

# Quality tools

Three formulas and two key rules, each with a worked example, then the three model sheets. They serve IPMA, PMI and APM exams alike.

## FORMULAS AND KEY RULES

### Cumulative percentage (Pareto chart)

**cumulative % = running total ÷ total × 100 (largest cause first)**

The **vital few** are the bars up to where the line bends, often near 80%; '80/20' is a rule of thumb (after Juran).

Example: 90, 50, 30, 14, 10, 6 of 200 → 45%, 70%, 85%, 92%, 97%, 100%: three causes of six give 85%

### Control limits (control chart)

**UCL = mean + 3 s · LCL = mean – 3 s · s =  $\sqrt{(\Sigma(x - \text{mean})^2 \div (n - 1))}$**

Take the mean and s from a stable period. By a common convention (Shewhart; Kerzner), about 99.7% of a stable process falls inside.

Example: 10, 8, 12, 9, 11, 7, 13, 10, 8, 12: mean 10; s =  $\sqrt{(36 \div 9)} = 2$ ; limits  $10 \pm 6 = 16$  and 4

### Signals of a special cause (rule of seven)

**a point outside the limits · or 7 consecutive points all above, or all below, the mean**

By chance, 7 on the same side is 1/2 seven times over: 1 in 128. Points inside with no pattern are **common cause** variation: leave them alone.

Example: Mean 10, limits 4 and 16: a day of 18 signals; so do 11, 12, 11, 13, 12, 11, 14 in a row

### Control limits are not specification limits (key rule)

**control limits: what the process does · specification limits: what is accepted**

Limits come from the data, specifications from the requirements (APM: acceptance criteria; ICB4: target values). Stable but off target? Change the process.

Example: Mean 20, s = 3: limits 11 and 29. A target of at most 18 is below the mean: most days miss it

### Choose the tool by the question (key rule)

**why? → fishbone + five whys · which first? → Pareto · changed? → control chart**

The fishbone (Ishikawa) goes wide; the five whys (Ohno) go deep, to a cause you can fix and prevent.

Example: 200 failed bookings: Pareto, timeouts 90 (45%); five whys, no load test; then a control chart, mean 10 a day

## IN THIS HANDOUT

|                                     |      |              |      |
|-------------------------------------|------|--------------|------|
| Cause-and-effect (fishbone) diagram | p. 2 | Pareto chart | p. 3 |
| Control chart                       | p. 4 |              |      |

**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); IPMA International Certification Regulations (ICR) v4.4 (2025); Ishikawa, Guide to Quality Control (1976); Ohno, Toyota Production System (1988); Juran, Quality-Control Handbook (1951); Juran (1975), The non-Pareto principle; Shewhart, Economic Control of Quality of Manufactured Product (1931); Kerzner, Project Management: A Systems Approach (11th ed.)

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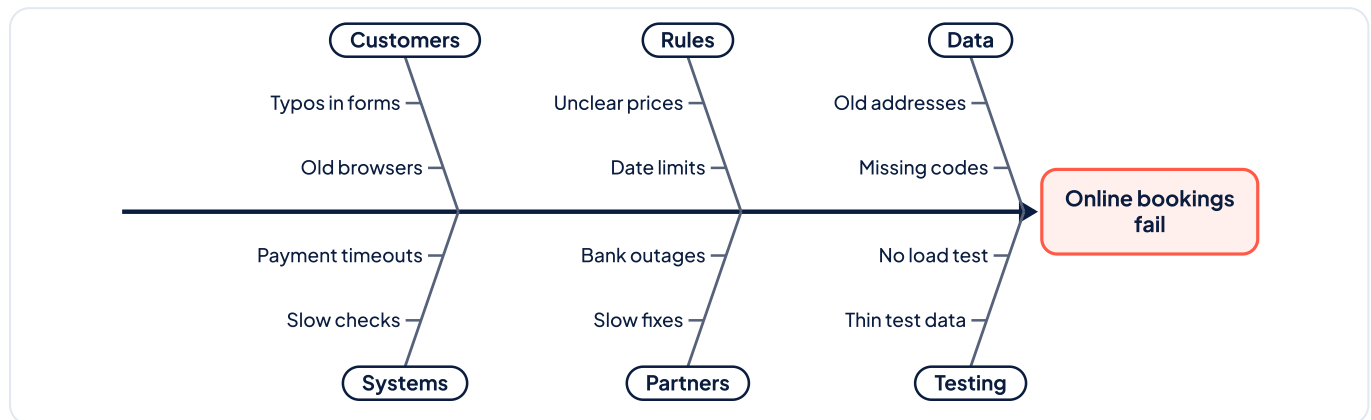
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# Cause-and-effect (fishbone) diagram

Sort the possible causes of one problem into groups, so the team looks across the whole system first.



