Cost Controlling Using Earned Value Analysis in Construction Industries

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Abstract - 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. 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. 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.

Keywords: **Project Management, Construction planning, Earned Value Analysis, Project scheduling, Earned Value Management, Cost Variance.**

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, the 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. This paper discusses effectiveness of developed software of Earned Value Analysis with MS Project and Primavera P6.

II. EARNED VALUE ANALYSIS –CONCEPT

Earned Value is a program management technique that uses "work in progress" to indicate what will happen to work in the future. EVA uses cost as the common measure of project cost and schedule performance. It allows the measurement of cost in currency, hours, worker-days, or any other similar quantity that can be used as a common measurement of the values associated with project work. EVA uses the following project parameters to evaluate project performance:

- Planned Value
- Earned Value
- Actual Value

As noted, there are many ways to calculate the EV, PV and AC of work packages that are in progress. Comparison of those figures can serve to identify specific work packages in which performance and progress is inadequate or advanced, which will hopefully lead to remedial action by the project manager and team. Cost and schedule performance should be measured and analyzed as feasible with regularity and intensity consistent with project management need including the magnitude of performance risk. Analysis should be progressive and should follow the principle of management by exception. Variance thresholds should be established in the planning phase and should be used to guide the examination of performance [2].
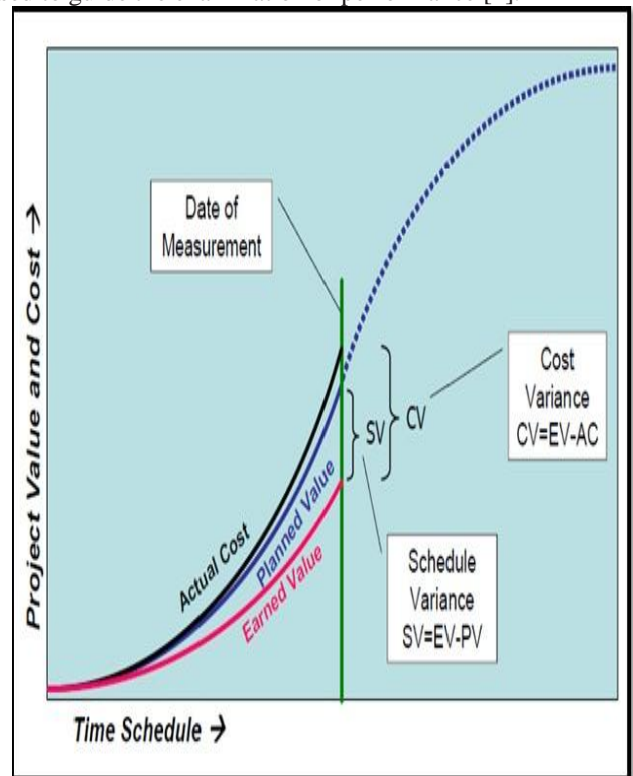

Fig: 1.Standard Earned Value Analysis Graph.

Table 1.Parameter of Earned Value Analysis

Name	Formula	Interpretation
Cost variance (CV)	EV – AC	NEGATIVE is over budget, POSITIVE is under budget.
Schedule Variance (SV)	EV – PV	NEGATIVE is behind schedule, POSITIVE is ahead of schedule.
Cost Performance Index (CPI)	EV / AC	Less than 1 poor performance Greater than 1 good performance.
Schedule Performance Index (SPI)	EV / PV	Less than 1 poor performance Greater than 1 good performance.
Estimate At Completion(EAC)	BAC / CPI AC + ETC	As of now how much do we expect the total project to cost Rs_____. • Used if no variances from the BAC have occurred. • Actual plus a new estimate for remaining work. Used when original estimate was fundamentally flawed. • Actual to date plus remaining budget. Used when current variances are atypical. • Actual to date plus remaining budget modified by performance. When current variances are typical.
Estimate To Complete (ETC)	EAC – AC	How much more will the project cost?
Variance At Completion (VAC)	BAC – EAC	How much over budget will we be at the end of the project?

Earned value project management is a well-known management system that integrates cost, schedule and technical performance. It allows the calculation of cost and schedule variances and performance indices and forecasts of project cost and schedule duration. The earned value method provides early indications of project performance to highlight the need for eventual corrective action [15].

III. DETAILS OF SOFTWARE

Taking lead from the literature review the present study aims at evaluating Earned Value Analysis function of three software namely Microsoft Project 07, Primavera 6 and Develop Software. The following sections explain the software in brief.

A. M.S. Project 07(MSP)

Microsoft Project (or MSP or WinProj) is a project management software program which is designed to assist project managers in developing plans, assigning resources to tasks, tracking progress, managing budgets and analyzing workloads. The application creates critical path schedules, and critical chain and event chain methodology with third-party add-ons. Cost Variance and Schedule Variance are visualized in a Report.

