25 CALCULATORS · ONE REFERENCE

Calculator Reference Toolkit

Every Lean Six Sigma calculator from the SimplicityHub tools suite in one place — each with its formula, a worked example, how to read the result, the mistakes to avoid, and a blank worksheet ready for your own numbers.

BUILT FOR

Lean Six Sigma practitioners, CI managers, analysts and improvement teams.

HOW TO USE IT

A desk reference for the maths behind each tool — run the live versions online when you need the answer instantly.

WHAT'S INSIDE

WHAT'S INSIDE

Contents

The 25 calculators are grouped into four families. Each entry gives the formula, a worked example, how to interpret the result, the common mistakes to avoid, and a blank worksheet for your own data.

Try the live interactive calculators at https://www.simplicityhub.co.uk/tools.html
For downloadable templates go to https://www.simplicityhub.co.uk/templates.html

FAMILY 01

Six Sigma & Quality

These calculators quantify quality. They turn raw defect counts into normalised, comparable performance measures — DPMO, sigma level, capability indices and the cost of getting it wrong — so you can benchmark processes and prove improvement.

CALCULATORS IN THIS FAMILY

Try the live interactive calculators at https://www.simplicityhub.co.uk/tools.html
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SIX SIGMA & QUALITY

DPMO Calculator

Calculate Defects Per Million Opportunities to measure your process quality and see exactly where it sits on the Six Sigma scale.

WHAT IT IS

DPMO (Defects Per Million Opportunities) is a normalised defect rate. It scales any defect count up to a per-million basis, so processes with different volumes or complexity can be compared directly. It is the headline measurement of Six Sigma and the input to Sigma Level conversion.

FORMULA

DPMO = (Defects ÷ (Units × Opportunities per Unit)) × 1,000,000

Defects is the total count of defects observed. Units is the number of items inspected. Opportunities is the count of distinct ways each unit could be defective. A clear, agreed definition of an "opportunity" is essential — get it wrong and DPMO becomes meaningless.

WORKED EXAMPLE

A medical device assembly has 5 distinct features that could be defective per unit. The team inspects 800 units and finds 12 defects across all features. DPMO = (12 ÷ (800 × 5)) × 1,000,000 = 3,000 DPMO. That corresponds to roughly a 4.25 sigma process. Reducing defects from 12 to 4 in the same sample drops DPMO to 1,000 and lifts the process to 4.6 sigma. The conversion makes operational gains visible on the same scale as everyone else's — useful for benchmarking, certification and internal reporting.

HOW TO READ THE RESULT

Use DPMO at the start of any Six Sigma project as the baseline measurement, then track monthly to confirm improvement. It is also the metric for benchmarking sites and supplier quality.

COMMON MISTAKES TO AVOID

- Defining "opportunities" inconsistently across products — making DPMO incomparable between sites.
- Inflating opportunities to make DPMO look better — a common gaming behaviour that erodes the metric's value.
- Counting only critical defects in some periods and all defects in others.
- Reporting DPMO without the underlying defect, unit and opportunity counts.
- Treating DPMO as a target in itself rather than as a baseline for improvement.

YOUR WORKSHEET

BLANK WORKSHEET

Number of defects ____________________

Number of units ____________________

Opportunities per unit ____________________

DPMO = ____________________

SIX SIGMA & QUALITY

Sigma Level Calculator

Enter your DPMO and instantly see where your process sits on the Six Sigma scale — from 1σ all the way to world-class 6σ performance.

WHAT IT IS

Sigma Level is a measure of process quality on a normalised scale from 1 to 6 (and beyond). It converts the defect rate (DPMO) into a number of standard deviations the nearest specification limit sits from the process mean. A higher Sigma Level means fewer defects and tighter, more capable performance.

FORMULA

Sigma Level = NORMSINV(1 − DPMO ÷ 1,000,000) + 1.5 (long-term shift)

Sigma Level is derived from DPMO by looking up the corresponding tail probability of the normal distribution. By convention a 1.5σ "long-term shift" is added so the short-term capability of a typical process can be compared to the long-term performance — which is why 6σ corresponds to 3.4 DPMO, not the strict 2 parts per billion the maths would give.

WORKED EXAMPLE

A process delivers 233 defects per million opportunities. That corresponds to a Sigma Level of 5σ — strong performance, roughly typical of best-in-class manufacturing and well above average service-industry quality. To move from 5σ to 6σ the team must reduce DPMO from 233 to 3.4 — a 68-times improvement. Each Sigma Level jump is exponentially harder than the last, which is why most improvement programmes target a one-Sigma-Level lift per year, not the headline 6σ.

HOW TO READ THE RESULT

Use Sigma Level as the headline quality score for any Six Sigma programme, scorecard or benchmarking exercise. Combine with DPMO and Pareto for a full picture of where the defects sit.

COMMON MISTAKES TO AVOID

- Reporting Sigma Level without DPMO and opportunity definition — a 4σ score is meaningless without knowing how it was measured.
- Confusing short-term and long-term Sigma — the 1.5σ shift conventionally accounts for long-term drift.
- Comparing Sigma Levels across processes with very different opportunity definitions.
- Treating 6σ as an obligatory target — most processes deliver more value moving from 3σ to 4σ than from 5σ to 6σ.
- Reporting only the headline Sigma Level without the trend over time, which is where the real story lives.

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For downloadable templates go to https://www.simplicityhub.co.uk/templates.html

YOUR WORKSHEET

BLANK WORKSHEET

DPMO value ____________________

Sigma Level = ____________________

SIX SIGMA & QUALITY

Cp / Cpk Calculator

Measure process capability and centering using Cp and Cpk — so you can see whether your process consistently meets specification limits and where it sits relative to them.

WHAT IT IS

Cp and Cpk are short-term process capability indices. Cp compares the width of the specification to the width of the process spread (6 standard deviations). Cpk additionally accounts for how off-centre the process mean is from the spec midpoint. Cp says "can it fit"; Cpk says "does it fit where it sits".

FORMULA

$$Cp = (USL - LSL) \div 6\sigma \qquad Cpk = \min((USL - \bar{x}), (\bar{x} - LSL)) \div 3\sigma$$

$Cp = (USL - LSL) \div (6\sigma)$. $Cpk = \min((USL - \bar{x}) \div (3\sigma), (\bar{x} - LSL) \div (3\sigma))$. Both indices use the short-term σ from a stable sample. Cpk is always ≤ Cp; the gap between them tells you how much capability you would gain by centring the process.

