Further Developments in Earned Schedule

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Abstract

Lipke, in his seminal paper "Schedule is Different" [1] proposed the concept of "Earned Schedule" (ES) to address the limitations and peculiarities inherent in the use of the historical Earned Value Management (EVM) Schedule Variance (SV ($)) and Schedule Performance Index (SPI ($)) for analysing a project's schedule status and performance. ES provides time-based measure of Schedule Variance (SV (t)) and Schedule Performance Index (SPI (t)) metrics with behaviour analogous to the EVM cost based counterparts.

Henderson retrospectively applied the ES measures proposed by Lipke to a small portfolio of six projects and subprojects managed using a "simplified" EVM approach. The results were published in the paper "Earned Schedule: A Breakthrough Extension to Earned Value Theory? A Retrospective Analysis of Real Project Data [2] where it was concluded, based on that small data sample, that the ES concept has validity.

This paper shares the results of continued collaboration which has resulted in further developments to the ES theory. These developments have resulted in conceptual parity between the historic EVM cost based indicators and duration based ES schedule indicators.

Earned Value and Earned Schedule Discussion

The basics of Earned Value are well and comprehensively documented in many public domain sources [3] [4] [5] [6]. [1] Earned Value, in the context of the proposed Earned Schedule (ES) extension to Earned Value Management (EVM) theory is discussed in the public domain sources by Lipke [1] and Henderson [2].

Earned Schedule

Lipke, expanding from earlier work described by Fleming [3] has developed and described the concept of "Earned Schedule". ES creates time or duration based indicators which are used instead of units of cost or value for measuring schedule performance. As explained by Lipke:

The cumulative value of ES is found by using BCWP to identify in which time increment of BCWS the cost value occurs. The value of ES then is equal to the cumulative time to the beginning of that increment (e.g., months) plus a fraction of it. The fractional amount is equal to the portion of BCWP extending into the incomplete time increment divided by the total BCWS planned for that same time period. [1] [2]

From the ES measurement the following cumulative time based metrics have been constructed:

Schedule Variance (t): SV(t) = ES – AT

Schedule Performance Index (t): SPI(t) = ES / AT

where AT is the actual time in the time-based unit of measure (e.g. weeks or months) being utilised. These metrics behave in an analogous manner to the EVM cost indicators, Cost Variance (CV) and Cost Performance Index (CPI).

Predictive Uses of Earned Schedule

Henderson [2] expanding concepts developed by Lipke, suggested techniques which can be used to independently calculate estimates of project duration and the project completion date. The first technique calculates an Independent Estimate of (project) Duration At Completion (IEDAC) by using:

IEDAC = PD / SPI(t)

where PD is the Planned Duration.

The second technique calculates an Independent Estimate of Completion Date (IECD) for the project. IECD may be calculated as:

IECD = Project Start Date + IEDAC

The behaviour of the IEDAC and IECD is consistent with the EVM cost based equivalent, the Independent Estimate at Compete (IEAC).

Planned Duration for Work Remaining

Further collaboration has resulted in the development of the self explanatory Earned Schedule concept of the Planned Duration of Work Remaining (PDWR). This indicator is analogous to the EVM cost based indicator, the Budgeted Cost of Work Remaining (BCWR). PDWR is calculated as:

PDWR = PD – ES cum

A simple test which can now be used to sanity check a claimed Time Estimate to Complete (TETC) is to compare the PDWR with the TETC. If the PDWR is greater than the TETC this may indicate, subject to review and analysis of the "real schedule", that the claimed TETC is too optimistic.

Since ES does not provide direct schedule information, especially in relation to the critical path, consistent with long standing EVM advice and practice, the project schedule should remain the primary source of duration based information and analysis.

However, consistent with the use of EVM IEAC cost predictors to sanity check "bottom up" cost Estimates to Complete (ETC) and Estimates at Completion (EAC), the ES indicators may be used to sanity check claimed and predicted schedule performance over time.

IEDAC Extension

The development of the PDWR enables the previously proposed formula for the IEDAC to be extended to:

IEDAC = AT + (PD – ES cum) / PF

where PF is a Performance Factor.

As well as extending the IEDAC formula to fully align to the EVM IEAC predictive formulae for cost, this formula also provides for the possibility of performance factors other than SPI(t) to be developed and utilised for predicting final schedule outcomes.

