International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Schedule and Cost Management using Earned Value Management

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ABSTRACT-

Earned Value Management (EVM) techniques describe the processes that are required for the effective use of Earned Value Analysis (EVA). It is a project performance measurement method that's widely followed by the infrastructure & construction industries in India. However, its application as project control technique is not very common in India In this paper, EVM System was applied on a Fabrication of Offshore Process Platform Bridge in Oil and Gas industry.

In this paper, we survey instructional and practitioner literature on Earned Value Management and its extensions and try to reconcile the debate by juxtaposing the claims and counterclaims towards parallel research streams in project management. We suggest an integrative scheme to ground the technique amidst the various bodies of research opinions to elicit future directions.

Keywords- performance measurement, Earned Value Management (EVM), Schedule Performance Index (SPI), Cost Performance Index(CPI).

I. INTRODUCTION

Delays within the construction projects are universal & the majority organizations face the identical. Many construction projects suffer from inconsistent time and the cost overruns that proves that there's problem of controlling multiple construction projects to deliver their Goals on time and within project cost. The identical is that the case in Oil and Gas Construction Projects. In spite the trouble made by the PMTs with the aim to regulate the performance of project, often performance scope, time & price are quite common problems that arise while dealing with O&G projects. The lack of common uniform decision tools and technique to live performance indicators on construction projects is additionally an issue. Even the communication gap between Project management team at the Onshore-Base & the Execution Team at the Offshore-site results in undesirable problems causing project delay. There's a requirement for the reliable technique for control line performance of the development industry for nearly every Oil & Gas Project. EVMS using Primavera P6 software takes a step further than traditional measurement like PERT to offer quantitative parameter which will allow the project manager to create better and effectively decision for the performance of the project.
Aim is to monitor & control the status of the KGDWN-98/2 NELP BLOCK for CPP-LQUP Bridge project with respect to triple constraints viz. scope, schedule, and budget using Earned Value Management System with Oracle Primavera P6 Software.

II. Literature Review

Project Management Overview

Many projects are over scheduled, over budgeted, and did not meet the satisfaction of the purchasers thanks to the calibre of ultimate product. This caused the necessity permanently interaction and effective communication with customers to be sorted for. In an oil and gas industry, the most objective of the project is to complete the scope of labour within budget in an exceedingly certain timeframe, to realize customers‟ satisfaction. To attain this objective, it's important to develop a decent plan before commencing a project. This plan should include all the work tasks, associate costs, and estimates of the complete period necessary to finish the project. The shortage of such a thought would lead to the failure to accomplish the complete project scope within budget if in the least on schedule. Within the oil and gas industry, as in other industries, good project planning, positive interaction, and communication between team members and with the shoppers are essential to forestall any unforeseen contingencies. Regular scheduled meetings or progress reports, effective communications via telephone, or e- mail are just few samples of communication channels to use for effective communication within the company. Customer satisfaction means involving and treating customers as partners within the successful completion of projects, through active participation during the project. Furthermore, by maintaining communication with customers, the project manager demonstrates to customers that he/she is genuinely concerned about the expectations of the purchasers. [2]

Why is Project Management so Important

Because not anything ever receives executed without first building a project plan, and no project plan gets executed without the proper environment or the proper processes. Project management is the action that helps planning scheduling and execute that project plan. It applies managerial and interpersonal

skills to the system of effectively bringing a project from concept to completion, instep with stated requirements. Fabrication of projects passes through different phases like any typical project including initiation, planning, engineering& procurement, execution, control & monitoring and close out. Any phase of those can be impacted by different aspects, which can affect the whole project life cycle. Main factors that cause schedule delays are changes in scope, the poor procurement process, lack of skilled laborers, poor planning and scheduling, inexperienced contractors, and bad performance by the subcontractors. Hence project scheduling, cost budgeting &controlling is important.