WORKED EXAMPLE

A process has a mean of 10.4, standard deviation of 0.3, and specs of 10 ± 1. Cp = 2 ÷ (6 × 0.3) = 1.11 — the spread fits comfortably inside the spec. Cpk = min((11 − 10.4) ÷ 0.9, (10.4 − 9) ÷ 0.9) = 0.67 — much lower, because the process is off-centre. The Cp / Cpk gap (1.11 vs 0.67) tells you the process is producing defects only because it is not centred. Re-centring to 10 would deliver Cpk = 1.11 with zero variation-reduction effort. That is the practical diagnostic Cp and Cpk together provide.

HOW TO READ THE RESULT

Use Cp / Cpk to validate process capability before sign-off, qualify new equipment, or to gate a process for release. They are central to PPAP, IATF and most quality-management standards.

COMMON MISTAKES TO AVOID

- Calculating Cp / Cpk on an unstable process — the index is meaningless until the process is in statistical control.
- Using a long-term standard deviation (which includes drift) instead of the short-term σ.
- Reporting Cp without Cpk — Cp tells you nothing about centring, which is usually where the defects come from.
- Mixing populations or operators in the sample, inflating σ and depressing the index artificially.
- Confusing Cpk (short-term, ideal) with Ppk (long-term, actual) — they are different metrics.

YOUR WORKSHEET

BLANK WORKSHEET

Upper spec limit (USL) ____________________

Lower spec limit (LSL) ____________________

Process mean (μ) ____________________

Standard deviation (σ) ____________________

Cp / Cpk = ____________________

SIX SIGMA & QUALITY

Pp / Ppk Calculator

Measure long-term process performance using overall standard deviation — and compare it to short-term capability to reveal instability, drift, and variation that only appears over time.

WHAT IT IS

Pp and Ppk are long-term process performance indices. Pp compares spec width to total variation (overall standard deviation, including drift and shift). Ppk additionally accounts for centring. Unlike Cp / Cpk, which represent the capability of a stable process, Pp / Ppk represent what is actually being delivered.

FORMULA

$$Pp = (USL - LSL) \div 6\sigma(\text{overall}) \qquad Ppk = \min((USL - \bar{x}), (\bar{x} - LSL)) \div 3\sigma(\text{overall})$$

Pp = (USL − LSL) ÷ (6σ_overall). Ppk = min((USL − x̄) ÷ (3σ_overall), (x̄ − LSL) ÷ (3σ_overall)). σ_overall is the standard deviation of all data combined, not the within-subgroup σ used for Cp / Cpk. Ppk is always ≤ Cpk; the gap quantifies the cost of long-term instability.

WORKED EXAMPLE

A process shows Cpk of 1.5 (short-term capability) but Ppk of 0.9 (long-term performance). The Cpk says the process is theoretically capable; the Ppk says it isn't delivering — drift, operator effects and tool wear are eating the headroom. Closing the Cpk-vs-Ppk gap by addressing the special causes of drift recovers the headroom without any equipment investment. That is why Pp / Ppk are essential for honest long-term performance reporting — Cpk alone is too optimistic.

HOW TO READ THE RESULT

Use Pp / Ppk for long-term reporting, PPAP submissions, supplier scorecards, and any time you need an honest performance figure rather than a best-case capability figure.

COMMON MISTAKES TO AVOID

- Reporting Ppk in place of Cpk for initial qualification — the two metrics answer different questions.
- Calculating Ppk on a sample so short it doesn't capture real long-term variation.
- Ignoring the Cpk-vs-Ppk gap, which is the most important diagnostic these indices provide.
- Treating a healthy Cpk as proof the process is performing — only Ppk shows actual delivered performance.
- Comparing Ppk values across suppliers with very different measurement windows.

YOUR WORKSHEET

BLANK WORKSHEET

Upper spec limit (USL) ____________________

Lower spec limit (LSL) ____________________

Process mean (x̄) ____________________

Overall std dev (s) ____________________

Within-subgroup std dev (σ̂) ____________________

Pp / Ppk = ____________________

SIX SIGMA & QUALITY

Rolled Throughput Yield Calculator

Multiply individual process step yields together to reveal true end-to-end performance — exposing hidden defects and the cumulative impact of variation across a multi-step process.

WHAT IT IS

Rolled Throughput Yield (RTY) is the probability that a unit passes through every step of a multi-step process correctly the first time, with no rework, scrap or hidden factory effort. It is the product of every step's first-pass yield and is almost always significantly lower than any single step's yield.

FORMULA

$$RTY = Y_1 \times Y_2 \times Y_3 \times \ldots \times Y_n \quad (Y_i = \text{first-pass yield of each step})$$

$RTY = Y_1 \times Y_2 \times Y_3 \times \ldots \times Y_n$, where each Y_i is the first-pass yield of one step (good units out ÷ units in, ignoring any rework). RTY is the mathematically honest end-to-end figure — and the multiplication is the reason a process with five "95% good" steps actually delivers around 77%.

WORKED EXAMPLE

A five-step assembly process reports first-pass yields of 98%, 95%, 99%, 96% and 97%. Each step looks healthy. RTY = 0.98 × 0.95 × 0.99 × 0.96 × 0.97 = 0.858, or 85.8%. Fifteen units in every 100 require rework somewhere — a hidden factory the per-step numbers hid. If the worst step (95%) is improved to 99%, RTY rises to 0.895. A single 4-point gain at the constraint step delivers more end-to-end improvement than a 2-point lift across all five steps combined — which is why RTY is so useful for prioritising improvement effort.

HOW TO READ THE RESULT

Use RTY on any multi-step process where rework is being absorbed within steps rather than being scrapped. It is essential for DMAIC, for Lean Six Sigma project scoping, and for benchmarking sites that share the same product.

COMMON MISTAKES TO AVOID

- Using overall final yield (units shipped ÷ units started) as if it were RTY — final yield hides rework, RTY does not.
- Including rework loops in the per-step yield calculation, which artificially inflates the result.
- Counting test/inspection as a yield-improving step rather than a containment step — it does not improve RTY.
- Omitting low-volume but high-variation steps because they "don't matter" — they drag RTY down disproportionately.
- Comparing RTY across processes with different step counts without normalising.

YOUR WORKSHEET

BLANK WORKSHEET

Step yields (one per line, %) ______________________

Rolled Throughput Yield = ______________________

SIX SIGMA & QUALITY

Cost of Poor Quality Calculator

Quantify the true financial impact of defects by combining internal failure, external failure, appraisal and prevention costs — so leadership can see quality losses in pounds, not percentages.

WHAT IT IS

Cost of Poor Quality (COPQ) is the total cost an organisation incurs because its processes do not produce right-first-time. It groups all quality-related cost into four buckets — internal failure (scrap, rework), external failure (warranty, returns, recalls), appraisal (inspection, audit) and prevention (training, mistake-proofing).