A. Earned Value analysis Using M.S. Project
B. Primavera 6

Primavera 6 manages and controls activities related to project management as well as portfolio management. Resources representing labour, materials and equipment are used to track time and costs for the project. Slippages of projects' activities are updated resulting in the adjustment of time related bars. It requires Data Base of Oracle My SQL.

C. Developed Software

The Earned value analysis software developed in Visual studio 2008, SQL server and .NET (C#) language. And it provides robust project scheduling and management functionality. Features available are Planning, Scheduling, Cost Management and Project review.

IV. CASE STUDY

The Case Study of Residential Project has been taken, using the information of an actual project its cost and scheduling.

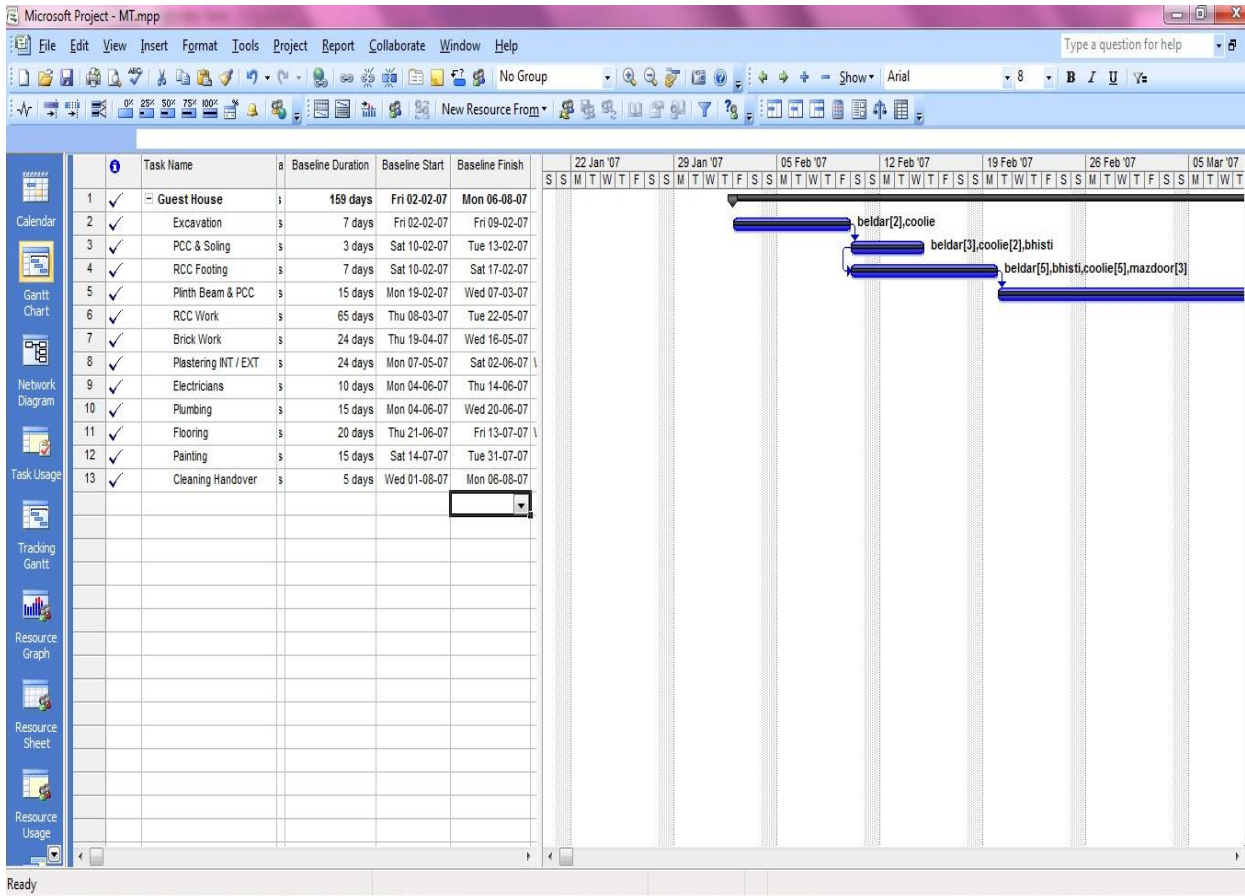The Built-up Area of residential building is 120 sq.m

