

# Earned Value Analysis For Residential And Commercial Building

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**Abstract-** *Earned Value Analysis is a recommended technique for monitoring and controlling project execution. Yet, despite four decades of institutional backing and sustained advocacy, its adoption still remains limited. It draws loyal adherents as well as opponents, and an ongoing debate about its practical utility. Empirical studies of its effectiveness or adaptation for different situations are sparse; and the claims, objections do not appear to be reconciled. In this paper, we survey academic and practitioner literature on Earned Value Management and its extensions, and attempt to reconcile the debate by juxtaposing the claims and counterclaims against parallel research streams in project management. We suggest an integrative schema to ground the technique amidst the various bodies of research opinions in order to elicit future directions.*

**Keywords-** Analysis, CPM, Earn value, MSP, PERT.

## I. INTRODUCTION

Earned Value analysis is a method of performance measurement. Earned Value is a program management technique that uses “work in progress” to indicate what will happen to work in the future. Earned Value is an enhancement over traditional accounting progress measures. Traditional methods focus on planned accomplishment (expenditure) and actual costs. Earned Value goes one step further and examines actual accomplishment. This gives managers greater insight into potential risk areas. With clearer picture, managers can create risk mitigation plans based on actual cost, schedule and technical progress of the work. It is an “early warning” program/project management tool that enables managers to identify and control problems before they become insurmountable. It allows projects to be managed better – on time, on budget. Earned Value Management System is not a specific system or tool set, but rather, a set of guidelines that guide a company’s management control system. In the case of cost overrun, project management team may execute a value engineering program for cost reduction either reducing scope and quality in some sections of project or providing additional budget to cover overrun cost. Similarly, for time overrun case, they may plan some program such as fast tracking or time

crashing for time reduction. Therefore, the role of EVM as well as correct and on time forecasting is very important to achieve project goals. This research includes implementation and improvement on EV to achieve a forecasting EAC based on statistical and econometrics techniques and traditional EV indexes as well.

The Earned Value Analysis (EVA) is a valuable technique to determine real gains and losses. EVA provides means to balance gains/losses, optimize the balance and maximize the gains. EVA is a powerful tool to control simultaneously physical and cost performance. EVA provides an integrated schedule (time), progress, and cost management, related to scope and procurement, quality, and risks.

Harold Kerzner (1998) considers EVA a relevant maturity differential in project management. To manage costs using EVA is called “manage with open eyes” because the manager can clearly see what was planned, what was performed, and the actual costs. This is a powerful tool in the decision making process. In the day-by-day of the manager, EVA provides “alarm” signs and allows decisions that keep the project on time and on budget.

The cost management in Construction Projects needs the planning of budgeted costs and their control. This is related to all the knowledge areas in the project. The actual costs are related with the work performed, but the work performed is not often exactly equal to the work scheduled. The solution is the control, measurement and determination of the budgeted cost of the work performed and compare it to the actual costs. One difficulty is the determination of the proper accounting system and deal with scope changes. The solution is an appropriate WBS – Work Breakdown Structure, and a suitable account plan. The solution requires distinguishing the financial control and cost control.

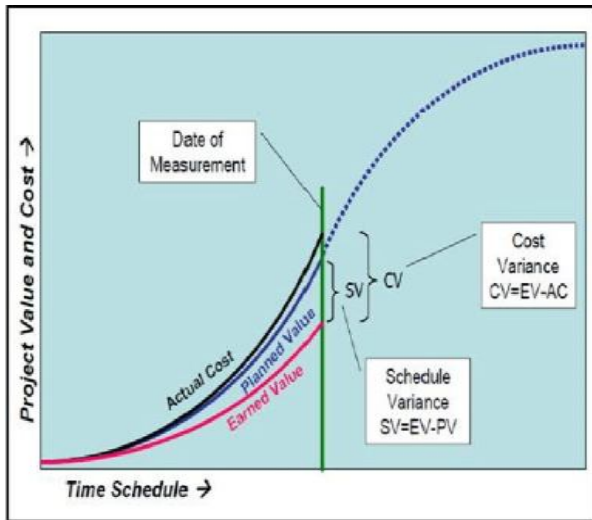


Fig 1: Standard Earned Value Analysis Graph

### Aim of study

To perform earned value analysis for residential and commercial building for better project tracking

### Objective of study

- To study earned value analysis and its implementation in construction industry.
- To identify cases for cost overrun in all construction activities.
- To reschedule activities to lower or increase cost performance index and schedule performance index of project to avoid cost overrun
- To perform S curve analysis in given case studies.

