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Study on Earned Value Analysis for Project Performance Analysis Using MS Project

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ABSTRACT : *Construction companies face new obstacles on a daily basis. Among all of these obstacles, it is critical to enhance a project's performance in terms of schedule and cost. Earned Value Analysis is a key method for assessing the performance of any construction project. It tracks project progress and assists in identifying important tasks, allowing the project to stay on track. This document depicts the Earned Value Analysis performed on a real-world project in Phnom Penh, using Microsoft Office Project. The study aided in identifying the crucial locations. It assured that the project was completed on schedule and on budget. This paper aims to develop an earned value analysis technique of measuring project performance can help the project manager know if the project is ahead or behind schedule, is the project over or under budget, and the utilization of funds? In order to measure project performance earned value analysis technique is grouped under the following three categories. For the sake of simplicity, we will take up only the first two as it helps to understand the core concepts.*
KEYWORDS: *Schedule; Progress; Earned Value Analysis*

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I. INTRODUCTION

Due to today's severe competition, all firms in the public and private sectors have been forced to move considerably quicker than in the past. As a result, practically every organization in business takes out many initiatives at the same time. Regardless of the extent and aim of the projects, the presence of a qualified project manager is one of the most significant factors for their success. Project control refers to the operations performed in the course of monitoring and updating the project. The disparities between the project plan and the actual situation are analyzed within the scope of the control, and the current plan is changed to reflect the real situation. As a result, the project's development is attempted to be managed. If there is a delay in the project following the update, the project manager may strive to avoid it by allocating more resources to subsequent tasks. Deviations in project success may be reduced by making sound judgments as a consequence of regulating and updating the project. In addition to project time changes, significant cost and quality indicators should be evaluated. S-curves are an important tool in project control in this situation. The S-curve, which graphs expense vs time, ensures a scale of timetable performance in this case. The primary purpose of project planning is to ensure that all project requirements are met successfully and on schedule [1]. Regardless of how rigorously the project schedule plan was followed, evaluating the project continuity and efficiency of work done, as well as the overall success of the construction project, is a difficult task without timely and ongoing performance oversight [2]. Choosing the most comfortable tracking system is one of the most time-consuming tasks in the building project industry. Actually, many buildings project teams in the globe simply compare actual costs to budgeted expenses. However, the disadvantage of this technique is that it does not evaluate the value of the job done, which eliminates the cost consideration: the earned value of the task [3].

II. LITERATURE REVIEW

Earned Value Management is a monitoring methodology that facilitates the combination of the planned amount of work with what has been fulfilled in reality, to determine if cost, schedule, and work done are running as per the planned schedule and quantification of work progress of project regular performance. Kim et al. examined the use of earned value for various types [4]. Furthermore, Vandevoorde and Vanhoucke suggested that

the earned schedule strategy is the most reliable method of anticipating time in fruition [5]. Lipke et al. offered an assured deciding system of total project cost and time duration on improving project managers' ability to make knowledgeable decisions [6]. Aceves et al. suggested that EVM should aggregate the metrics from claimed venture expenditure and strategy for risk management in a graphical format [7]. Czemplik used EVM to monitor the progress of building projects [8]. Beginning with those industrial engineering techniques that, as a matter of interest, looked at "cost-performance" methodology, the fundamental concept of earned value may have been centered. The comparability of desired and real characteristics of values and expenditure may have been realized in the change in cost-performance evaluation. Over time, this system was used for more than only government, military, and industrial operations; it was also somewhat overworked for commercial and private endeavors [9]. The EVM's value comes from the way it adheres to a precise dimension of the cost and time yield in the monitoring and tracking of projects. Christensen and his colleagues conducted a scientific investigation between 1998 and 2002, and they concluded that the cost performance index determiner derived between 15-20% of project completion guarantees a very reliable scale for project cost forecasting with a maximum error of ±10% [10]. With the advantage of assessing the earned value indices and the time and cost estimations toward realization under dubious circumstances, Moslemi-Naeni et al. suggested another fuzzy-based earned value instance [11]. Eirgash et al. have contributed to the wider practical use of earned value methodology by demonstrating the theoretical and practical aspects of performance measurement on a small-scale building project [12].

