

PMP Exam Tips on Cost Management, Fourth Edition

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Parallels between Cost and Time estimating:



There are strong parallels between cost estimating and time estimating so you should have experienced some déjà vu when you first read it. In fact cost and time management have five tools/techniques in common – expert judgment, analogous estimating, parametric estimating, three-point estimates and reserve analysis.

For example, if you are building a brick wall, and you know how long it takes to build one square metre, how long will the whole wall take? Simply multiply the time per square metre by the area of the required wall – and the technique for estimating this is called “parametric estimating” (see later).

And if you want to estimate the cost of building the same brick wall, and you know how much it costs to build one square metre, then multiply by the area of the wall – so again it’s by parametric estimating.

And so on with the other estimating TT’s...

As I’ve said many times, PMI has three overarching views, and these are reflected in the exam. So unless otherwise stated (or indicated) in the exam:

1. You are working on a **huge** project.

Why is this important? - you have time and resources to complete all – or most of – the steps in PMBOK. In PMBOK you will see a note that on small projects, cost estimating and cost budgeting may be viewed as a single tightly linked process, but in the exam, that is unlikely to be the case.

2. You are usually **internal** to the organisation, not a contractor or supplier.

Why is this important? - you will be concerned about aligning the project with the strategic plan, and so you will care about full life-cycle costs and ways of saving the organisation time, money and effort.

3. There is growing trend for teams to be managed more like small companies, with the Project Manager acting like a proprietor. Why is this important? - this means that **PM’s are starting to pick up more HR duties**. Impact – General Management is starting to creep into the exam



Project managers have traditionally been good in the “hard skills” areas (technical areas) and not so good in the “soft skills” (interpersonal, influencing, motivating, etc) and so in PMBOK 4th, Appendix G and Chapter 9, HR management, Develop Project Team and Manage Project Team processes, include considerable detail on interpersonal skills, intended to highlight this very important part of the PM’s role. It’s part of what good PMP instructors have been teaching their students for many years, so it shouldn’t raise many problems for PMP students.

But this means that CAPM aspirants will need to learn about the Soft Skills too, because traditionally the PMP exam is 60% PMBOK and CAPM is 100% PMBOK based, so CAPM's didn't need to know much in this area (to pass the exam, not to be PMs) but now that it is enshrined in PMBOK, it can be on the CAPM exam too. So read it ten times.

Please bear these three views of PMI in mind throughout the exam.

The Voice of PMBOK

As I mentioned elsewhere, PMBOK 4th uses active voice for the processes etc, e.g. "Cost Estimating" has become "Estimate Costs", and so on

Cost Management consists of three processes:

- **Estimate Costs** – developing an approximation of the costs of the resources needed to complete project activities.
- **Determine Budget** – aggregating the estimated costs of individual activities or work packages to establish an authorized cost baseline.
- **Control Costs** – monitoring the status of the project to update the project budget and managing changes to the cost baseline.

Despite the change to active voice in PMBOK 4th, there is a subtle change here in the Control Costs process, from the Third Ed, as this process now appears to be more passive. In the PMBOK 3rd, Cost control was defined as "Influencing the factors that create variances, and controlling changes to the project budget" but in the Fourth it just says "monitoring... and controlling" - interesting!

A Fourth Cost Process?

There is a hidden process at the start of Cost management, which is part of the Develop Project Management Plan process:

"The work involved in performing the three processes of Project Cost Management is preceded by a planning effort of the project management team. This planning effort is part of the Develop Project Management Plan process (Section 4.2), which produces a cost management plan that sets out the format and establishes the criteria for planning, structuring, estimating, budgeting, and controlling project costs." PMBOK page 165

And so in Cost Management you see the Cost Management Plan as an input to... NOTHING! How strange is that! It is an input to the Plan Risk Management, Identify Risks, and Perform Quantitative Risk Analysis processes, but not the cost processes. That might be worth remembering for the exam.