As one example, Anbari [6] in a paper which comprehensively describes the Earned Value method and extensions which pre-date ES, discusses the use of the Critical Ratio (CR) as a predictor for both cost and schedule performance. The CR is the product of CPI multiplied by SPI($). Restated to be consistent with ES terminology, the formula suggested is:

IEDAC = PD / CR (see note 3)

Anbari suggests that this formula “may provide a better indication of estimated time at completion, when adherence to budget is critical to the organization” [6].

In view of the limitations identified by Henderson [2] in the predictive utility of SPI($), a modification to the CR which might provide improved predictive utility could be:

CR_{ES} = CPI x SPI(t)

where CR_{ES} is the Critical Ratio, Earned Schedule adjusted.

Flaws in Pre ES, Schedule Prediction Techniques

Prior to the development of the ES theory and in spite of the uncertainties and limitations in the predictive utility of SPI($), EVM practitioners have advocated and used techniques to predict schedule performance [2] [6]. These techniques generally proposed the use of:

IEDAC = PD / PF

where the PF is either SPI($) or a combination of factors which includes SPI($).

Table 1 contains the data and IEDAC calculations using pre ES calculation techniques from a late finish project from my portfolio of completed projects managed using simplified EVM techniques [2]. EVM and ES data prior to week 11 are not available.

Commercial IT Infrastructure Expansion Project Phase 1 Independent Estimates of Duration at Complete (IEDAC) Calculations as at Project Completion: Week Starting 15th July xx												
Independent Estimates of Duration at Completion Calculated Using Planned Duration Divided by Performance Factors (pre Earned Schedule Techniques)												
Planned Duration (weeks)	20	20	20	20	20	20	20	20	20	20	20	20
Actual time	11	12	13	14	15	16	17	18	19	20	21	22
Percentage Complete cum	45%	52%	61%	70%	76%	83%	84%	86%	88%	88%	88%	88%
CPI cum	0.66	0.66	0.68	0.69	0.68	0.67	0.60	0.59	0.59	0.57	0.56	0.56
SPI(t) cum	1.06	1.05	1.06	1.07	1.05	1.05	0.99	0.95	0.92	0.87	0.83	0.79
SPI($) cum	1.12	1.09	1.10	1.11	1.08	1.06	0.99	0.94	0.90	0.88	0.88	0.88
Critical Ratio cum	0.74	0.72	0.75	0.77	0.73	0.71	0.60	0.56	0.53	0.50	0.50	0.49
IEDAC PD/SPI(t) cum	18.9	19.1	18.9	18.7	19.1	19.1	20.2	21.0	21.8	22.9	24.1	25.2
IEDAC PD/SPI($) cum	17.9	18.4	18.1	18.0	18.5	18.8	20.2	21.4	22.3	22.7	22.7	22.7
IEDAC PD/CR cum	27.1	27.9	26.8	25.8	27.4	28.0	33.4	36.0	37.9	40.0	40.4	40.9
Planned Duration (weeks)	20	20	20	20	20	20	20	20	20	20	20	20
Actual time	23	24	25	26	27	28	29	30	31	32	33	34
Percentage Complete cum	89%	89%	89%	89%	91%	94%	95%	96%	97%	98%	99%	100%
CPI cum	0.55	0.54	0.54	0.53	0.54	0.55	0.54	0.54	0.54	0.54	0.53	0.52
SPI(t) cum	0.76	0.73	0.70	0.68	0.66	0.66	0.64	0.62	0.61	0.59	0.59	0.59
SPI($) cum	0.89	0.89	0.89	0.89	0.91	0.94	0.95	0.96	0.97	0.98	0.99	1.00
Critical Ratio cum	0.49	0.48	0.48	0.48	0.49	0.51	0.52	0.52	0.53	0.53	0.52	0.52
IEDAC PD/SPI(t) cum	26.1	27.3	28.4	29.6	30.2	30.5	31.3	32.1	32.9	33.7	33.9	34.0
IEDAC PD/SPI($) cum	22.5	22.5	22.5	22.5	22.0	21.3	21.1	20.8	20.6	20.4	20.2	20.0
IEDAC PD/CR cum	40.7	41.3	41.8	42.1	40.8	39.0	38.8	38.5	37.9	37.6	38.1	38.7

Table 1: Late Finish Commercial IT Infrastructure Project, Pre ES IEDAC Calculations

IEDAC calculations at project completion using the pre ES techniques highlights:

1. The CR PF produces an IEDAC of 38.7 weeks which is greater than the Actual Duration of 34 weeks

2. SPI($) produces a nonsensical IEDAC of 20 weeks (i.e. "on time" completion) in spite of the 14 weeks schedule delay actually experienced
3. SPI(t) produces the correct IEDAC calculation at completion of 34 weeks.

