Predicting Completion in Agile & Distributed Projects

Introduction

The generally accepted way of assessing progress on a project, and predicting its completion, is to use a Critical Path Method (CPM) schedule. A well-constructed CPM schedule models the intended sequence of work on the project. Then by updating the schedule with progress 'as at' a specific date, the CPM scheduling tools move any incomplete work into the future and recalculate the time needed to complete the project. This rich, dynamic, data allows the baseline, and current, critical path and float to be compared and the effect of intervening events to be assessed with mathematical precision.

There are well recognised challenges and shortcomings in this approach, but after 65 years, skilled practitioners can produce useful information for the management and overall assessment of most traditional project's progress and health[1].

However, the CPM paradigm does not work across a wide range of projects where there is no predetermined sequence of working that *must* be followed. There may be a high level 'road map' outlining the desired route to completion and/or specific constraints on the sequencing of parts of the work but in both Agile and distributed projects, the people doing the work have a high degree of flexibility in choosing the way most of the work is accomplished.

Projects using the Agile paradigm, have a deliberate management intent not to follow a predetermined sequence of activities, the assumption is the people doing the work are best placed to decide what needs doing next. In distributed projects, while there may be a CPM schedule developed at the start, when circumstances force a change in the plan, often there is very little disruption to the productive output of the resources; they simply move onto something else. This reality cannot be properly modelled in a CPM schedule without rebuilding the logic every time something changes. These types of project are defined, and discussed in detail, in ***Scheduling Challenges in Agile & Distributed Projects***[2].

The focus of this paper is to offer a practical solution to the challenge of assessing progress, and calculating the likely completion date in Agile and distributed projects. A second paper ***Assessing Delays in Agile & Distributed Projects***[3] looks at the issues of determining delay and disruption in projects where the CPM paradigm does not provide an acceptable answer.

Projects not suited to CPM

CPM theory assumes there is one best way of doing the project, which can be accurately described in a schedule. The schedule allows the critical path and float to be calculated and for delays to be assessed based on their impact on the schedule. CPM theory and calculations are 65 years old; they have survived because they are very useful in a lot of situations. However, there are many projects that cannot be effectively scheduled using CPM. The two most common types are *soft projects* and *distributed projects*.

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1 For more on ***developing and using CPM schedules*** see: https://mosaicprojects.com.au/PMKI-SCH-010.php

2 See ***Scheduling Challenges in Agile & Distributed Projects***: https://mosaicprojects.com.au/PDF_Papers/P208_Scheduling_Challenges_in_Agile_+_Distributed_Projects.pdf

3 See ***Assessing Delays in Agile & Distributed Projects***: https://mosaicprojects.com.au/PDF_Papers/P215_Assessing_Delays_In_Agile_+_Distributed_Projects.pdf

Soft projects

A *soft project* is one where completion is not defined by the creation of a tangible asset. This includes:

- Software developments
- Business change, and
- Marketing projects.

The project's *soft objective* can be achieved in many different ways. The *best way* (and occasionally the objective) adapts and emerges as the work progresses. Because of their emergent nature, soft projects have largely abandoned CPM and gone Agile; better delivery outcomes are claimed. There are many different forms of Agile involving a range of tools and techniques including: Scrum, SAFe®, Disciplined Agile, Kanban, etc. But across all of these different methodologies, the essence of Agile remains:

- Intelligent flexibility; the people doing the work, in consultation with the client, choose what to work on next
- Scope changes are welcome provided the change increases the overall value delivered by the project
- The team's focus is on deliverables (early and often) and the project stakeholders.

Consequently, in the entire Agile / Scrum / Iterative project family:

- CPM has been abandoned as a detail level control tool
- CPM (or more usually, bar [Gantt] charts) may be used for the high-level road map
- Other techniques such as burndown charts and Kanban boards are used for lower levels of control.

But there are only limited tools that calculate progress and productivity, and virtually none that are designed to consistently predict the expected competition date.

Distributed projects

Distributed projects are a subset of hard projects that exhibit two dominant characteristics:

1. A significant portion of the work is comprised of a series of physically separated units that are similar or identical in design, and
2. The need for the different units to be built in a specific sequence is either non-existent or minimal.