FORMULA

COPQ = Internal Failure + External Failure + Appraisal + Prevention

The calculator sums the four buckets and expresses the total in pounds and as a percentage of revenue. Typical organisations sit between 15% and 25% of revenue — most of which is invisible because it is buried in indirect cost centres.

WORKED EXAMPLE

A £20m manufacturer reports scrap and rework of £600k, warranty and returns of £400k, inspection labour of £350k, and prevention spend of £150k. COPQ = £1.5m, or 7.5% of revenue — and the bulk sits in internal and external failure, both avoidable. Shifting £200k of failure cost into prevention (training, poka-yoke, supplier development) typically cuts failure costs by £400-600k within twelve months. The COPQ figure makes that business case visible in pounds, not in defect counts.

HOW TO READ THE RESULT

Use COPQ when building a business case for Six Sigma, prioritising improvement portfolios, justifying prevention spend, or benchmarking quality cost against peers.

COMMON MISTAKES TO AVOID

- Counting only visible failure costs and missing hidden ones like expediting, inventory buffers and lost sales.
- Treating inspection as if it were prevention — it is appraisal, and increasing it rarely reduces defects.
- Reporting COPQ as a percentage only — leadership responds faster to pounds.
- Omitting external failure because it sits in a different P&L line — warranty and returns are the most damaging cost of all.
- Comparing COPQ across very different industries without normalising — semiconductor COPQ and financial-services COPQ are not directly comparable.

YOUR WORKSHEET

BLANK WORKSHEET

Annual revenue (£)	______________
Internal failure costs (£/year)	______________
External failure costs (£/year)	______________
Appraisal costs (£/year)	______________
Prevention costs (£/year)	______________
Cost of Poor Quality =	______________

FAMILY 02

Lean & Flow

Lean calculators describe how work flows. They expose the rhythm of demand, the time work actually takes, where it waits, how much a line can produce, and the payback from faster changeovers — the levers behind shorter lead times and higher throughput.

CALCULATORS IN THIS FAMILY

01 OEE Calculator
Calculate Overall Equipment Effectiveness by breaking performance down into Availability,...

02 Takt Time Calculator
Find the pace at which your process must produce one unit to exactly match customer demand — the...

03 Cycle Time Calculator
Measure how long it actually takes your process to produce one unit, then compare against takt to...

04 Lead Time Calculator
Apply Little's Law to predict how long work will spend in your process — so you can manage queues,...

05 Production Capacity Calculator
Translate available time, cycle time and OEE into a realistic units-per-shift, day, week and year capacit...

06 Process Cycle Efficiency Calculator
Reveal how much of your total lead time is actually adding value vs sitting in queues, waits and rewor...

07 SMED Changeover ROI Calculator
Quantify the financial and capacity gains from reducing changeover time — compare current vs targe...

LEAN & FLOW

OEE Calculator

Calculate Overall Equipment Effectiveness by breaking performance down into Availability, Performance and Quality — so you know exactly where the losses are hiding and how far you are from the world-class 85% benchmark.

WHAT IT IS

OEE is a single percentage that combines Availability (how often the equipment is running when planned), Performance (how fast it runs compared with ideal) and Quality (how many units pass first time). Multiplied together, the three factors give one figure between 0% and 100% that summarises overall equipment loss.

FORMULA

OEE = Availability × Performance × Quality

Availability = Run Time ÷ Planned Production Time. Performance = (Total Units × Ideal Cycle Time) ÷ Run Time. Quality = Good Units ÷ Total Units. OEE = A × P × Q. The denominator is planned time, not calendar time — planned downtime such as breaks and scheduled maintenance is excluded.

WORKED EXAMPLE

A line is planned to run for 480 minutes. Downtime is 60 minutes, so Run Time is 420 minutes — Availability is 420 ÷ 480 = 87.5%. The ideal cycle time is 0.5 minutes per unit and 760 total units were produced, so Performance is (760 × 0.5) ÷ 420 = 90.5%. Of those 760 units, 730 met quality first time, so Quality is 730 ÷ 760 = 96.1%. OEE = 0.875 × 0.905 × 0.961 = 76.1%. The line is roughly 9 points away from the world-class 85% benchmark. Performance is the weakest of the three factors, so small-stops and slow-running losses are the right place to start.

HOW TO READ THE RESULT

Use OEE on tier-one daily boards, weekly reviews, monthly steering meetings, capital justifications, and any external benchmark. It is also the right tool when prioritising which of the Six Big Losses to tackle first on a constraint asset.

COMMON MISTAKES TO AVOID

- Including planned downtime in the denominator — that produces TEEP, not OEE.
- Using an optimistic ideal cycle time, which makes Performance look better than it is.
- Counting reworked units as good — Quality should reflect first-pass yield only.
- Reporting a single OEE for a whole line instead of measuring the constraint asset.
- Chasing the headline number instead of the weakest sub-score.

YOUR WORKSHEET

BLANK WORKSHEET

Planned production time ______________________

Run time ______________________

Total units produced ______________________

Good units produced ______________________

Ideal cycle time ______________________

OEE = ______________________

LEAN & FLOW

Takt Time Calculator

Find the pace at which your process must produce one unit to exactly match customer demand — the heartbeat of a balanced, waste-free production system.

WHAT IT IS

Takt time is the maximum allowable time between completed units that still satisfies customer demand. It is calculated from available production time and the number of units required in the same period. Takt is a planning rate, not a measured speed — it sets the target, while cycle time measures the reality.

FORMULA

Takt Time = Available Production Time ÷ Customer Demand

Available time is the net time after planned breaks, changeovers and scheduled maintenance — not calendar time. Customer demand is the number of units required in the same period as the available time, taken from real orders or a validated forecast.

WORKED EXAMPLE

A line runs one 8-hour shift per day. After breaks and a daily changeover the net available time is 420 minutes. The customer wants 210 units per day. Takt time = 420 ÷ 210 = 2 minutes per unit. Every station on that line must be able to complete its work in 2 minutes or less. If demand doubles to 420 units per day with no extra shift, takt time halves to 60 seconds. Every station now needs re-balancing — either by splitting tasks, adding people, or removing waste — because the heartbeat of the line has changed.

HOW TO READ THE RESULT

Use takt whenever you set up a new line, re-balance an existing one, plan a shift pattern, quote a delivery promise, or want to expose overproduction. It is also the right starting point before any kaizen event focused on flow.

COMMON MISTAKES TO AVOID

- Using gross shift time instead of net available time — always subtract planned breaks, changeovers and maintenance.
- Confusing takt time (a target pace) with cycle time (the actual measured time).
- Forgetting to recalculate when demand or available time changes.
- Treating takt as fixed across all products in a mixed-model line — different products need different takts or a weighted-average takt.
- Setting cycle times above takt and assuming overtime will absorb the gap.