Our own example: possible causes of failed online bookings, grouped by the team. Illustrative.

## WHAT IT IS

Write the **effect** in a box on the right, with a spine to it; each rib is a group of possible causes for this problem. **Kaoru Ishikawa** made the diagram popular. The **five whys** (Taiichi Ohno, Toyota) go deep down one rib, until the answer can be fixed and prevented. It shows what could cause the effect, not how often.

## HOW IT WORKS

- 01 State the effect with a number: 200 failed bookings.
- 02 Pick 4–6 groups that fit; add causes with the team.
- 03 Ask why down the likeliest rib until you can fix it.
- 04 Check with data; act to correct and to prevent.

### MID-LEVEL · WORKED EXAMPLE

#### Apply it well

**The situation:** A city team has moved resident parking permits online. In month one, 120 residents get their renewal reminder after their permit has expired.

A one-hour fishbone with the service desk and the supplier, then the five whys: reminders go out in one monthly batch and nobody owns the rules. Fix: send each 30 days ahead; name an owner.

**In the exam:** The effect with a number, the groups, the five whys down one rib; then the root cause, both actions and the evidence.

### 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. Defects that cross systems keep recurring.

One fishbone per recurring defect, with the same groups for every service and supplier, and evidence before blame. Causes in contracts or governance go to the steering board.

**In the exam:** Show shared groups across the parties, evidence before blame, and who decided the actions.

## WHERE IT SITS

| IPMA · ICB4                                                                           | PMI · PMBOK® GUIDE 8 · PMP® EXAM                                                            | APM · BOK 8 · PMQ EXAM                                                                                                                  |
|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| 4.5.6.3: detect defects, analyse their causes, explain a root-cause analysis (p. 121) | Guide: fishbone and five whys, p. 150; root cause analysis, p. 196. Outline: Process task 7 | BoK (APM's Body of Knowledge) §5.3.3: defects documented; ch. 6: diagnostic analytics. PMQ (APM's Project Management Qualification) 18b |

**Sources:** Ishikawa, Guide to Quality Control (1976); Ohno, Toyota Production System (1988); 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)

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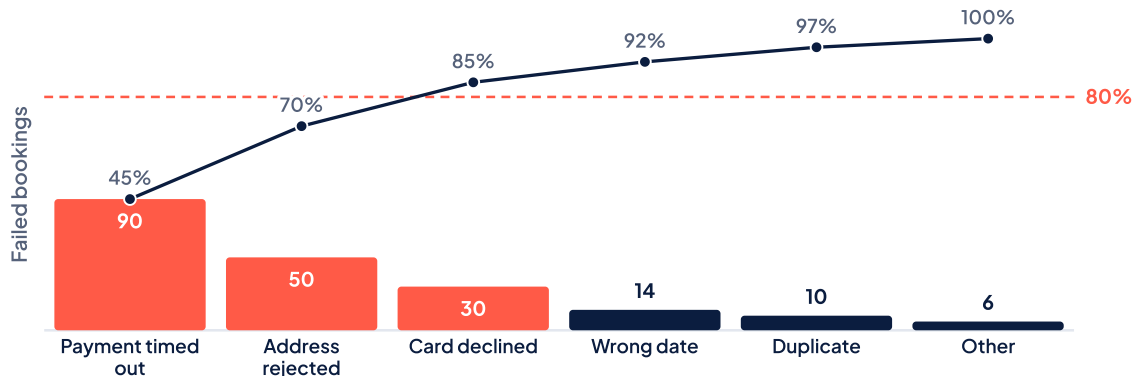
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# Pareto chart

Rank the causes of a problem by count, so the team fixes first the vital few that produce most of the effect.



Illustrative: 200 failed bookings in a month. Cumulative 45%, 70%, 85%: three causes of six give 85%.

## WHAT IT IS

One bar per cause, largest on the left, and a line adding up their share. **Joseph Juran** applied the idea to quality (1951): a **vital few** causes produce most of the losses. He named it after the economist **Vilfredo Pareto**, then called that name his mistake (1975). '80/20' is a rule of thumb: fix where the line bends; weigh a rare cause by its cost.