Estimate Costs

"The process of developing an approximation of the costs of the monetary* resources needed to complete project activities" (page 168 PMBOK).

* I think PMBOK 4th doesn't say it quite right here. The word "monetary" was added in PMBOK 4th, but when you think about it, you are estimating the cost of all resources (i.e. the cost of labor, materials, equipment, services, and facilities, etc), not just the cost of obtaining money, inflation, contingency costs etc.

Cost Management should consider the effect of project decisions on the cost of using, maintaining, and supplying the product, service, or result of the project. Why? See point 2 above.

Estimate Costs includes identifying & considering various cost alternatives (again see point 2 above) and the accuracy should improve as the project progresses (as a result of progressive elaboration). A cost estimate is a quantitative assessment of the likely costs for resources required to complete the activity.

The **Scope Baseline** is the “big picture” view, and contains the **entire** project, so it should be no surprise that it is a major input to the Estimate Costs process.

Important Topics:

As a project manager (and for the exam) it is **your responsibility** to estimate, budget, and manage project costs and to know the mechanisms and formulae. Note that although the PM has overall responsibility for the project estimates, the individual estimates will normally be produced by others.

And as with Time management, for **general tasks** the best person to provide the estimate is the person who will be doing the work.

As with cost **estimates**, use **documented** sources (e.g. Organizational Process Assets – remember, this is important everywhere). Again the recollections of a team member **can** be used when all else fails, but it should be **corroborated** if at all possible, with documented evidence.

Cost and time estimates should **not** be accepted from **management** (another PMBOKism) unless those members of management are recognized expert resources in the area. Note, that in the exam the term “management” normally means senior management.

Please remember that although you probably **study** knowledge areas almost in **isolated** from each other (e.g. almost as if they are not related to each other) in the exam PMI will happily **mix and match** knowledge areas, and cross boundaries. And when managing actual projects, the knowledge areas tend to run in continuous loops throughout the project.

You need to know how activity estimates are derived.

Nine estimating methods are highlighted in PMBOK 4th:

1. **Expert judgment.** Should always be guided by reliable historical information from previous projects. Expert judgment, as well as being used to estimate costs, can also be used to select and combine the estimating methods to be used. And finally it can be used to reconcile the differences in the outputs of the different methods.
2. **Analogous** means a **comparison** with **previous** (or parts of previous) similar projects. In this method, the amount expended in the similar project is multiplied by an estimated “complexity figure”. The information on previous comes from your Organizational Process Assets (or sometimes from purchased tables) and the estimated complexity figure usually comes from expert judgment.

For example, if your organization previously built a one-story house, and now it is building a two-story dwelling, you could say that house one, multiplied by a complexity factor (say 1.8 in this case) provides an estimate for the two-story house.



x a complexity =
factor



This is a **top-down** approach, so it should **cost much less** than other more detailed (bottom up) methods, but of course is **much less accurate**. This method is used to provide a “ballpark figure”, usually to facilitate a very early go/no go decision, and then is followed up by one of the following methods when a more accurate estimate is called for.

(Note: if the project involves actually building a ballpark, analogous estimating is not the only choice)

IMPORTANT: analogous estimating relies on the assumption that the projects being compared are **truly similar**, and that the circumstances and **conditions** are similar, e.g. the costs involved in completing an outdoor construction project in winter might be quite different from a project managed in summer. Again, Analogous Estimating is a form of **expert judgment** (the expert is often backed up by the ever-popular Organizational Process Assets).

3. **Parametric modeling** uses the known cost required to complete a unit of work and multiplies it by a parametre to calculate the cost of a larger task. For example if you know the cost required to lay one square metre of brickwork, then to estimate the cost of laying 100 square metres, you simply multiply the costs by 100 (100 is the “parametre” in this instance). Estimates can be per ton, per line of code, per hour, or whatever is appropriate in the situation, then multiply by the number of units required.
4. **Bottom-up** estimating, so named because you start with nothing, gradually **adding** together (sometimes referred to as “rolling up”) the **estimated** costs for all the individual parts, to obtain an estimate for the whole.