YOUR WORKSHEET

BLANK WORKSHEET

Available production time ______________________

Customer demand ______________________

Takt Time = ______________________

LEAN & FLOW

Cycle Time Calculator

Measure how long it actually takes your process to produce one unit, then compare against takt to spot bottlenecks and overproduction risks.

WHAT IT IS

Cycle time is the actual, measured time taken to complete one unit of work from start to finish at a given step. It is different from ideal cycle time (the theoretical fastest), and different again from lead time (which includes queues and waits between steps). Cycle time is one of the four Lean foundation metrics.

FORMULA

Cycle Time = Net Production Time ÷ Units Produced

Net production time is the time the process was actually running, after planned breaks, changeovers and downtime. Units produced should normally be good units only — counting rejects flatters the result and hides quality losses.

WORKED EXAMPLE

A packing line runs for 480 minutes of net time and completes 240 good cases. Cycle time = 480 × 60 ÷ 240 = 120 seconds per case, or 30 cases per hour. That is the real pace the line delivered, including all the micro-stops that normally hide in shift notes. If takt time is 100 seconds per case, this step is the bottleneck — cycle exceeds takt by 20%. SMED on the changeover, a 5S sweep of the operator zone, or a small kaizen on the slowest sub-task is the right place to spend improvement effort before adding capacity.

HOW TO READ THE RESULT

Use cycle time on every Value Stream Map, OEE study, A3 problem statement and capacity quotation. It is also the foundation measurement for any line-balancing or kaizen event.

COMMON MISTAKES TO AVOID

- Counting reject or reworked units as good — cycle time should reflect first-pass output.
- Using ideal cycle time instead of the measured value when reporting performance.
- Forgetting to deduct planned breaks, changeovers and meetings from the available time window.
- Reporting one cycle time for a whole line instead of one per constraint step.
- Comparing cycle time across products with very different complexity without normalising.

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YOUR WORKSHEET

BLANK WORKSHEET

Net production time ____________________

Units produced in that time ____________________

Takt time (optional) ____________________

Cycle Time = ____________________

LEAN & FLOW

Lead Time Calculator

Apply Little's Law to predict how long work will spend in your process — so you can manage queues, set realistic delivery promises and target WIP reductions.

WHAT IT IS

Lead time is the total elapsed time for one unit of work to move through a process or value stream, from start to finish. Unlike cycle time, which measures one step, lead time includes all the queues and waits between steps — which is usually where most of the time hides.

FORMULA

Lead Time = Work In Process ÷ Throughput (Little's Law)

Little's Law: Lead Time = Work In Process ÷ Throughput. WIP is the number of units inside the process at any moment. Throughput is the rate at which finished units exit. The relationship is mathematical, not assumed, and holds for any stable process — manufacturing, software, services or healthcare.

WORKED EXAMPLE

A claims team has 100 cases in progress and closes 20 cases per day. Lead Time = 100 ÷ 20 = 5 days. Customers wait an average of 5 days for a decision — regardless of how fast any single case is actually worked. If the team caps WIP at 40 cases (same throughput), lead time drops to 2 days. The work isn't done faster — the queue is simply shorter. That is why WIP limits are the single most powerful Lean lever for lead-time reduction.

HOW TO READ THE RESULT

Use Little's Law any time you need to predict delivery promises, set WIP limits, justify a kanban system, or estimate the impact of a queue-reduction initiative.

COMMON MISTAKES TO AVOID

- Confusing lead time (end-to-end) with cycle time (one step) — they are not the same.
- Counting only working time and ignoring queues between steps, which usually dominate the total.
- Applying Little's Law to an unstable process where WIP and throughput change rapidly.
- Trying to reduce lead time by speeding up individual tasks rather than removing WIP.
- Forgetting that lead time and throughput are calendar-time measurements, not pure work time.

YOUR WORKSHEET

BLANK WORKSHEET

Work in Progress (WIP) ____________________

Throughput ____________________

Lead Time = ____________________

LEAN & FLOW

Production Capacity Calculator

Translate available time, cycle time and OEE into a realistic units-per-shift, day, week and year capacity figure — so you know whether your process can meet forecasted demand.

WHAT IT IS

Production capacity is the number of good units a process can realistically produce in a given period. It is not the same as ideal capacity, which assumes the equipment never stops and never produces a reject. Realistic capacity adjusts for the losses captured by OEE — availability, performance and quality.

FORMULA

Capacity = (Available Time ÷ Cycle Time) × OEE

Available time is net planned production time, cycle time is the time per unit at the constraint, and OEE multiplies in the real-world losses. Without the OEE term you get theoretical capacity, which is almost always over-promised.

WORKED EXAMPLE

A line has 480 minutes of net planned time per shift, an ideal cycle of 2 minutes per unit, and a measured OEE of 75%. Ideal capacity = 480 ÷ 2 = 240 units. Realistic capacity = 240 × 0.75 = 180 units per shift. Quoting against ideal capacity means missing delivery promises in 25% of cases. Quoting against realistic OEE-adjusted capacity sets honest expectations and exposes the size of the prize — the gap between 180 and 240 is where the improvement programme lives.

HOW TO READ THE RESULT

Use this any time you quote delivery dates, build a capital business case, size a new shift pattern, or argue whether a constraint really needs new equipment versus an OEE improvement programme.

COMMON MISTAKES TO AVOID

- Using ideal cycle time without applying OEE, which produces theoretical capacity rather than realistic capacity.
- Applying OEE measured on one shift to a different shift pattern with different losses.
- Calculating capacity for the whole line rather than for the constraint step — only the constraint matters.
- Forgetting to deduct planned downtime from the available time window.
- Quoting customers against ideal capacity and absorbing the gap with overtime.

YOUR WORKSHEET

BLANK WORKSHEET

Available production time per shift ____________________

Cycle time per unit ____________________

OEE (%) ____________________

Demand per day (optional) ____________________

Production Capacity = ____________________

LEAN & FLOW

Process Cycle Efficiency Calculator

Reveal how much of your total lead time is actually adding value vs sitting in queues, waits and rework — with a clear PCE percentage and a benchmark against world-class lean processes.

WHAT IT IS

Process Cycle Efficiency (PCE) is the percentage of total lead time spent actually adding value to the unit, as opposed to sitting in queues, waits, transport, inspection or rework. It is the headline diagnostic of how much waste a value stream contains — and a powerful before/after measure of Lean improvement.

FORMULA

PCE = (Value-Added Time ÷ Total Lead Time) × 100%

PCE = Value-Added Time ÷ Total Lead Time × 100%. Value-added time is the sum of steps that change the product in a way the customer would pay for. Total lead time is the calendar-time end-to-end, including every queue, batch wait and transport step. The two are measured from a value stream map.

