

Earned Value Analysis & Estimation of Twin Bungalow By Using MSP

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Abstract- Construction industries are facing challenges day by day. Amidst all these challenges it is very crucial to improve the performance of a project with respect to Schedule and Cost. Forecasting provides a reasonable & uniform approach for project tracking and control. It measures the project progress and helps in identifying the critical activities thereby bringing the project on schedule.

The Earned Value Management technique has been widely used to monitor & control the performance of the project up to a status date & forecasting the project's final duration and cost. It's an application to schedule performance forecasting in predicting project duration. This paper aims to explore in greater depth through a real time case study project in Pune, using EVM as a planning and control tool. The analysis helped in identifying the performance parameters. This paper also studies the practical calculation of Schedule Variance in terms of schedule. In this paper, MS-Excel and Microsoft Project (MSP) software's were used. MS-Excel has been used for estimation of quantity of construction material and BBS used for estimation of steel required and MS Project software were used for measuring performance parameters scheduling. It ensures that the project is on time and within the budget.

Keywords- Project Management, Earned Value Analysis, Project scheduling, Earned Value Management, Cost Variance, Schedule Variance, Cost Performance Index, Schedule Performance Index, Planned Value Rate, Spent Rate, Time Variance

I. INTRODUCTION

India is one of the biggest economies in the world and being a developing country the construction industry has a tremendous scope. In Construction industry, controlling a project is key to the success or failure of the project. Project control is the process performed to observe project execution in order to identify potential problems or opportunities in a timely manner such that corrective actions can be taken when necessary. The key benefit is that the current project status is observed on a regular basis, which enables the calculation of the project performance variance that is equal to the gap

between actual performance and the baseline schedule. Measuring the project performance along the life of the project is a way to provide early warning signals that can be used as triggers for corrective actions in case the project is in danger.

Forecasting is a common statistical task in business, where it helps to inform decisions about the scheduling of production, transportation and personnel, and provides a guide to long-term strategic planning.

A large part of a forecaster's time can be spent in locating and collecting the available data prior to developing suitable forecasting methods. Time series models used for forecasting include decomposition models, exponential smoothing models and ARIMA models. The time series model may give more accurate forecasts than an explanatory or mixed model. The model to be used in forecasting depends on the resources and data available, the accuracy of the competing models, and the way in which the forecasting model is to be used.

Forecasting is an essential aspect of decision making within the normally uncertain project environment. Forecasting in Project Management might will be a self-defeating prophecy, but at the same time, that may be good for organization. Forecasting using these techniques provides a reasonable and uniform approach for project tracking and control

1.1 EARNED VALUE MANAGEMENT

Earned Value Management (EVM) is a methodology used to measure and communicate the real physical progress of a project and to integrate the three critical elements of project management (scope, time and cost management). It takes into account the work completed, the time taken and the costs incurred to complete the project and it helps to evaluate and control project risks by measuring project progress in monetary terms. The methodology has been used since the 1960s, when the USA department of defense proposed a standard method to measure a project's performance. Earned Value Management & similar techniques helps managers to focus on project or work packages that need the most attention. The EVM technique has been widely used to

monitor & control the performance of a project up to a reporting date & forecasting the project's final duration. EVM was originally developed for cost management.

SV is expressed as a monetary unit which makes it difficult to understand as a variance in the schedule, which should presumably be in the units, such as days or months. Unfortunately, there are no generally available formulas for calculating Earned Schedule, which means that it is difficult to calculate. A major criticism of the standard EVM is that the schedule variance is measured in cost units, not time. This issue has been addressed in two ways

- Converting the Schedule Variance into time units (Anbari 2003)
- Measuring the Time delays on the cumulative cost curve. (Fleming & Koppleman, 2000)

1.2 EVM TERMINOLOGY

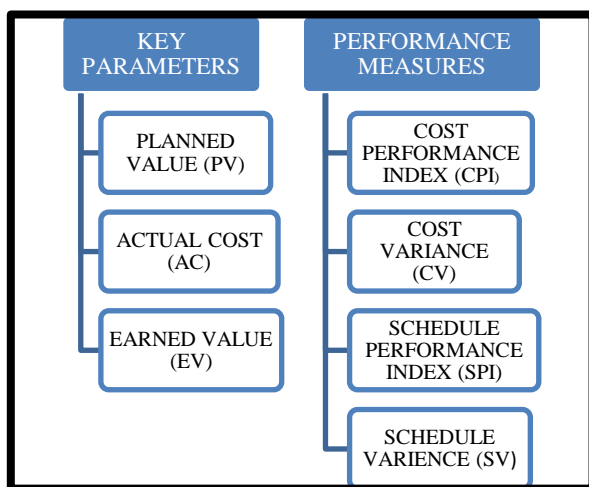


Fig No 1.1: Key Parameters & Performance Measures

1.2.1 Key Parameters

The three key parameters of EVM are given along the following lines:

- **Planned Value (PV):** Time-phased budget baseline as an immediate result of the baseline schedule, often called the Budgeted Cost of Work Scheduled (BCWS).
- **Actual Cost (AC):** The cumulative actual cost spent at a given status date, often referred to as the Actual Cost of Work Performed (ACWP).
- **Earned Value (EV):** Represents the amount budgeted for performing the work that was accomplished by a given status date, often called the Budgeted Cost of Work Performed

(BCWP) and equals the total activity (or project) budget at completion multiplied by the percentage activity (or project) completion (PC) at this particular point in time (= PC * BAC).

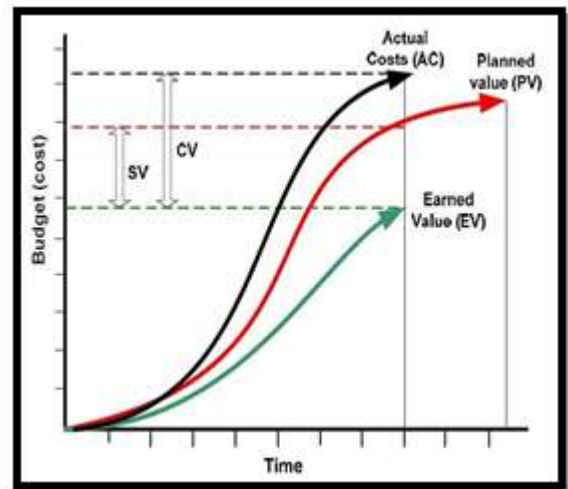


Fig No 1.2: Graphical Representation of Standard Earned Value Elements

1.2.2 Performance Measures

Project performance, both in terms of time and costs, is determined by comparing the key parameters PV, AC, EV and ES, which results in the following performance measures.

- **Time performance:** The Schedule Performance Index (abbreviated as SPI or SPI(t) depending on whether EV or ES is used) is a measure to express the current time performance of the project, showing whether the project is ahead of schedule (>100%), on time (=100%) or late (<100%).
- **Cost performance:** The Cost Performance Index (abbreviated as CPI) is a measure to express the current time performance of the project, showing whether the project cost is below budget (>100%), on budget (=100%) or above budget (<100%).
- The main EVA variables (indicators) are:
- BCWS (Budgeted Cost of Work Scheduled) - PV (Planned Value)
- BCWP (Budgeted Cost of Work Performed) - EV (Earned Value)
- ACWP (Actual Cost of Work Performed) - AC (Actual Cost)
- SV (Schedule Variance) : $VP = EV - PV$
- CV (Cost Variance): $VC = EV - AC$
- SPI (Schedule Performed Index): $SPI = EV / PV$; $SPI = 1$ (project on time)
- $SPI < 1$ (performing less than planned); $SPI > 1$ (performing more than planned)

- CPI (Cost Performed Index): $CPI = EV / AC$; $CPI = 1$ (project on budget)
- $CPI < 1$ (spending more than planned); $CPI > 1$ (spending less than planned)

II. LITERATURE REVIEW

Most of the construction projects suffer from cost and time overruns due to a multiplicity of factors. Earned value management (EVM) is a project performance evaluation technique that has origins in industrial engineering, but which has been adapted for application in project management. The earned value analysis gives early indications of project performance to highlight the need for eventual corrective action. In this chapter we will see number of author studied about Earned Value Analysis, Terminology of Earned Value Analysis, Scope of the Earned Value Analysis.

