Software Project Management

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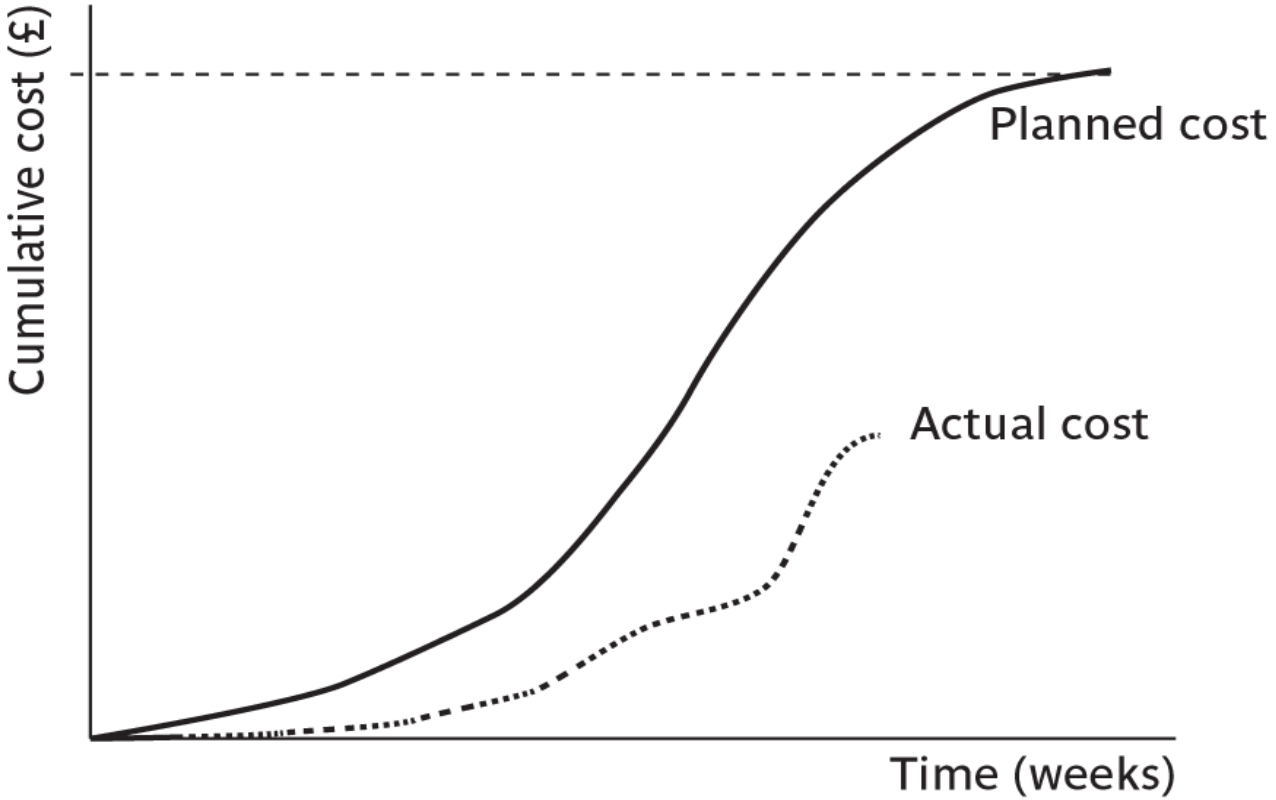
Cost monitoring

- A project could be late because the staff originally committed have not been deployed
- In this case the project will be *behind time* but *under budget*
- A project could be on time but only because additional resources have been added and so be *over budget*
- Need to monitor both achievements and costs

Cost monitoring cont ...