Very important: use expert judgment, historical records, industry tables etc – DON'T JUST GUESS estimates.

Bottom-up estimating is considered the **most accurate**, but is comparatively **slow** and **expensive** to derive (i.e. don't use it for an initial “ballpark estimate”). It involves estimating the cost to perform each activity on the Activity List (an extension to the WBS – see my tips on Time Management, Activity definition) and then rolling-up the costs for each control account, to give the cost estimate for the entire project.

5. **Three-point estimates.**

The estimates we have looked at so far are generally single-point (a single value is derived).

Three-point estimates still return a single value, but as an intermediate step, three estimates are produced and then averaged to one value.

The three intermediate estimates produced are:

- Most likely (M)
- Optimistic (O) which is a best-case scenario, and
- Pessimistic (P) or worst-case.

The three-point estimate is then $(M + O + P) / 3$ i.e. the simple average.

The assumption is that averaging three guesses produces a more accurate estimate.

Suppose for example you are asked how long it would take to produce a new computer chip as part of a project. You might say 20 days.

However if you three-point estimate it, you would probably retain 20 days as the most likely estimate (M).

But even if every planet in the universe lines up, the most you could possibly save (because of the lengthy test requirements for new chips) is 2 days, so "O" is 18 days.

When considering the pessimistic estimate, you note that porcupine flu has been reported in the area (which recently crossed with prickly heat) so after some head scratching, this could add 40 days to this phase of the project if the engineers catch the flu. So "P" is 60 days

The three-point estimate is now $(20 + 18 + 60) / 3 = 32.67$ days, which is very different your single-point estimate.

Welcome back PERT!

In PMBOK 3rd, three-point estimating replaced PERT estimates, and so dropped off the exam.

PERT is a weighted average, whose formula is: $(O + 4M + P) / 6$

The optimists thought it was gone for ever, but the pessimists thought it was 4 times most likely to return.

The pessimists were right! In the Fourth Edition, the formula for PERT is explicitly stated (on page 173 for example) and it is also compared with three-point estimating, so that means PERT could appear on the exam again. So learn the formula, it's very easy and could possibly mean an easy exam point (or three).

Although the Third Edition Glossary said that the Three Point Estimate could be used for both cost and time estimates, it appeared only in Time Management. In the Fourth Edition, three-point estimating, has been added to Cost as well.

Note that in both Time and Cost chapters it now appears as a "Tool & Technique".

Applying PERT to our chip example, we now get $(18 + 80 + 60) / 6 = 26.33$ days.

6. Reserve Analysis.

Contingency reserves (aka contingency allowances) are created to allow for project uncertainty. But as uncertainty *should* reduce (through progressive elaboration) as the project advances, these reserves can be adjusted to suit. Obviously then, this tool can be applied only after you are some way into the project. (or out of the project., depending upon whether you are an pessimist or an optimist).

7. Cost of Quality

Similar to the logic behind tool 7 (see PMBOK section 8.1.2.2 for more information)

8. Project management Estimating Software.

“Project management cost estimating software applications, computerized spreadsheets, simulation, and statistical tools are becoming more widely accepted to assist with cost estimating. Such tools can simplify the use of some cost estimating techniques and thereby facilitate rapid consideration of cost estimate alternatives.” PMBOK page 173

9. Vendor Bid Analysis.

When you put work out to tender, you can examine and compare the estimates provided by the vendors (PMBOK expects the team to analyze these estimates, not blindly just accept them – even if they are produced by your cousin)

For the exam you need to know that **Regression Analysis** is not a way to remember who was mean to you as a kid, it's also known as a scatter chart, and both it and **Learning Curve** are **parametric** modeling methods (see learning curve below in exam tips).

Cost estimates (like time estimates) are subject to **progressive elaboration** and refinements as more detail becomes available. Know that basing estimates on the Scope Baseline improves accuracy (and know what the Scope Baseline is).

