

Estimation

O, M and P are the optimistic, most likely and pessimistic values of one estimate; tE is the expected value, and SD the standard deviation. Each formula has a worked example with its own numbers; the two model sheets follow. They serve IPMA, PMI and APM exams alike; for APM's PMQ exam, know what a range tells you and why you re-estimate.

FORMULAS

Triangular mean

$$tE = (O + M + P) \div 3$$

The plain average: the best and worst cases weigh as much as M. PMI's guide uses it when there is little history or only judgement.

Example: Testing a new online form, O 8, M 11, P 20 days: $39 \div 3 = 13$ days

PERT (beta) mean

$$tE = (O + 4M + P) \div 6$$

PERT, the program evaluation and review technique (Malcolm et al., 1959), assumes a lopsided beta curve and counts M four times; the weights 1 + 4 + 1 make 6. With a long high tail, both means exceed M.

Example: Testing a form, O 8, M 11, P 20 days: $(8 + 4 \times 11 + 20) \div 6 = 72 \div 6 = 12$ days

Standard deviation (SD) of one estimate

$$SD \approx (P - O) \div 6 \cdot \text{variance} = SD^2$$

Why six: PERT assumes O and P lie about three SDs either side of the mean, so the range spans about six.

Example: Testing a form, O 8, P 20 days: $(20 - 8) \div 6 = 2$ days; variance $2^2 = 4$

A chain of activities

$$\text{mean} = \Sigma \text{ means} \cdot SD = \sqrt{(\Sigma SD^2)}$$

Add the means and the variances, never the SDs: some overruns and savings cancel out. Only for independent activities; a shared cause widens the spread.

Example: Two activities in a row, means 12 and 16 days, SDs 3 and 4 days: 28 days, SD $\sqrt{(9 + 16)} = 5$ days, not 7

Confidence range

$$\text{mean} \pm 1 SD \approx 68\% \cdot \text{mean} \pm 2 SD \approx 95\% \cdot \text{below mean} + 1 SD \approx 84\%$$

Holds for a bell-shaped (normal) total and honest O and P values: roughly for one lopsided activity, better for a chain of independent ones.

Example: Mean 28 days, SD 5: 23–33 days about 68 in 100; 18–38 days about 95 in 100; 33 days or less about 84 in 100

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Sources: IPMA ICB4 (2015); PMI, PMBOK® Guide, 8th ed.; PMI, PMP® Examination Content Outline (2026); APM Body of Knowledge, 8th ed.; APM, PMQ handbook (v6, 2026); APM, PFQ handbook (v5, 2026); IPMA International Certification Regulations (ICR) v4.4 (2025); Malcolm et al. (1959), PERT; Dalkey & Helmer (1963), the Delphi method; Boehm, Software Engineering Economics (1981); McConnell, Software Project Survival Guide (1997); Tversky & Kahneman (1974); Flyvbjerg & Gardner, How Big Things Get Done; Grenning (2002), planning poker

Key: IPMA = International Project Management Association; ICB4 = IPMA's Individual Competence Baseline; PMI = Project Management Institute; PMBOK® Guide = PMI's body-of-knowledge guide; PMP® = PMI's Project Management Professional; APM = Association for Project Management; PMQ = APM's Project Management Qualification; PFQ = APM's Project Fundamentals Qualification; ICR = IPMA's International Certification Regulations. Unofficial study material for IPMA®, PMI® and APM exams. Not affiliated with, endorsed by or approved by IPMA, PMI or APM, and not an accredited or endorsed training provider. IPMA® and IPMA ICB® are registered trademarks of IPMA in Switzerland and other countries. PMI, PMP, CAPM and PMBOK are registered marks of Project Management Institute, Inc. APM is a trade mark of the Association for Project Management. Other marks belong to their owners. PMP® exam facts are from PMI's public PMP® Examination Content Outline (2026); check the current version on pmi.org. APM's qualifications are its own; this series is not an APM Accredited Provider or APM Endorsed. Examples use a fictional city and its projects.