WORKED EXAMPLE

A purchase order takes 12 working days from request to delivery. Mapping the value stream shows the actual value-adding work — approve, raise PO, place with supplier, receive — totals 38 minutes. PCE = 38 ÷ (12 × 8 × 60) × 100 = 0.66%. Less than 1% of the lead time adds value. The other 99% is queue, waiting for approval, batch processing and email pinging. Even a modest reduction in queue time would dramatically improve customer experience without any change to the value-adding work itself.

HOW TO READ THE RESULT

Use PCE as the headline metric of every value stream map, kaizen event, and Lean transformation case for change. It is also the right metric for benchmarking before and after a flow improvement.

COMMON MISTAKES TO AVOID

- Including inspection or QA time as value-adding — the customer pays for the product, not for it being checked.
- Measuring value-added time per unit and lead time per batch — both must use the same unit basis.
- Treating rework as value-added — rework is a quality cost, not value.
- Targeting PCE improvement by speeding up value-added work rather than removing queues.
- Forgetting that very high PCE (>50%) usually means the value stream has been mapped too narrowly.

YOUR WORKSHEET

BLANK WORKSHEET

Value-added time ______________________

Total lead time ______________________

Process Cycle Efficiency = ______________________

LEAN & FLOW

SMED Changeover ROI Calculator

Quantify the financial and capacity gains from reducing changeover time — compare current vs target setup, see the recovered production minutes per day, extra units, and annual revenue impact.

WHAT IT IS

SMED — Single-Minute Exchange of Die — is the Lean discipline of reducing setup and changeover time to under ten minutes. Every minute removed from a changeover that happens multiple times per day adds directly to available production time, without any extra equipment or labour spend.

FORMULA

Time Saved / Day = (Current − Target Changeover Time) × Changeovers per Day

Time Saved per Day = (Current Changeover Time − Target Changeover Time) × Changeovers per Day. Extra Units = Time Saved ÷ Cycle Time. Annual Revenue Impact = Extra Units × Working Days × Unit Margin. The calculator combines these to size the prize and justify the SMED programme.

WORKED EXAMPLE

A line runs four changeovers a day, each taking 45 minutes. A SMED programme targets 15 minutes. Time saved = (45 − 15) × 4 = 120 minutes per day. At a cycle time of 2 minutes, that's 60 extra units per day with zero capital spend. Across 250 working days at £15 margin per unit, the SMED programme delivers £225,000 of additional contribution annually — usually for the cost of a couple of kaizen workshops, some quick-release fixtures and a checklist.

HOW TO READ THE RESULT

Use SMED ROI to size the prize before launching a changeover-reduction programme, to justify quick-release fixtures or pre-staging trolleys, and to track financial impact after each kaizen event.

COMMON MISTAKES TO AVOID

- Counting only the visible changeover time and ignoring pre-staging, paperwork, and post-changeover ramp-up.
- Targeting the first changeover only, ignoring the second and third per day where the same minutes can be saved again.
- Confusing internal time (machine stopped) with external time (machine running) — most SMED gains come from converting internal to external.
- Sizing ROI on revenue rather than margin — only contribution margin is recovered, not full revenue.
- Assuming all recovered minutes become saleable units — only if demand exists for the extra capacity.

YOUR WORKSHEET

BLANK WORKSHEET

Current changeover time (minutes)	
Target changeover time (minutes)	
Changeovers per day	
Production rate (units / minute)	
Contribution per unit (£)	

SMED Changeover ROI = ____________________

FAMILY 03

Process & Data Analysis

These tools make patterns visible. Control limits separate signal from noise, Pareto focuses on the vital few, and box plots and dataset summaries reveal the spread, centre and outliers hiding inside your numbers.

CALCULATORS IN THIS FAMILY

PROCESS & DATA ANALYSIS

Control Limits Calculator

Paste your process data and instantly see UCL, CL, and LCL — with a live control chart that flags out-of-control points and Western Electric rule violations.

WHAT IT IS

Control limits are statistically calculated boundaries on a control chart — usually three standard deviations either side of the process mean. Points inside the limits represent common-cause (normal) variation; points outside the limits or violating Western Electric rules signal special-cause variation that needs investigation.

FORMULA

X-bar chart: $UCL = \bar{x} + 3\sigma \div \sqrt{n}$ $LCL = \bar{x} - 3\sigma \div \sqrt{n}$

For an X-bar chart: $UCL = \bar{x} + 3\sigma \div \sqrt{n}$, $LCL = \bar{x} - 3\sigma \div \sqrt{n}$. Different chart types (X-bar R, Individuals, p-chart, c-chart) use slightly different formulas, but the principle is the same — limits that capture about 99.7% of natural variation, so points outside are statistically rare under normal operation.

WORKED EXAMPLE

A bottling line has a mean fill weight of 500g with a within-sub-group σ of 2g and sub-group size of 5. $UCL = 500 + 3 \times (2 \div \sqrt{5}) \approx 502.7$g; $LCL \approx 497.3$g. Anything outside that range is a one-in-370 event under normal operation — almost certainly a real change. When the chart shows seven consecutive points above the centre line (a Western Electric run rule), the calculator flags a likely process shift even though no single point breached the limits. That early warning is the whole point of SPC — catch shifts before they become defects.

HOW TO READ THE RESULT

Use control charts on any critical-to-quality output, key process input, or KPI being monitored over time. They are the standard tool for the Control phase of DMAIC.

COMMON MISTAKES TO AVOID

- Using spec limits as control limits — they are different things. Spec limits define acceptability; control limits define statistical stability.
- Calculating control limits on unstable historical data — the limits inherit the instability and become useless.
- Reacting to every point rather than only out-of-control signals — this is "tampering" and increases variation.
- Ignoring Western Electric run rules — many real shifts are spotted by rules before any point breaches the limit.
- Recalculating limits after every shift, which masks long-term drift and defeats the purpose of monitoring.

Try the live interactive calculators at https://www.simplicityhub.co.uk/tools.html
For downloadable templates go to https://www.simplicityhub.co.uk/templates.html

YOUR WORKSHEET

BLANK WORKSHEET

Chart type ____________________

Subgroup size (n) ____________________

Process data ____________________

Control Limits = ____________________

PROCESS & DATA ANALYSIS

Pareto Chart Calculator

Paste your defect or cost data, rank the categories from largest to smallest, and instantly visualise the Pareto principle — with descending bars, a cumulative percentage line, and the 80% threshold highlighted.

WHAT IT IS

A Pareto chart ranks categories from largest to smallest and overlays a cumulative percentage line. It is named after the Pareto principle (80/20 rule) which observes that roughly 80% of effects come from 20% of causes. In Lean Six Sigma it is the standard tool for prioritising defects, cost drivers, complaint reasons and downtime causes.