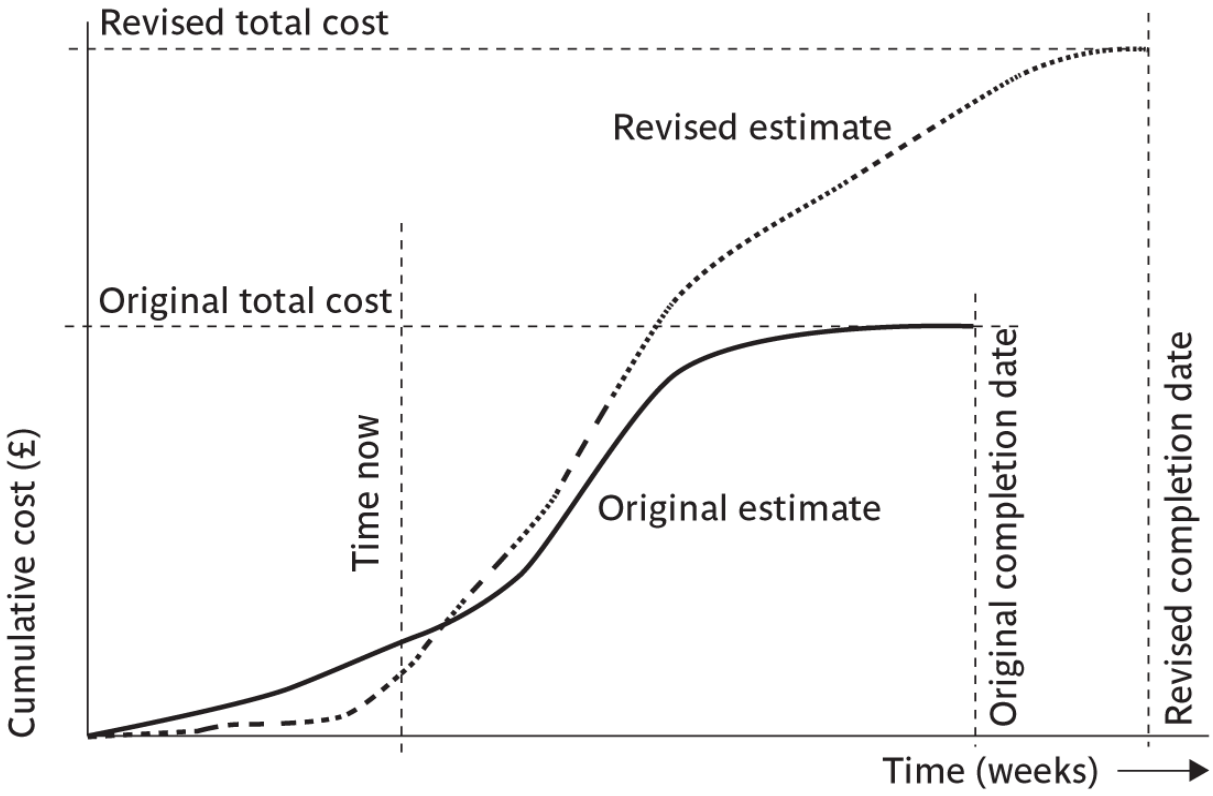
- Expenditure monitoring is an important component of project control, not only in itself, but also because it provides an indication of the effort that has gone into (or at least been charged to) a project.
- A project might be on time but only because more money has been spent on activities than originally budgeted.
- A cumulative expenditure chart provides a simple method of comparing actual and planned expenditure.
- By itself it is not particularly meaningful.
  - A project may run late or on time but the chart shows substantial costs savings.

Tracking cumulative expenditure



Cost monitoring cont ...

- We need to take account of the current status of the project activities before attempting to interpret the meaning of recorded expenditure.
- Cost charts become much more useful if we add projected future costs calculated by adding the estimated costs of uncompleted work to the costs already incurred.
- Where a computer-based planning tool is used, revision of cost schedules is generally provided automatically, once actual expenditure has been recorded.



The cumulative expenditure

Cost monitoring cont ...

- The figure illustrates the additional information available once the revised cost schedule is included
  - In this case it is apparent that the project is behind schedule and over budget.
- The figure also shows the revised estimates of cost and completion date.

Earned value analysis

- Earned value analysis has gained in popularity in recent years and may be seen as a refinement of cost monitoring.
- It originated in the USA's Department of Defence (DOD) as a part of a set of measures to control projects being carried out by contractors for the DOD.
- It is based on assigning a 'value' to each task or work package based on the original expenditure forecasts.

Earned value analysis cont ...

- One way of looking at this is as the equivalent of the price that might be agreed by a contractor to do some unit of work.
- The assigned value is the original budgeted cost for the item and is known as the *planned value* (PV) or *budgeted cost of work scheduled* (BCWS).
- A task that has not started is assigned an earned value of zero and when it has been completed, it, and hence the project, is credited with the original planned value of the task.

