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## Project Performance Evaluation through Earned Value Analysis

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**ABSTRACT:** It is evident that the successful completion of construction project, effective management plays an important role. In the upcoming competitive market place the management of technical projects becoming more challenge to the professional engineers and managers. In any project, timely measuring project performance fortifies managers to identify and to mitigate upcoming problems. Earned value analysis is a proven effective management technique for estimating how a project is doing in terms of its budget and schedule. This paper exhibits benefits of Earned value analysis on a typical project.

**KEYWORDS:** Project Performance, Earned Value Analysis (EVA), budget, Schedule.

### I. INTRODUCTION

The Indian economy has been showing great resilience in the present global scenario and more ever the growth trajectory is also satisfying for the present. During the 12<sup>th</sup> five year plan, the Indian government is likely to invest over ₹ 45 lakh crores for the infrastructure projects, which is nearly double over 11<sup>th</sup> five year plan. Effective utilization huge investment and resources is most crucial factor and requires effective project management techniques. EVA is one of such principle which interprets cost, time and scope of a project/program. EVA is proven and effective management principle for measuring cost and time overrun. The purpose of earned value is to obtain an estimate for the resources that have been used at completion of a project. Earned value analysis has been widely applied in various industrial sectors and many studies have been carried out on EVA and its application in the construction industry. Many project managers measure their project performance by comparing planned to actual results, but they end up in spending more money because it does not indicate the worth of work which is completed at any given time.

EVA measures the amount of money spent and the amount of work performed so far, this gives current figure of a project which can be compared to its original plans. Earned value usually expressed in terms of monetary units.

### II. DESCRIPTION OF BASIC EVA ATTRIBUTES

The following terms are defined using 'Brick work' as an example: Consider 10 Sqm of brick work to be done at ₹ 1000 for 12 days. Cost distribution is assumed to be uniform over 12 days. After 6 days it is found that the brick work completed only 4 Sqm and the cost incurred to build 4 Sqm is found to be ₹ 600.

**Planned Value (PV):** Targeted value set for the particular activity during the planning stage of project. In the above Brick work example PV for 6 days is ₹ 500 for 5 Sqm and PV for 12 days ₹ 1000 for 10 Sqm.

**Earned Value (EV):** It is value of the work received by carrying out the planned value of work. In the above example after carrying out 6 days of work EV is ₹ 400 for 4 Sqm of brick work.

**Actual Cost (AC):** It is the cost incurred to carry out the work due many factors like inaccuracy of project estimate, change in design and scope of project, inefficient planning, Labour inefficiencies, change in market prices of materials, etc. AC may be more or less or equal to PV. In the above example the actual cost is ₹ 600 for 4 Sqm of brick work, we

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may say it because of change in market price of Bricks, □ 200 more spent as against to planned □ 400 for 4 Sqm of brick work.

### III. METHODOLOGY

In the project management numerous inputs that are to be incorporated from various parties involved in the construction project. Best practices ever followed are emphasis on positive or negative progress of the project with reference to cost and time. As the construction project involves numerous activities and tasks, it becomes complex to handle, monitor and control, it is necessary to use a suitable method for identification of delays. The method shall also has detailed procedure for collection, analysis and interpretation of data related to construction projects. Major information about a project are collected based on its importance for analysis are project name, location, client, contractor, project management consultant, time for completion, contact value, conditions of contract, scope of works etc.

Apart from details, other details like, bill of quantities, detailed schedule, planned programs, updated status of project and rate analysis etc., are also collected for the purpose of calculating the basic elements of EVA. The data like BAC, PV, Earned Value and AC can be used to analyse the current status of project and forecast its future.

The following step by step procedure is adopted for planning, scheduling, updating and controlling project process.

- Make a detail list of activities pertaining to the scope of works.
- Preparing the network diagram for the above listed activities.
- Estimate the time required to carry out each work activities
- Identify the critical path of the project
- Allocate the resources to each activities.
- Establishing performance Measurement Baseline (PMB) and Updating baseline with actual progress of works.
- Recording of cost and time associated with actual progress of work on regular basis.
- By comparing the planned baseline with the update programme, the basic key elements of EVA, variances, indices and forecast can be found out.
- From the baseline elements of EVA, S- curve is plotted.
- Collected data was recorded in the tabular format, so that it helps the top management to take corrective/preventive action, when there is deviation of project from the planned baseline programme.