Earned Value is a step up from conventional accounting performance metrics. The traditional approaches emphasize real expenditures and expected expenses. Managers may develop risk mitigation measures based on the real cost, timing, and technical advancement of the task with a clearer picture. It is a project management tool that gives managers the ability to recognize and handle issues before they become insurmountable. It enables improved project management that is both on schedule and within budget.

The parameters that make up the analysis were described in this study. Then, several work items connected to a small sample project are subjected to Earned Value Analysis, and the performance of the work items has been evaluated. Finally, a discussion and a conclusion are presented, respectively.

III. TERMINOLOGIES

There are mainly three terms which identifies Earned Value Technique:

- Budgeted Cost of Work Scheduled (BCWS) or Planned Value (PV)
- Budgeted Cost of Work Performed (BCWP) or Earned Value (EV)
- Actual Cost of Work Performed (ACWP) or Actual Cost (AC)

1. PLANNED VALUE

The planned value is that portion of the approved total cost estimate which is planned to be spent on an activity during a given period.

PV = Physical Work + Approved Budget

2. ACTUAL COST

Actual cost (AC), also called actual cost of work performed (ACWP), is the total of direct and indirect costs incurred in accomplishing work on an activity during a given period.

3. EARNED VALUE

The earned value (EV), also called the budgeted cost of work performed (BCWP), is an approximation of the value of the physical work actually completed. It relates the original planned costs for the project or activity and the rate at which the team is completing work on the project or activity to date.

From the above terms, following parameters are defined.

- Estimate At Completion
- Budget At Completion
- Schedule Performance Index
- Cost Performance Index
- Schedule Variance
- Cost Variance

4. ESTIMATE AT COMPLETION

The Estimate at Completion (EAC) is the sum of actual cost in current till date and the estimated cost for the remaining work.

EAC = Actual Cost (AC) + Estimate to Complete (ETC)

5. SCHEDULE PERFORMANCE INDEX

Schedule Performance Index (SPI) can be used to estimate the projected time to complete the project based on the performance to date. It is given by:

SPI = EV / PV

SPI = 1 means that project is on schedule.
SPI < 1 means that project is behind schedule.
SPI > 1 means that project is ahead of schedule.

6. COST PERFORMANCE INDEX

Cost Performance Index (CPI) can be used to estimate the projected cost to complete the project based on performance to date. It is given by:

CPI = EV / AC

CPI = 1 means that the planned and actual costs are same.
CPI < 1 means that project is under budget.
CPI > 1 means that project is over budget.

7. SCHEDULE VARIANCE

Schedule Variance (SV) is the comparison of amount of work performed during a given period of time to what was scheduled to be performed. It is calculated as follows

SV = EV – PV

A negative schedule variance indicates that the project is behind schedule which means it took longer time than planned to perform the work. In the same way, a positive variance indicates that the project is ahead of schedule which means it took lesser time than planned to perform.

8. COST VARIANCE

Cost Variance (CV) is the comparison of the budgeted cost of work performed with the actual cost. It is calculated as follows

CV = EV – AC

A negative cost variance means the project is over budget that is performing the work cost more than planned. When this happens, the project managers will be able to know that cost is going beyond the budget.

The reasons for this can be analyzed and suitable corrective measures can be taken to bring the project back on budget. In the same way, a positive cost variance means that the project is progressing at a cost lesser than what was planned to be spent. This is a good sign as it shows that the project is progressing efficiently.

9. BUDGET AT COMPLETION

Budget at Completion (BAC) is the baseline cost that shows the planned cost for a task, a resource for all assigned tasks or for work to be performed by a resource on a task. The terms and their interpretations are presented in Table 1 given below.

Earned value management (EVM) combines a project's domain, schedule, under a bound together situated metrics to monitor and forecast the project's performance. Description about the greater part EVM terms is given in Table 1.

Table 1. Earned Value Terms [13].