## II. LITERATURE REVIEW

**2.1 T. Subramani , D. S. Stephan Jabasingh , J. Jayalakshmi ‘Analysis of Cost Controlling In Construction Industries by Earned Value Method Using Primavera’ Vol. 4, Issue 6( Version 1), June 2014[1]**

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. The purpose of this dissertation is in 3-fold. Firstly, Earned Value Analysis software is developed in Visual studio 2008, SQL Server 2005, .Net (C# language). Next Comparison of selected parameters between M.S Project 2007, Primavera P6 and developed software is done. Therefore, it can be concluded that the software could be used in a wide range of projects for Earned Value Analysis calculation.

This study is to present and discuss the main parameters involved in the calculation of Earned Value Analysis (EVA) in the cost management of civil construction projects.

**2.2 Jose Angelo Valle, Carlos Alberto Pereira Soares ‘The Use Of Earned Value Analysis (Eva) In The Cost Management Of Construction Projects ’January 2004 [2]**

The objective of this article is to present and discuss the main factors involved in the use of Earned Value Analysis (EVA) in the cost management of civil construction projects. These factors include advantages and disadvantages, difficulties and benefits, problems and solutions and criteria and results based on the experience of a real case study in Brazil.

EVA was applied in the civil construction of an indoors amusement park, named Monica Park, inside the Citta America Shopping Center, in Rio de Janeiro, Brazil. The park has 30 attractions, covers an area of 10,000 square meters was built in 10 months from January to October 2000, for US\$ 5 million. The case study is documented with reports, graphs, analyses and comments. A critical review of the application of EVA for the Amusement Park is provided in this paper. EVA contributed to the success of the case study project which finished on time and on budget. The findings of the case study will contribute to the further use of EVA on other projects in Brazil by identifying the main problems and solutions. The case study results are analyzed and the article concludes with 10 recommended steps for future implementation of the EVA process.

It shows that EVA had a relevant role in the integrated management of the project scope, time, progress, cost and risks and the procurement of the main project supplies and services.

**2.3 Sangram M. Patil, D. B. Desai, Dr. A. K. Gupta ‘Earned Value Analysis In Construction Industry’ ISSN (Online): 2347-1697, March 2015[3]**

Construction industry is an important industry at both the global level and national level. It is second largest sector in India. It provides huge employment to the people and plays

very significant role in country economy. Project delay is most common problems in the construction industry. Project overruns due to time and cost result in delays during project execution. In developing countries project overruns is a serious where implementation of project faces many uncertainties. It result in wastage of scare financial resources, delays in providing facilities, development and also make construction costlier .With globalization and technology driven economic growth all over the world, a scientific and systematic approach to project management becomes imperative to ensure that project objectives are attained within the constraints of time and resources .EVA is the process of measuring performance of project work against a baseline plan. EVA application helps in providing performance standard for the evaluation of progress report of project and it also act as a control device to take care of time and cost schedule. Earned Value is an enhancement over traditional process of cost accounting.

It provide better performance picture of project and gives better forecast of the final completion cost.

#### **2.4 Chris Fortune,Mark Gran ‘Construction Project Cost Management Tools In-use: a UK Perspective’2011 Volume 17(3) [4]**

The effective control of a construction project budget from project inception to completion and occupation is one of the primary tasks of any organization employed to deliver construction project management services irrespective of the projects actual global location. This paper sets out the key issues and problems involved in the delivery of this service to construction industry clients in the UK. The main features of a project cost management system are identified in the paper before it addresses the principal problem areas of initial cost budget or baseline setting and project cost performance management. The literature reviewed identifies the potential project management tools that can be used to contribute to the management of each of the principal problem areas. The data on project performance measurement reported in the paper have been collected by mailed survey from one hundred and fifty two organizations involved in delivering project management services in the UK in 2004. The survey achieved a 42% response rate and its results raises questions about the claimed benefits of a bespoke project cost performance management tool termed as earned value analysis. The paper concludes by considering the direction of future construction related project cost management education and the role that can be played by professional institutions to promote change in practice.

The paper reports evidence collected from previous data collection exercises with practitioners based in the UK that allows current practice to be illustrated.

