

PROJECT CONTROLS EXPO 2019

Technical Paper

Estimate at Completion Calculation at a Project Level

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Author Profile

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Mostafa has over 5 years of experience in project management including scheduling, planning and cost control. Mostafa was responsible of planning and controlling mega projects of 1 billion dollars in Canada. Mostafa is also a part time project management instructor at Northern Alberta Institute of Technology (NAIT).

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Abstract

This paper discusses two different approaches to calculating Estimate at completion at a project level. Seamless EAC reporting is essential. Variances between results, based on the same data input, of estimate at completion at project level between different software can confuse and mislead project management professionals, especially if these differences result in extreme project performance indicator variances between different software.

This paper compares between two methods of two scheduling software packages (MS Project and Primavera P6) used to calculate EAC at a project level:

- 1) Adding up EAC for all control accounts on a project, at their appropriate levels to generate the EAC of the project.
- 2) Adding up Actual costs and Earned Value for all control accounts on a project at their appropriate levels, calculating the project's Cost Performance Index (CPI), and using this CPI to calculate EAC.

The paper also discusses different case studies that will magnify the issue discussed. The goal of this paper is to be the first step of gaining consensus on how EAC is calculated at a project level.

Introduction

Projects are planned to follow a certain budget and schedule; however, the many projects deviate from their plans for various reasons. Therefore, project forecasting is required at different project stages to estimate the expected end-result of any project. Project Estimate at Complete (EAC) is a vital part of project forecasting. EAC indicates a project's profitability based on actual performance and/or assumed future performance.

Different formulas used to determine EAC will be presented in this paper. However, the focus of this paper is to provide a guideline to how EAC should be summarized at the project level. The paper compares between two different methods of rolling up EAC to the project level, and outlines which method should be used on projects for an accurate Estimate at Completion.

This paper will be based on two case studies to ensure results represented are reflective of what happens on real-life projects.

Background

There are different methods to calculate Estimate at Completion. This section covers some of the formulas used to estimate project's costs at completion.

According to PMBok guide sixth edition by Project Management Institute (PMI) [1, p. 264], Estimate at Completion can be estimated by the project manager based on actual costs spent to date and estimate of how much will be spent on the remaining work. Equation 1 below is one method of calculating EAC:

$$EAC = AC + \text{Bottom-up ETC} \quad \text{Equation 1}$$

Where:

EAC = Estimate at Completion

AC = Actual cost incurred on the project to date

Bottom-up ETC = Estimated cost to be spent on remaining work.

The process of evaluating the estimated cost for remaining work is a significant effort. This process requires proper progress gathering to allow the project manager to estimate the remaining work properly. This process also requires integration between the project manager and the finance/accounting team. The project manager should be able to accurately estimate the costs of remaining work. Therefore, past actual costs need to be clearly captured and recorded.

If a project manager is not able to provide a detailed bottom-up estimate or if the current cost and/or schedule performances are expected to influence Estimate at Completion, there are different formulas that can be used to calculate EAC. Table 1 below lists some of these formulas.

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Equation	Assumptions
$EAC = AC + (BAC - EV)$ Equation 2 Where: BAC = Budget at Completion EV = Earned Value	a) Acceptance of current actual costs spent. b) Future ETC to be accomplished at the budgeted rate
$EAC = BAC / CPI$ Equation 3 Where: CPI = Cumulative Cost Performance Index	a) Cost performance experienced to date is expected to continue in the future
$EAC = AC + \frac{BAC - EV}{CPI \times SPI}$ Equation 4 Where: SPI = Schedule Performance Index	a) Both cost and schedule performance factors are considered b) Project schedule impacts ETC

Table 1 – EAC Formulas [2, p. 4 and 5]

Project scope is usually broken down into manageable levels through Work Breakdown Structure. Projects' costs, similarly, are broken down into different levels through Cost Breakdown Structures. Control Accounts are broken down to a level where Earned Value is computed and Estimate at Completion values are forecasted. After EAC is computed for every control account, EAC for the project is computed. The two methods below are assumed and assessed for the purpose of this analysis:

- A) Adding up EAC values for control accounts on the project
- B) Using one of the above-mentioned formulas to calculate EAC at the project level

Values generated from the two methods above can be different. There should be guideline on how EAC at a project level should be computed, because Estimate at Completion is a vital indicator of a project's forecasted success or failure.