Term	Description	Interpretation
PV (BCWS)	Planned Value	It is the budgeted cost for the work scheduled to be completed on an activity or WBS component in a particular time. It is obtained from the cash flow diagram (The S-curve).
EV (BCWP)	Earned Value	It is the budgeted amount for the work actually accomplished on the schedule activity or work breakdown structure (WBS) component during a given time.
AC (ACWP)	Actual Cost	It is resolved from accounting records that keeps record of actual expenditure money, that means it is secret and actual money spent by the contractor.
BAC	Budget at Completion	The total approved budget when the scope of the project is completed.
EAC	Estimate at Completion	The expected total cost of the project when the defined scope of work is completed.
ETC	Estimate to Complete	The expected extra cost necessary to finish the project.
Cost Variance (CV)	EV – AC	Negative means over budget, Positive means under budget
Schedule Variance (SV)	EV – PV	Negative means behind schedule, Positive means ahead of schedule
Cost Performance Index (CPI)	EV / AC	More than 1 means Profit and less than 1 means loss.
Schedule Performance Index (SPI)	EV / PV	More than 1 means ahead of schedule and less than 1 means behind the schedule.

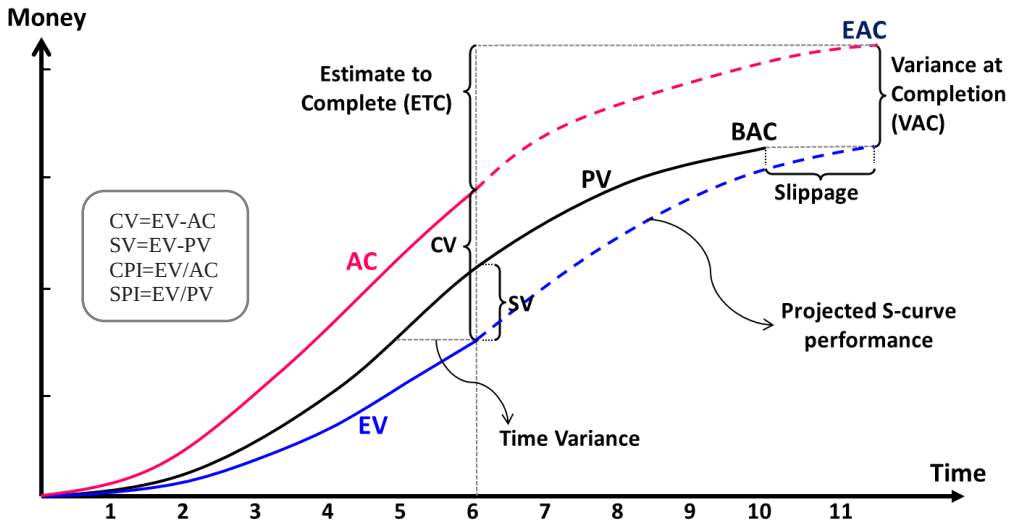


Figure 3.1 Earned Value Analysis curve

Figure 3.1 shows the graphical representation of the costs with respect to time. It shows the expected budget and how there is a variation of actual cost from this expected budget or the planned value. The estimate of work which was actually performed is also shown as Earned value.