Fig 2 Scheduling activity, relationship SS, FS, FF, SF, Start Date, Finish Date
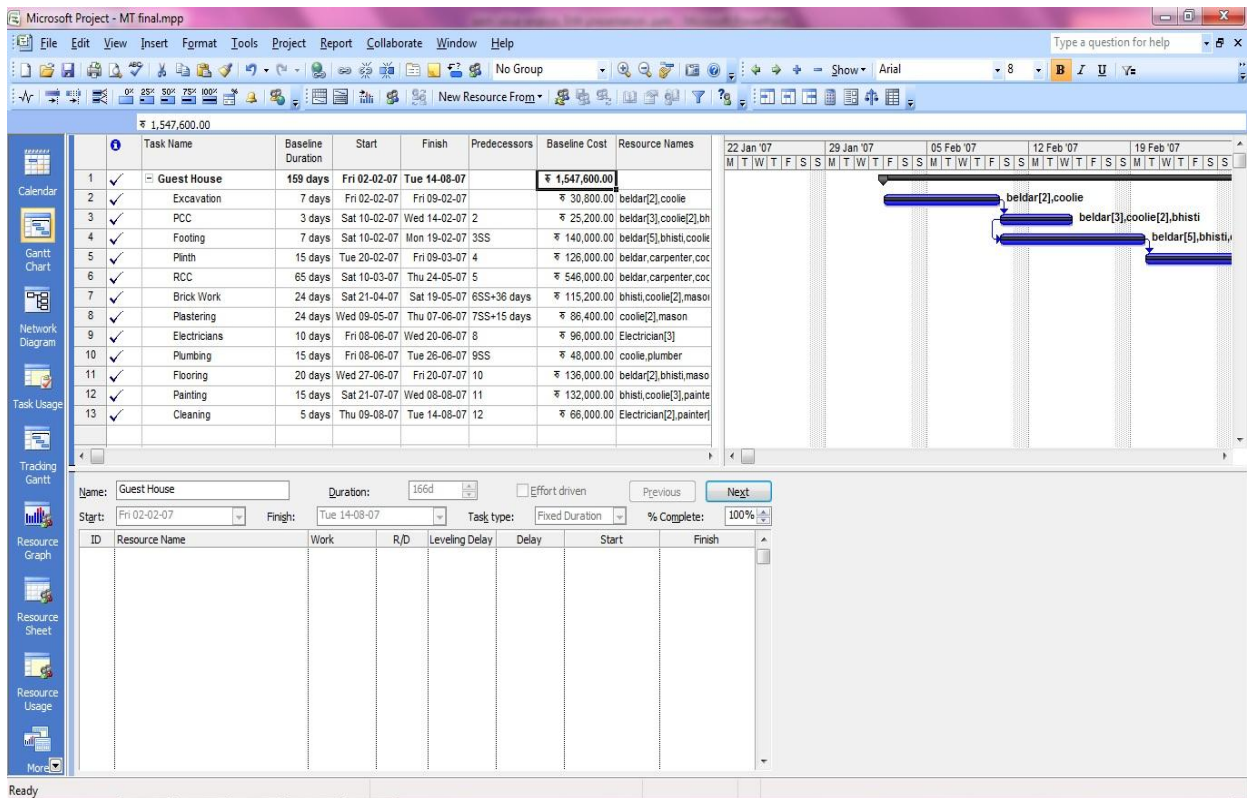