This paper assumes the use of equation 3, for simplicity. CPI is assumed to be the cumulative CPI and is calculated as follows:

$$CPI = EV / AC \quad \text{Equation 5}$$

Where:

EV = Earned Value to date

AC: Actual Costs spent to date

How MS Project and Primavera P6 calculate EAC at a project level

The topic of this paper was initiated when a discrepancy was found between MS Project and Primavera P6 on how each software calculates EAC at a project level. An example is given below to highlight this discrepancy. MS Project 2013 and Primavera P6 R16.2 are used.

For consistency, one project was assumed and applied to MS Project and Primavera. Same resources were allocated to both software and same progress was entered.

Project Data

A simple project of 4 activities, where every activity represents a control account, was assumed. Activities were numbered 1 through 4, and given durations of 4, 3, 6 and 7 days respectively. A FS relationship was assumed between all activities. A resource that costs \$62.5 per hour was allocated to all activities. This project is set as a baseline. Figures 1 and 2 below show the project summary in MS Project and Primavera P6, respectively.







		Task Mode	Task Name	Duration	Start	Finish	Predecessors	Baseline Cost
0			Project	20 days	12/17/2018	1/11/2019		\$10,000.00
1			1	4 days	12/17/2018	12/20/2018		\$2,000.00
2			2	3 days	12/21/2018	12/25/2018	1	\$1,500.00
3			3	6 days	12/26/2018	1/2/2019	2	\$3,000.00
4			4	7 days	1/3/2019	1/11/2019	3	\$3,500.00

Figure 1 – Project Summary in MS Project

Activity ID	Original Duration	Start	Finish	Predecess	BL Project Total Cost
Project	20.00	Dec-17-18	Jan-11-19		10,000.00
1	4.00	Dec-17-18	Dec-20-18		2,000.00
2	3.00	Dec-21-18	Dec-25-18	1	1,500.00
3	6.00	Dec-26-18	Jan-2-19	2	3,000.00
4	7.00	Jan-3-19	Jan-11-19	3	3,500.00

Figure 2 – Project Summary in Primavera P6

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Project Data

Table 2 below provides a summary of the project progress used to update MS Project and Primavera P6 schedules.

Data Date: Jan 5, 2019				
Activity	Percent Complete	Earned Value	Actual Cost	
1	60%	\$1,200	\$1,900	
2	93%	\$1,395	\$1,100	
3	90%	\$2,700	\$2,700	
4	80%	\$2,800	\$3,000	

Table 2 – Project Progress

The progress in the table above was entered into MS Project and Primavera P6. CPI values were automatically calculated by each software using equation 5. EAC calculations settings in Primavera P6 were set to equation 3 (EAC = BAC/CPI) to match the equation used by MS Project. Figures 3 and 4 below provide progress summaries on both software.

Task Name	Act. Start	Phys. % Comp.	Act. Cost	BCWP	CPI	EAC
Project	12/17/2018	81%	\$8,700.00	\$8,095.00	0.93	\$10,747.40
1	12/17/2018	60%	\$1,900.00	\$1,200.00	0.63	\$3,166.68
2	12/21/2018	93%	\$1,100.00	\$1,395.00	1.27	\$1,182.80
3	12/26/2018	90%	\$2,700.00	\$2,700.00	1	\$3,000.00
4	1/3/2019	80%	\$3,000.00	\$2,800.00	0.93	\$3,750.00

Figure 3 – Project progress and EAC on MS Project

Activity ID	Actual Start	Physical % Complete	Actual Cost	Earned Value Cost	Cost Performance Index	Estimate At Completion Cost
Project	Dec-17-18		8,700.00	8,095.00	0.93	11,099.46
1	Dec-17-18	60%	1,900.00	1,200.00	0.63	3,166.67
2	Dec-21-18	93%	1,100.00	1,395.00	1.27	1,182.80
3	Jan-26-19	90%	2,700.00	2,700.00	1.00	3,000.00
4	Jan-3-19	80%	3,000.00	2,800.00	0.93	3,750.00

Figure 4 – Project progress and EAC on Primavera P6

It can be seen from figures 3 and 4 above how MS Project and Primavera calculated EAC at a project level differently. Despite the identity of project data and progress entered into MS Project and Primavera P6 and despite the fact that CPI values are calculated to be exactly the same for every activity on each software, the EAC at the project level presented by each software is different. This is due the fact that Primavera uses method A in calculating EAC at a project level (Adding EAC of every activity to roll up to project level) while MS project uses method B (Adding up EV and AC of all activities to roll up to project level, then using these values to calculate CPI at project level and using this CPI to estimate cost at completion at a project level).