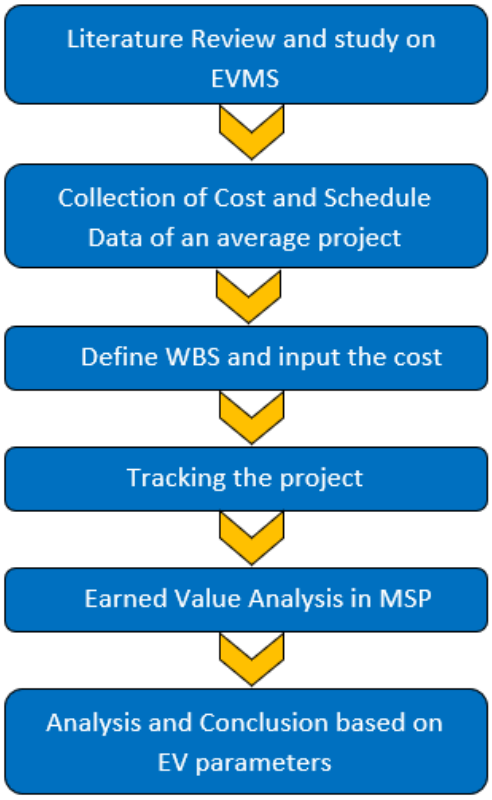
IV. OBJECTIVES OF STUDY

This study is done to fulfill the following objectives

- To improve management control system of a construction project by keeping the project on time and on budget.
- To identify and control project planned cost in potential project plan.

V. METHODOLOGY

The Methodology for this paper is shown in a flow chart as follows.



The First approach is to collect the existing research and analysis that have been done on Earned Value Analysis.

- The Second approach is to study the implementation of EV in various projects, how they have concluded based on the results.
- The third approach is to collect schedule and cost data of an average project which is in progress so that EV analysis can be done and conclusions can be made regarding the future of the project.
- The fourth approach is to start tracking the project and keep a note on the progress of different activities
- The fifth approach is to perform the analysis on a particular date after inputting the actual cost. The analysis is done using Microsoft Office Project software.
- The sixth approach is to yield project progress report on different status dates. The report may include critical activities, activities in progress, budgeted costs, cost incurred etc.
- The final approach is to make suitable conclusions based on the Schedule and Cost indices obtained after Earned Value Analysis.

VI. APPLICATION

The project is the construction of an Office building in located Dangkor, Phnom Penh in the southern part of Cambodia. Analysis is made after collecting schedule and cost data.

The project is expected to finish in January 2024. The EV analysis is done at certain points of progress of the project. Based on the results suitable conclusions are drawn regarding cost at the completion of the project and when the project will be completed.

The sequence of activities, their duration, start dates, finish dates and the predecessors for a part of the project is shown in Figure 6.1.

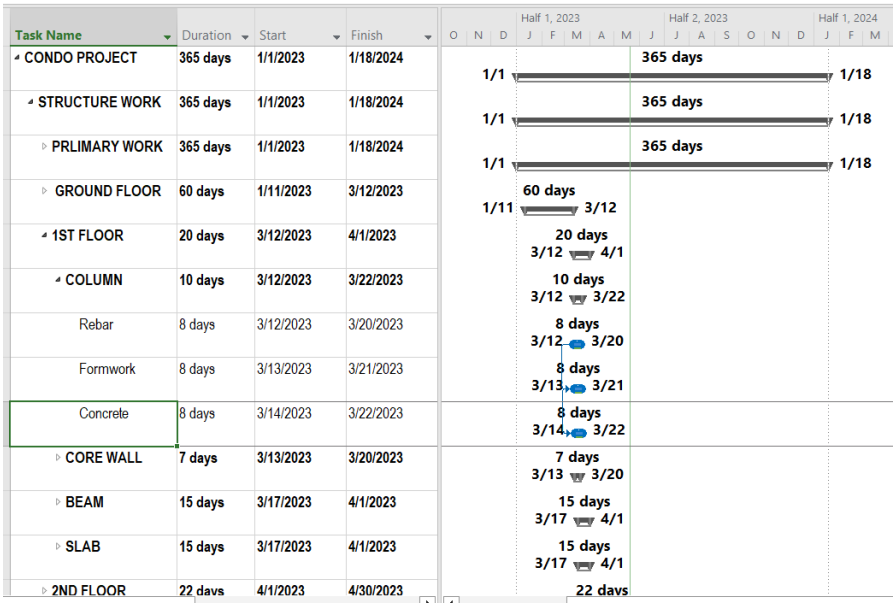


Figure 6.1 Microsoft Project Schedule

After developing a suitable MSP file, tracking of the project starts. The sequence of activities as in MSP is shown in figure 6.2. The progress of the project has been analyzed on different dates from January 2023 to May 2023. Till now 40 % of the project has been completed. Based on the cost and schedule analysis, conclusions have been drawn.