#### **2.5 Rohan Ghadge & GajananKanade ‘Earn Value Analysis Using Primavera for Construction Industry- A Review’ Vol-3, Issue-7, 2017[5]**

Project cost is the one of the governing factor in project success. Project management is used to increase productivity in terms of human resource and materials. Earned value management (EVM) is a project performance evaluation technique which has been adapted for application in project management. The technique helps in comparison of budgeted cost of work to actual cost.

The present study deals with the review of the project management involving earned value analysis.

### **III. THEORETICAL CONTENT**

Earned Value Analysis (EVA) is an industry standard method of measuring a project's progress at any given point in time, forecasting its completion date and final cost, and analyzing variances in the schedule and budget as the project proceeds.

Earned value management (EVM), or earned value project/performance management (EVPM) is a project management technique for measuring project performance and progress in an objective manner.

Earned value management is a project management technique for measuring project performance and progress. It has the ability to combine measurements of the project management triangle: scope, time, and costs.

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)

**Essential features of any EVM implementation include**

- A project plan that identifies work to be accomplished
- A valuation of planned work, called planned value (PV) or budgeted cost of work scheduled (BCWS)
- Pre-defined "earning rules" (also called metrics) to quantify the accomplishment of work, called earned value (EV) or budgeted cost of work performed (BCWP)

**3.1 CPM**

The critical path method (CPM), or critical path analysis (CPA), is an algorithm for scheduling a set of project activities. It is commonly used in conjunction with the program evaluation and review technique (PERT).

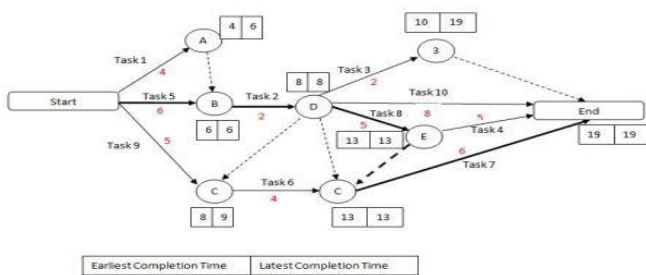


Fig 2: Tree Diagram For CPM Method

Following are advantages of critical path methods:

- Offers a visual representation of the project activities.
- Presents the time to complete the tasks and the overall project.
- Tracking of critical activities.

**3.2 PERT**

The program (or project) evaluation and review technique, commonly abbreviated PERT, is a statistical tool, used in project management, which was designed to analyze and represent the tasks involved in completing a given project. First developed by the United States Navy in the 1950s, it is commonly used in conjunction with the critical path method (CPM).

Following are advantages of PERT

- The best thing about PERT is its ability to integrate the uncertainty in project times estimations into its methodology.
- It also makes use of many assumption that can accelerate or delay the project progress.
- Using PERT, project managers can have an idea of the possible time variation for the deliveries and offer delivery dates to the client in a safer manner.

**IV .DATA ANALYSIS**

**CASE STUDY- SITE DETAILS**

- Name of site :ARCASIA
- Location of site: Arcasia, Kasar Amboli, Taluka Mulshi, Pune
- A G+stilt+4 proposed building with 1 and 2 BHK flats and of 7 shops is taken for case study location is in pune.
- Design Team : Sketch art
- Owner and Developer :K.K developer
- Architect :Sketch art
- Cost of project: 3.75 Cr.
- Structural Engineer :Sagar Jagdale and associates
- Builder: K.K developer
- Built up Area : 15500 sq.feet
- This project is based on sustainable structure
- Present condition of the project: complete
- Total 27flats and 7 shops.

- i. 9 flats – 2BHK
- ii. 18 flats – 1BHK
- iii. 7 shops – commercial road front shops.