Typical examples include a project to replace 2000 desktop computers across an organization, or the building of a new wind farm. In both cases, the sequence of work is easily changed for large parts of the project's work, and management's focus is (or should be) on optimizing resource productivity.

Managing distributed projects needs a pragmatic strategy:

- An appropriate level of detail in an overall 'road map'
- Recognising there are always likely to be some mandatory sequences that must be followed:
  - These must be planned
  - But let the people doing the work manage the rest
- Focusing on resource workflows and optimizing productivity by balancing overall constraints with the flexibility to proactively adapt to circumstances and overcome issues.

Managing projects without CPM

There is a lot of similarity between managing distributed projects and managing soft projects. Both Agile and Lean Construction are built on the premise that the team doing the work knows what is best, but their planning focus tends to be short term. The degree of flexibility in how the work can be managed also varies, in some projects there are virtually no constraints limiting the work sequence, in others there are significant requirements limiting flexibility. This means there is no 'one-size' solution, controls need to be designed for the project, and standard forms of contract need to recognize this challenge.

In ***Scheduling Challenges in Agile & Distributed Projects***[4] the concept of project classifications based on the applicability of CPM was developed. The classifications are:

1. **Physically constrained** – there is only one viable work sequence
2. **Practically constrained** – management has agreed the one best work sequence, for example, a road can be built from either end – but, once management decide on the start point all of the trades needs to follow the imposed flow in sequence
3. **Overarching constraints** – Soft and distributed projects, there is a required overall sequence of working, with varying degrees of flexibility in the way the detailed work is performed
4. **Arbitrary constraints** – there is no required sequence of working (as in Class 1 or 2), but management has decided to impose a detailed sequence of work as a matter of choice.

Under this classification, CPM works well in Class 1 and 2 projects, but is suboptimal in Class 3 and 4 projects. Class 4 projects are facing legal challenges and should be managed as Class 3 projects[5].

Challenges in the absence of CPM

The courts have identified the failings in CPM when applied to distributed projects (Class 3 & 4). The industry has identified the failings in CPM when applied to Agile projects (Class 3). But without a CPM schedule there are major challenges in:

- Measuring how the work is progressing, to allow the identification of issues and opportunities
- Predicting project completion in a consistent and defensible way
- Assessing the consequences of delay and disruption to calculate EOTs and delay costs.

This problem affects:

- All distributed projects
- All Agile projects where development is done in sprints or iterations (not just IT)
- Projects using 'lean construction' and 'last planner' techniques.

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[4] See ***Scheduling Challenges in Agile & Distributed Projects***: https://mosaicprojects.com.au/PDF_Papers/P208_Scheduling_Challenges_in_Agile_+_Distributed_Projects.pdf

[5] The legal challenges to Class 4 projects are discussed in ***Assessing Delays in Agile & Distributed Projects***: https://mosaicprojects.com.au/PDF_Papers/P215_Assessing_Delays_In_Agile_+_Distributed_Projects.pdf

An effective solution to these problems is also likely to work on some of the smaller, or simpler projects in Class 1 & 2, allowing the CPM schedule (if one is developed) to be used proactively rather than contractually.

Assessing progress without CPM

Surveys show most projects do not use CPM or EVM for a variety of reasons. Some are legitimate, CPM has been found inappropriate for use on distributed projects, and Agile methodologies have been designed to avoid using CPM. However most objections to the current controls paradigm are based around the complexity of the tools, difficulty of implementation, and/or a general desire to ignore problems. We cannot do much about wilful ignorance, but there are options for controlling projects without CPM. Earned Value Management (EVM) is an established option, this paper introduces the concept of Work Performance Management™ (WPM™)[6].

Applying EVM to Class 3 projects

A lot of work has been done on applying Earned Value Management (EVM) to Agile projects, and the system works![7] This means the same approach will work for applying EVM to all soft and distributed projects (Class 3).

The key elements of applying EVM to Class 3 Projects are:

- Work packages need to be focused on deliverables, not activity (sprints are an activity)
- All similar deliverables that will be produced by a single resource crew are best in the one work package:
    - The 'crew' may choose to work on any of its deliverables in any order
    - The key question is: Are they producing enough?
- Deliverables need to be countable and sizeable (eg, stories and story points[8] with, or without $ attached).

