Carlos Consulting Group

Simple Earned Value Management

Financial analysis that goes one step beyond "Budget versus Actual"

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Introduction

There are “lucky” project managers whose projects were completed “on time” and “within budget.” However, chances are these PMs represent a small minority. Everyone else has probably faced a situation where one of the following statements are true:

- The project is within budget and schedule but we do not see the “expected” results
- The project is taking longer than expected
- The project is costing more than anticipated

- The novice project manager probably uses analysis tools that are considered “two-dimensional.”
- Budget and Actual are the two dimensions.
- There is a much needed third dimension- one that reflects Performance and Efficiency.

Performance and Efficiency indicate whether or not we are actually completing the intended tasks and producing the expected project deliverables within the designated budget and schedule.

Earned Value Management

The process of considering scope, schedule, and resources, measured against a project's actual performance. It compares the planned amount of work to the completed tasks, to the projects' cost, to determine if the cost, schedule, and work completed (thus far) are all in synch and in accordance with the plan. This analysis will show past performance and will estimate future efforts to complete the project (with the desired results).

“Project and Assumptions”

- John is managing a software development project.
- The project estimates include a total of 100 hours of development time.
- There are five separate tasks that will take 20 hours each.
- Each task has 4 subtasks that take 5 hours to complete.

“Project and Assumptions”

- John hires five programmers. Each have twenty percent of the work that can be completed concurrently.
- Each programmer will charge $100 per hour. Total budget for the project is $10,000.
- Based on the distribution of work, it is determined that the project can be completed within one week.

“The Initial Reports”

- At the end of the week, the programmers turn in time sheets.
- A total of 90 hours is reported.
- Based on this information, John quickly assumes the project is 90% complete.
- John grimaces knowing that the project will not be completed on time.
- So John’s status report claims that the project is within budget but not on time. I have no idea how much additional time is needed.

“Question”

Would you agree with John’s assessment of the project?

“Answer”

If you answered “no” or “I do not have enough information to support that claim” you’re right on track. To understand why that is the correct answer, let’s dig further into the problem.

What do we know at this point?

- The project has 5 tasks, 20 hours each, total 100 hours.
- The programmers were given 1 week to complete their tasks.
- Timesheets show 90 hours of work.

What do we not know at this point?

- How many of the tasks (or portions of a task) have been completed?
- Do we know that work performed was solely dedicated to completing tasks or was the time spent on non-related tasks or inefficiencies?

John gathers the data

Programmer	Budgeted Time	Cost Per Hour	Total Cost
Bob	20 hours	$100	$2,000
Sue	20 hours	$100	$2,000
Roger	20 hours	$100	$2,000
Mike	20 hours	$100	$2,000
Jill	20 hours	$100	$2,000
Total time and costs incurred	**100 hours**		**$10,000**

Table 1

John gathers the data

Programmer	Budgeted Time	Actual time spent	Invoices Submitted	Estimated Percentage of all tasks completed
Bob	20 hours	15 hours	$1,500	60%
Sue	20 hours	25 hours	$2,500	75%
Roger	20 hours	5 hours	$500	10%
Mike	20 hours	30 hours	$3,000	50%
Jill	20 hours	15 hours	$1,500	80%
Total time and costs incurred		**90 hours**	**$9,000**	

Table 2

* Estimated Percentage of all tasks completed was a number given by the programmer.

Notes

- Without going any further John can see the project has encountered a serious problem.
- The programmers show 90 hours of work.
- However, no one programmer can make the claim that they have completed 90% of their assigned task (and final deliverable).
- Collectively, the team shows poor performance.

The Basic EVM Formulas

Symbol	Description	Formula	Explanation
PV	Planned Value	None	The estimated value of the work planned to be done thus far.
AC	Actual Costs	None	The total costs incurred to date, based on timesheets, invoices, other expenses, etc.
EV	Earned Value	Σ -Sum of all tasks (Task Budget * % Completed)	The estimated value of (intended) work completed thus far, as it relates to the expected deliverables.

Notes

- PV and AC are easily derived.
- PV is based on what should have been completed thus far.
- AC are your actual costs
- For multi-period projects, PV will seldom equal the full budget figure.

In reality, EVM analysis will be done over several periods and the value for PV will be constantly changing.