Case Study 1

A project sample is provided in this section. EAC is calculated using the two different methods above-mentioned. Results from the two methods are compared and results are presented.

Project Information

A project ABC is assumed to have a total budget of \$120,000,000. This budget is divided to five control accounts. Every control account has % complete, hence Earned Value. Every control account has an actual cost. CPI for every control account is calculated by equation 5. EAC for every control account is calculated by equation 3. Below are the details of every control account and a project summary.

Control Account #1

Control Account #1
Total Budget: \$10,000,000
% Complete: 100%
Earned Value (EV): \$10,000,000
Actual Cost: \$13,300,000
CPI: 0.75
EAC: \$13,300,000

Table 3 – Control Account #1 Details

This control account #1 is over budget and is completed, therefore the estimate at completion is equal to the actual cost to date.

Control Account #2

Control Account #2
Total Budget: \$15,000,000
% Complete: 95%
Earned Value (EV): \$14,250,000
Actual Cost: \$17,800,000
CPI: 0.8
EAC: \$18,736,842

Table 4 – Control Account #2 Details

This control account #2 is over budget and is almost complete. EAC is expected to be \$18,736,842 when the activities linked to this control account are completed.

Control Account #3

Control Account #3
Total Budget: \$20,000,000
% Complete: 70%
Earned Value (EV): \$14,000,000
Actual Cost: \$16,500,000
CPI: 0.85
EAC: \$23,571,429

Table 5 – Control Account #3 Details

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This control account #3 is over budget and is 85% complete. EAC is expected to be \$23,571,429 when the activities linked to this control account are completed.

Control Account #4

Control Account #3
Total Budget: \$25,000,000
% Complete: 55%
Earned Value (EV): \$13,750,000
Actual Cost: \$11,500,000
CPI: 1.2
EAC: \$20,909,091

Table 6 – Control Account #4 Details

This control account #4 is under budget and is 55% complete. EAC is expected to be \$20,909,091 when the activities linked to this control account are completed.

Control Account #5

Control Account #3
Total Budget: \$50,000,000
% Complete: 40%
Earned Value (EV): \$20,000,000
Actual Cost: \$20,000,000
CPI: 1
EAC: \$50,000,000

Table 7 – Control Account #5 Details

This control account #5 is on budget and is 40% complete. EAC is expected to be equal to the total budget of that control account.

Case Study 1 Summary

Project’s summary is presented in table 8 below. The table shows every control account on the project and their related progress information as well as the estimate at completion.

Control Account #	Budget	% Complete	Earned Value	Actual Cost	CPI to date	EAC
1	\$10,000,000	100%	\$10,000,000	\$13,300,000	0.75	\$13,300,000
2	\$15,000,000	95%	\$14,250,000	\$17,800,000	0.80	\$18,736,842
3	\$20,000,000	70%	\$14,000,000	\$16,500,000	0.85	\$23,571,429
4	\$25,000,000	55%	\$13,750,000	\$11,500,000	1.20	\$20,909,091
5	\$50,000,000	40%	\$20,000,000	\$20,000,000	1.00	\$50,000,000

Table 8 – Project A Summary

The following section provides a comparison between the two different methods of calculating the estimate at completion at the project level.

Project A Estimate at Completion Analyses

Based on the information available on the project, estimate at completion at the project level can be computed via two different methods.

Method A

Method A entails summing up EAC at completion of every control account to get the rolled-up estimate at completion at the project level. Summing up all EAC values in table 8 above results in an estimate at completion of \$126,517,362 at the project level. This number indicates an expected loss of \$6,517,362 (5.43% of total budget)

Method B

Method B entails summing up Earned Value and Actual costs of every control account to get the rolled up Earned Value and Actual Cost at the project level. This results in the following:

Earned Value of project = \$72,000,000

Actual Cost of project = \$79,100,000

Those two values are then used to calculate CPI using equation 5.

$$\text{CPI} = \text{EV}/\text{AC} = \$72,000,000/\$79,100,000 = 0.91$$

Estimate at completion at the project level using this method is calculated by equation 3.

$$\text{EAC} = \text{BAC}/\text{CPI} = \$120,000,000/0.91 = \$131,833,333$$

This number indicates an expected loss of \$11,833,333 (9.86% of total budget)

Case Study 2

Two observations can be seen from the analyses of project A. Firstly, there is a difference in EAC values generated from both methods. Secondly, Method B results in higher estimate at completion. Therefore, it could be debated that method B is more conservative and should be used to prepare for worst case scenario. The intent of analyses on another project is to indicate that method B doesn't always result in a higher estimate at completion.