When EVM is applied effectively, the question of progress and the predicted completion date are resolved by using Earned Schedule (ES)[9]. ES uses EVM data for:

- Determining current status ahead / behind plan, and
- Determining the predicted completion date.

The only schedule input required to create the EVM Performance Management Baseline (PMB) is an assessment of when each work package is planned to start and finish, this information sets the time

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6 ***Work Performance Management*** and ***WPM*** are Trademarks of Mosaic Project Services Pty Ltd.

7 For more on ***applying EVM to Agile*** see GAO Agile Assessment Guide (page 137 – 149) https://mosaicprojects.com.au/PDF-Gen/GAO-Agile_Assessment_Guide.pdf and https://mosaicprojects.com.au/PMKI-ITC-040.php#Process1

8 Story points are units of measure for expressing an estimate of the overall effort required to fully implement a product backlog item or any other piece of work. Teams assign story points relative to work complexity, the amount of work, and risk or uncertainty.

9 For more on ***Earned Schedule (ES)*** see: https://mosaicprojects.com.au/PMKI-SCH-040.php#Process2

element of the PMB. There is no need for a complex CPM schedule to develop this data, simple heuristics will work most of the time. But a carefully thought through bar chart (Gantt chart) is better, and there is no reason not to use a CPM schedule if it is appropriate for the type of project.

An example of EVM for a Class 3 project: Replace 200 Telstra pits in a suburb

Work involved:

- Prerequisites:
  - Somewhere to dispose of the old pits (asbestos cement is a hazardous material)
  - New pits to install (procurement)
  - Trained people
  - Notice to home owners before work in their street
- Repetitive element
  - Remove old fibro cement pits (asbestos hazard)
    Note: the underground conduits (ducts) are not being replaced
  - Replace with new 'plastic pits'
  - Tidy up the area
- Finalize the project.

The repetitive work of replacing the pits can be done in almost any sequence.

Consider the schedule needed for this project, given a contract period of 13 weeks (3 months) to replace the 200 pits:

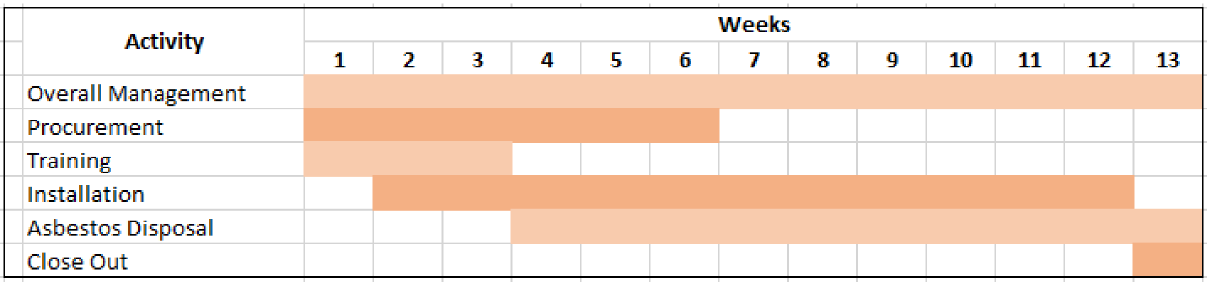
- Allow 2 weeks for initial procurement and training
- Allow 1 week for initial on-the-job learning – 11 pits only
- Allow 1 week at the end for project finalization
- Therefore 9 weeks are left to install 189 pits = 21 per week.

Note: A contingency may be needed for inclement weather.

To use EVM, there may be 5 or 6 work packages, based on the outline schedule above the package timings can be determined as:

- Overall management – Weeks 0 to 13

- Procurement – Weeks 0 to 6 (the end will depend on the situation)
- Training – Weeks 0 to 3 (includes initial installation of 11 pits)
- Installation – Week 4 to 12 (at 21 pits per week)
- Asbestos disposal – Weeks 4 to 13
- Close out – Week 13.



Based on this data, a standard EVM PMB can be established, and as the work progresses, its performance measured. Then, based on the EVM data, ES can calculate the current status and the predicted completion date. EVM does not need to be complex! [10]

WPM as an alternative to ES and CPM

Work Performance Management (WPM) is designed as an alternative approach to project controls. It uses the same concept as Earned Schedule, but offers a simple, practical tool that uses project metrics that are already being used for other purposes. The function of WPM is to assess progress and calculate a predicted completion date in a consistent, repeatable, and defensible way.

