Earned Value Management
Earned value management is a project management technique for measuring project performance and progress. It has the ability to combine measurements of the project management triangle:

- Scope
- Schedule, and
- Costs

In a single integrated system, Earned Value Management is able to provide accurate forecasts of project performance problems, which is an important contribution for project management.

Essential features of any EVM implementation include:

- a project plan that identifies work to be accomplished,
- a valuation of planned work, called Planned Value (PV) and,
- pre-defined “earning rules” (also called metrics) to quantify the accomplishment of work, called Earned Value (EV)
- Current expenditure on project, called Actual Cost (AC).
• You hire a bricklayer to build a 4 side fence in your backyard. Each side is built in sequence, one after the other. He charges by the hour, 200€ a day. Each side takes him one day of work. He starts working on 12/09/2011. You budgeted 800€.

• At the end of the 3rd day (14/09/2011):
  o He has completed side 1 (cost 200€)
  o and side 2 (cost 275€)
  o Side 3 is 50% complete (cost 200€)

• How much are you going to pay in the end?
EVM and ITM Platform

- You can see EVM data in view Follow-up Tab, table Earned Value
- Before that, you need to:
  - Assign resources to tasks
  - Enter standard rates for each resource
  - Register Actual Work + update pending Work for each task
Estimated vs Actual

- **Estimated Work** = Planned hours for a resource/task (ongoing re-planning)
- Changing **Work** means re-planning: How many hours do we need to complete? When?
- Tasks are by default effort driven: Project will tend to keep the effort constant (person-hours)
- **Estimated Cost** = **Work** * **Category Rate**
- **Actual Work** = data entry
- **Actual Cost** = **Actual Work** * **Category Rate**
EVM and ITM Platform

- ITM Platform calculates for us Earned Value Management variables, and also variations and indexes.
The project value projections indicate how the main budget variables will be affected by considering three different scenarios.

### Prediction: Continuity Scenario

<table>
<thead>
<tr>
<th>Description</th>
<th>Hours</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Budgeted Cost on Conclusion (BCC)</td>
<td>32.00</td>
<td>800.00 €</td>
</tr>
<tr>
<td>Cost Performance Index (CPI)</td>
<td>0.74</td>
<td></td>
</tr>
<tr>
<td>Estimated Cost on Conclusion (ECC)</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

The "continuity" scenario assumes that there will be no variations in performance and performs a cost and deadline estimate based on the current situation.

### Prediction: Absolute Correction

<table>
<thead>
<tr>
<th>Description</th>
<th>Hours</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Budgeted Cost on Conclusion (BCC)</td>
<td></td>
<td>800.00 €</td>
</tr>
<tr>
<td>Cost Performance Index (CPI)</td>
<td>2.40</td>
<td></td>
</tr>
<tr>
<td>Estimated Cost on Conclusion (ECC)</td>
<td>890.00 €</td>
<td></td>
</tr>
</tbody>
</table>

The "absolute correction" scenario takes into consideration the performance required to fulfill the planned values, correcting where necessary the deviation which has occurred to date.

### Prediction: According to the Budget from Now

<table>
<thead>
<tr>
<th>Description</th>
<th>Hours</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Budgeted Cost on Conclusion (BCC)</td>
<td>800.00 €</td>
<td></td>
</tr>
<tr>
<td>Cost Performance Index (CPI)</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Estimated Cost on Conclusion (ECC)</td>
<td>975.00 €</td>
<td></td>
</tr>
</tbody>
</table>

The "as per budget from now" scenario considers the performance required in order to fulfill the planned performance from this point onwards.

The table and graph provide a visual representation of the projections for different scenarios, allowing for a clear understanding of the budget variables and their expected outcomes.
How is the project going?

Good Practice: Control and Monitor cost at the Control Account level

**A very simple case:**
- 6 months duration project (4 control accounts)
- follow-up meeting on April the 30th

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**Data date April the 30th means nothing...**
How is the project going?

Since the beginning, you have planned durations and costs estimations (if you prefer, you can manage working hours as your cost magnitude)
Since the beginning, you can have a representation of BAC over time
During execution, you can register actual work

Case:
- BAC = 6000 h (1500 + 1500 + 2000 + 1000)
- Work Scheduled by end of April = 4000 h (1500 + 1500 + 1000 + 0)
- Actual Work by end of April = 3700 h (1200 + 1000 + 1500 + 0)

We have spent 300 hours less than planned.
Seems good… but you don’t know yet
How is the project going?

