, had the project team observed that weather-related disruptions become an issue during the second quarter (July to September 2023), they could have adjusted resources accordingly. In the third phase from February to May 2024, EVM brought cost variances under control and helped improve schedule performance. This demonstrates how beneficial EVM is, as such precise prediction allows for commercial construction to be more inclined in using it on a larger scale.

4.2 Performance Metrics Analysis with EVM

a) Cost Performance Index (CPI) analysis:
The values of CPI have shown various chances for active cost management. The target of 0.91 was surpassed, but the early value of 0.78 has indicated several accruals of costs that could have been avoided. A value of 0.60 describes that more possibilities could have been missed. EVM helps to get the cost insight at any given moment to invest strategy and improve financial performance.

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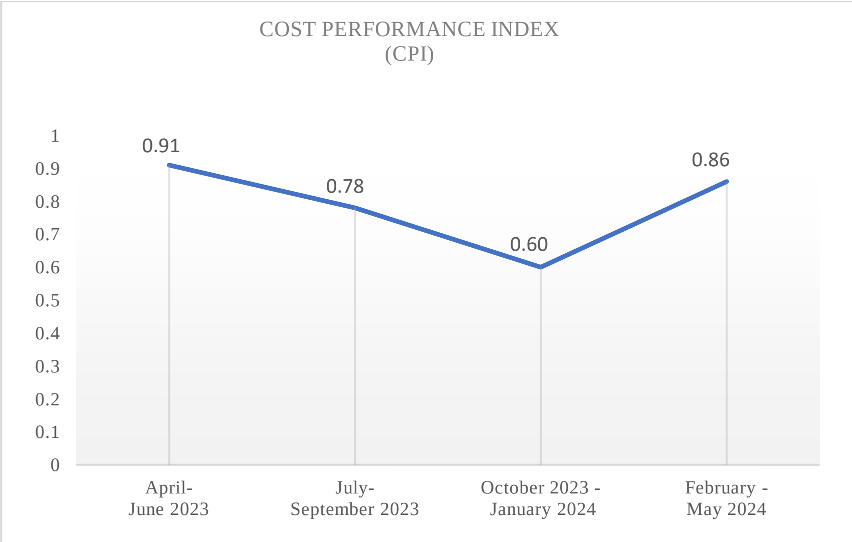

Figure 8: Graph for Cost Performance Index (CPI).

b) Schedule Performance Index (SPI) Analysis:
The delays on the other hand, won out in terms of size with SPI values. The schedule adherence represented by the initial SPI of 0.64 decreased to 0.56 and further dropped down to a value of 0.41. The EVM allows for proactive interventions to improve schedule predictability and resource utilization, supporting on-time project delivery.

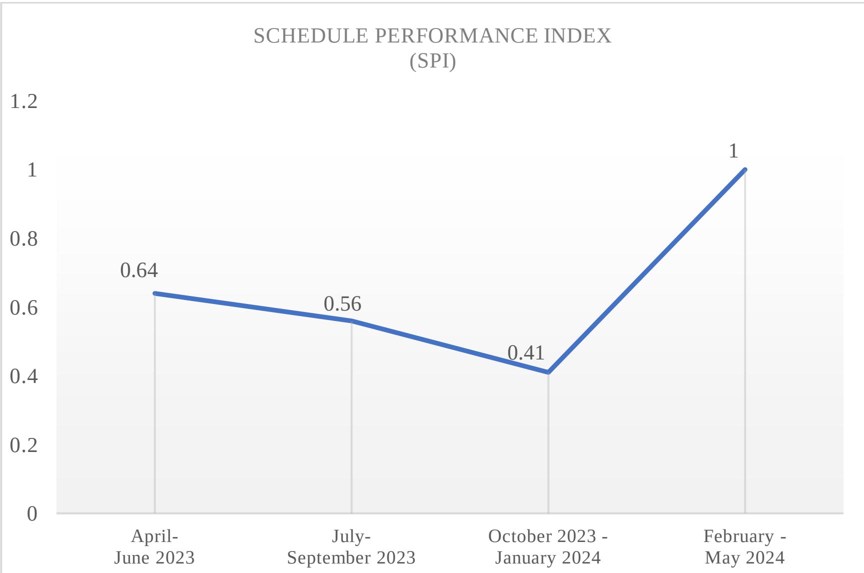

Figure 9: Graph for Schedule Performance Index (SPI).

c) Cost Variance (CV) Analysis:
Budget overruns were indicated by consistent negative CV values. So, this allows to promptly alarm EVM when corrective action needs to be taken such as cost saving initiatives where finances can come into question, improved accuracy for forecasting financials, and sustaining project profitability.