Case Study 2 Summary

The same project is assumed, with a change in actual costs captured to date on all control accounts. Table 9 below provides a summary of the project and the progress on each control account.

Control Account #	Budget	% Complete	Earned Value	Actual Cost	CPI to date	EAC
1	\$10,000,000	100%	\$10,000,000	\$9,500,000	1.05	\$9,500,000
2	\$15,000,000	95%	\$14,250,000	\$13,250,000	1.08	\$13,947,368
3	\$20,000,000	70%	\$14,000,000	\$13,250,000	1.06	\$18,928,571
4	\$25,000,000	55%	\$13,750,000	\$14,000,000	0.98	\$25,454,545
5	\$50,000,000	40%	\$20,000,000	\$22,000,000	0.91	\$55,000,000

Table 9 – Project B Summary

It can be seen from the table above that more control accounts are under budget compared to project A. Total Earned value of the project is \$72,000,000 and the actual costs also add up to \$72,000,000 at the project level.

Method A

Method A entails summing up EAC at completion of every control account to get the estimate at completion at the project level. Summing up all EAC values in table 9 above results in an estimate at completion of \$122,830,485 at the project level. This number indicates an expected loss of \$2,830,485 (2.36% of total budget)

Method B

Because the earned value is equal to the actual cost at the project level, method B results in an estimate at complete equal to the project's budget (\$120,000,000).

Analyses of project B annuls the assumption that using method B in calculating EAC at a project level is more conservative.

Numerical Analyses – Project B’s cost performance continues

To be able to judge which method is more accurate to calculate EAC at a project level, project B’s cost performance is assumed to continue throughout the project. Table 10 below provides a summary of project B after it is finished.

Control Account #	Budget	% Complete	Earned Value	Actual Cost	CPI to date
1	\$10,000,000	100%	\$10,000,000	\$9,500,000	1.05
2	\$15,000,000	100%	\$15,000,000	\$13,947,368	1.08
3	\$20,000,000	100%	\$20,000,000	\$18,928,571	1.06
4	\$25,000,000	100%	\$25,000,000	\$25,454,545	0.98
5	\$50,000,000	100%	\$50,000,000	\$55,000,000	0.91

Table 10 – Project B’s cost performance continues

Table 10 above assumes cost performance in table 9 continues. Therefore, project B is finished with total actual cost of \$122,830,485. This value is equal to the EAC estimated earlier by method A. This analysis indicates that method A is more accurate than method B in calculating estimate at completion at a project level.

Conclusion

In conclusion, estimate at completion may be used to make decisions or take corrective actions and should be of high accuracy. If an executive at a company looks at a report of a project, that has two control accounts, and realizes that one control account is expecting an estimate at completion of \$2,000,000 and \$1,000,000 on the other control account, then it will be most realistic to this executive that the estimate at completion for the project should be \$3,000,000. Method A guarantees that and therefore should be applied to calculate estimate at completion at a project's level. This method should also apply for any control account that is broken down to lower levels. EAC at the control account should be equal to the sum of EACs of the lower levels.

Moreover, the paper compared between how Primavera P6 and MS Project calculate estimate at completion at a project level. Primavera P6 uses method A where all EAC values for different control accounts are added. On the other hand, MS Project calculates estimate at completion at the project level by adding up earned value and actual costs for the project to obtain a CPI for the project overall, and then use this CPI to generate an estimate at completion for the project.

List of Acronyms

AC: Actual Cost
BAC: Budget at Completion
CPI: Cost Performance Index
EAC: Estimate at Completion
ETC: Estimate to Complete
EV: Earned Value
SPI: Schedule Performance Index

References

- [1] Project Management Institute (PMI), A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 6th Edition, Newton Square, PA: PMI, 2017.
- [2] AACE International, Recommended Practice No. 80R-13, Estimate at Completion (EAC), Morgantown, WV: AACE International, Latest revision.