Homayoun Khamooshi focused on Earned Duration Index (EDI) and studied Exponential Smoothing Technique to predict the duration and completion of an in progress project and compare's several models which provides comparative analysis of performance of these model. His research suggested that Earned Duration Index with Exponential Smoothing gives better results than Schedule performance Index based on $SPI(t)$. Sandhya suresh and Ganapathy Ramsamy N combined studied on the topic how to analyze project performance using EVA. This research paper helped in identifying the critical areas which ensured that the project is on time and within the budget. Luis Felipe Candido, Luiz Fernando, Mahlmann Heineck, Jose de Paula Barrows Neto have analyzed four major problem in their research for an enlarged list of topics & they concluded that EVM is just an extension of the traditional approach of measuring physical and financial advances over time. Warburton, Roger David Hand, Kanabar & Vijay studies the practical calculation of schedule variance in terms of schedule which includes the methodology for converting SV into time units and various technical terms are used such as Spent Rate, Planned Value Rate & Time Variance.

III. OBJECTIVE

1. To study earned value analysis and its implementation in construction industry.
2. Preparation of WBS of selected project for EVM.
3. To reschedule activities to maintain CPI and SPI of project to avoid cost overrun
4. To perform S curve analysis in given case studies

5. Compare the project with respect to budgeted cost v/s Earn value cost by actual tracking of project.

IV. WORKING METHODOLOGY

The sequential methodology needed to be followed in this dissertation is given as follows;

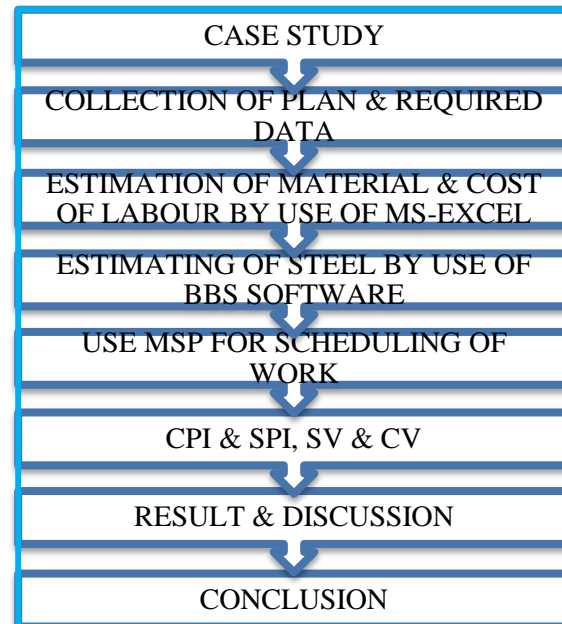


Fig no 4.1: Flow chart of Methodology

V. CASE STUDY: TWIN BUNGALOW

5.1 Projected Site

The selected site for the case study that is Twin bungalow located in Uruli-Kanchan, Pune, Maharashtra. It is bungalow having 2034sq.ft (190sq.m) built-up area and having duration of 6 months. Collected all the information required for calculations of the EVMS and used it as MSP inputs. When all the proper information is entered in MSP it provides all the parameters with their subsequent results of each work packages. The tabular data gives the cumulative values for PV, EV and AV and which is also used to draw the graph. MSP software output gives some numerical data after clarification author given it in tabular format in cumulative approach. To know the project performance in a glance author is created information in tabular format in cumulative way.



Fig no 5.1.1 Actual site progress in 3D max image

1.2 Description Of Project

Table 5.2 Project Details

SR.NO	PARTICULAR	INFORMATION
1	Name of the Contractor	Nirman Properties Pvt.ltd.
2	Name of the Project	TWIN BUNGALOW
3	Location of the Project	Uruli Kanchan, Pune
4	Structural designer	Mr Sandeep Kanchan
5	Architect of project	Mr Sandeep Kanchan
6	Project manager	Mr Sunil Jawale
7	Total Built-up Area	2034sqft
8	Contractor Amount	Rs 5,00,000/-
9	Total Duration	6 months
10	Start Date	4/09/2018
11	Substantial Completion date of the Project	4/02/2019

All the data shown in table 5.1 is collected from company, concerning with the site In charge of the project and for the analysis work the data required is collected from the Project Manager.

5.3 Estimating & Costing of Input Data

The residential project of a well-known firm in a city selected for Earned value analysis to facilitate effective management.. Following were the steps adopted for Earned value analysis of project.