For each Control Account, you register the % of work completed.
The 3 points Planned / Actual / Complete is all what you need to get:
• Variance at this point
• Variance forecast in the end

Case:

Status report (58% completed):
• 3% of over budget (200 hours)
• 8% of delay (10 days)

Forecast report:
• 6% of over budget (343 hours)
• 14% of delay (17 days)

Planned-Actual-Complete tell us how is the project going and how is going to end.
EVM is the accepted standard method (ANSI 748) to quantify project performance.
EVM (standard ANSI 748)
Earned Value Management

- **EVM** it’s a objective method used to measure executing progress. Combines three aspects of major importance in Project execution: technique (compliance of planned work), costs (if spend more tan planned) and Schedule (if project is delayed or ahead).

1. Detailed Project planning shows what and when to do, as how it will cost (staff and material effort). All this data is know as **Planned Value**, or the work scheduled.

2. On the other hand, based on planned tasks completion at Project’s beginning calculated in each moment. This will result in what we know as **Earned Value**, or actual work developed.

3. Finally, at each moment we know **Actual Costs**.
• Earned Value Management technique is useful not only to report actual return of a Project, as well as estimate future Schedule and cost deviations.
EVM Breakthrough

- EVM is already a standard in international projects related to defense and aeronautics and space sector.
- It was introduced by the US DoD to control internally or contracted projects efficiently.
- Later it spread throughout the American administration for acquisitions, control and monitoring of projects.
- Since 1998 ANSI 748 standard.
## EVM Formulas

<table>
<thead>
<tr>
<th>Term</th>
<th>Formula</th>
<th>Value</th>
<th>Calculation</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>baseline</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BAC</td>
<td>Budget At Completion</td>
<td>6000</td>
<td></td>
<td>We budget 6000 person-hours for the total project effort</td>
</tr>
<tr>
<td>SAC</td>
<td>Schedule At Completion</td>
<td>120</td>
<td></td>
<td>We schedule 120 days for the total project effort</td>
</tr>
<tr>
<td>PV</td>
<td>Planned Value</td>
<td>4000</td>
<td>$1500+1500+1000$</td>
<td>As of today, the estimated value of the work planned to be done was 4000</td>
</tr>
<tr>
<td><strong>status</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EV</td>
<td>Earned Value</td>
<td>3500</td>
<td>$1500+1500<em>33%+2000</em>75%</td>
<td>As of today, the estimated value of the work actually accomplished has been of 3500</td>
</tr>
<tr>
<td>AC</td>
<td>Actual Cost</td>
<td>3700</td>
<td>$1200+1000+1500$</td>
<td>As of today, the actual cost incurred for the work accomplished has been of 3700</td>
</tr>
<tr>
<td>CV</td>
<td>Cost Variance</td>
<td>-200</td>
<td>$3500-3700$</td>
<td>Negative is over budget; positive is under budget</td>
</tr>
<tr>
<td>SV</td>
<td>Schedule Variance</td>
<td>-500</td>
<td>$3500-4000$</td>
<td>Negative is behind schedule; positive is ahead of schedule</td>
</tr>
<tr>
<td>TV</td>
<td>Time Variance</td>
<td>-10</td>
<td>$-500/(6000/120)$</td>
<td>We have a cumulated delay of 10 days</td>
</tr>
<tr>
<td>CPI</td>
<td>Cost Performance Index</td>
<td>0.95</td>
<td>$3500/3700$</td>
<td>We are getting 95 cents out of every euro spent. Funds are not being used efficiently</td>
</tr>
<tr>
<td>SPI</td>
<td>Schedule Performance Index</td>
<td>0.88</td>
<td>$3500/4000$</td>
<td>We are only progressing at 88% of the rate originally planned</td>
</tr>
<tr>
<td>POC</td>
<td>Percentage of Completion</td>
<td>0.58</td>
<td>$3500/6000 = 3700/6343$</td>
<td>We have completed 58% of the work so far</td>
</tr>
<tr>
<td>TCPI</td>
<td>To Complete Performance Index</td>
<td>1.09</td>
<td>$(6000-3500)/(6000-3700)$</td>
<td>We need to produce 1.09€ for each euro invested in order to end on budget</td>
</tr>
<tr>
<td><strong>forecast</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EAC</td>
<td>Estimate At Completion</td>
<td>6343</td>
<td>$6000/0.95 = 3700+2643$</td>
<td>We currently expect a total cost of 6343 person-hours</td>
</tr>
<tr>
<td>ETC</td>
<td>Estimate To Complete</td>
<td>2643</td>
<td>$(6000-3500)/0.95 = 6343-3700$</td>
<td>From this point on, we expect it to cost 2643 person-hours more to finish the project</td>
</tr>
<tr>
<td>VAC</td>
<td>Variance At Completion</td>
<td>-343</td>
<td>$6000-6343$</td>
<td>As of today, we expect to be 343 person-hours over budget at the end of the project</td>
</tr>
<tr>
<td>TEAC</td>
<td>Time Estimate At Completion</td>
<td>137</td>
<td>$120/0.88$</td>
<td>We currently expect a total duration of 137 days</td>
</tr>
<tr>
<td>TVAC</td>
<td>Time Variance At Completion</td>
<td>-17</td>
<td>$120-137$</td>
<td>As of today, we expect to be 17 days behind schedule at the end of the project</td>
</tr>
</tbody>
</table>
PV, EV, AC defined