Progressive elaboration implies an increasingly accurate estimate.

Estimating (THESE PERCENTAGES ARE IMPORTANT FOR THE EXAM):

- Order of magnitude Accuracy **–25% to +75%**, used in the **initiation** process and in **top-down** estimating.
- Budget estimate Accuracy **–10% to +25%**, used **early** in the **planning** process and also in **top-down** estimating.
- Definitive estimate Accuracy **–5% to +10%**, used **late** in the **planning** process and in **bottom-up** estimating.

Look out for any numbers, ranges, percentages etc in the PMBOK, as all are possible questions.

The tool for measuring project performance is Earned Value Management (EVM).

Earned Value is important for the exam

Over the last few years there has been an average of **twelve Earned Value** questions in the exam, and **half** of them involved calculations.

Earned Value is really quite easy, in fact the only time that It's likely to give you any trouble at all, is when you try to use it or try to answer questions on it.

No seriously, EV calculations are **very easy** if you **take the time to learn** the formulae and know how to apply them. But for an overview of the topic, **please see Appendix 1: Earned Value**

More Exam tips

On a complex project where you are in unfamiliar territory you need to employ a **Subject Matter Expert (SME** – not to be confused with a Small to Medium Enterprise). And where the team in general is lacking necessary skills you should provide **training** for them. The SME and training courses will need to be budgeted for (cost and time). If the team's skills are still not up to the task then consider outsourcing part of the project, or employing / hiring expert staff, to spread the risk (at a cost).

When a project is performed under contract, know the difference between **cost estimating** (how much will it **cost you** to create the product or service) and **pricing** (how much you will **charge** to provide the product or service)

Pricing (how much you will charge) is a business decision, but of course the cost estimates are considered in making pricing decisions.

Estimate Costs should also consider alternatives, as the exam normally considers you to be internal to the organization, e.g. would employing additional expert staff, leasing more advanced machinery, or larger premises, or investing more time in the planning stages, save money overall?

Bottom-up estimating is a team-building tool and assists with team buy-in, because everyone gets involved and has input to the process. This is why creating the WBS is also considered a team-building tool, as it is created in this way.

Learning curve. There is a reasonable chance you will see this on the exam. Simply put, people get faster/better with practice so with repetitive tasks, or series of similar tasks, you can expect to see a decrease in cost and/or time.

When I was an accountant in Belfast I was involved in the audit of a bus building company. The new buses required 5 coats of paint applied by brush (not spray). The buses had up to then been painted in Manchester and shipped over, but recently the company had set up their own paint shop.

Management had the dreaded time-and-motion study experts observe the painting process, and they calculated an average 390 person-hours *they were called man-hours back then) to complete the painting of a single bus. It was then agreed with the union that times under 390 hours would attract a bonus. So far so good. I returned one year later and discovered that the average time to paint a bus had dropped to 310 hours (so bonuses all round). But one individual was able to paint a bus single-handed (well maybe he used both hands and brushes – who knows? ☺) in 39 hours!!! Guess who was getting a humungous bonus. Yet his work passed **all** quality tests! Good old learning curve!

There will be no project management software-specific questions on the exam but there may be questions where it is necessary to know how PM

software can help the project manager generically (creating graphs and charges, performing calculations, estimates, simulations, and so on, rapidly).

You will need to know how to calculate simple **Straight-Line Depreciation**.

All you may need to know about “**Accelerated Depreciation**” is that it depreciates **faster** than straight-line, and that there are **two types**:

- **Double Declining Balance**, and
- **Sum of the Years Balance**”

You **don't** need to calculate these.

Life-cycle Costing – the costs incurred by the product of the project **after** the project is completed (ongoing maintenance etc). All you need to know is that it happens **after** the end of the project and project managers **should consider** it when planning the project (i.e. planning the project the cheapest way may cost the company more in the long run). It hasn't been on for a while, so maybe this is the year for it?