**4.1 EARNED VALUE ANALYSIS**

Task Name	Planned Value - PV (BCWS)	Earned Value - EV (BCWP)	AC (ACWP)	SV	CV	EAC	BAC	VAC	CP	SP
1 LEVELLING, CLEARANCE & INITIAL DEVELOPMENT	Rs 188,000.00	Rs 188,000.00	Rs 188,000.00	Rs 0.00	Rs 0.00	Rs 188,000.00	Rs 188,000.00	Rs 0.00	1	1
2 FIFTH WORK	Rs 632,985.00	Rs 632,985.00	Rs 632,985.00	Rs 0.00	Rs 0.00	Rs 632,985.00	Rs 632,985.00	Rs 0.00	1	1
3 FIRST SLAB	Rs 435,930.89	Rs 431,704.32	Rs 435,906.29	Rs 4,226.57	Rs 4,226.57	Rs 441,085.00	Rs 441,085.00	Rs 4,280.68	0.99	0.99
4 SECOND SLAB	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 441,085.00	Rs 441,085.00	Rs 3,450.00	0	0
5 THIRD SLAB	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 441,085.00	Rs 441,085.00	Rs 3,450.00	0	0
6 FOURTH SLAB	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	0	0
7 FIFTH SLAB	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	0	0
8 SIXTH SLAB	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	0	0
9 SEVENTH SLAB	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	0	0
10 TERRACE SLAB	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 441,085.00	Rs 441,085.00	Rs 0.00	0	0
11 OVERHEAD WATER TANK, LIFTS, LOFTS	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 1,594,885.00	Rs 1,594,885.00	Rs 0.00	0	0
12 MASONRY WORK	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 3,494,885.00	Rs 3,494,885.00	Rs 1,500,000.00	0	0
13 DOORS & WINDOWS	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 46,400.00	Rs 46,400.00	Rs 0.00	0	0
14 PLASTERING & CURING	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 0.00	Rs 23,750.00	Rs 23,750.00	Rs 144,000.00	0	0

**V. RESULTS AND DISCUSSION**

**SCHEDULE VARIANCE AND COST VARIANCE OF PROJECT**

Resource Name	Planned Value - Pv (Bcws)	Earned Value - Ev (Bcwp)	Ac (Acwp)	SV	CV
Excavation	Rs 246,500.00	Rs 216,920.00	Rs 216,920.00	(Rs 29,580.00)	Rs 0.00
Pcc	Rs 56,375.00	Rs 56,375.00	Rs 56,375.00	Rs 0.00	Rs 0.00
Footing	Rs 145,120.00	Rs 145,120.00	Rs 145,120.00	Rs 0.00	Rs 0.00
Backfilling	Rs 728,460.00	Rs 604,621.80	Rs 604,621.80	(Rs 123,838.20)	Rs 0.00
Rcc (Ground Floor)	Rs 893,965.20	Rs 706,232.51	Rs 706,232.51	(Rs 187,732.69)	Rs 0.00
2nd Slab (First Floor Slab)	Rs 557,764.32	Rs 524,298.46	Rs 524,298.46	(Rs 33,465.86)	Rs 0.00
3rd Slab (Second Floor Slab)	Rs 697,205.40	Rs 522,904.05	Rs 522,904.05	(Rs 174,301.35)	Rs 0.00
4th Slab (Terrace Floor Slab)	Rs 522,904.05	Rs 522,904.05	Rs 522,904.05	Rs 0.00	Rs 0.00
Block Work	Rs 334,636.38	Rs 334,636.38	Rs 334,636.38	Rs 0.00	Rs 0.00
Electrical Wall Conducting & Switch Board Fixing	Rs 134,531.32	Rs 134,531.32	Rs 134,531.32	Rs 0.00	Rs 0.00
Internal Plater	Rs 142,511.67	Rs 142,511.67	Rs 142,511.67	Rs 0.00	Rs 0.00
Doors	Rs 1,277,500.00	Rs 1,098,650.00	Rs 1,098,650.00	(Rs 178,850.00)	Rs 0.00
Internal	Rs	Rs	Rs	Rs 0.00	Rs 0.00

Plumbing Work	Rs 127,500.00	Rs 127,500.00	Rs 127,500.00		
Waterproofing	Rs 24,600.00	Rs 24,600.00	Rs 24,600.00	Rs 0.00	Rs 0.00
Tiling	Rs 723,809.40	Rs 665,904.65	Rs 721,396.70	(Rs 57,904.75)	(Rs 55,492.05)
Aluminium Window Fixing	Rs 43,500.00	Rs 43,500.00	Rs 43,500.00	Rs 0.00	Rs 0.00
External Plaster	Rs 187,544.00	Rs 187,544.00	Rs 187,544.00	Rs 0.00	Rs 0.00
External Paint	Rs 111,403.50	Rs 85,780.69	Rs 85,780.70	(Rs 25,622.81)	Rs 0.00
Compound Wall	Rs 520,000.00	Rs 431,785.71	Rs 531,428.57	(Rs 88,214.29)	(Rs 99,642.86)