FORMULA

Cumulative % = (running total ÷ grand total) × 100 (categories sorted high → low)

The calculator sorts your categories by frequency (or cost) high-to-low, then computes the cumulative percentage as a running sum divided by the grand total. The cumulative line crosses 80% somewhere in the early categories — those are the vital few that should be tackled first; everything to the right is the trivial many.

WORKED EXAMPLE

A QA team logs 480 defects across 12 categories in a month. Sorting by frequency, the top three categories — surface scratch (180), wrong label (110) and seal failure (75) — total 365, or 76% of all defects. The next category alone takes the cumulative to 82%. The team focuses kaizen effort on those three causes rather than spreading thin across all twelve. After two months the top-three rate halves, and a fresh Pareto reveals a new top three — at which point the cycle repeats. That is the engine of continuous improvement.

HOW TO READ THE RESULT

Use Pareto on defect categories, complaint reasons, downtime causes, scrap cost by SKU, or any data set with multiple categories competing for attention. It is the first tool to reach for in the Analyse phase of DMAIC.

COMMON MISTAKES TO AVOID

- Using raw counts when severity or cost varies significantly — Pareto by cost or weighted impact gives a different priority.
- Stopping at the first Pareto rather than re-running after each round of improvement to spot the new top causes.
- Including "Other" as a single category — split it so genuine top causes are not hidden inside a catch-all.
- Skipping the cumulative percentage line, which is what reveals where the 80% threshold actually falls.
- Pareto on too few categories (under five) where ranking adds little insight beyond a simple bar chart.

YOUR WORKSHEET

BLANK WORKSHEET

Data (one per line: category, value) ____________________

Pareto Chart = ____________________

PROCESS & DATA ANALYSIS

Box Plot Calculator

Paste your data and instantly visualise the five-number summary, IQR, whiskers, and outliers — with a real box plot chart and plain-English interpretation of distribution shape.

WHAT IT IS

A box plot (or box-and-whisker plot) is a graphical summary of a data set using the median, the lower and upper quartiles, and whiskers that extend to the most extreme non-outlier values. Outliers are plotted as individual points. It is one of the most information-dense visualisations in statistics.

FORMULA

$$IQR = Q3 - Q1 \qquad \text{Whiskers} = Q1 - 1.5 \times IQR \ \text{ to } \ Q3 + 1.5 \times IQR$$

The five-number summary is: minimum, lower quartile (Q1), median (Q2), upper quartile (Q3), maximum. The box spans Q1 to Q3 (the inter-quartile range, IQR). Whiskers extend to the most extreme values within 1.5 × IQR from the box. Anything beyond that is plotted as an outlier.

WORKED EXAMPLE

Two operators produce parts with the same average weight (50g) but very different distributions. Operator A: box from 49.8 to 50.2, no outliers — tight, controlled. Operator B: box from 49.5 to 50.5, with three outliers above 51 — wider variation, evidence of occasional special causes. The box plots tell the story instantly: averages are identical, but Operator B is far more variable and has out-of-control episodes. Mean alone would have hidden both signals. That is why a box plot belongs alongside every summary statistic in process analysis.

HOW TO READ THE RESULT

Use box plots whenever you want to compare distributions — between operators, shifts, suppliers, products, or time periods. They are essential at the Measure and Analyse phases of DMAIC.

COMMON MISTAKES TO AVOID

- Reporting only the mean — box plots reveal the distribution behind the average.
- Confusing outliers with errors — outliers might be the most informative data points, not the ones to discard.
- Comparing two box plots informally instead of using a proper hypothesis test when the difference matters.
- Using box plots on very small samples ($n < 10$) — quartiles become unstable.
- Ignoring skew — non-symmetric box plots invalidate many tests that assume normality.

Try the live interactive calculators at https://www.simplicityhub.co.uk/tools.html
For downloadable templates go to https://www.simplicityhub.co.uk/templates.html

YOUR WORKSHEET

BLANK WORKSHEET

Dataset name (optional) ______________________

Data values ______________________

Box Plot = ______________________

PROCESS & DATA ANALYSIS

Dataset Analysis

Upload a CSV or Excel file, select a numeric column, and get a full Minitab-style analysis: descriptive statistics, normality test (Anderson-Darling), histogram, box plot, Q-Q plot — with specific guidance if your data is non-normal.

WHAT IT IS

A Dataset Analysis is the structured exploratory phase of any statistical study. It combines descriptive statistics (mean, median, σ, skewness, kurtosis), a formal normality test, and visualisations (histogram, box plot, Q-Q plot) to characterise the data before any modelling, capability calculation or hypothesis test is run.

FORMULA

$$\text{Mean} = \Sigma x \div n \qquad s = \sqrt{\Sigma(x - \bar{x})^2 \div (n - 1)} \quad + \text{ normality test}$$

The tool computes the standard descriptive statistics, runs the Anderson-Darling test for normality (more powerful than Shapiro-Wilk for tails), and generates three plots. If the data fails the normality test, it provides specific guidance — try a Box-Cox transformation, switch to non-parametric tests, or use non-normal capability methods.

WORKED EXAMPLE

You upload 500 cycle-time measurements. The tool reports mean 12.3s, median 11.8s, σ 3.5s, skewness +1.4 (right-skewed), Anderson-Darling $p < 0.005$ (clearly non-normal). The histogram confirms a right tail; the Q-Q plot shows the upper end pulled away from the line. The tool flags that running Cpk or a t-test on this data without transformation would mislead. After a log transform the data is approximately normal, and the analyses become valid. That single diagnostic step prevents weeks of wrong conclusions in DMAIC Analyse.

HOW TO READ THE RESULT

Use it on every dataset before computing capability indices, running hypothesis tests, building regression models or designing experiments. It is the first step in DMAIC Measure and Analyse.

COMMON MISTAKES TO AVOID

- Skipping the diagnostic step and running parametric tests on non-normal data.
- Stripping outliers without first checking they are real values rather than data-entry errors.
- Reporting mean and standard deviation on heavily skewed data — median and IQR are more honest.
- Treating a normality test pass as proof of normality — it just fails to find evidence of non-normality.
- Using normal-based capability indices (Cpk, Ppk) on visibly non-normal data without transformation.

YOUR WORKSHEET

BLANK WORKSHEET

Numeric column ______________________

Dataset Analysis = ______________________

FAMILY 04

Statistics & Sampling

Statistical calculators keep your conclusions honest. They size samples correctly, quantify uncertainty with confidence intervals, standardise values, test significance, and check whether relationships in the data are real or coincidence.

CALCULATORS IN THIS FAMILY

01 **Sample Size Calculator**
Calculate the minimum sample size needed to achieve your target precision — for estimating means,...

02 **Attribute Sample Size Calculator**
Calculate the sample size needed to detect or confirm defect rates for pass/fail data — with zero-...