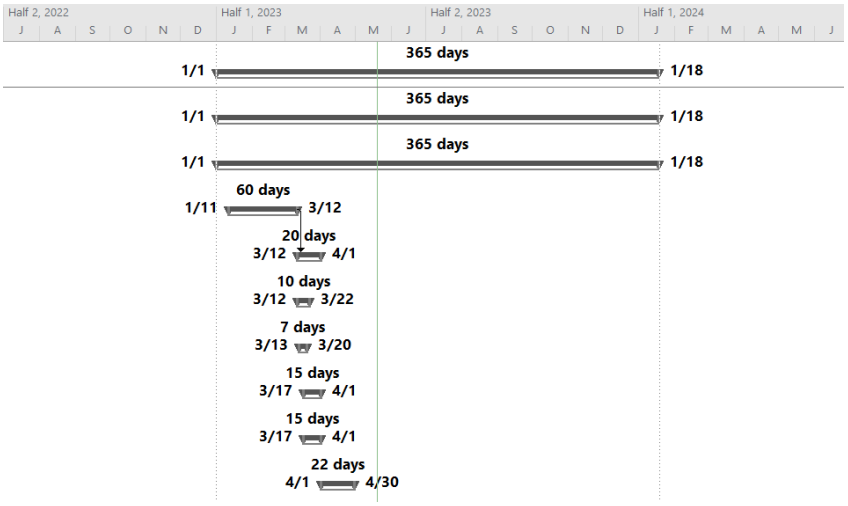


Figure 6.2 Work Sequence of Activities

Cost and Schedule analysis have been done separately as shown in Figure 6.3.

Task Name	Planned Cost (PV)	Actual (EV)	Remaining (CV)	% Complete
CONDO PROJECT	**$1,788,875.04**	**$465,901.54**	**$1,322,973.50**	**35%**
STRUCTURE WORK	**$1,411,514.61**	**$465,901.54**	**$945,613.07**	**46%**
PRLIMARY WORK	**$96,000.00**	**$96,000.00**	**$0.00**	**100%**
GROUND FLOOR	**$421,690.85**	**$321,381.75**	**$100,309.11**	**72%**
1ST FLOOR	**$104,356.53**	**$48,519.80**	**$55,836.73**	**57%**
COLUMN	**$38,298.46**	**$38,298.46**	**$0.00**	**100%**
Rebar	$27,265.00	$27,265.00	$0.00	100%
Formwork	$4,572.30	$4,572.30	$0.00	100%
Concrete	$6,461.16	$6,461.16	$0.00	100%
CORE WALL	**$7,050.72**	**$4,500.47**	**$2,550.26**	**76%**
Rebar	$2,475.00	$2,475.00	$0.00	100%
Formwork	$2,382.90	$2,025.47	$357.44	85%
Concrete	$2,192.82	$0.00	$2,192.82	0%
BEAM	**$20,083.88**	**$3,729.15**	**$16,354.73**	**40%**
Formwork	$3,808.95	$2,590.09	$1,218.86	68%
Rebar	$11,390.63	$1,139.06	$10,251.57	10%
Concrete	$4,884.30	$0.00	$4,884.30	0%
SLAB	**$38,923.47**	**$1,991.72**	**$36,931.75**	**10%**
Formwork	$10,482.75	$1,991.72	$8,491.03	19%
Rebar	$17,442.00	$0.00	$17,442.00	0%
Concrete	$10,998.72	$0.00	$10,998.72	0%

Figure 6.3 Work Sequence of Activities

Fig 6.3 shows the cost schedule analysis. Take an example. The progressing activity which is structural frame is on schedule with a value of $. 465,901.54. The progressing for the overall completed 35 % of what was originally planned.

VII. ANALYSIS

The main objective of this case study on this project is to study and analyze the Planned cost and come to a conclusion regarding how the values were arrived at. The Planned Cost Analysis for activities where variation is large is tabulated and shown in Fig. 7.1.