Value Analysis – another PMBOKism, it means **examining** the project with a view to **reducing** project cost or time, but **maintaining** the same project **scope**.

Types of Cost:

- **Variable** - varies with volume of output, e.g. fuel.
- **Fixed** - does not vary with volume of output – e.g. building rent.
- **Direct** - directly attributable to a project.
- **Indirect** - overhead allocated to the project by the overall organization.
- **Nonrecurring** - project cost not expected to recur on future work.
- **Recurring** - production cost (not project cost).

Appendix 1: EV (Earned Value)

One of the nice things about Earned Value reporting is that it is very useful in real life. In fact it is one of the most important and commonly used performance reporting tools (which is why it appears in Communications Management too).

EV calculations look scary, but they are really quite simple once you get by the warty appearance.

If we consider a project after a given time T.

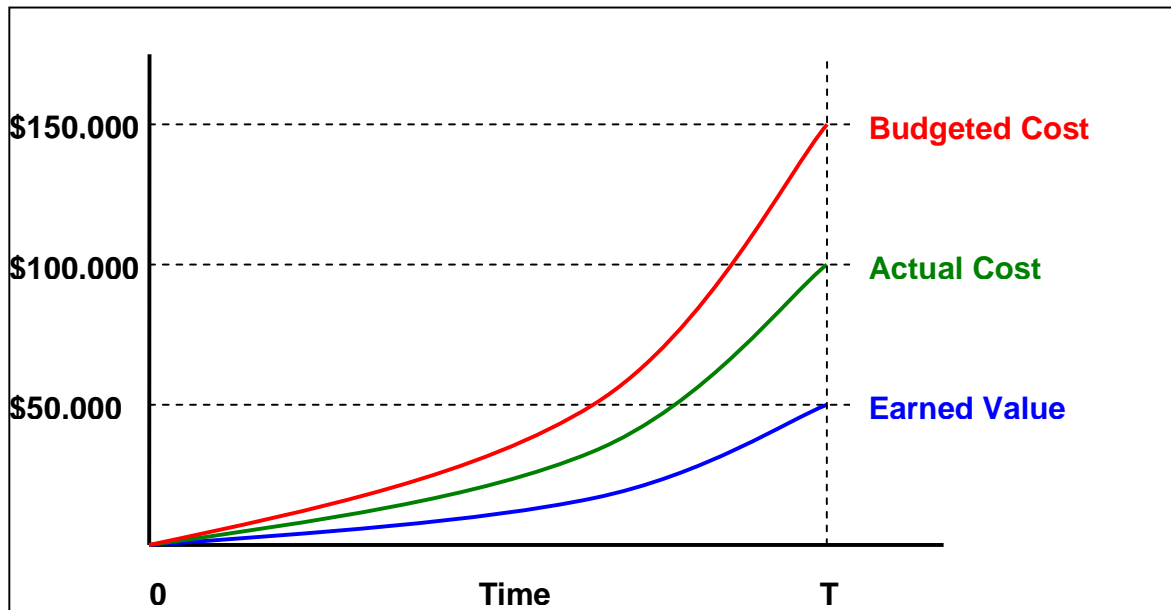
Suppose the Budgeted Cost is \$150,000 and the Actual Cost is \$100,000, what does this mean? Does it mean we've saved \$50,000?

The answer is that we can't tell. But if we add the Earned Value to the picture then (in this case) we can see that it's not party time and promotions all round for the PM and team.

The simple graph below shows that we have budgeted \$150K and spent \$100K, but we have achieved only \$50K of work.

In real terms, if our project was to build a group of three aircraft hangers at \$50K each in six months. The actual result is we have spent enough to build two of them in that time, but only actually built one – which is quite a different picture from how it first appeared, isn't it?

In fact it's important to note that you should investigate **any** large variances in your project by root cause analysis, **even under-budget** ones, just in case a shortfall is in fact caused by the accidental omission of part of the project, rather than the amazing abilities of the PM and team to save time or money.