### IV. CASE STUDY

The project 'Ramky One North' consists of A, B, C, D and E Blocks. These are Designed and built to satisfy basic amenities for living which are constructed uniquely to each other. A-Block is selected for EVA study. A-Block is an executive block consists of 2 and 3 BHK flats in each floor and in-total of 54 flats in 13 floors. At present data date 29-02-2016, as work order for MEP works not yet received, the work order given to carryout is shell and core work only. So the EVA analysis is carried out for Shell and core work of A-Block only. Details of the project is gathered form site, as shown in Table 1. The scheduling, budget allocation, resource allocation, setting up, comparing, updating PMB, for each activities is carried out using Microsoft Project 2010 software. As limited pages presented in this journal extract of software's output is presented.

**Table 1: Details of Project**

Sl. No.	Details	Description
1	Project type	Residential apartment Building
2	Project name	Ramky One North (A-Block)
3	Number of Floors	2B+G+12

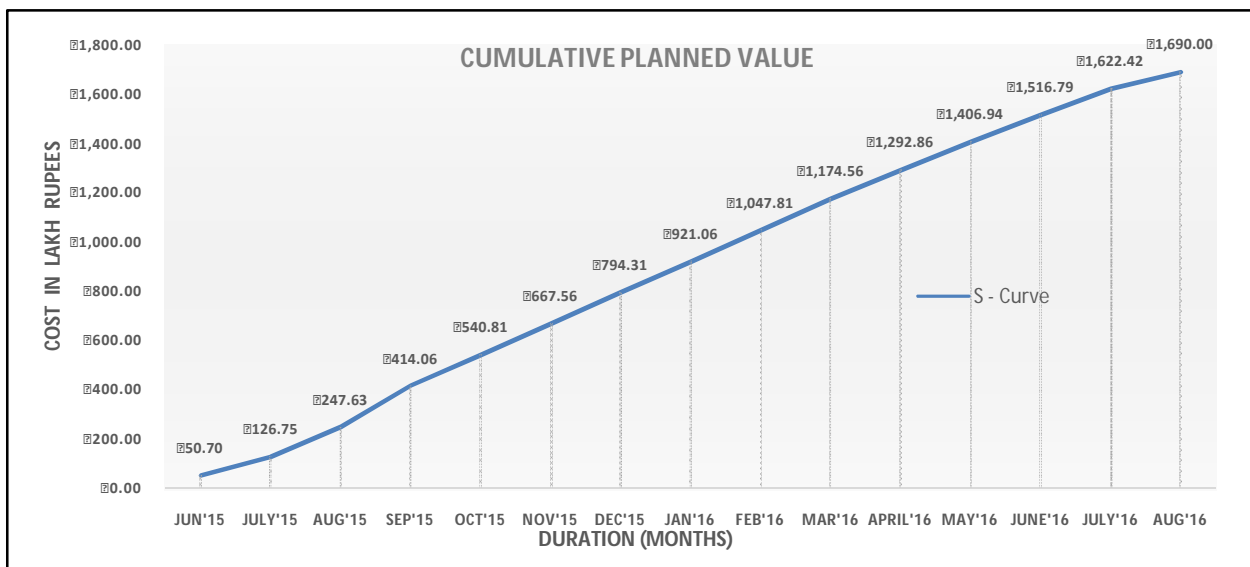
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4	Location	Yelahanka, Bengaluru
5	Client	Ramky Estates Farms Limited
6	Contractor	Ramky Infrastructure Limited
7	PMC	A.N Prakash Project Management Consultants
8	Time for completion	465 calendar days
9	Project start date	25-05-2015
10	Project finish date	31-08-2016
11	Total Cost	1,690 Lakh Rupees
12	Type of Contract	Item Rate Contract
13	Scope of Works	Constructing Shell and Core Works of A-Block (2B+G+12) as per designs, drawings and specifications.

Data collected from the schedule details of 15 month project gives the Duration vs. Cost plot. The cumulative planned value or the S-Curve or the Cost Baseline of the project A-Block from June 2015 to Aug 2016 is as shown in Figure 1. The S- Curve is the summation of direct indirect and overhead cost which can be used to monitor the present and future project cost performance. It is a convenient tool for cost management which forecast the future spending.



**Figure 1: Cumulative Planned Value of the Project**

Project data collected up to Feb 2016, the Planned Value, Earned Value, and Actual Cost is as shown in Table 2. The scheduled activities from June 2015 to Feb 2016 involves Earthwork excavation and backfilling. Footing works involving shuttering, rebar fabricating and concreting. Superstructure involving shuttering, rebar fabricating and concreting of slabs, beams and columns up to 9<sup>th</sup> floor. Block work up to 4 floor. Internal wall plastering up to 3<sup>rd</sup> floor. During internal plastering electrical wall casing is carried out.

Remaining works like electrical works, painting, plumbing, water proofing, Dadoing in toilets and in utilities, vitrified flooring, wall putty, kitchen granite fixing, door polishing and fixing, CP and sanitary fixing, snagging and desnagging etc, are to be carried out.