**Former names**

<table>
<thead>
<tr>
<th>PV</th>
<th>BCWS = Budget Cost of Work Scheduled</th>
</tr>
</thead>
<tbody>
<tr>
<td>EV</td>
<td>BCWP = Budget Cost of Work Performed</td>
</tr>
<tr>
<td>AC</td>
<td>ACWP = Actual Cost of Work Performed</td>
</tr>
</tbody>
</table>

**Planned Value (PV)**
PV is the budgeted cost for the work scheduled to be completed on an activity or WBS component up to a given point in time.

**Earned Value (EV)**
EV is the budgeted amount for the work actually completed on the schedule activity or WBS component during a given time period.

**Actual Cost (AC)**
AC is the total cost incurred in accomplishing work on the schedule activity or WBS component during a given time period. This AC must correspond in definition and coverage to whatever was budgeted for the PV and the EV (e.g., direct hours only, direct costs only, or all costs including indirect costs).
Using EVM

- Project duration 10 weeks, budget 100 k€. In follow-up meeting PV=60 k€, AC=80 k€, EV=50 k€
  - **Cost Variance** CV = EV-AC=50-80= -30 k€ (negative meaning over budget 30 k€)
  - **Schedule Variance** SV = EV-PV=50-60= -10 k€ (negative meaning behind schedule). In the end SV=0
  - **Cost Performance Index** CPI = EV/AC = 0.63 (minor than 1 meaning over budget: 1€ invested produces 63c)
  - **Schedule Performance Index** SPI = EV/PV = 0.83 (minor than 1 meaning behind schedule). In the end SPI=1

![Graph showing Actual Cost (AC), Planned Value (PV), and Earned Value (EV) over time. Budget at Completion (BAC) and Schedule at Completion (SAC)]
Earned Value Management

Variances

- **CV** at the end of the project will be the difference between the budget at completion (BAC) and the actual amount spent.
- **SV** will ultimately equal zero when the project is completed because all of the planned values will have been earned.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV</td>
<td>Cost Variance</td>
<td>EV – AC</td>
</tr>
<tr>
<td>SV</td>
<td>Schedule Variance</td>
<td>EV – PV</td>
</tr>
<tr>
<td>PVR</td>
<td>Planned Value rate</td>
<td>BAC / SAC</td>
</tr>
<tr>
<td>TV</td>
<td>Time Variance</td>
<td>SV / PVR</td>
</tr>
<tr>
<td>CVP</td>
<td>Cost Variance Percent</td>
<td>CV / EV</td>
</tr>
<tr>
<td>SVP</td>
<td>Schedule Variance Percent</td>
<td>SV / EV</td>
</tr>
</tbody>
</table>

- **CV** - 30 K€
- **SV** - 10 K€
- **TV** - 1 week
- **CVP** - 60%
- **SVP** - 20%

Actual Costs (AC) vs. Planned Value (PV) vs. Budget at Completion (BAC):

- **Cost (K€)** over **time**
- **100**
- **80**
- **60**
- **50**

**BAC** vs. **EV** vs. **PV**

- **Cost** vs. **Time**
- **AC**
- **PV**
- **EV**
**Performance Indexes**

- **CPI** < 1.0 indicates cost overrun
- **SPI** < 1.0 indicates schedule slippage
- **CR** > 1.0 indicates good global performance

<table>
<thead>
<tr>
<th>Index</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPI</td>
<td>EV / AC</td>
</tr>
<tr>
<td>SPI</td>
<td>EV / PV</td>
</tr>
<tr>
<td>CR</td>
<td>SPI x CPI</td>
</tr>
</tbody>
</table>

- Actual Costs (AC)
- Planned Value (PV)
- Earned Value (EV)
- Data date
- 10 weeks
- Schedule at Completion (SAC)
Earned Schedule (ES)

\[ ES = 20 + \Delta = 24.58 \text{ days} \]

\[ SV(t) = \text{Schedule Variance in units of time} = ES - \text{Actual Time} = 24.58 - 35 = -10.42 \text{ days} \]
Forecasting