Earned value analysis cont ...

- The total value credited to a project at any point is known as the *earned value*(EV) or *budgeted cost of work performed* (BCWP) and this can be represented as a money value, an amount of staff time or as a percentage of the PV.
- EV is thus analogous to the agreed price to be paid to the contractor once the work is completed.

Earned value analysis cont ...

- Where tasks have been started but are not yet complete, some consistent method of assigning an earned value must be applied.
- Common methods in software projects are
  - *The 0/100 technique*
  - *The 50/50 technique*
  - *The 75/25 technique*
  - *The milestone technique*
  - *The percentage complete technique*

Earned value analysis cont ...

- The 0/100 technique is preferred for software development.
- The 50/50 technique can give a false sense of security by over-valuing the reporting of activity starts.
- The milestone technique might be appropriate for activities with a long duration estimate but, in such cases, it is better to break that activity into a number of smaller ones.

The 0/100 technique

- A task is assigned a value of zero until such time that it is completed, when it is given a value of 100% of the budgeted value.

The 50/50 technique

- A task is assigned a value of 50% of its value as soon as it is started and then given a value of 100% once it is complete
  - This matches some contractual arrangements where a contractor is given half the agreed price when starting the work, perhaps to help pay for raw materials, and the remainder on successful completion.

The 75/25 technique

- The task is assigned 75% on starting and 25% on completion
  - This is often used when a large item of equipment is being bought:
    - 75% is paid when the equipment is actually delivered and the rest when installation and testing have been satisfactorily completed.

The milestone technique

- A task is given a value based on the achievement of milestones that have been assigned values as part of the original budget plan.

The percentage complete

- In some cases there may be a way of objectively measuring the amount of work completed
  - For example, as part of the implementation of an information system, a number of data records have to be manually typed into a database.
  - The actual number so far completed can be objectively counted and the value can be assigned accordingly.