The "static" values for IEDAC $_{SPI(\$)}$ after week 20, the planned completion date and period of delay for this project at around 22.7 weeks before trending to 20 weeks at project completion clearly demonstrates a breakdown in the predictive utility of SPI($).

Table 2 provides the data and IEDAC calculations using pre ES calculation techniques from an early finish project from my portfolio.

IEDAC calculations at project completion using the pre ES techniques highlights:

1. The CR PF produces an IEDAC of 10.3 weeks which is less than the Actual Duration of 22 weeks
2. SPI($) produces an IEDAC of 21.4 weeks which is close the 22 weeks Actual Duration
3. SPI(t) produces the correct IEDAC calculation at completion of 22 weeks.

While of academic interest only, consistent with the algebraic "quirk" of SPI($) trending up to 1 at planned completion even after an early finish, IEDAC $_{PD/SPI(\$)}$ exhibits similar behaviour and predicts a PD of 25 weeks, 3 weeks after actual completion!

Commercial IT Infrastructure Expansion Project Phases 2 and 3 Combined Independent Estimates of Duration at Complete (IEDAC) Calculations as at Project Completion: Week Starting 15th July xx													
Independent Estimates of Duration at Completion Calculated Using Planned Duration Divided by Performance Factors													
Planned Duration (weeks)	25	25	25	25	25	25	25	25	25	25	25	25	25
Actual time	1	2	3	4	5	6	7	8	9	10	11	12	13
Percentage Complete cum	2%	5%	7%	9%	11%	13%	17%	20%	23%	27%	29%	33%	38%
CPI cum	0.84	0.92	1.05	1.11	1.26	1.14	1.17	1.12	1.11	1.11	1.10	1.14	1.10
SPI(t) cum	0.90	1.12	1.04	0.97	0.92	0.89	0.96	0.96	0.96	0.98	0.94	0.95	0.96
SPI ($) cum	0.90	1.12	1.05	0.96	0.91	0.88	0.95	0.95	0.95	0.98	0.93	0.92	0.95
Critical Ratio cum	0.75	1.03	1.10	1.06	1.15	1.00	1.11	1.07	1.06	1.09	1.02	1.05	1.04
IEDAC PD/SPI(t) cum	27.9	22.3	24.1	25.9	27.1	28.0	26.0	26.0	26.0	25.5	26.5	26.3	26.0
IEDAC PD/SPI($) cum	27.9	22.3	23.9	26.0	27.4	28.3	26.3	26.2	26.2	25.6	26.9	27.1	26.4
IEDAC PD/CR cum	33.4	24.4	22.8	23.5	21.7	24.9	22.4	23.4	23.6	23.0	24.5	23.7	24.1
Planned Duration (weeks)	25	25	25	25	25	25	25	25	25	25	25	25	
Actual time	14	15	16	17	18	19	20	21	22	23	24	25	
Percentage Complete cum	42%	50%	60%	61%	61%	61%	80%	90%	100%				
CPI cum	1.15	1.30	1.38	1.38	1.36	1.36	1.75	1.92	2.08				
SPI(t) cum	0.96	1.01	1.08	1.02	0.97	0.92	1.05	1.09	1.14				
SPI ($) cum	0.94	1.02	1.12	1.04	0.95	0.88	1.07	1.12	1.17	1.10	1.05	1.00	
Critical Ratio cum	1.08	1.32	1.54	1.43	1.29	1.19	1.86	2.16	2.43				
IEDAC PD/SPI(t) cum	26.1	24.7	23.3	24.4	25.9	27.3	23.9	23.0	22.0				
IEDAC PD/SPI($) cum	26.6	24.6	22.3	24.2	26.3	28.5	23.4	22.3	21.4	22.8	23.9	25.0	
IEDAC PD/CR cum	23.1	18.9	16.2	17.5	19.3	21.0	13.4	11.6	10.3				

**Table 2: Early Finish Commercial IT Infrastructure Project,
Pre ES IEDAC Calculations**

Table 3 provides the data and IEDAC calculations for the late finish project using the extended ES formula described above.