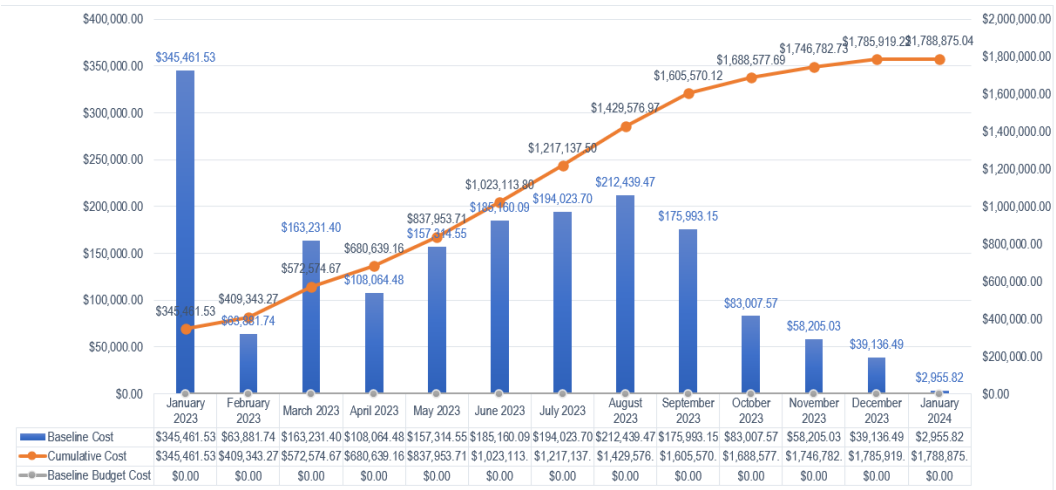


Figure 7.1 Project Cost Planned Analysis

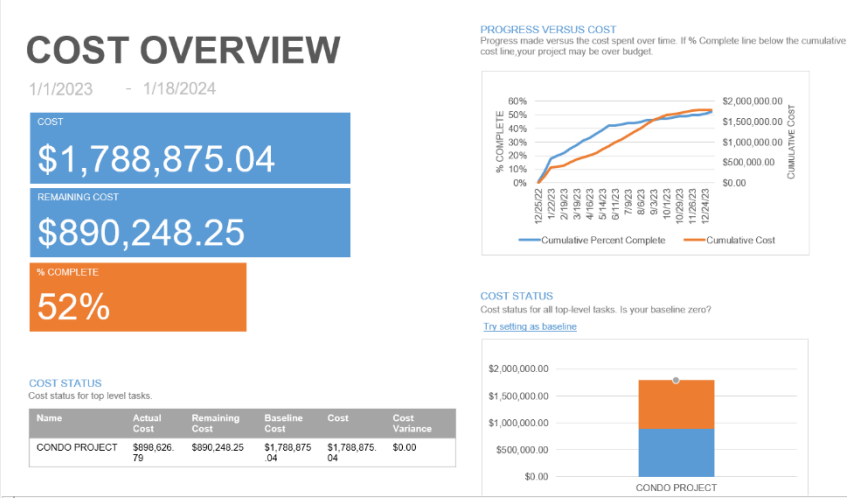


Figure 7.2 Project Cost Overview

Fig. 7.2 is shown the project cost status will show all the details like Cumulative percentage completed, Cumulative cost, remaining cost, direct costs, etc.

VIII. CONCLUSION

There are many benefits to installing a monitoring system — some of which strongly interrelate with each other. A cost-benefit analysis is a tool that can be used to evaluate a project or course of action, and its benefits outweigh the limitations. Microsoft Project is very handy for executing the cost-benefit analysis. Cost overview, work overview, and cost flow reports can be easily generated in Microsoft Project. There are some limitations to keep in mind when using a cost-benefit analysis, but overall, it is a helpful tool for decision-making.

The main conclusion is that Cost Overview can provide an important contribution in cost management of a construction project.

- It can be sensitive to scope change.
- Scheduling in MSP proves to ease the scheduling of projects.
- It acts as a warning system to the project managers and thus helps in efficient project management.
- The reports can be used in future projects as to possible hindrances that may well arise in other

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