WPM is primarily intended for use in Class 3 (soft and distributed) projects, but it can also be applied to smaller / simpler Class 1 and 2 projects where EVM or CPM is not being used. The calculations that run in a simple spreadsheet[11] are based on the concepts used in Earned Schedule, but without the need for either EVM or a detailed schedule. WPM is not intended as a replacement for CPM in large or complex Class 1 and 2 projects, or EVM in large or complex Class 1, 2 and 3 projects.

Assessing progress using WPM

Work Performance Management is designed to assesses progress in a project by comparing the amount of work achieved at a point in time with the amount of work planned to have been achieved at the same point in time; and based on this data calculate an expected completion date. WPM is not designed as a scheduling tool or a cost performance management tool:

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[10] ***EVM does not need to be complex***: https://mosaicprojects.com.au/Mag_Articles/AA015_Practical_EVM.pdf

[11] For access to the ***WPM Spreadsheet***, see: https://mosaicprojects.com.au/shop-easy-WPM_WS.php

- In Agile and distributed projects, there needs to be an overarching plan for the work to set up the WPM baseline, and detailed scheduling is assumed to be undertaken by the project team
- WPM has no capability for cost estimating, management, or control, it is assumed these functions are undertaken by other tools or systems.

The theoretical basis of WPM

WPM has been designed to fill an identified gap in the current controls systems used on Agile and Distributed projects. Currently, there is a lack of a simple process for assessing current performance and predicting the expected completion date for this type of project. WPM also offers a simple solution on projects that simply do not have a functioning schedule.

Existing approaches that have been shown to accurately predict project completion without a CPM schedule include Earned Schedule (as an extension to Earned Value Management) and Earned Duration (ED). Both use a process that:

- Identifies the quantum of work achieved to a point in time
- The point in time when this amount of work was planned to be achieved
- Calculates the difference between these two points to assess the current status (variance)
- Calculates the ratio between the time needed, and the time planned, to complete the quantum of work (schedule performance index [time] – SPI(t))
- Then applies this ratio to the overall project duration to calculate an expected project completion date.

The results from ES and ED have been shown to be more reliable than CPM updates, they are also repeatable, and defensible.

Both systems are based on metrics that represent the work being accomplished by the project's resources:

- The metric used in ED is the number of activity days derived from a bar chart or CPM schedule. The system sums the number of activities in progress on each day, and produces a cumulative graph of the total number of days work planned for the project. The number of days work achieved at a point in time is compared to this baseline[12].
- The metric used in ES is typically money (but other metrics can be used). Based on the EVM performance management baseline a cumulative planed value can be plotted showing the total planed value of work over time needed to complete the project. The value of work achieved at a point in time is compared to this baseline[13].

Experience derived from EVM, ES, and Earned Duration (ED) show that the metric does not have to be identical in every case for the system to provide valuable information. EVM and ES assume the amount of effort required to deliver $1000 of value in one work package is the same in every other work package. ED assumes the amount of effort needed to accomplish one days' worth of progress on one activity is the same as the amount of effort required on every other activity per day.

Neither of these assumptions are true. Compared to the average, some elements of work will be more difficult and need more effort to complete, others will be much easier. But the systems produce useful

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[12] For more on ***Earned Duration*** see: https://mosaicprojects.com.au/PMKI-SCH-025.php#ED

[13] For more on ***EVM and ES*** see: https://mosaicprojects.com.au/PMKI-SCH-040.php#Overview

information because on average the amount of work needed to earn $1000, or complete a day's work against an activity bar, will balance out. The easy elements of work compensate for the more difficult[14].

WPM is based on the same premise and is expected to achieve a similar level of reliability by comparing the amount of work planned to be accomplished to the amount of work actually achieved in the period through to a data date (Time Now). However, unlike ES and ED, WPM focuses on the core elements of the work.