## HOW IT WORKS

- 01 Log each case with one cause from an agreed list.
- 02 Order the causes, the biggest first; draw the bars.
- 03 Cumulative share: running total ÷ total.
- 04 Fix the vital few first, then count again.

### MID-LEVEL · WORKED EXAMPLE

#### Apply it well

**The situation:** A city team has moved resident parking permits online. In two weeks, the service desk logs 160 calls about online renewals, one reason each.

Login help (64), payment questions (40) and unclear zones (24): 40%, 65%, then 128 of 160, or 80%. Login help is fixed first; two more weeks check the drop.

**In the exam:** Show the counts, order and cumulative shares; name the vital few, what you fix first and how you check it.

### SENIOR · WORKED EXAMPLE

#### Design and lead it

**The situation:** A city is joining 14 online services under one login over 30 months. Each service and supplier logs defects its own way.

The project manager agrees one list of causes for all. The steering board sees one Pareto per group of services, weighted by cost to residents as well as count, and decides where fixes are funded.

**In the exam:** Explain the shared categories, count against cost, and how the chart set funding priorities.

## WHERE IT SITS

### IPMA · ICB4

4.5.6: quality analysis tools and indicators (knowledge list, p. 119); 4.4.8.3: analyse data and trends (p. 90)

### PMI · PMBOK® GUIDE 8 · PMP® EXAM

Guide: data shown as bar charts and histograms, p. 163. Exam outline: Process task 7

### APM · BOK 8 · PMQ EXAM

BoK (APM's Body of Knowledge) §5.3.4: quantitative evaluation (gathering and analysing data) for continuous improvement. PMQ (APM's Project Management Qualification) 18b

**Sources:** Juran, Quality-Control Handbook (1951); Juran (1975), The non-Pareto principle; 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)

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# Control chart

Tell normal variation from a real signal over time, so you act on special causes and change the process for the rest.



Illustrative. Days 1–10: mean 10,  $s = 2$ , so limits  $10 \pm 6$ . Day 11 is above the UCL (upper control limit); days 14–20 run above the mean.

## WHAT IT IS

**Walter Shewhart** set out the method in 1931. Plot one measure over time with its **mean** and **control limits**: by a common convention, the mean  $\pm 3$  standard deviations of a stable period (Kerzner). Points between them are **common cause** variation, the noise of the process. A point outside, or seven in a row on one side, signals a **special cause**. **Specification limits** come from the requirements, not the data.

## HOW IT WORKS

- 01 Take a stable period: its mean and standard deviation,  $s$ .
- 02 Limits: mean  $\pm 3s$ . Draw the target apart.
- 03 Signals: a point outside, or 7 in a row on one side.
- 04 In control but off target? Change the process.

### MID-LEVEL · WORKED EXAMPLE

#### Apply it well

**The situation:** A city team has moved resident parking permits online. Over 20 days, payments fail 5 times a day on average ( $s = 1$ ); the target is at most 7.

Limits:  $5 \pm 3 \times 1$ , so 2 and 8. Days of 6 or 7 are common cause, left alone. Day 23 has 9, above 8: a special cause. The payment provider had changed a setting.

**In the exam:** Show the mean and limits with the arithmetic, name each signal, keep control limits apart from the target.

### 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.

Each key measure has a chart with agreed signals, an owner and a time to react. Supplier service levels are specification limits, and the data is shared. Common cause variation is not a person's fault.

**In the exam:** Explain the rules for many parties: which signals start action, who acts, how fast, and no blame for noise.

## WHERE IT SITS

| IPMA · ICB4                                                                               | PMI · PMBOK® GUIDE 8 · PMP® EXAM                                                        | APM · BOK 8 · PMQ EXAM                                                                                                                                |
|-------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4.5.6.1: indicators with quality target values (p. 120); 4.4.8.3: data and trends (p. 90) | Guide p. 158: control limits are not specification limits. Exam outline: Process task 7 | BoK (APM's Body of Knowledge) §5.3.3: QC measures outputs against the acceptance criteria. PMQ (APM's Project Management Qualification) objective 18b |

**Sources:** Shewhart, Economic Control of Quality of Manufactured Product (1931); Kerzner, Project Management: A Systems Approach (11th ed.); 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)

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