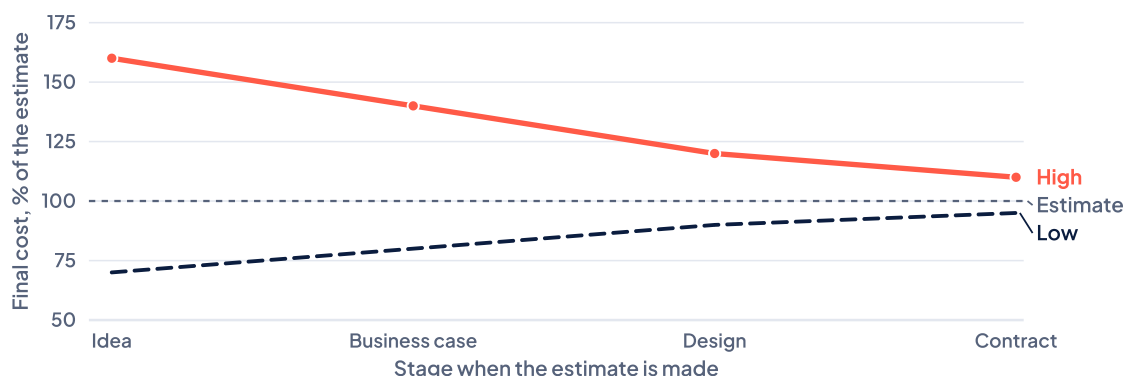
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Estimating techniques by stage

Fit the technique to the stage and the data, and show how wide the estimate still is.



Our own illustrative cone: where the final cost may land, by the stage of the estimate. The high side is wider.

WHAT IT IS

Early, estimate **top-down**: by analogy with a similar past job, or with a parametric rate. Later, estimate **bottom-up** from the work packages, with the people who will do them. Iterative teams size items against each other in story points; in planning poker (Grenning, 2002), all cards show at once. Ranges narrow as facts arrive (Boehm, 1981): the **cone of uncertainty**.

HOW IT WORKS

- 01 **Analogous**: a similar past job, adjusted; quick but rough.
- 02 **Parametric**: a quantity $\times$ a rate from past data.
- 03 **Bottom-up**: each work package with its doers, added up.
- 04 **Delphi** (Dalkey and Helmer, 1963): experts estimate alone, see the spread, repeat.

MID-LEVEL · WORKED EXAMPLE

Apply it well

The situation: A city team has eight months to move resident parking permits online; 58 users (18 at the service desk, 40 parking wardens) need training.

A parametric rule: 58 users in groups of about 10 make 6 sessions (5.8, rounded up); at half a day each, 3 trainer-days. The project manager checks it against the trainers' bottom-up estimate.

In the exam: Name the technique and why it fits, show the arithmetic, give a range, and check it with a second.

SENIOR · WORKED EXAMPLE

Design and lead it

The situation: A city is joining 14 online services under one login over 30 months, in three groups, with a steering board.

The project manager writes one estimating guide for all teams: the technique at each gate, estimates collected before any target is shared, a review of the largest work packages; later groups reuse earlier results.

In the exam: Describe the **estimating system** you set: techniques by stage, who estimates, how bias is checked, how results feed back.

WHERE IT SITS

IPMA · ICB4	PMI · PMBOK® GUIDE 8 · PMP® EXAM	APM · BOK 8 · PMQ EXAM
4.5.7 knowledge: cost estimating methods (p. 123); 4.5.7.1: top-down or bottom-up	Guide p. 52: techniques, incl. Delphi, story points; p. 119: accuracy rises. Outline: tasks 1, 8	BoK (APM's Body of Knowledge) §5.4.1: comparative (analogous), analytical (bottom-up, incl. Delphi); the estimating funnel. PMQ (APM's Project Management Qualification) 20c

Sources: IPMA ICB4 (2015); PMI, PMBOK® Guide, 8th ed.; PMI, PMP® Examination Content Outline (2026); APM Body of Knowledge, 8th ed.; APM, PMQ handbook (v6, 2026); Dalkey & Helmer (1963), the Delphi method; Grenning (2002), planning poker; Boehm, Software Engineering Economics (1981)

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Three-point estimate (PERT)

Replace a single guess with a range: an expected value and a spread that show how sure the estimate is.