**COST PERFORMANCE INDEX AND SCHEDULE PERFORMANCE INDEX**

Resource Name	Planned Value - Pv (Bcws)	Earned Value - Ev (Bcwp)	Eac	Bac	Vac	Cp i	Sp i
Excavation	Rs 246,500.00	Rs 216,920.00	Rs 246,500.00	Rs 246,500.00	Rs 0.00	1	0.88
Pcc	Rs 56,375.00	Rs 56,375.00	Rs 56,375.00	Rs 56,375.00	Rs 0.00	1	1
Footing	Rs 145,120.00	Rs 145,120.00	Rs 145,120.00	Rs 145,120.00	Rs 0.00	1	1
Backfilling	Rs 728,460.00	Rs 604,621.80	Rs 728,460.00	Rs 728,460.00	Rs 0.00	1	0.83
Rcc (Ground Floor)	Rs 893,965.20	Rs 706,232.51	Rs 893,965.20	Rs 893,965.20	Rs 0.00	1	0.79
2nd Slab (First Floor Slab)	Rs 557,764.32	Rs 524,298.46	Rs 557,764.32	Rs 557,764.32	Rs 0.00	1	0.94
3rd Slab (Second Floor Slab)	Rs 697,205.40	Rs 522,904.05	Rs 697,205.40	Rs 697,205.40	Rs 0.00	1	0.75
4th Slab (Terrace Floor Slab)	Rs 522,904.05	Rs 522,904.05	Rs 522,904.05	Rs 522,904.05	Rs 0.00	1	1
Block Work	Rs 334,636.38	Rs 334,636.38	Rs 334,636.38	Rs 334,636.38	Rs 0.00	1	1

Electrical Wall Conducting & Switch Board Fixing	Rs 134,531.32	Rs 134,531.32	Rs134,531.32	Rs134,531.32	Rs 0.00	1	1
Internal Plater	Rs 142,511.67	Rs 142,511.67	Rs 142,511.67	Rs 142,511.67	Rs 0.00	1	1
Doors	Rs 1,277,500.00	Rs 1,098,650.00	Rs 1,277,500.00	Rs 1,277,500.00	Rs 0.00	1	0.86
Internal Plumbing Work	Rs 127,500.00	Rs 127,500.00	Rs 127,500.00	Rs 127,500.00	Rs 0.00	1	1
Waterproofing	Rs 24,600.00	Rs 24,600.00	Rs 24,600.00	Rs 24,600.00	Rs 0.00	1	1
Tiling	Rs 723,809.40	Rs 665,904.65	Rs 784,126.85	Rs 723,809.40	(Rs 60,317.45)	0.92	0.92
Aluminium Window Fixing	Rs 43,500.00	Rs 43,500.00	Rs 43,500.00	Rs 43,500.00	Rs 0.00	1	1
External Plaster	Rs 187,544.00	Rs 187,544.00	Rs 187,544.00	Rs 187,544.00	Rs 0.00	1	1
External Paint	Rs 111,403.50	Rs 85,780.69	Rs 111,403.50	Rs 111,403.50	Rs 0.00	1	0.77
Compound Wall	Rs 520,000.00	Rs 431,785.71	Rs 640,000.00	Rs 520,000.00	(Rs 120,000.00)	0.83	0.84

**VI. CONCLUSIONS**

- The main conclusion is that EVA provides a relevant contribution to the cost management in construction projects, namely in the case ARCASIA Project.
- EVA contributed to cost management in ARCASIA Project and the use of EVA in ARCASIA Project contributed also to the application of EVA in construction projects, in general, and in the future, through the data, perceptions and concerns developed in this paper.
- Some considerations were added to the ones found in the main EVA book references. For changing the scope of a project it gets very complex by using EVM. This was very clear in the use of EVA in ARCASIA One insight that reduced problems was that the reports allow easy and fast fixing of mistakes. Not only mistakes on digitizing numbers, but mistakes in the expectations related to the measuring criteria.

- The record and reporting method offer easy regularity analysis of data. Wrong data was easily identified and fixed. Error recognition allowed improved practices and provided support for the decision making process, as well as discussions with suppliers and 3rd parties
- These are the activity, which are behind the schedule & Cost Over i.e,(SPI<1),(CPI<1,It is required to be rectified..

SR.NO	ACTIVITY	CPI	SPI
1	EXCAVATION	1	0.88
2	BACKFILLING	1	0.83
3	RCC(GROUND FLOOR)	1	0.79
4	FIRST FLOOR	1	0.94
5	SECOND FLOOR	1	0.75
6	DOORS	1	0.86
7	TILING	0.92	0.92
8	EXTERNAL PAINT	1	0.77
9	COMPOUND WALL	0.83	0.83

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