The design of WPM is based on ES, but uses metrics derived directly from the project's primary deliverables. The major difference between WPM and ES is:

- EVM is designed to measure cost performance and then this data is adapted by ES to predict time performance. Consequently, all of the project costs matter, and have to be included in the PMB
- WPM is focused on schedule performance only, therefore, peripheral and support elements in the project can usually be ignored. This makes applying WPM much simpler, and any failings in the peripheral areas (eg, procurement) inevitably manifest in delays in performing the core elements of the work either immediately, or with a short lag.

Apart from the differences outlined above, the basis of calculation used in WPM is the same as in ES, and therefore a similar level of usefulness and accuracy is expected from WPM. To facilitate ease of use, the measure of 'work' used by WPM is flexible, the only requirement is that the measure can be applied consistently across the core work of the project and ideally, the measure is already being used within the project. The measures of work are discussed in more detail later, in many cases, simply counting the units of production (eg, Telecom pits installed) is adequate.

WPM Terminology

The terminology used for the data points in WPM is:

- **WP = Work Planned** measured in an appropriate unit – cumulative over time
- **WA = Work Accomplished** measured on the same basis as WP
- **PC = Planned Completion** project duration in time units (working days, weeks, months)
- **TN = Time Now** the number of PC time units to the date of assessment
- **TE = Time Earned** the number of PC time units to the point where WA = WP

From this information, the work performance measures are calculated as follows:

- **WPV = Work Performed Variance** TE - TN, negative values show the schedule slip in PC time units
- **WPI = Work Performed Index** TE/TN, values less than 1.0 show less work has been accomplished than planned
- **EC = Expected Completion** the expected project duration in PC time units calculated by PC/WPI = EC

[14] For more on the assumptions implicit in ED and ES see ***Earned Schedule - the First 20 Years*** (page 14, ES -v- ED): https://mosaicprojects.com.au/PDF_Papers/P207_Earned_Schedule_the_First_20_Years.pdf

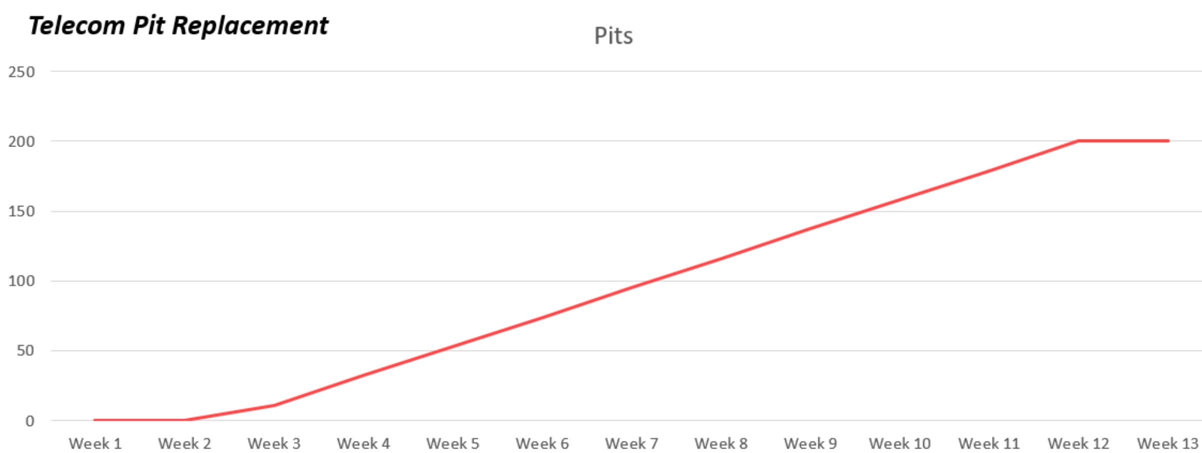
Applying WPM to the *Telecom Pit Project*

The following example is based on the 'Telecom Pit Project' discussed in the EVM section above.

The first step is to plot the measure of performance to create a project baseline using previously planned durations:

- Contract period 13 weeks therefore: **PC = 13**
- Allow 2 weeks for initial procurement and training
- Allow 1 week for initial learning (11 pits only)
- Allow 9 weeks to install 189 pits at 21 per week
- Allow 1 week for project finalization.