- Estimate At Completion \( \text{EAC} \) is always equal to Actual Cost plus Estimated to Complete
  \[ \text{EAC} = \text{AC} + \text{ETC} \]
- What it takes to complete the project (ETC) will depend on the situation. Four typical scenarios are:
  - When the assumptions are incorrect: new estimate for the remaining work
  - When the current variances are not typical -> remaining budget: \( \text{ETC} = \text{BAC} - \text{EV} \)
  - When the current variances are expected to remain the same:
    - remaining budget affected by cost performance factor: \( \text{ETC} = (\text{BAC} - \text{EV}) / \text{CPI} \)
    - remaining budget affected by cost and schedule performance factors: \( \text{ETC} = (\text{BAC} - \text{EV}) / (\text{CPI} \times \text{SPI}) \)
Forecasting

- El ratio To Complete Performance Index (TCPI) is remaining work / remaining funds
- It means how much work should be get out of each unit invested
- Two scenarios:
  - If cost limit is Budget at Completion (BAC):
    - TCPI₁ = (BAC-EV) / (BAC-AC)
  - If cost limit is Estimated at completion (EAC):
    - TCPI₂ = (BAC-EV) / (EAC-AC)

TCPI = 1.09
We need to produce 1,09€
for each euro invested in
order to end on budget

CPI = 0.95
We are getting 95 cents out
of every euro spent
Using EVM in corporate reports

- Budget 100 M€, duration 5 years (60 months)
- At the end of year 4, actual cost 90 M€, planned cost 80 M€
- Progress 75% (Earned Value 75 M€)

- $EV = 75$ M€; $AC = 90$ M€; $PV = 80$ M€
- $CPI = 75 / 90 = 0.83$
- $CV = 75 - 90 = -15$ M€
- $ETC = (100 - 75)/ 0.83 = 30$ M€
- $EAC = 90 + 30 = 100 / 0.83 = 120$ M€
- $VAC = 100 - 120 = -20$ M€
- $SPI = 75 / 80 = 0.94$
- $SV = 75 - 80 = -5$ M€
- $TV = (75 - 80) / (100/60) = -3$ months
- $TEAC = 60 / 0.94 = 64$ months
- $TVAC = 60 - 64 = -4$ months

Current over budget of 15 M€
Expected final over budget of 20 M€
Current delay of 3 months
Expected final delay of 4 months

Sarbanes-Oxley material financial issues
Using EVM in our previous case

**Status report (58% completed):**
- 3% over budget (200 hours)
- 8% of delay (10 days)

**Forecast report:**
- 6% over budget (343 hours)
- 14% of delay (17 days)

<table>
<thead>
<tr>
<th>Project</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Account 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.500 / 1.500 / 1.200 / 1.500 (100%)</td>
</tr>
<tr>
<td>Control Account 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.500 / 1.500 / 1.000 / 500 (33%)</td>
</tr>
<tr>
<td>Control Account 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.000 / 1.000 / 1.500 / 1.500 (75%)</td>
</tr>
<tr>
<td>Control Account 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.000 / 0 / 0 / 0 (0%)</td>
</tr>
</tbody>
</table>

**Data:**
- **BAC = 6000**
- **SAC = 6 *20 = 120**
- **PV = 4000**
- **AC = 3700**
- **EV = 3500**

**Status report:**
- **POC = EV / BAC = 3500 / 6000 = 58%**
- **CV = 3500-3700 = -200**
- **SV = 3500-4000 = -500**
- **TV = SV / (SAC/BAC) = -500/(6000/120) = -10**
- **CPI = 3500 / 3700 = 0.945**
- **SPI = 3500 / 4000 = 0.875**

**Forecast report:**
- **EAC = BAC / CPI = 6000 / 0.945 = 6343**
- **VAC = BAC – EAC = 6000 - 6343 = -343**
- **TEAC = SAC / SPI = 120 / 0.875 = 137**
- **TVAC = SAC - TEAC = -17**

April 30th
Using EVM in the management language

Planned 758 k€; Actual 798 k€; Completed 559 k€; ETC 2.178 k€

Status Report: Over budget 239 k€; Slippage 1.3 moths

Forecast Report: Over budget 891 k€ (43%); Slippage 5 moths

<table>
<thead>
<tr>
<th>Project PR1</th>
<th>2015</th>
<th>2016</th>
<th>BUDGET / ACTUAL / COMPLETED (2276 / 798 / 559)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>01</td>
<td>02</td>
<td>03</td>
</tr>
<tr>
<td>Req &amp; Analysis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System A</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Technical Design</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Software Coding</td>
<td></td>
<td></td>
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<tr>
<td>Deployment</td>
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<td></td>
<td></td>
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<tr>
<td>System B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical Design</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Software Coding</td>
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<tr>
<td>Deployment</td>
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<td></td>
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<tr>
<td>Maintenance</td>
<td></td>
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</tbody>
</table>

Forecast Report: 891 k€ (43%); Slippage 5 moths