Earned Value in action

Now some important definitions that you must know for the exam:

These variables all changed name around 2005, but the exam will use just the new names, e.g. EV for Earned value, but the old acronym (BCWP) for Budgeted Cost of Work Performed, MAY appear in brackets.

My tip is: **forget the old names**, you don't need them and they will just confuse you, and I would advise you not to use text books that have the old names too.

But I would like to clarify one point before we forget these names forever and move on.

I was asked recently why Earned Value (EV) was called "**Budgeted** Cost of Work Performed"

This confuses many people because with EV you are assessing the value of what you have **already** achieved, so you are looking at past results, not future – so where does "budget" come in?

To understand this it is helpful to remember that the words "budget" and "estimate" are largely interchangeable. Now, remember back to Time management, you decomposed your work packages (deliverables at the lowest level of the WBS), into activities on the Activity List (an extension of the WBS)?

Now in Estimate Costs we have estimated the cost to perform each activity. So now the sum of all these **estimates** is the project **budget**.

So far so good.

So at any point in your project you can determine which activities you have completed, and then to find the **estimated value** of this work you simply add up all the original estimates (**budgets**) for performing these tasks.

So EV is the “Budgeted Cost of Work Performed” or the **estimated** cost of work performed, based on your **original** estimates – or budgets - from Estimate Costs.

So if our project is to build three aircraft hangers, and we have estimated (budgeted) \$50,000 each and we have completed 1.5 hangers, then our EV will be \$75,000.

NB When we are calculating EV though, we don't actually go around ticking off tiny deliverables and activities from a giant checklist (my hangers are a significant oversimplification) instead we estimate the **percentage** of work completed, and then multiply the original budget by this percentage.

Phew! I hope that explains it for you.

NOW DUMP THOSE OLD TERMS IN THE TRASH CAN



The terms to remember:

PV	Planned Value	The estimated value of the work planned to be done
EV	Earned Value	The estimated value of the work performed
AC	Actual Cost	The actual money we have spent to complete this work
BAC	Budget At Completion	The sum (aggregation) of all the estimates for all the work in the total project.
EAC	Estimate At Completion	From now, how much do we estimate it will cost us to finish the project? Here we are taking a fresh look at the situation and looking just at our outstanding work
VAC	Variance At Completion	How much over budget or under budget do we expect to be when we complete the project?

Memorize the following list – this is very important:

- **EV** (Earned Value) = %complete x BAC
- **VAR** (Variance) = BAC - AC
- **CV** (Cost Variance) = EV - AC
- **SV** (Schedule Variance) = EV - PV
- **CPI** (Cost Performance Index) = EV / AC
- **SPI** (Schedule Performance Index) = EV / PV
- **EAC*** (Estimate at Completion) = BAC / CPI
- **VAC** (Variance at Completion) = BAC - EAC
- **ETC** (Estimate to Complete) = EAC - AC

The **CPI** shows how well the project is performing financially.

The **SPI** shows how well the project is performing in terms of schedule.

- A question about an **Index** is a **division** question.

An index of **< 1 is bad**.

- A question about a Variance is a subtraction problem.

A **negative** variance is **bad**.

Note when **EV** is used in a formula the **EV** always comes first (i.e. in SPI, CPI, SV and CV).

* **EAC** may be calculated in four ways. The **most frequently** occurring one in the exam is:

$$\mathbf{EAC = BAC / CPI}$$

But know them all.

The most common method for showing project performance is through earned value analysis and this information must be communicated regularly to concerned stakeholders, such as customers, management and the project team

N.B. Some project managers may have different viewpoints or opinions to those expressed here – but PMI are marking your exam, so the PMBOK is *always* right and if I say anything that appears to contradict the PMBOK, then believe the PMBOK.

PS I've made every effort to get this right to help you in your exam – but if I've missed something please let me know.

Regards, Jim Owens PMP

Columnist with www.PMHub.net