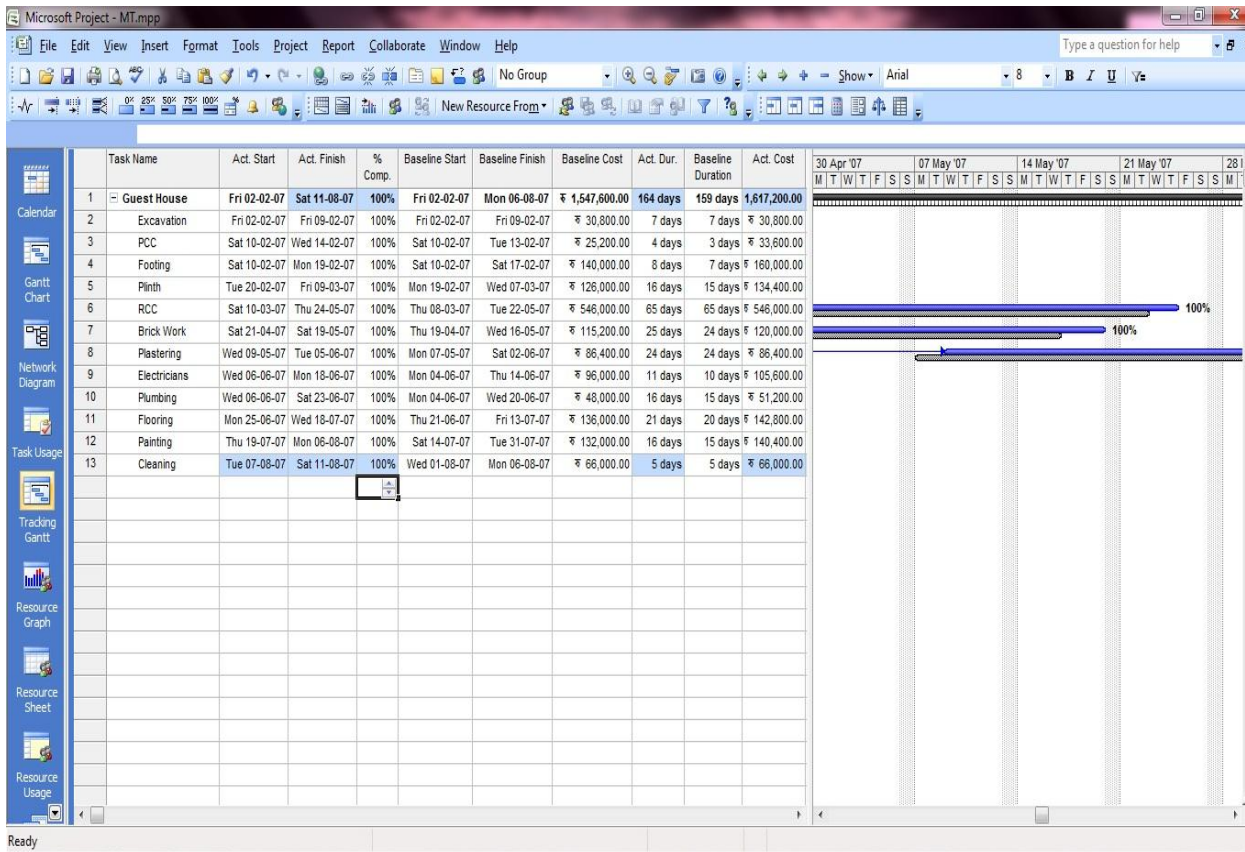**Fig 3.Resource sheet, Resource allocation for each activity**