Basic EVM Calculations

Term	Value	Notes
PV	$10,000	Our budgeted figure
AC	$9,000	Total invoices submitted thus far
EV	$5,500	($2,000 * 60%) + ($2,000 * 75%) + ($2,000 * 10%) + ($2,000 * 50%) + ($2,000 * 80%)

Table 3

To derive EV, multiply the *budget* figure by the percentage of all tasks completed (see Table 1). For example, Bob was given 20 hours to complete 4 subtasks. He estimated that 60% of the subtasks are completed. You multiply $2,000 by 60% and this gives a value of $1,200. So you can clearly see that Bob's (real) work does not equal the actual cost of $1,500. As a result, Bob has fallen behind (in schedule and cost) based on this one calculation.

Notes

- The group has fallen behind on their work.
- They have submitted $9,000 as the cost but produced only $5,500 of (Earned) value.
- The project “appears” to be $3,500 over budget.
- The project is behind schedule (because the tasks were not completed within the 1 week time frame).

The Performance Index Formulas

Symbol	Description	Formula	Explanation
CPI	Cost Performance Index	EV/AC	CPI compares the relationship between the Earned Value and Actual Cost. *"I am (only) getting (blank) cents performance out of every $1 spent."*
SPI	Schedule Performance Index	EV/PV	SPI compares the relationship between the Earned Value and Planned Value. *"I am only progressing at (blank) % of the original plan."*

The Performance Index Calculations

Term	Value	Notes
CPI	61.11%	Using (EV/AC); ($5,500 / $9,000)
SPI	55.0 %	Using (EV/PV); ($5,500 / $10,000)

Table 4

- The CPI index tells John that *he is receiving 61.11% performance efficiency* or *$.61 cents performance out of every $1 spent.*
- The SPI index tells John that *he is only progressing at 55% of the original plan and will most likely need another week to complete the project.*

“Questions”

- How much longer will it take to complete the project?
- What is the additional cost to complete the project?

“Answer”

- If you answered “another week and $3500” you’ve jumped the gun.
- Let’s dig further into the formulas.

At Completion Calculations

Symbol	Description	Formula	Explanation
BAC	Budget At Completion	N/A	The original budget for the total job
EAC	Estimate At Completion	BAC / CPI	The amount "currently expected" for the total project cost
ETC	Estimate To Complete	EAC-AC	From this point on, how much MORE do you expect the cost will be to finish the job

At Completion Calculations

Symbol	Value	Notes
BAC	$10,000	The original budget
EAC	$16,363	Using (BAC/CPI); [$10,000/.611]
ETC	$7,363	Using (EAC-AC); ($16,363 - $9,000)

Table 5

*Calculating a value for EAC can be tricky. There are four different methods for calculating EAC. Each method can yield a different result. Since John employs the principle of “conservatism” and wants the “worst case scenario” he uses the formula the yields the highest figure. (Refer to the Handout Appendix for all EAC formulas).

The Variance Calculations

Symbol	Description	Formula	Explanation
VAC	Variance At Completion	BAC-EAC	How much over or under budget will the project come in at. (This assumes that each task will have the same inefficiency as task 1)
CV	Cost Variance (in dollars)	EV-AC	Negative is over budget, Positive is under budget (Up to now)
SV	Schedule Variance (in dollars)	EV-PV	Negative is behind schedule, Positive is ahead of schedule (Up to now)

The Variance Calculations

Term	Value	Notes
VAC	- $6,363	Using (BAC-EAC); ($10,000 - $16,363)
CV	- $3,500	Using (EV-AC) with answer in dollars; $5,500 - $9,000
SV	- $4,500	Using (EV-PV) with answer in dollars; ($5500 - $10,000)

Table 6

- **At this point in time, the project appears to be $6,363 over budget (VAC). It will be next to impossible to hit the original target figure of $10,000.**
- **The current EAC value assumes that the programmers will continue working at the same pace.**
- **The Cost (CV) and Schedule (SV) variances indicate that the project is "over budget" and "behind schedule."**

The Status Report

- John is shaking his head in disbelief.
- The project cannot meet the original estimates.
- John knows that the management team will not be able to follow the calculations shown above.
- He needs to simplify the reporting to three simple values.

Efficiency Ratings

Symbol	Description	Formula	Explanation
PE	Planned Earned	EV/BAC	Project % Complete (as it relates to time and deliverables)
PS	Percent Spent	AC/BAC	Project % Spent (as it relates to cost)
CSI	Cost Schedule Index	CPI * SPI	The overall efficiency rating. The further CSI is from 1.0, the project will have difficulties in recovering.

The Efficiency Ratings

Term	Value	Notes
PE	55%	Using (EV/BAC); ($5,500 / $10,000)
PS	90%	Using (AC/BAC); ($9,000 / $10,000)
CSI	.336	Using (CPI * SPI); (61.11% * 55%)

Table 7

- The values for PE and PS do not surprise John. He has seen these figures before
- The “CSI” is surprising.
- This value is far from “1” - so it indicates a problem with the project’s overall efficiency.