Project Management Triangle

Project management triangle or also called as Triple Constraint can be described as a graphic triangle to illustrate the relationship between three primary forces in a project. cost represents the amount of money or resources available Time is the available time to deliver the project, and quality represents the fit-to-purpose that the project must achieve to be a success. [4]

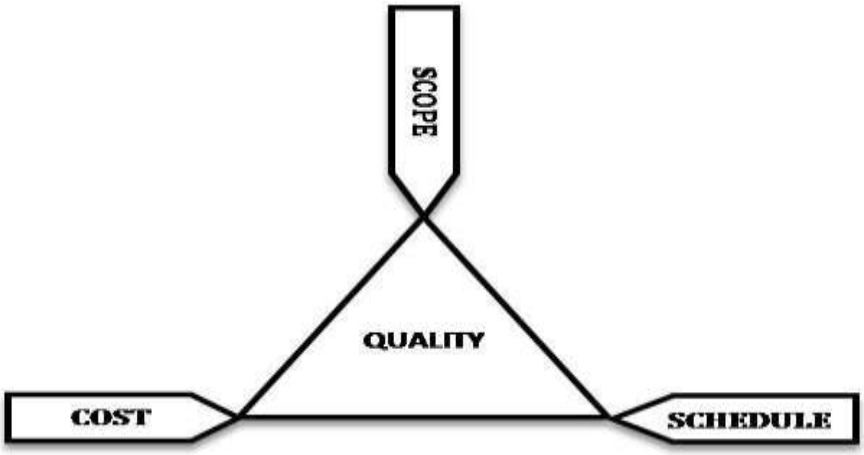

Figure 1: Project Management Triangle

Objectives of Study

Following are the objectives of the study:

- To obtain the integration between projects triple constraints.
- To develop a detailed project schedule by integrating project scope, time & cost using Primavera P6 Software
- To analyse the project from EVM Metrics.
- To extrapolate the results to predict future estimates of the project.

III. Methodology

Earned Value Management

EVM integrates project scope, cost, and time through periodic measurements of actual cost and work completion. It views project progress in terms of cost as a function of time against a baseline set up at the beginning of the project. When the project is originally planned, it is divided into Work Breakdown Structure (WBS) and further sub-divided into work packages. These work packages are assessed for cost estimates and scheduled in a time sequence. Taken together, WBS, schedule and cost budgets form the baseline, represented as a graph of planned costs over time. This is the planned value (PV). It simply tells how the costs will flow over time as planned. During the project execution, actual costs (AC) and the quantum of work completed are periodically noted. The work completion is pro-rated to equivalent monetary value based on the budgetary costs for the work packages completed (work-in-progress packages are assessed on % completion). This is the earned value (EV). These three numbers, i.e. PV, AC and EV drive the operation of EVM.

EVM focuses on the flow rates of actual cost and completion against the planned cost and completion. PV, EV and AC make it possible to compute cost and time variances, as well as extrapolate how much cost and time would be required for project completion (Figure 2). Simple calculations based on these three numbers yield several ratios for project control. Of these, three ratios can be regarded as important: Cost Performance Index (CPI), Schedule Performance Index (SPI), and Cost Estimate at Completion (CEAC). By giving historical and forward information about the project, EVM becomes a tool for monitoring and course corrections.[5]