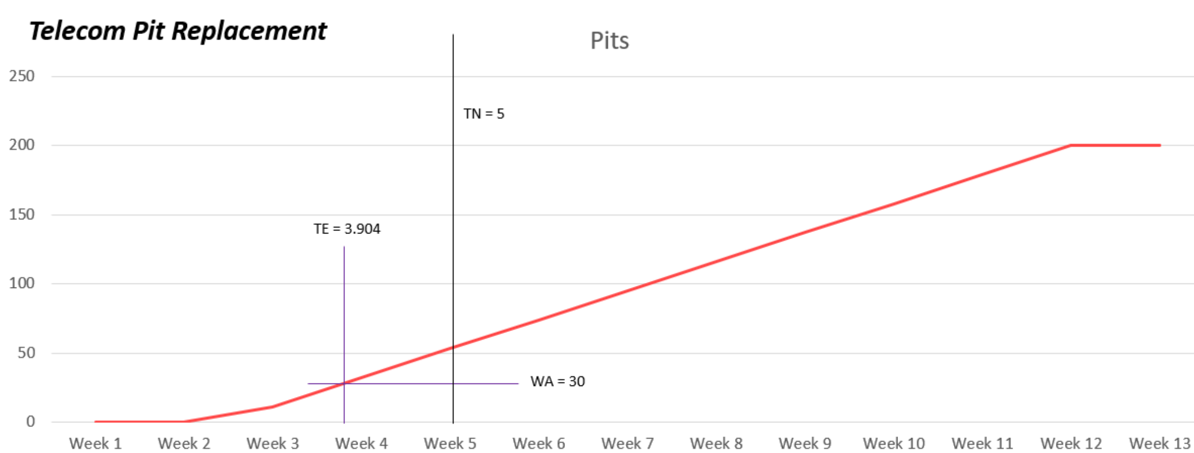
This produces the following cumulative graph:



Then to assess progress at a point in time all that is needed is a count of the pits completed.

The measured progress at the end of Week 5 shows:

- Time Now = 5 **TN = 5**
- The actual progress is measured as 30 pits complete **WA = 30**
- The planned progress at Week 5 was 53 pits complete **WP = 53**



TE is calculated on the assumption that the work within a week is a 'straight line' from the start of the week to the end. The time 30 pits were planned to be complete occurs at some point in week 3:

- 11 pits were planned to be complete at the start of week 3 (end of week 2) **TE = 3.???**
- The remaining 19 pits were completed during week 3, and the planned production rate is 21 pits per week. Therefore, the fraction of week 3 needed to achieve 30 pits is: 19/21 = **0.905**
- Therefore: **TE = 3.905**

We now have the data needed to calculate the work performance measures:

WPV = 3.905 - 5 = -1.095 Progress is currently 1.095 weeks behind schedule (just over 1 week late)

WPI = 3.905/5.0 = 0.781 Less work is being done than planned.

Based on the WPI, the predicted project completion is calculated as:

EC = PC/WPI 13/0.781 = 16.645 weeks

The project is expected to complete 16.645 - 13 = 3.645 weeks (or 3 weeks 3 days) late based on a 5-day week. This prediction assumes no management action is taken to improve performance.

WPM units of work

The core element in developing an effective WPM system is defining a robust measure of the work involved in the project. This needs to be a unit that can be applied uniformly across the core work of the project.

The measure does not need to include everything. In the example above cost items such as procurement, the overall management of the project, and the disposal of hazardous materials are not captured in the metric. However, problems in any of these areas are likely to have an immediate impact on the progress of the team delivering the core measure, or in the case of the waste disposal are unlikely to be critical. WPM is not a cost management system it is focused on measuring the progress of work that directly affects completion, based on an impartial measure to assess the quantum of work planned and achieved.

Some of the options for effective measures of work include:

- Direct measures where the project's output can be counted are useful for many straightforward projects:
  - Telecom pits installed
  - Computers replaced
  - Interviews conducted
- Measures that describe the amount of effort applied to accomplish each component of the work, the estimate of the amount of effort involved in each unit of measure needs to be consistently applied across the project (eg, every story point involves the same amount of work):
  - Function points
  - Stories and story points
  - Hrs of effort (Note: for this measure the WA is based on the planned hours per component completed, not the timesheet record of hours actually worked[15])

[15] The EVM equivalents are PV and EV (not AC)

- Monetary values ($), this metric is particularly useful for commercial projects where a planned cashflow is established, and then monthly claims submitted to the client based on a schedule of rates for the work completed – care is needed to make sure the WP and WA remain aligned.