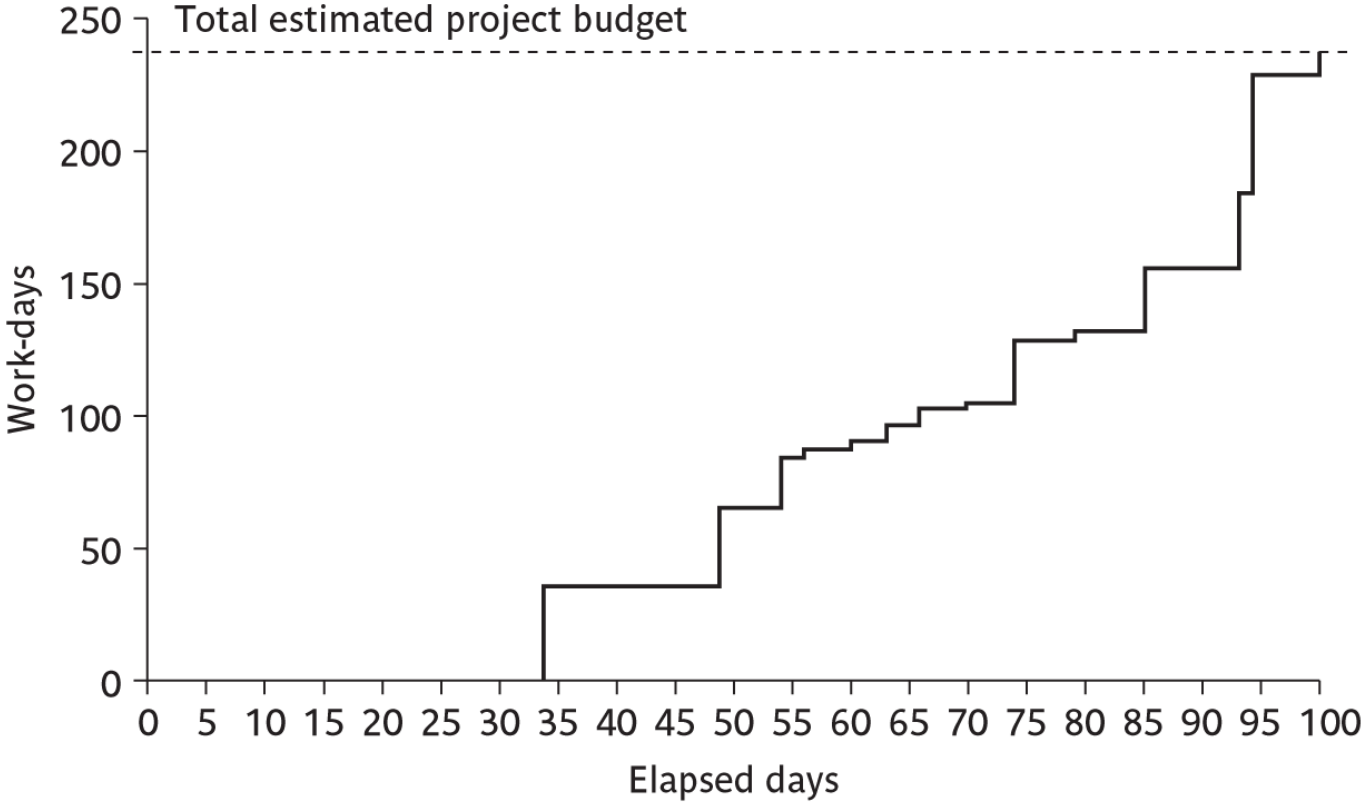
Earned value analysis

- *Planned value (PV)* or *Budgeted cost of work scheduled (BCWS)* – original estimate of the effort/cost to complete a task (compare with idea of a 'price')
- *Earned value (EV)* or *Budgeted cost of work performed* (BCWP) – total of PVs for the work completed at this time

The baseline budget

- The first step in setting up an earned value analysis is to create the *baseline budget*.
- The *baseline budget* is based on the project plan and shows the forecast growth in earned value through time.
- Earned value may be measured in monetary values but, in the case of staff-intensive projects such as software development, it is common to measure earned value in person-hours and workdays.

The baseline budget



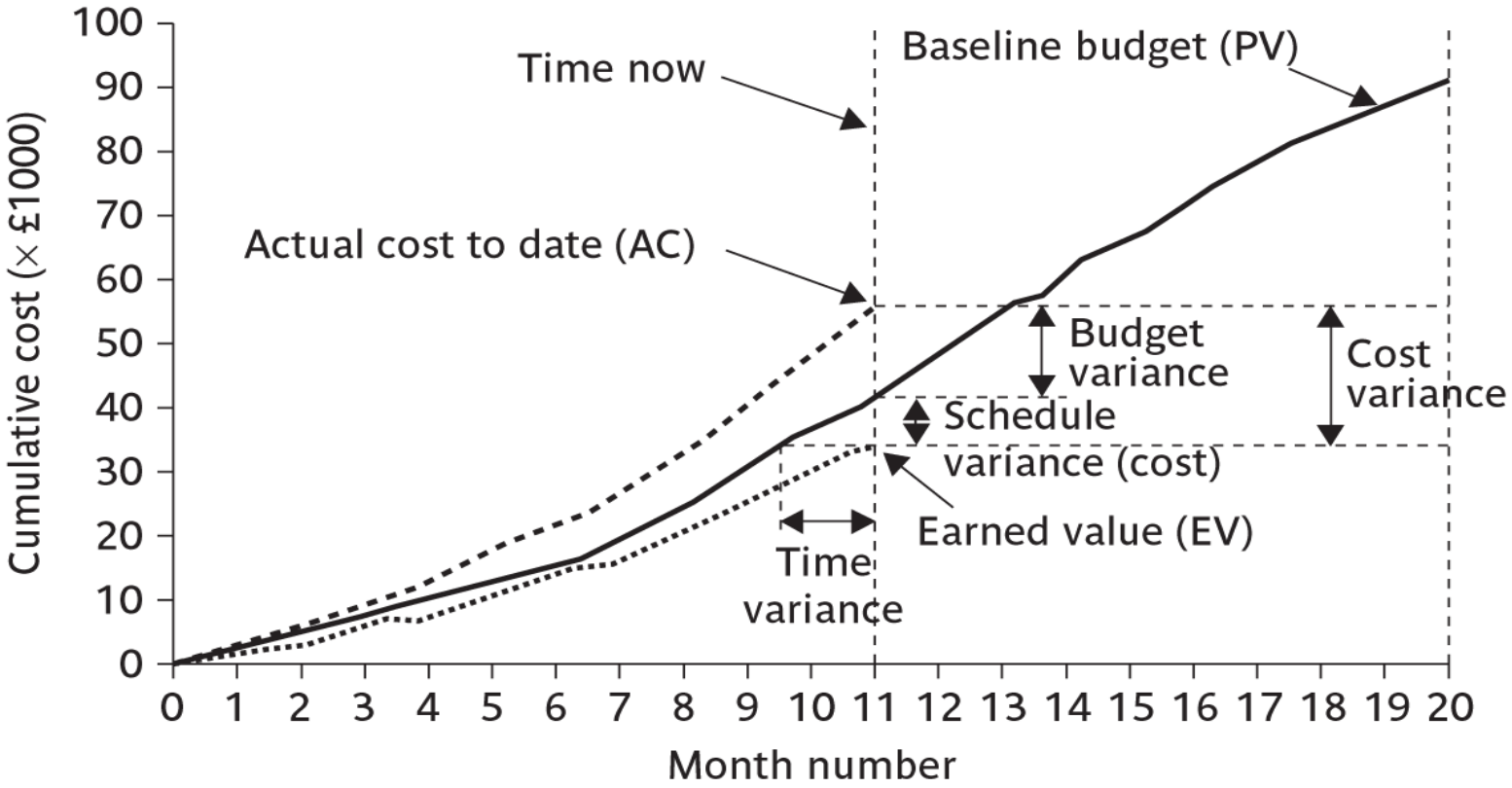
The baseline budget cont ...