Period 1 Analysis

- The formulas provide a mathematical analysis of performance.
- Unfortunately, they cannot explain “why” the inefficiencies have occurred.
- For this, John will need to examine the work of each programmer in order to understand why they are all running over the allotted time for each task.

Lessons Learned

- It’s possible that the task lengths were severely underestimated.
- Interviews with the programmers may show that they in fact are working to the best of their ability.
- The problem may have occurred in the original project estimates.

Summary - Period 1

Earned Value Management Analysis

Project Information	
Project duration (weeks)	1
Project start date	3/1/07
This report date	3/5/07
Estimated end date	3/5/07

Task #	Description	Budget Hrs	Hrly Cost	Total Est Cost	Actual	Cost To Date	Percentage of Tasks Completed *1
T1	Bob's Tasks	20.00	$ 100	$ 2,000.00	15.00	$ 1,500.00	60%
T2	Sue's Tasks	20.00	$ 100	$ 2,000.00	25.00	$ 2,500.00	75%
T3	Roger's Tasks	20.00	$ 100	$ 2,000.00	5.00	$ 500.00	10%
T4	Mike's Tasks	20.00	$ 100	$ 2,000.00	30.00	$ 3,000.00	50%
T5	Jill's Tasks	20.00	$ 100	$ 2,000.00	15.00	$ 1,500.00	80%
(Enter values were you see a blue font)		100.00		$ 10,000.00	90.00	$ 9,000.00	

(Enter values were you see a blue font)

*1 - Information as reported by programmers

Term	Description	Value
PV	Planned Value *2	$ 10,000.00
AC	Actual Cost	$ 9,000.00
EV	Earned Value	$ 5,500.00
CPI	Cost Performance Index	61.11%
SPI	Schedule Performance Index	55.00%

(Enter values were you see a blue font)

*2 Remember that PV is based on what should have been completed thus far.
For multi-period projects, it will not equal the same value as BAC.

Term	Description	Value
PE	Planned Earned	55.0%
PS	Percent Spent	90.0%
CSI	Cost Schedule Index	0.336

Alternate methods to Calculate EAC

Term	Description	Value
EAC #1	BAC/CPI	$ 16,363.64
EAC #2	AC + ETC	$ 16,363.64
EAC #3	AC + BAC - EV	$ 13,500.00
EAC #4	AC +[(BAC-EV)/CPI]	$ 16,363.64

Term	Description	Value
BAC	Budget At Completion	$ 10,000.00
EAC *3	Estimate At Completion	$ 16,363.64
ETC	Estimate To Complete	$ 7,363.64
VAC	Variance At Completion	$ (6,363.64)
CV	Cost Variance (in dollars)	$ (3,500.00)
SV	Schedule Variance	$ (4,500.00)

(Enter values were you see a blue font)

*3 Using Max Value of EAC #1, EAC #3, or EAC #4
(Using EAC #2 will create a circular error)

Your project Status:	
If EV > =PV and EV >= AC	
If EV < PV	Schedule Problem
If EV < AC	Cost Problem
If EV < PV and EV < AC	Cost and Schedule Problem

To Finish The Project

- Complete the work as originally planned- no scope changes or deviations.
- Update the values of the Basic Formulas – (PV will remain the same, Actual Costs will change, Earned Value will change).
- Rerun calculations and review all other formulas.
- Let your Excel worksheet do the work.
- Create a separate Excel tab for each work period (and thus save the old data).

Final Thoughts

- There is much more to EVM than discussed in this presentation. But you are now aware of the third dimension of a project's financial analysis. All three dimensions are key elements that must be considered when analyzing project performance.
- The EVM formulas provide a mathematical analysis of past and potential future performance. Unfortunately, they cannot explain "why" the inefficiencies occur. For this, a project manager will need to examine the work of each resource in order to understand why they perform the way they do.

What next?

- Visit www.carlosconsulting.com/resources and study the presentation on “Building A Playhouse.” This is a multi-period project with analysis and graphs.
- Buy a book, read articles, become familiar with the applications and projects that are suited for EVM.

About the Author

Tom Carlos has over 25 years of cumulative experience in business, technical, and training environments. He is a Certified Project Management Professional (PMP) and member of the Sacramento Valley PMI Chapter. Tom is the author and instructor of the Project Management 1A and Risk Management 1A Training Classes.

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