Commercial IT Infrastructure Expansion Project Phase 1 Independent Estimates of Duration at Complete (IEDAC) Calculations as at Project Completion: Week Starting 15th July xx												
Independent Estimates of Duration at Completion Calculated Using Extended Earned Schedule Formulae												
Planned Duration (weeks)	20	20	20	20	20	20	20	20	20	20	20	20
Actual time	11	12	13	14	15	16	17	18	19	20	21	22
Earned Schedule cum	11.6	12.6	13.8	14.9	15.7	16.7	16.9	17.2	17.4	17.4	17.4	17.4
Planned Duration Work Remaining	8.4	7.4	6.2	5.1	4.3	3.3	3.1	2.8	2.6	2.6	2.6	2.6
Percentage Complete cum	45%	52%	61%	70%	76%	83%	84%	86%	88%	88%	88%	88%
CPI cum	0.66	0.66	0.68	0.69	0.68	0.67	0.60	0.59	0.59	0.57	0.56	0.56
SPI(t) cum	1.06	1.05	1.06	1.07	1.05	1.05	0.99	0.95	0.92	0.87	0.83	0.79
SPI ($) cum	1.12	1.09	1.10	1.11	1.08	1.06	0.99	0.94	0.90	0.88	0.88	0.88
Critical Ratio cum	0.74	0.72	0.75	0.77	0.73	0.71	0.60	0.56	0.53	0.50	0.50	0.49
Critical Ratio ES cum	0.70	0.69	0.72	0.74	0.71	0.70	0.60	0.57	0.54	0.50	0.47	0.44
IEDAC SPI(t) cum	18.9	19.1	18.9	18.7	19.1	19.1	20.2	21.0	21.8	22.9	24.1	25.2
IEDAC SPI($) cum	18.5	18.8	18.7	18.5	18.9	19.1	20.2	21.0	21.8	22.9	23.9	24.9
IEDAC CR cum	22.3	22.4	21.4	20.5	20.8	20.6	22.2	23.1	23.8	25.1	26.2	27.2
IEDAC CR ES cum	23.0	22.8	21.7	20.8	21.0	20.7	22.2	23.0	23.7	25.1	26.5	27.8
Planned Duration (weeks)	20	20	20	20	20	20	20	20	20	20	20	20
Actual time	23	24	25	26	27	28	29	30	31	32	33	34
Earned Schedule cum	17.6	17.6	17.6	17.6	17.9	18.3	18.5	18.7	18.8	19.0	19.5	20.0
Planned Duration Work Remaining	2.4	2.4	2.4	2.4	2.1	1.7	1.5	1.3	1.2	1.0	0.5	0.0
Percentage Complete cum	89%	89%	89%	89%	91%	94%	95%	96%	97%	98%	99%	100%
CPI cum	0.56	0.55	0.54	0.54	0.53	0.54	0.55	0.54	0.54	0.54	0.54	0.53
SPI(t) cum	0.76	0.73	0.70	0.68	0.66	0.66	0.64	0.62	0.61	0.59	0.59	0.59
SPI ($) cum	0.89	0.89	0.89	0.89	0.91	0.94	0.95	0.96	0.97	0.98	0.99	1.00
Critical Ratio cum	0.49	0.48	0.48	0.48	0.49	0.51	0.52	0.52	0.53	0.53	0.52	0.52
Critical Ratio ES cum	0.42	0.40	0.38	0.36	0.36	0.36	0.35	0.34	0.33	0.32	0.31	0.30
IEDAC SPI(t) cum	26.1	27.3	28.4	29.6	30.2	30.5	31.3	32.1	32.9	33.7	33.9	34.0
IEDAC SPI($) cum	25.7	26.7	27.7	28.7	29.3	29.8	30.6	31.4	32.2	33.0	33.5	34.0
IEDAC CR cum	27.9	29.0	30.0	31.1	31.3	31.2	31.9	32.6	33.2	33.9	34.0	34.0
IEDAC CR ES cum	28.7	30.0	31.4	32.7	32.9	32.6	33.3	34.0	34.6	35.2	34.7	34.0

Table 3: Late Finish Commercial IT Infrastructure Project, IEDAC Calculations using ES Extended Formulae

Table 4 provides the same data set and IEDAC calculations for the early finish project.