03 **Confidence Interval Calculator**
Calculate confidence intervals for a mean or a proportion — choose your confidence level (90%, 95%...

04 **Standard Deviation Calculator**
Paste your data to calculate sample or population standard deviation — with variance, coefficient of...

05 **Z-Score Calculator**
Convert any raw value into a standardised Z-score using the mean and standard deviation — with the...

06 **P-Value Calculator**
Calculate p-values for Z-tests, T-tests, and Chi-square tests — one-tailed or two-tailed. Includes a liv...

07 **Correlation Calculator**
Paste two columns of paired data to instantly calculate Pearson's correlation coefficient (r) — with a...

08 **Binomial Distribution Calculator**
Calculate exact and cumulative binomial probabilities for pass/fail processes — with a full probability...

STATISTICS & SAMPLING

Sample Size Calculator

Calculate the minimum sample size needed to achieve your target precision — for estimating means, detecting differences between two groups, or measuring proportions. Includes a precision vs sample size trade-off chart.

WHAT IT IS

Sample size is the number of observations you need so that your estimate is precise enough, or that your hypothesis test has enough power to detect a real difference. Too small and the result is noise; too large and you waste effort and money. The right size depends on the variability of the data and the size of effect you want to detect.

FORMULA

Mean: $n = (Z \times \sigma \div E)^2$ Proportion: $n = Z^2 \times p(1-p) \div E^2$

For a mean: $n = (Z \times \sigma \div E)^2$, where σ is the standard deviation and E is the margin of error you want. For a proportion: $n = (Z^2 \times p(1-p)) \div E^2$. For comparing two groups, the formula includes both the desired statistical power and the minimum detectable difference. The calculator handles each case.

WORKED EXAMPLE

A team wants to estimate average satisfaction within ±0.2 points with 95% confidence. The standard deviation of past scores is 1.5. $n = (1.96 \times 1.5 \div 0.2)^2 \approx 216$ customers. Anything less and the interval is too wide to detect the changes leadership cares about. If they accept ±0.3 precision instead, sample size drops to 97 — less than half. The calculator makes the precision-vs-cost trade-off explicit, so leadership can choose how much rigour they want to pay for before commissioning the survey.

HOW TO READ THE RESULT

Use this calculator before any survey, audit, capability study, A/B test or DOE. Calculating the right n in advance is far cheaper than discovering after the fact that the sample wasn't big enough.

COMMON MISTAKES TO AVOID

- Skipping sample-size calculation and "just collecting some data" — then discovering the result is inconclusive.
- Using last project's sample size as a default rather than recalculating for the new effect size and variability.
- Forgetting that detecting smaller effects requires disproportionately larger samples (n grows as the square of 1/E).
- Confusing precision (CI width) with power (ability to reject H_0) — they are related but distinct concepts.
- Using a normal-distribution formula on small samples that should use the t-distribution.

YOUR WORKSHEET

BLANK WORKSHEET

Confidence level	
Standard deviation (σ)	
Margin of error (E)	
Confidence level (α)	
Power (1–β)	
Pooled std dev (σ)	
Min detectable diff (δ)	
Estimated proportion (p)	

Sample Size = ______________________

STATISTICS & SAMPLING

Attribute Sample Size Calculator

Calculate the sample size needed to detect or confirm defect rates for pass/fail data — with zero-acceptance sampling, proportion estimation, and observed-defects confidence interval analysis.

WHAT IT IS

Attribute sample size answers the question "how many pass/fail items must I inspect to be sufficiently sure of the underlying defect rate?". It is the discrete counterpart to continuous-data sample-size calculations and is the standard approach for audits, supplier acceptance and conformity inspection.

FORMULA

Zero-acceptance: $n = \ln(1 - \text{Confidence}) \div \ln(1 - \text{AQL})$

For zero-acceptance: $n = \ln(1 - \text{Confidence}) \div \ln(1 - \text{AQL})$. For proportion estimation: $n = (Z^2 \times p(1-p)) \div E^2$. For confidence on observed defects, the calculator uses exact binomial methods rather than the normal approximation, which matters when defect counts are small.

WORKED EXAMPLE

A buyer wants 95% confidence the supplier's defect rate is below 1%. Zero-acceptance sample size: $n = \ln(0.05) \div \ln(0.99) \approx 299$ units. Inspect 299 with zero defects allowed; any defect rejects the lot. If the buyer relaxes the AQL to 2%, sample size drops to 149. Doubling the AQL roughly halves the sample. The calculator makes the trade-off between acceptable quality level and inspection cost explicit before the audit is commissioned.

HOW TO READ THE RESULT

Use this for incoming-goods inspection, audit sample selection, supplier qualification, process audits, and any pass/fail acceptance decision.

COMMON MISTAKES TO AVOID

- Using continuous-data sample-size formulas on pass/fail data — they give the wrong answer.
- Picking a sample size by convention (n=30) without checking it meets the confidence requirement.
- Using the normal approximation on small defect counts — exact binomial methods are correct.
- Confusing AQL (acceptable quality level) with the actual defect rate — AQL is a planning input.
- Forgetting that zero defects in n samples is not proof of zero defect rate — it gives an upper confidence bound on the rate.

YOUR WORKSHEET

BLANK WORKSHEET

Confidence level	______________
Max acceptable defect rate (p)	______________
Estimated defect rate (p)	______________
Margin of error (E)	______________
Sample size (n)	______________
Defects found (d)	______________
Defect opportunities per unit	______________

Attribute Sample Size = ______________

STATISTICS & SAMPLING

Confidence Interval Calculator

Calculate confidence intervals for a mean or a proportion — choose your confidence level (90%, 95%, 99% or custom), and see the margin of error and lower and upper bounds.

WHAT IT IS

A confidence interval (CI) is a range of values that, given the sampling method, is expected to contain the true population parameter at a stated level of confidence. A 95% CI means that if you repeated the sampling many times, 95% of those intervals would contain the true value — not that there is a 95% chance the true value is inside this particular one.

FORMULA

$CI = \bar{x} \pm z \times (s \div \sqrt{n})$ Proportion: $CI = \hat{p} \pm z \times \sqrt{\hat{p}(1-\hat{p}) \div n}$

For a mean: $CI = \bar{x} \pm z \times (s \div \sqrt{n})$, where $\bar{x}$ is the sample mean, s the standard deviation, n the sample size, and z the critical value from the normal distribution at the chosen confidence level (1.96 for 95%). For a proportion: $CI = \hat{p} \pm z \times \sqrt{\hat{p}(1-\hat{p})/n}$.