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**Table 2: Cumulative values of Planned, Earned, and Actual Cost**

Sl. No.	Months	PV(cum) in □ Lakhs	EV (cum) in □ Lakhs	AC (cum)in □ Lakhs
1	JUN'15	□ 50.70	□ 49.45	□ 51.2
2	JULY'15	□ 126.75	□ 125.88	□ 126.9
3	AUG'15	□ 247.63	□ 247.60	□ 250.67
4	SEP'15	□ 414.06	□ 412.06	□ 414.89
5	OCT'15	□ 540.81	□ 540.8	□ 540.81
6	NOV'15	□ 667.56	□ 666.04	□ 667.9
7	DEC'15	□ 794.31	□ 793.97	□ 795.21
8	JAN'16	□ 921.06	□ 921.60	□ 922.01
9	FEB'16*	□ 1,047.81	□ 1,046.90	□ 1047.99
10	MAR'16	□ 1,174.56	-----	-----
11	APRIL'16	□ 1,292.86	-----	-----
12	MAY'16	□ 1,406.94	-----	-----
13	JUNE'16	□ 1,516.79	-----	-----
14	JULY'16	□ 1,622.42	-----	-----
15	AUG'16	□ 1,690	-----	-----
Data collected up to end of FEB'16				

Using Table 2 data, the following equations gives the earned value analysis key parameters. These parameters gives whether the project is ahead of schedule or behind schedule, over spent or less spent, project's likely cost at completion.

$$\begin{aligned}
 \text{Schedule variance: } SV &= EV - PV && (1) \\
 \text{Cost variance: } CV &= EV - AC && (2) \\
 \text{Schedule Performance index: } SPI &= EV/PV && (3) \\
 \text{Cost Performance index: } CPI &= EV/AC && (4) \\
 \text{Estimate at completion: } EAC &= BAC/CPI && (5) \\
 \text{Estimate to complete: } ETC &= EAC - AC && (6) \\
 \text{Variance at completion: } VAC &= BAC - EAC && (7) \\
 \text{Time Estimate at Completion: } EACT &= \left(\frac{BAC}{SPI}\right) / \left(\frac{BAC}{months}\right) && (8)
 \end{aligned}$$

## V. RESULTS AND DISCUSSIONS

The Earned value analysis at the end of Feb 2016 gives the following data under the Table 3, which determines the health of project. Analysis using Earned value concept gives lot of facts and figures of the A-Block. This in turn helps project manager to monitor the changes happening from the baseline. In this residential project the analysis yields the following results:

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**Table 3: Earned Value Analysis Results to determine the Performance and Forecast completion time and cost.**

Sl. No.	EVA Parameters	Value
1	PV	□ 1,047.81Lakhs
2	EV	□ 1,044.9 Lakhs
3	AC	□ 1,049.9 Lakhs
4	CV	□ -27.2 Lakhs
5	SV	□ -17.3 Lakhs
6	CPI	0.988
7	SPI	0.992
8	CV%	-2.610
9	SV%	-1.659
10	EAC	□ 1,709.31Lakhs
11	ETC	□ 659.32Lakhs
12	VAC	□ -19.31Lakhs
13	EACt	15 months

- At the end of Feb 2016, a SV of □ -17.390 Lakhs shows the value of job is lagging behind the planned date.
- SPI 0.992 showed that A-Block is progressing at 99.2% of the rate originally scheduled.
- CPI 0.988 means that for every one rupee spent on the A-Block, we are getting a productivity of 98.8 paisa only.
- CV%= -2.61% means A-Block is 2.61% overspent for budgeted work performed.
- SV%= -1.659% means A-Block is 1.659% behind schedule.
- Estimate at complete of A-Block is forecasted to be □ 1,709.310 Lakhs as against to plan of □ 1,690 Lakhs.
- Variance at complete is □ -19.310, shows the contractor is under loss of □ 19.310 Lakhs.
- Project Estimate at complete is 15.108 months not 15 months, requires nearly 4 days more to the planned date of completion.
- The above all key parameters shows that residential project 'A-Block' is showing good progress which nearly meets expectations of the management.

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## VI. CONCLUSIONS

- Earned value analysis gives the futuristic view of a project and a reliable data to analyse and to take corrective actions on the project.
- It helps to pin point the delay and cost overruns in the activities, otherwise it is a tedious process in a large project to identify and to take corrective actions.
- It enables contactors and clients to measure the key parameters of a project success namely Time, Cost, Scope.
- Helps to prepare well in advance and to counteract the changes to these project's parameters.
- Interpretation is quite simple and gives combined results in terms of time and cost.
- Overall health of a project can be determined and maintained using EVA, if deviations found helps to finding out possible solution to the planned activities itself.

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