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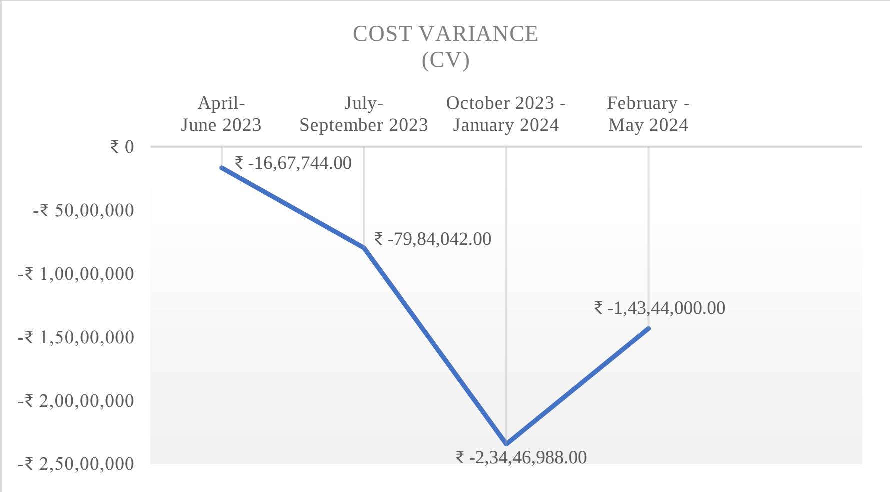

Figure 10: Graph for Cost Variances (CV).

d) Fundamental EVM Parameters (EV, PV and AC):

Analysis revealed a varied fluctuation in performance. Originally, fewer EV and AC against PV: meant effectiveness concerns. Future quarters continued to face headwinds from high AC and weak EV demonstrating ongoing difficulties. But the third period suggested recovery attempts, both in terms of a more competitive EV and closer correlation to PV but at greater costs. The last period demonstrated proper control, synchronizing AC in accordance with PV and EV exhibiting the project is stabilizing towards completion.

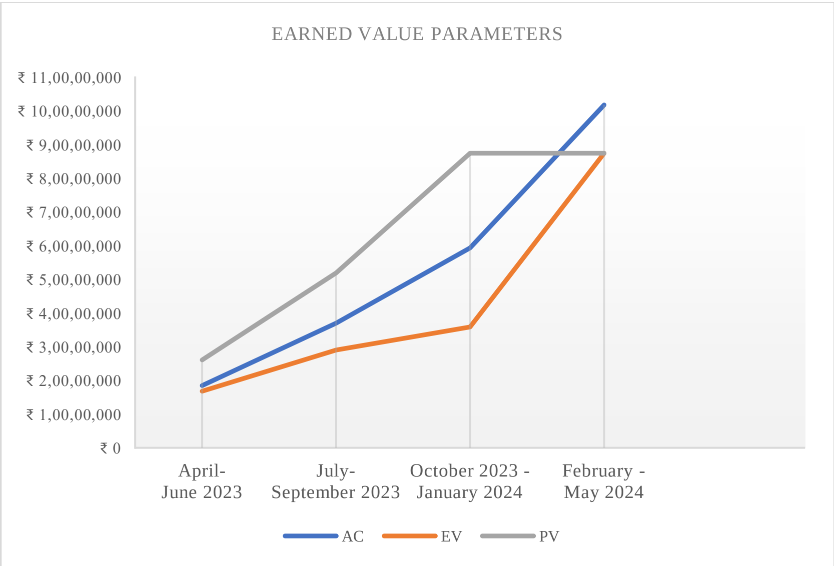

Figure 11: Graph for EVM Parameters.

In conclusion, this commercial construction project uses EVM which shows its importance as a key factor in modern-day project management. EVM capability provides many performance insights that can enable proactive decision-making to successfully traverse the complex projects encountered, manage risks effectively ensuring successful delivery. Starting with EVM is the best way to offer organizations with improved project management capability and give them better cost and schedule conformance, which will lead in turn to delivering what stakeholders want. This information concludes an attractive case for standardizing EVM in commercial construction as it reveals various advantages that lean towards project performance and success.

5. STATEMENTS AND DECLARATIONS

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Conflicts of Interest
There are no conflicting interests as stated by the authors.

Authors contribution statement
Fatema Sobiya: Original Draft, Literature Review, Methodology, Data Collection and Analysis, Case Study, Writing and Editing.
Dr. Girish B. Mahajan: Review, Validation, Supervision.

Data Availability
The data supporting the findings of this study can be obtained from the corresponding author at a reasonable request.

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