- The example baseline budget uses 0/100 technique for crediting earned value to the project.
- This project is not expected to be credited with any earned value until day 34, when the activity 'specify overall system' is to be completed.
- This activity was forecast to consume 34 person-days and it will therefore be credited with 34 person-days of earned value when it has been completed.
- The other steps in the baseline budget chart coincide with the scheduled completion dates of other activities.

Monitoring earned value

- Having created the baseline budget, the next task is to monitor earned value as the project progresses.
- This is done by monitoring the completion of tasks (or activity starts and milestone achievements in the case of the other crediting techniques).
- As well as recording EV, the actual cost of each task can be collected as *actual cost* (AC).
- This is also known as the *actual cost of work performed* (ACWP).

An earned value tracking chart



Monitoring earned value

- The figure illustrates the following performance statistics, which can be shown directly or derived from the earned value.
  - Schedule variance (SV)
  - Time variance (TV)
  - Cost variance (CV)
  - Performance ratios

Schedule variance (SV)

- The schedule variance is measured in cost terms as SV = EV-PV
- It indicates the degree to which the value of completed work differs from that planned.
- Say, for example, that work with a PV of £40,000 should have been completed by now. In fact, some part of that work has not been done, so that the EV is only £35,000.
- So, SV = £35,000- £40,000 = - £5,000.
- A negative SV means the project is behind schedule.

Time variance (TV)

- This is the difference between the time when the achievement of the current earned value was planned to occur and the time now.
- In this case, the current EV should have been achieved in the early part of month 9 and as the time now is the end of month 11,
  - So, the TV is about -1.75 months.
  - TV negative indicates project is running late.

Cost variance (CV)

- This is calculated as CV = EV-AC
- It indicates the difference between the earned value or budgeted cost and the actual cost of completed work.
- Say that when the SV above was calculated as -£5,000, £55,000 had actually been spent to get the EV.
- The CV in this case would have been £35,000- £55,000, i.e. -£20,000.
- It can also be an indicator of the accuracy of the original cost estimates.
- A negative CV means that the project is over cost.

Performance ratios

- Two ratios are commonly tracked:
  - The cost performance index (CPI=EV/AC)
  - The schedule performance index (SPI=EV/PV)
- Using the examples,
  - CPI would be £35,000/ £55,000, that is, 0.64
  - SPI would be £35,000/ £40,000, that is, 0.88
- The two ratios can be thought of as a 'value-for-money' indices.
- A value greater than one indicates that work is being completed better than planned, whereas a value of less than one means that work is costing more than and/or proceeding more slowly than planned.