In both examples, the IEDAC calculations at project completion using ES techniques confirms that, irrespective of performance factors used, the result is the ES IEDAC formulae correctly calculates the Actual Duration.

The reason for this outcome is that, consistent with the behaviour of the BCWR for cost, the PDWR approaches and resolves to zero at project completion.

Whilst assessments of the predictive utility of the ES calculated IEDACs and the relative merits of using the various performance factors available are matters for further research and empiric validation, the theoretical integrity of ES now seems confirmed.

Anbari provides a pertinent observation with respect to project forecasting techniques:

Forecasting in project management may well be a self-defeating prophecy, and that may be good for the organization. Large deviations usually attract management's attention and result in corrective action. Small deviations are usually left alone. By quantifying and highlighting such deviations, EVM [and ES] helps focus management's interest on projects or work packages that need the most attention [6].

Commercial IT Infrastructure Expansion Project Phases 2 and 3 Combined Independent Estimates of Duration at Complete (IEDAC) Calculations as at Project Completion: Week Starting 15th July xx													
Independent Estimates of Duration at Completion Calculated Using Extended Earned Schedule Formulae													
Planned Duration (weeks)	25	25	25	25	25	25	25	25	25	25	25	25	25
Actual time	1	2	3	4	5	6	7	8	9	10	11	12	13
Earned Schedule cum	0.9	2.2	3.1	3.9	4.6	5.4	6.7	7.7	8.6	9.8	10.4	11.4	12.5
Planned Duration Work Remaining	24.1	22.8	21.9	21.1	20.4	19.6	18.3	17.3	16.4	15.2	14.6	13.6	12.5
Percentage Complete cum	2%	5%	7%	9%	11%	13%	17%	20%	23%	27%	29%	33%	38%
CPI cum	0.84	0.92	1.05	1.11	1.26	1.14	1.17	1.12	1.11	1.11	1.10	1.14	1.10
SPI(t) cum	0.90	1.12	1.04	0.97	0.92	0.89	0.96	0.96	0.96	0.98	0.94	0.95	0.96
SPI ($) cum	0.90	1.12	1.05	0.96	0.91	0.88	0.95	0.95	0.95	0.98	0.93	0.92	0.95
Critical Ratio cum	0.75	1.03	1.10	1.06	1.15	1.00	1.11	1.07	1.06	1.09	1.02	1.05	1.04
Critical Ratio ES cum	0.75	1.03	1.09	1.07	1.16	1.02	1.12	1.08	1.07	1.09	1.04	1.08	1.06
IEDAC SPI(t) cum	27.9	22.3	24.1	25.9	27.1	28.0	26.0	26.0	26.0	25.5	26.5	26.3	26.0
IEDAC SPI($) cum	27.9	22.3	23.9	26.0	27.3	28.3	26.2	26.2	26.1	25.6	26.8	26.7	26.2
IEDAC CR cum	33.2	24.2	23.0	23.9	22.7	25.6	23.4	24.2	24.5	24.0	25.3	24.9	25.0
IEDAC CR ES cum	33.2	24.2	23.1	23.8	22.5	25.4	23.3	24.1	24.4	23.9	25.1	24.6	24.8
Planned Duration (weeks)	25	25	25	25	25	25	25	25	25	25	25	25	
Actual time	14	15	16	17	18	19	20	21	22				
Earned Schedule cum	13.4	15.2	17.2	17.4	17.4	17.4	20.9	22.8	25.0				
Planned Duration Work Remaining	11.6	9.8	7.8	7.6	7.6	7.6	4.1	2.2	0.0				
Percentage Complete cum	42%	50%	60%	61%	61%	61%	80%	90%	100%				
CPI cum	1.15	1.30	1.38	1.38	1.36	1.36	1.75	1.92	2.08				
SPI(t) cum	0.96	1.01	1.08	1.02	0.97	0.92	1.05	1.09	1.14				
SPI ($) cum	0.94	1.02	1.12	1.04	0.95	0.88	1.07	1.12	1.17				
Critical Ratio cum	1.08	1.32	1.54	1.43	1.29	1.19	1.86	2.16	2.43				
Critical Ratio ES cum	1.10	1.31	1.48	1.41	1.32	1.24	1.83	2.09	2.37				
IEDAC SPI(t) cum	26.1	24.7	23.3	24.4	25.9	27.3	23.9	23.0	22.0				
IEDAC SPI($) cum	26.3	24.6	23.0	24.4	26.0	27.7	23.8	23.0	22.0				
IEDAC CR cum	24.7	22.4	21.1	22.3	23.9	25.4	22.2	22.0	22.0				
IEDAC CR ES cum	24.5	22.5	21.3	22.4	23.8	25.1	22.2	22.1	22.0				