Fig 4.Tracking schedule
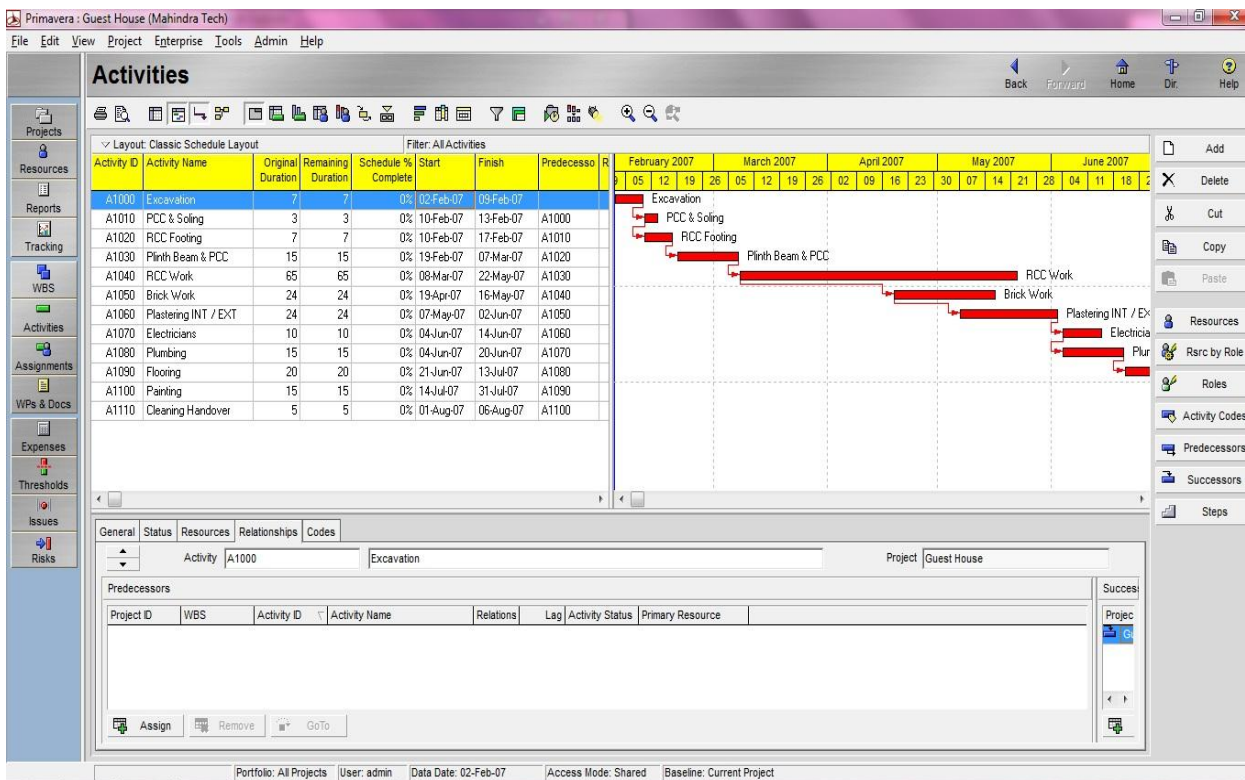
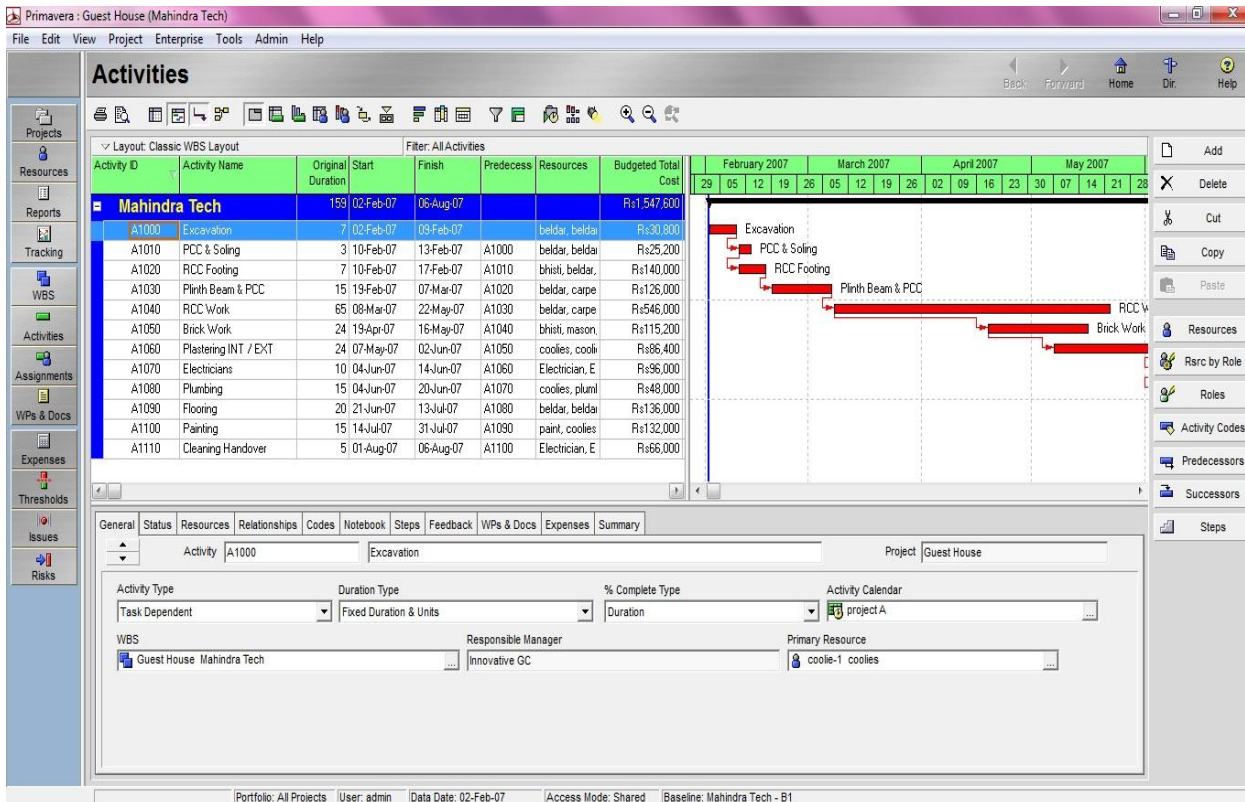## B. Earned Value analysis in Prima Vera