- Step 1 : Collection of data
- Step 2 : Input of collected data for budget
- Step 3: BBS used for steel quantity
- Step 4 : MSP for Scheduling
- Step 5 : Project Tracking

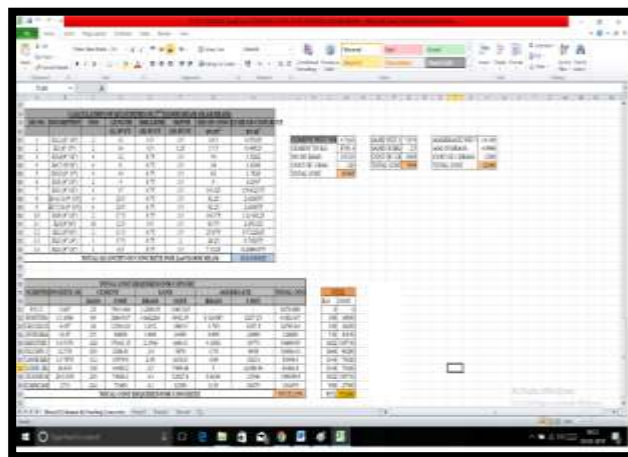


Fig no 5.3.1 Quantity & cost of concrete in MS Excel

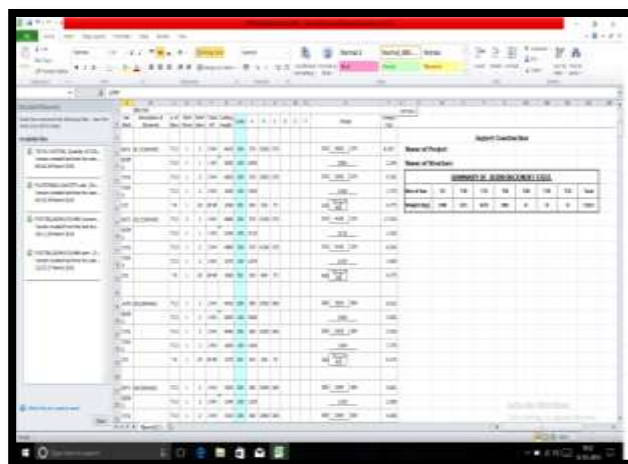


Fig no 5.3.2 Quantity of steel in BBS Software

After finishing the estimating and costing for the project profit loss analysis done to find out the budget of project.

Table no 5.3.2: Total amount estimated for concrete and steel

BUDGET OF TWIN BANGALOW		
SR. NO	TASK	AMOUNT (Rs)
1.	PCC	11554
2.	FOOTING	58324
3	STUB COLM	36043
4.	PLINTH BEAM	167030
5.	SUB GRND SLAB 1	160410
6	COLUMN 1,2	108607
7.	BEAM 1	125869
8.	BEAM 2	137383
9.	SLAB 1,2	215110
10.	STAIRCASE	131955
	TOTAL	Rs.1152287/-

5.3.1 MSP for EVM Analysis

This is the progress bar chart of project works are first split in to activities. These activities are then listed in order of construction priorities, generally on the left hand side column, while the time scale shows project calendar, and the scale can be plotted horizontally on the top and/or bottom of the chart.

5.3.2 Project Tracking

The start date of the project is on 4 Sept 2018 and finish date of the project is 04 Feb 2019. The total duration of the project is 110 days. After every activity the progress of execution is checked, it is found that some activities work is completed as on schedule but many activities are not completed on schedule. For the tracking purpose the flow chats of the activities are created for the major activates.

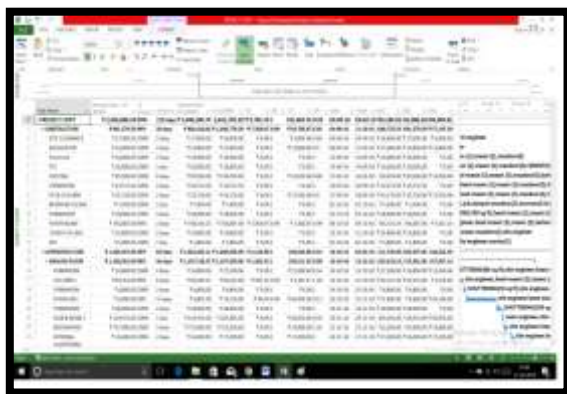


Fig no 5.3.3 Earn value with its all the parameters

This figure 5.3.3 indicates Earn value sheet with their all the parameters of overall project. It indicates the depth at which we have to go for forecasting and remarkable conclusions.