Table 4: Early Finish Commercial IT Infrastructure Project, IEDAC Calculations using ES Extended Formulae

"To Complete" Schedule Performance Indicators

The final extension to the ES theory provides for analogous indicators to the EVM cost based To Complete Performance Indexes (TCPI) which provide forward looking projections of the future performance required to achieve project cost objectives. The analogous Earned Schedule indicator to the CPI TO GO is calculated as:

SPI(t) TO GO = (PD - ES) / (PD - AT)

The ES analogous TO COMPLETE CPI indicator is calculated as:

TO COMPLETE SPI(t) = (PD - ES) / (TEAC - AT)

where TEAC is the Time Estimate at Completion.

The behaviour of both these indicators is consistent with their cost based equivalents. An historic SPI(t) performance of less than 1 will, if not corrected, result in the forward looking SPI(t) TO GO and the TO COMPLETE SPI(t) performance indicators exceeding 1 (or SPI(t)) and progressively deteriorating until either effective corrective action is undertaken or the ability of the remaining scheduled work to be completed within the PD or TEAC is questioned.

Summary and Conclusions

The continued collaboration and development of the ES theory has resulted in full alignment between the EVM, cost based and ES schedule based measures, indicators and predictive formulae.

These developments are expected to increase the utility of ES in analysing a projects' schedule performance, particularly in situations where the project schedule is not readily available to analysts.

Whilst assessments of the predictive utility of the ES calculated IEDACs and the relative merits of using the various performance factors available require further research and empiric validation using statistically valid and large scale project data sets, the theoretical integrity of ES appears to be confirmed.

In the meantime, there is little theoretical justification for EVM practitioners continuing to use the pre ES predictors of schedule performance. Conversion to and use of the ES based techniques is strongly recommended.

Full alignment of the ES concept to the familiar EVM cost based equivalents should ease the integration and use of ES as a natural extension to EVM by practitioners and stakeholders alike.

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About the Author

Kym Henderson's Information Technology (IT) career features broad experiences covering, Project Management, Software Quality Assurance Management and Project Planning and Control. He has worked for a number of reputable IT companies across many industry sectors including commercial IT, Defence, Government, Manufacturing, Telecommunications and Financial Services. The focus has been large, complex project and corporate environments.

He has a Masters of Science (Computing) from the University of Technology Sydney. He has also received a number of awards including a Reserve Force Decoration (RFD) for 15 years efficient service as a commissioned officer in the Australian Army Reserve. He is currently the Education Director of the PMI Sydney Australia Chapter and is also a member of the PMI College of Performance Management.

Kym has extensive experience in "project recovery", where the use of simplified EVM techniques to assist in rapidly evaluating current project status, statistically predicting a likely range of project Costs at Completion and objectively measuring project progress to completion have proven invaluable.

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End Notes

1 The basic EVM measures are:

ACWP = Actual Cost for Work Performed
BCWP = Budgeted Cost for Work Performed (Earned Value)
BCWS = Budgeted Cost for Work Scheduled (Planned Values)

Cost Variance (CV) and Schedule Variance (SV) [$] are calculated as:

CV = BCWP - ACWP
SV = BCWP - BCWS

Cost Performance Index (CPI) and Schedule Performance Index (SPI) [$] are calculated as:

CPI = BCWP/ACWP
SPI = BCWP/BCWS

2 ES cum is equal to the number (N) of BCWS($) time increments BCWP($) exceeds plus a fraction of the next BCWS time increment. In equation form:

$$ES_{cum} = N + \frac{[BCWP(\$) - BCWS(\$)_{preceding\ period}]}{[BCWS(\$)_{current\ period} - BCWS(\$)_{preceding\ period}]}$$

where N is the number of BCWS($) time increments exceeded by BCWP($).

3 The terminology used by Anbari is

$$TEAC_C = SAC / CR$$

where $TEAC_C$ is the Time Estimate at Completion, cost adjusted and SAC is Schedule At Completion.