Fig 5 Scheduling activity

Fig 6 Resource allocation

Fig 7 Tracking schedule

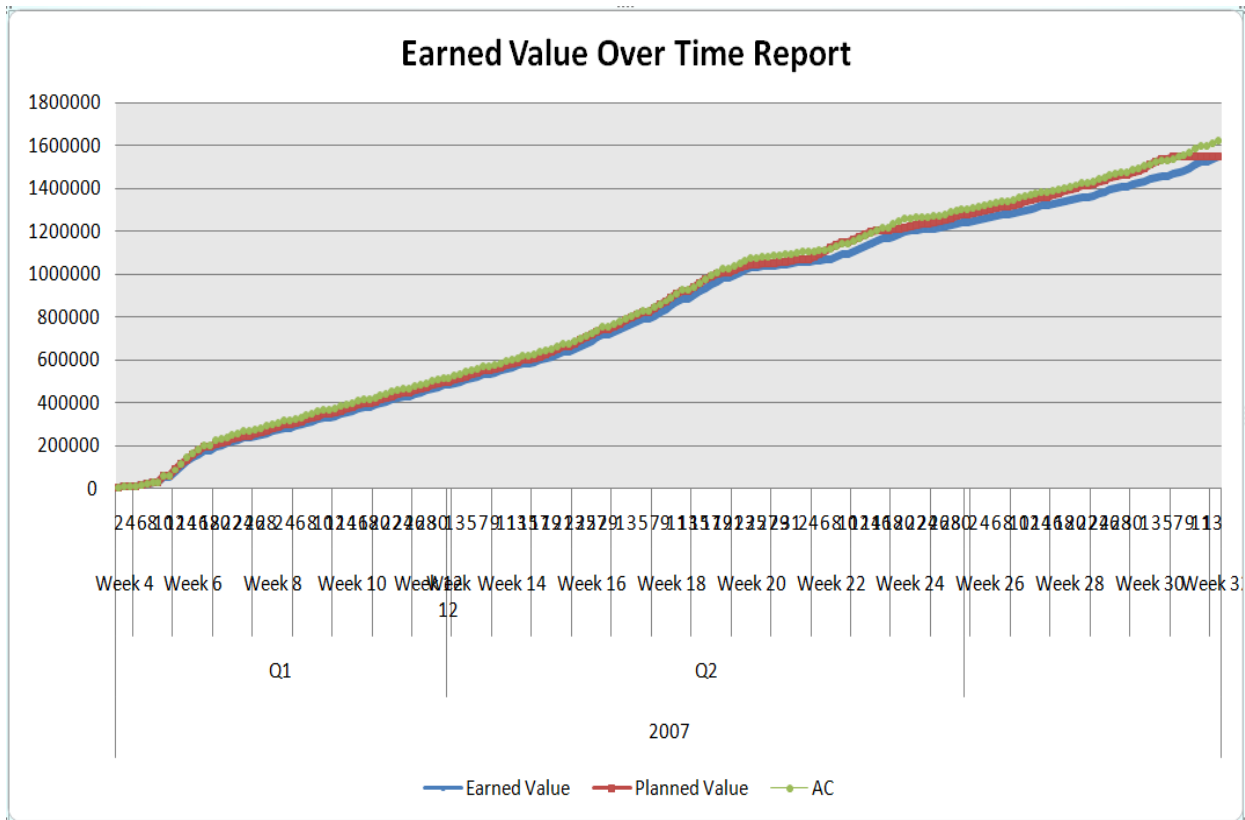**Fig 8 Earned Value Analysis**

Fig 9 Graphical presentation of Earned Value Analysis

C. EARNED VALUE ANALYSIS IN DEVELOPED SOFTWARE