The key to obtaining valuable information from a WPM analysis is selecting a robust metric, ideally one that is used in other aspects of the project.

Care is needed to avoid confusing activity with work! For example, in software development the output from a sprint is variable, a sprint is timeboxed, and the team may produce nothing (everything goes back into the backlog) or a lot of finished work, it depends on circumstances. Whereas, function points, or story points both describe an amount of work that is embedded in the product. A story that has 6 story points is expected to take twice as much effort to deliver as a story with only 3 story points. When a story is delivered at the end of a sprint, the work involved in accomplishing its story points has been completed.

Scheduling units of work

Scheduling the work should be as realistic as possible, but in many situations a straightforward pragmatic approach will suffice. For example, looking at a 20-week software project that has 27 stories of various size, and a total of 86 story points, and the resource planning is to use 2 scrum teams. In the absence of any other information, you could assume:

- The first 2 weeks are needed for team development, planning and other start-up processes
- Sprints are expected to take 2 weeks each, and
- the last two weeks will be for contingencies, bug fixes and other finalization work
- This leaves 16 weeks for productive work, therefore, the first stories should be delivered at the end of the first productive sprint, week 4, and all stories by the end of week 18.

This means the rate of planned production between the start of week 2, and the end of week 18 is 86/16 = 5.375 story points per week. Based on these assumptions, at the end of week 4 (2 weeks of production) we can expect 10+ story points to be complete, and at the end of week 18 all 86 story points complete. The rest of the planned distribution is simply a straight line between these two points.

We know sprints will not take exactly 2 weeks every time, some will overrun, occasionally some will finish early, and we also know the number of story points generated in each sprint will vary. But on average, if the two sprint teams together are not completing a bit over 5.3 story points per week, every week, the project will finish late.

Once this basic rate of production has been determined for the project, WPM measures the actual work delivered (WA) and shows the time variance at Time Now (TN) and uses this information to predict the Expected Completion (EC).

The Agile approach to working is to let the team decide what is best to do next, they choose the stories to work on in each sprint. All WPM does is measure if they are producing enough finished work to complete the overall project on time.

In other types of project, there may be an overall roadmap, or a detailed schedule, of some other form of planning that identifies when the work should be done. If these tools are available, they should be used to set the planned work curve.

Easy WPM

A simple spreadsheet has been developed that allows:

- Users to set the time units to be used (working days, weeks, months)
- The metric used in their project to measure work
- Create the project's PMB, this can be up to 60-time units
- Set Time Now (TN) and record progress
- The calculations are performed as at TN, there is no need to update the spreadsheet every time unit
- The spreadsheet calculates the TE, WPV, WPI and EC for the project

At this stage of development, the user has to convert the output into calendar dates. The spreadsheet and instructions can be downloaded from https://mosaicprojects.com.au/shop-easy-WPM_WS.php

The next stage in the development of WPM is to validate the assumptions built into the tool. To facilitate this process, the spreadsheet and user instructions will be available free of charge through to 1st August 2023.

Conclusions

WPM is designed to be a simple robust performance measurement system that will provide an accurate assessment of the project's status from a time management perspective. It can assess how far ahead or behind plan the work currently is, and based on this information, the likely project completion date based on the assumption work will continue at the current rate. **It is not intended as an alternative to EVM and CPM on major or complex projects!**

Where WPM can provide a cost efficient, simple controls tool is for the many projects that are either:

- Relatively small requiring a straightforward controls tool, or
- Large, but with a single primary deliverable that is easy to measure, or
- Fall into the Class 3 classification of Agile or Distributed projects where management has chosen not to use the ES extension to EVM.

The two requirements to implement WPM are:

- A consistent metric to measure the work planned and accomplished, and
- A simple but robust assessment of when the work was planned to be done

The metric used can be a core deliverable (eg, 2000 computers replaced in an organization), or a representation of work such as 'story points', or the $ value of the components to be delivered to the client. Peripheral and support activities can usually be ignored when establishing the WPM metric, they rarely impact the project delivery independently; failures in the support areas typically manifest in delays to the primary delivery metric.

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