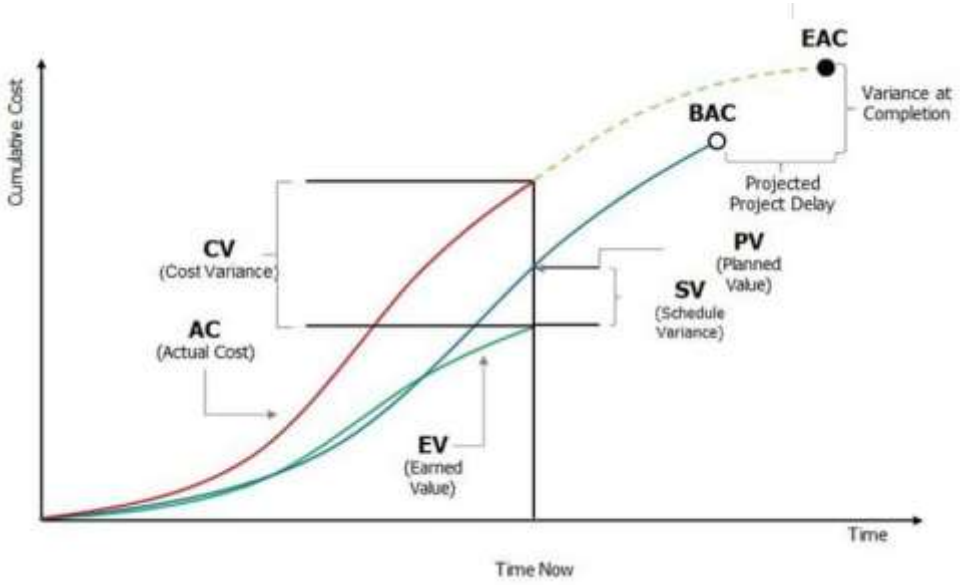

Figure 2: PV, AC, EV S curve

Table 1 - Forecasting Indicators by EVM technique

Indicator	**Equation**	**Interpretation**
Budget at Completion (BAC)		BAC represents total budget at completion; at completion PV=BAC
Estimate at Completion (EAC)	EAC= (BAC/SPI) / (BAC/Month)	The estimated completion time for the project if the work continues at the current rhythm
Estimate To Complete (ETC)	[1]ETC = BAC − EV	Cost to complete the project if all packages remain achieving the goals of time and cost, irrespective of what happened to EV
Estimate To Complete (ETC)	[2]ETC = (BAC – EV) / CPI	Cost to complete the project assuming that current cost performance will remain the same (as occurred up to EV) throughout the rest of the project
Estimate To Complete (ETC)	ETC = (BAC – EV) / (CPI *SPI)	Cost to complete the project assuming that current performance cost and schedule performance will the same as occurred up to EV) throughout the rest of the project
Estimate at Completion (EAC)	EAC = AC + BAC -EV	Final cost of the project based in the original budget. The optimistic scenario assumes that all remaining work will be performed just with what remains on the initial budget.
Estimate at Completion (EAC)	EAC = AC + (BAC -EV) / (CPI*SPI)	Final cost of the project if current performance trends to CPI and SPI continue. The pessimistic scenario assumes that all work remaining will performed with the actual CPI and SPI, both in terms of cost and durations.
Estimate at Completion (EAC)	EAC = AC + (BAC-EV) /CPI	Final cost of the project if current performance trends to CPI continue. The realistic scenario assumes that all work remaining will performed with the actual CPI.

IV. DATA COLLECTION

Data collection might be a systematic process of gathering and scrutinizing specific information to tender solutions to applicable questions and examine the outcomes. It focuses on looking for all there's to a specific material. Data is collected to be similarly subjected to hypothesis testing which seeks to elucidate a phenomenon. Hypothesis trying out removes assumptions while creating a proposition from the idea of reason. For collectors of information,

there's a variety of outcomes that the information is collected, but the key purpose that data is collected is to place a researcher in an exceedingly vantage position to form predictions about future probabilities and trends. [1]

Table 2. Data collection from KGDWN-98/2 Project of oil & gas sector

Table 2.1: Scope of work

CPP-LQUP Bridge			
Sr.No	**Description**	**Scope**	**Unit of Measurement**
1	Top & Bottom Chord	516	No of joints
2	Elevation Row	324	No of joints
3	Lifting Padeye	52	No of joints
4	ERS	189	No of joints
5	Top& Bottom Walkway Framing	609	No of joints
6	Sliding & Fixed Ends	257	No of joints
7	Walkway(Stair, Grating & Access PF)	262	No of joints
8	Handrails & ladder	310	No of joints
9	Roofing Support	626	No of joints
10	Corrugated Wall Plate	4105	Meter
11	Cladding Bracing & Door Frame	203	No of Joints
12	Monorail	138	No of joints
13	Pipe support	576	No of joints
14	Piping Support	2508	Inch Diameter
15	Painting	11400	Sq.Mtr