STEP	FORMULA	FORM TEST: 8 · 11 · 20 DAYS
Triangular mean	$(O + M + P) \div 3$	$39 \div 3 = 13$
PERT (beta) mean	$(O + 4M + P) \div 6$	$72 \div 6 = 12$
Standard deviation	$(P - O) \div 6$	$12 \div 6 = 2$
Range: $\pm 1 \text{ SD} \cdot \pm 2 \text{ SD}$	About 68% · about 95%	10–14 · 8–16 days

Illustrative: O 8, M 11, P 20. Both means lie above M, because the worst case is further from M than the best case.

WHAT IT IS

Ask the people who know the work for **three values**: optimistic (O), most likely (M) and pessimistic (P). The triangular mean is their plain average. **PERT**, the program evaluation and review technique (Malcolm and colleagues, 1959), assumes a lopsided (beta) curve that leans towards M, counts M four times, and takes a sixth of the range as the standard deviation (SD). The PMBOK® Guide (PMI's body-of-knowledge guide) calls this multipoint estimating.

HOW IT WORKS

- 01 Ask for O, M and P one by one, before anyone hears a target.
- 02 Triangular = $(O + M + P) \div 3$; PERT = $(O + 4M + P) \div 6$.
- 03 $SD \approx (P - O) \div 6$: O and P lie about 3 SD either side of the mean.
- 04 A chain: add the means; $SD = \sqrt{(\text{sum of } SD^2)}$, if independent.
- 05 $\pm 1 \text{ SD} \approx 68\%$, $\pm 2 \text{ SD} \approx 95\%$: for a bell-shaped total and an honest P.

MID-LEVEL · WORKED EXAMPLE

Apply it well

The situation: A city team has eight months to move resident parking permits online. Moving the old permit data: 12 days at best, 15 most likely, 24 at worst.

PERT: $(12 + 4 \times 15 + 24) \div 6 = 96 \div 6 = 16$ days; $SD (24 - 12) \div 6 = 2$; triangular $51 \div 3 = 17$. The project manager plans 16 days, tells the steering group '14 to 18 days, about two times in three', and records what the 24 days assume.

In the exam: Show the three values, both means and the SD; say which mean you use and why; give a range, its confidence and what P assumes.

SENIOR · WORKED EXAMPLE

Design and lead it

The situation: A city is joining 14 online services under one login over 30 months, with two main suppliers and a steering board; the base estimate is €11.5m.

Each work package gets three points from the people who will do it, before any target is shared. A simulation adds them up: a 50% chance of costing at most €12.3m, 80% at most €12.7m. The board picks 80% and funds the €1.2m gap as contingency.

In the exam: Treat the confidence level as the **sponsor's decision**: its cost, who holds the gap, and how you kept anchoring out of the three points.

WHERE IT SITS

IPMA · ICB4	PMI · PMBOK® GUIDE 8 · PMP® EXAM	APM · BOK 8 · PMQ EXAM
4.5.7 knowledge: three point estimation (p. 123); 4.5.4.2: effort and duration (p. 113)	Guide p. 183: multipoint estimating, the triangular formula; PERT, p. 52. Exam outline: tasks 6, 8	BoK (APM's Body of Knowledge) §5.4.1: three-point estimates give a range; assumptions feed contingency. PMQ (APM's Project Management Qualification) 20c, 22a

Sources: IPMA ICB4 (2015); Malcolm et al. (1959), PERT; PMI, PMBOK® Guide, 8th ed.; PMI, PMP® Examination Content Outline (2026); APM Body of Knowledge, 8th ed.; APM, PMQ handbook (v6, 2026)

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