VI. RESULTS

EVA measures project performance for the current period and the cumulative performance till date. The important performance parameters like variances, indices, and forecasts that developed using Planned Value, Earned Value, and Actual Cost are discussed here.

The Microsoft Project works on the tracking of the schedule, rescheduling of the task which is depending upon the performance parameters of the project.

Table no 5.4: EVA Parameters by M.S Project 2007
TITLE NAME EARN VALUE PARAMETERS MS PROJECT

TITLE NAME	EARN VALUE PARAMETE RS	MS PROE CT
TWIN BANG ALOW	Planned value	RS. 24560 86/-
	Earned Value	RS. 24463 00/-
	Actual value	RS. 26417 05/-
	Cost variance	RS. 19540 5/-
	Schedule variance	RS. 9786/-
	Cost variance index	0.93
	Schedule variance index	1
	Estimate complete	At RS. 27591 81/-
	Variance complete	to RS. 20409 5/-

Above table 5.4 shows all the parameters of the Earn value analysis which were outputs of MSP software

EARNED VALUE OVER TIME

The project’s earned value based on the status date. If actual cost (ACWP) is higher than earned value (BCWP),

then the project is over budget. If planned value (BCWS) is higher than earned value, then the project is behind schedule.

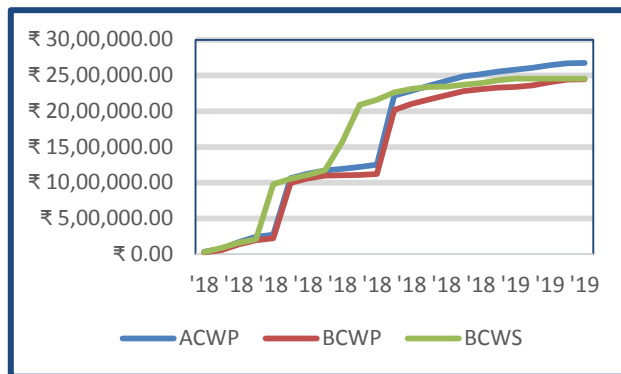


Fig no 5.4 Earned Value with time S curve

This fig 5.4 shows the relation between planned value (BCWS), actual cost (ACWP) and earned value (BCWP) of the project.

VIII. CONCLUSION

Predicting project performance is essential in tracking and controlling construction projects. After analysis and interpretation of data in this chapter we will see the conclusion and recommendation for Earned Value Analysis. Based on that data future schedule and cost can be estimated, the graphs give the relation between the duration costs of the project. From graph it is clear that project is over budgeted and behind of schedule. The earn value is profitable when the assumption of budget and resource is near to the actual value. . It inspires the workers to pay more attention towards cost and progress and it motivates staff to minimize the project cost and to complete it in time.

6.1 EVA and M.S Project Performance Analysis and Forecasting

Table 6.1 shows the calculation of various project performance indicators. It is clear that

1. A SPI of 1 would tell us that the project is progressing at 100% of the rate originally planned. SPI indicates the rate at which the project is progressing.
2. The project has an unfavorable Cost Variance of Rs-195,404.76 that means the project is over budget.
3. Estimate at completion shows that the expected total cost of a project at completion is based on the performance of the data date. Rs 2555086 divided by

0.93 is Rs 2759180.92, therefore EAC is Rs 2759180.92, in other words, since the project is getting only Rs 0.93 out of every rupee.

4. Variance at completion shows the variance of total cost of the work and expected cost. Here it is Rs-204094.
5. The project has an unfavorable Schedule Variance of Rs 9785.76 that means the project is on schedule.

Table 6.1: Project Performance Indicators

To Calculate	Formula	Value	Interpretation
Schedule Variance(SV)	$SV = EV - PV$	Rs 9785.76	On Schedule
Schedule Performance Index(SPI)	$SPI = EV / PV$	1	On Schedule
Cost Variance(CV)	$CV = EV - AC$	Rs-195,404	Over Budget
Cost Performance Index (CPI)	$CPI = EV / AC$	0.93	Over Budget
Estimate At Completion (EAC)	$EAC = BA / CPI$	Rs 2759180	Over Budget

Source: By author

From the above table 6.1 we have clear view of the project of how well a project is doing and where it is heading. Predicting project performance is essential in tracking and controlling

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