Table 2.1: Budget Of Project

Sr. No	**Description**	**Weightage**	**Plan Cost**
1	Chord Fabrication	22%	₹ 96,80,000
2	Bracing Fabrication	12%	₹ 52,80,000
3	Walkway	8%	₹ 35,20,000
4	Pipe Support Frame	10%	₹ 44,00,000
5	Pipe Support & E&I Support	4%	₹ 17,60,000
6	Roof Support	3%	₹ 13,20,000
7	Top& Bottom Chord AB -A1B1 Assembly	12%	₹ 52,80,000
8	Roof Chord CD Assembly	9%	₹ 39,60,000
9	Piping Installation	5%	₹ 22,05,000
10	Painting	10%	₹ 44,00,000
11	Final Clearance & Loadout	5%	₹ 22,00,000
12	Total	100%	₹ 4,40,05,000

Reason for delay

- Delay in material issue from the client organization
- Delay in fabrication because of insufficient number of skilled manpower
- Frequent amendments in design drawings
- Fabrication work was affected because of covid restrictions

- Delay in milestone payment

V. RESULT

Equations used in calculations from PMBOK Cost Management chapter:

1. Cost variance (CV) = Earned value (EV) - Actual cost (AC)
2. Cost performance index (CPI) = Earned value (EV) / Actual cost (AC)
3. Schedule variance (SV) = Earned value (EV) – Planned Value (PV)
4. Schedule performance index (SPI) = Earned value (EV) / Planned Value (PV)
5. Estimate to Complete (ETC) = Budget at Completion (BAC) – Earned Value (EV)
6. Estimate at Completion (EAC) = ETC + AC

Table 3 : Result case

Case 1	Case 2	Case 3
CV = 0; as per budget, CPI =1	CV = -ve; budget at over run, CPI <1	CV = +ve; budget at under run, CPI >1
SV = 0; as per schedule, SPI =1	SV = -ve; behind schedule, SPI <1	SV = +ve; ahead schedule, SPI >1

Table 4: EVM Final Results

EVM Parameter	**Details**
Budget at Completion, BAC	₹ 4,40,00,000
Planned Value, PV	₹ 4,40,05,000
Earned Value, EV	₹ 3,94,92,750
Actual Cost, AC	₹ 4,35,06,536
Schedule Variance, SV=EV-PV	-₹ 45,12,250
SV % = SV/PV	-10.25%
CV%=CV/Ev	-10.00%
Total duration	355days
Estimate at Complete EAC(t) =(BAC/SPI)/(BAC/months)	394 days
Cost Performance Index CPI=EV/AC	0.9
Estimate to Complete	₹ 45,12,250
Estimate at Complete	₹ 4,80,18,786
Planned schedule % complete	100%
Actual schedule % complete	90%

VI. CONCLUSION

- This negative value of CV indicates that the project is over budget.
- A CPI value of 0.91 indicates that the project is over budget.
- The project has a negative value for the schedule variance which indicate that the project behind schedule
- Schedule variance % is -0.10 therefore the project is 10.25% behind the schedule

- SPI value 0.90 indicates that the project is only progressing at 90% of the rate originally planned. The project has cost variance of -₹ 40,13,786
- Estimate at completion of project is ₹ 4,80,18,786

Generally, it can be concluded that inadequacy in implementation of monitoring policies has been observed.

- It can be said "quality" as critical consideration for oil and gas companies that contribute to a project success. Therefore, the contractors will have to abide with the request of the client. The contractors must also work within the "time" agreed upon and the "scope" of work must also go through the clients" as the clients will have to ensure the quality of the final product.
- Cost is highly dependent on the decision making in the dimension of time, quality and scope. The event that brought about this is the nature of the complexity and the upmost importance of the final product to the oil and gas companies to ensure project success. Oil and gas (O&G) industry plays a very important part as the nation building, even though each of its facility is having a unique requirement

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