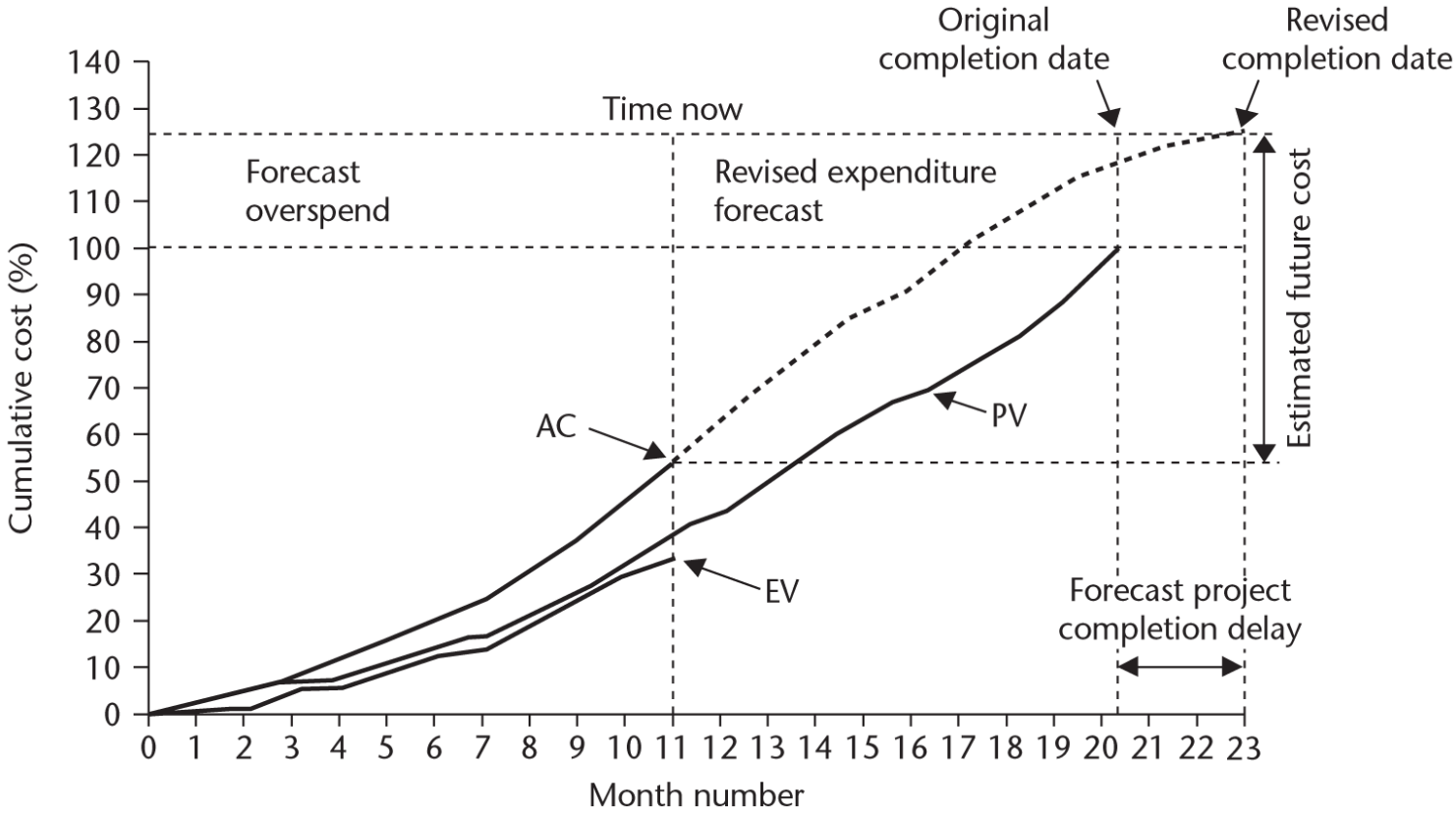
Performance ratios cont ...

- EAC is calculated as BAC/CPI where BAC (budget at completion) is the current projected budget for the project.
- If the BAC was £100,000 then a revised estimate at completion (EAC) would be £100,000/0.64 or £156,250.
- CPI can be used to produce a revised cost estimate for the project, called estimate at completion (EAC).
- Similarly, the current SPI can be used to project the possible duration of the project given the current rate of progress.

Performance ratios cont ...