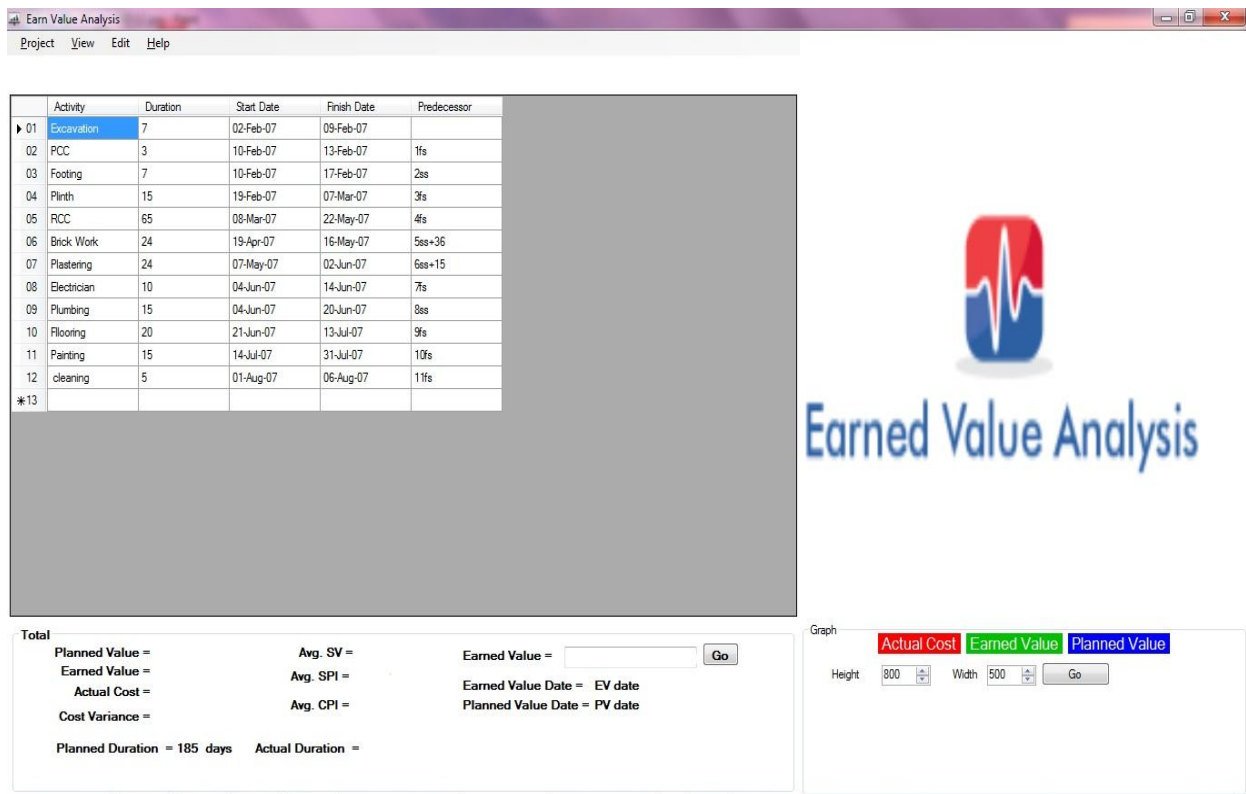

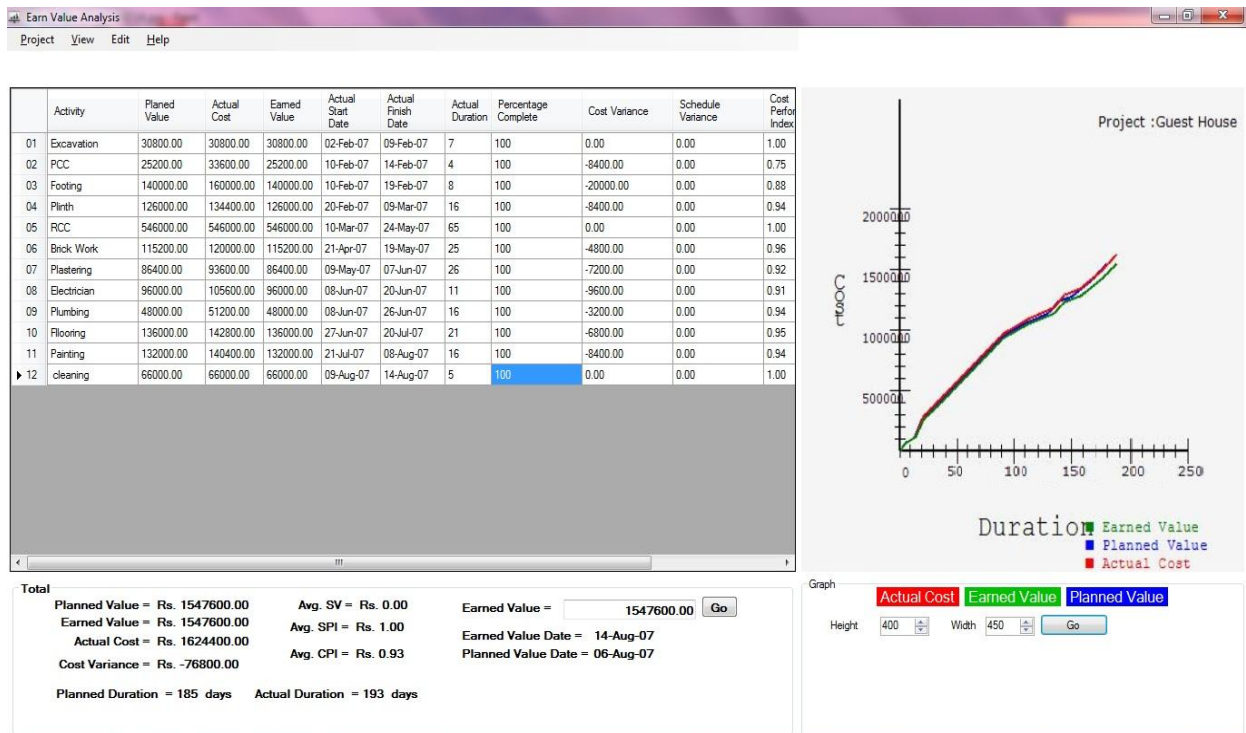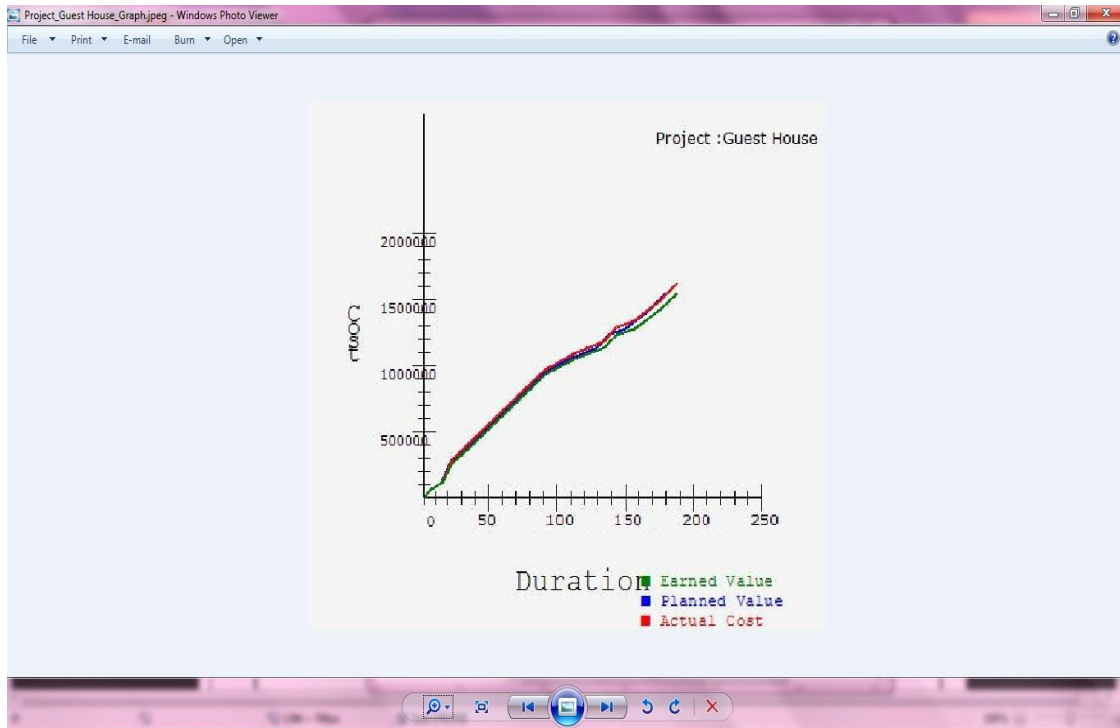**Fig 10 Scheduling Activity, Relationship SS, FS, FF, SF, Start Date, Finish Date**