- A time estimate at completion (TEAC) can be calculated as SAC/SPI.
- In this case, it would be 23/0.88, that is, 26.14 months.
- This is only an approximate guide:
  - Where there are several parallel chains of activities being carried out concurrently
    - the project duration will depend on the degree to which the activities that have been delayed are on the critical path.
- Say the planned total duration is 23 months – in earned value terminology this is called *schedule at completion* (SAC).

An earned value chart with revised forecasts



Performance ratios cont ...

- Earned value analysis has not yet gained universal acceptance for use with software development projects,
  - perhaps largely because of the attitude that, whereas a half-built house has value reflected by the labour and materials that have been used,
    - a half-completed software project has virtually no value at all.
- This is to misunderstand the purpose of earned value analysis, which is a method for tracking what has been achieved on a project
  - Measured in terms of the budgeted costs of completed tasks or products.

Earned value – an example

- Tasks
  - Specify module 5 days
  - Code module 8 days
  - Test module 6 days
- At the beginning of day 20, PV = 19 days
- If everything but testing, completed EV = 13 days
- Schedule variance (SV) = EV-PV = 13-19 = -6
- Schedule performance indicator (SPI) = EV / PV = 13/19 = 0.68
- SV negative or SPI <1.00, indicates project is behind schedule.

Earned value analysis – actual cost

- Actual cost (AC) is also known as Actual cost of work performed (ACWP)
- In previous example, if
  - 'Specify module' actually took 3 days
  - 'Code module' actually took 4 days
- Actual cost = 7 days
- Cost variance (CV) = EV-AC = 13-7 = 6 days
- Cost performance indicator (CPI) = EV/AC = 13/7 = 1.86
- Positive CV or CPI > 1.00 means project is within budget.

Earned value analysis – actual costs cont ...

- CPI can be used to produce new cost estimate
- Budget at completion (BAC) – current budget allocated to total costs of project
- Estimate at completion (EAC) – updated estimate = BAC/CPI
  - e.g. say budget at completion is £19,000 and CPI is 1.86
  - EAC = BAC/CPI = £10,215
  - Projected costs reduced because work being completed in less time

Earned value analysis - Time Variance Example

- Time variance (TV) – difference between time when specified EV should have been reached and time it actually was
- For example, say an EV of £19000 was supposed to have been reached on 1st April and it was actually reached on 1st July then TV = - 3 months
- TV negative indicates project is running late.

Another Example

- Suppose a project is to be completed in one year at the cost of Rs. 100,000. after 3 months, you realize that the project is 30% complete at a cost of Rs. 40,000. Assess the performance of the project.

Another Example ---- solution

- Planned value (PV) = planned percentage completion of work X Budgeted cost = 25% X Rs.100,000 = Rs. 25,000.
- Earned value (EV) = percentage work actually completed X Budgeted cost = 30% X Rs. 100,000 = Rs. 30,000.
- Cost performance index(CPI) = EV/Actual Cost incurred = EV/AC =Rs.30,000/Rs.40,000 = 0.75
- Schedule performance Index (SPI)= EV/PV =Rs.30,000/Rs.25,000 = 1.2

Another Example ---- solution

- **Assessment of project performance:**

✓ Since CPI <1, the project is over budget. For every rupee spent, we are getting only 0.75 worth of work.

✓ Since SPI >1, it indicates that the project is ahead of schedule.

✓ At this rate, the project will be delivered ahead of schedule, but at over budget.

- **So, corrective action needs to be taken**

Summary

- Presented basic concepts of cost monitoring
- Discussed briefly earned value analysis
  - *The 0/100 technique*
  - *The 50/50 technique*
  - *The 75/25 technique*
  - *The milestone technique*
  - *The percentage complete technique*
- Presented the concept baseline budget

Summary

- Discussed monitoring of earned value through
  - Schedule variance (SV)
  - Time variance (TV)
  - Cost variance (CV)
  - Performance ratios
- Explained the above with suitable examples

References :

1. B. Hughes, M. Cotterell, R. Mall, *Software Project Management*, Sixth Edition, McGraw Hill Education (India) Pvt. Ltd., 2018.
2. R. Mall, *Fundamentals of Software Engineering*, Fifth Edition, PHI Learning Pvt. Ltd., 2018.

Thank you