Fig 11 Earned Value Analysis and SV(t)

Fig 12 Graph generated by Developed software

V. RESULTS

In this study 8 parameters where consider for effectiveness of Developed Software, for this purpose comparison was done between M.S Project, Primavera P6, Developed software.[parameters- SV(t), CV ,CPI, PV, EV, AC, PD, AD] .

Table 1: Comparison Between M.S Project, Primavera P6, Developed Software.

Sr.no	TITLE	PARAMETER	MS PROJECT	PRIMAVERA P6	DEVELOP SOFTWARE
1	Case Study Mahindra Tech	Planed Duration	159 days	159 days	159 days
		Actual Duration	166 days	166 days	166 days
		PV	Rs.15,47,600	Rs.15,47,600	Rs.15,47,600
		AC	Rs.16,24,400	Rs.16,24,400	Rs.16,24,400
		EV	Rs.15,47,600	Rs.15,47,600	Rs.15,47,600
		CV	0.93	0.93	0.93
		CPI	Rs.76,800	Rs.76,800	Rs.76,800
		SV(t)	-	-	8 days

[PV - Planned Value, AC - Actual Value, EV - Earned Value, CV - Cost Variance, CPI - Cost Performance Index, PD - Planned Duration, AD - Actual Duration, SV(t) - Schedule Variance respect to time.]

VI. CONCLUSION

Although EVA(Earned Value Analysis) may be most easily associated with the monitoring and evaluation of project cost that are undertaken within an organization, it can also be readily applied, with some adjustment, to the control of project cost that are performed by contractors and vendors. In those circumstances, however, it must be recognized that the client and contractor will have differing perspectives on actual and budgeted costs. This study also indicated that EVA has significant value and presents unique features that can benefit clients, consultants and contractors involved in the wide range of construction industries.

The two Projects were analysed using the developed software (in C#, .Net & SQL server) and MS Project 2007 and Primavera P6 based on Earned Value Analysis Method. CPI, PD, AD, CV, PV, AC, EV variable were selected. The result shows a strong relation between each software. The final result gives more than 99.5% accuracy. A new parameter SV (t) (Schedule Variances respect to time) is identified and incorporated in developed software which is not in MS Project 2007 and Primavera 6. The final result gives almost 100% accuracy.

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