WORKED EXAMPLE

A survey of 400 customers gives a satisfaction score with mean 7.8 and standard deviation 1.5. At 95% confidence: $CI = 7.8 \pm 1.96 \times (1.5 \div \sqrt{400}) = 7.8 \pm 0.147$. The true mean satisfaction is between 7.65 and 7.95 with 95% confidence. If you doubled the sample to 800, the interval shrinks to 7.8 ± 0.104 — a 30% improvement in precision for double the sampling cost. CIs make the precision-vs-cost trade-off explicit before committing to a sample size.

HOW TO READ THE RESULT

Use CIs every time you report a sample mean, sample proportion or process capability index. Also use them to test whether a process change has produced a statistically meaningful improvement.

COMMON MISTAKES TO AVOID

- Saying "there is a 95% chance the true value is in this interval" — that is a Bayesian statement, not what a frequentist CI means.
- Confusing confidence level (95%) with precision — a narrow CI at 90% may be more useful than a wide CI at 99%.
- Reporting a CI without the sample size — readers need n to judge the figure.
- Using the z formula when n is small (under 30); use the t-distribution instead.
- Comparing two CIs visually instead of running a proper hypothesis test on the difference.

YOUR WORKSHEET

BLANK WORKSHEET

Mode ____________________

Sample mean ____________________

Sample standard deviation ____________________

Successes ____________________

Sample size (n) ____________________

Confidence level (%) ____________________

Confidence Interval = ____________________

STATISTICS & SAMPLING

Standard Deviation Calculator

Paste your data to calculate sample or population standard deviation — with variance, coefficient of variation, z-scores, σ-zone breakdown, and a histogram with normal curve overlay.

WHAT IT IS

Standard deviation measures the typical distance of data points from the mean. A low value means the process is tight and consistent; a high value means the process is variable. It is the single most useful statistic in process improvement and the basis of nearly every other inferential method.

FORMULA

$$\text{Population } \sigma = \sqrt{\Sigma(x_i - \mu)^2 \div N} \qquad \text{Sample } s = \sqrt{\Sigma(x_i - \bar{x})^2 \div (n - 1)}$$

Population $\sigma = \sqrt{\Sigma(x_i-\mu)^2 \div N}$. Sample $s = \sqrt{\Sigma(x_i-\bar{x})^2 \div (n-1)}$. Variance is the square of standard deviation. The (n−1) divisor for samples produces an unbiased estimator and matters most for small samples — get this wrong and capability indices, p-values and CIs are all subtly off.

WORKED EXAMPLE

Two lines both have a mean weight of 100g. Line A: σ = 0.4g. Line B: σ = 1.2g. Same average — but Line B varies three times as much. Customers will see Line B defects (overfill, underfill) far more often, even though "average" is identical. Standard deviation feeds straight into Cp / Cpk, control charts and Sigma Level. Halving σ on Line B would deliver dramatic improvements in defect rate without any change to the mean — which is why variation reduction is the heart of Six Sigma.

HOW TO READ THE RESULT

Use standard deviation whenever you want to characterise the spread of any continuous data set — process outputs, cycle times, weights, dimensions, financial returns.

COMMON MISTAKES TO AVOID

- Using population σ when you have a sample — it produces a slightly biased estimate.
- Calculating σ across non-stable data (drift, special-cause variation) — chart the data first.
- Reporting σ without the units — σ = 0.5 is meaningless without context (mm? minutes? £?).
- Comparing σ across data sets with different means — use coefficient of variation (σ ÷ mean) for fair comparison.
- Treating one σ value as representative of the whole process when subgroups behave differently.

Try the live interactive calculators at https://www.simplicityhub.co.uk/tools.html
For downloadable templates go to https://www.simplicityhub.co.uk/templates.html

YOUR WORKSHEET

BLANK WORKSHEET

Data values ____________________

Standard Deviation = ____________________

STATISTICS & SAMPLING

Z-Score Calculator

Convert any raw value into a standardised Z-score using the mean and standard deviation — with the corresponding percentile, probability, and a normal curve showing exactly where the value sits.

WHAT IT IS

A Z-score is a standardised value. It tells you whether a result is above the mean, below the mean, or close to the centre of the data. A score of 0 means the value is exactly average. A score of +1 means one standard deviation above the mean. A score of -1 means one standard deviation below the mean.

FORMULA

$$Z = (x - \mu) \div \sigma$$

The calculation takes the value you are checking, subtracts the mean, then divides by the standard deviation. The calculator also converts the result into probabilities so you can see the percentage of values expected below and above that point on a normal curve.

WORKED EXAMPLE

A candidate scores 75 on a test where the mean is 60 and the standard deviation is 8. The Z-score is (75 - 60) ÷ 8 = 1.875. That places the candidate around the 97th percentile, meaning they performed better than most people in that test group. Now compare that with another candidate who scored 80 on a different test where the mean is 70 and the standard deviation is 12. Their Z-score is 0.83, around the 79th percentile. Even though the raw score is higher, the first candidate performed better relative to their peer group.

HOW TO READ THE RESULT

Use a Z-score when you need to compare different data sets, understand where a result sits in a distribution, support a hypothesis test, or explain whether a performance measure is unusual compared with historic results.

COMMON MISTAKES TO AVOID

- Using a Z-score on very small data sets without checking whether the data is reliable.
- Assuming every unusual score is automatically a defect or failure.
- Mixing population and sample standard deviation without being consistent.
- Ignoring the practical impact of the result and focusing only on the statistic.

YOUR WORKSHEET

BLANK WORKSHEET

Raw value (x) ____________________

Mean (μ) ____________________

Standard deviation (σ) ____________________

Z-Score = ____________________

STATISTICS & SAMPLING

P-Value Calculator

Calculate p-values for Z-tests, T-tests, and Chi-square tests — one-tailed or two-tailed. Includes a live distribution curve with the rejection region, significance verdict at α=0.05 and 0.01, and plain-English interpretation.

WHAT IT IS

A p-value is the probability of observing data at least as extreme as your sample, assuming the null hypothesis is true. A small p-value (typically < 0.05) is evidence against the null and grounds for accepting the alternative. A large p-value means your data is consistent with the null — not that the null is proven correct.

FORMULA

Two-tailed: $p = 2 \times P(Z \geq |z|)$ One-tailed: $p = P(Z \geq z)$

The calculator computes the test statistic appropriate to the test (Z, t, or chi-square), then converts it to a p-value using the relevant distribution. The p-value is the area under the curve more extreme than the observed test statistic, on one tail or both depending on the test direction.

WORKED EXAMPLE

A team changes a machine setting and measures defect rates before and after. A two-sample t-test gives $t = 2.78$ with 58 degrees of freedom. P-value = 0.0073, well below $\alpha = 0.05$. The team rejects the null hypothesis of "no difference" and concludes the change has reduced defect rates. They still report the size of the effect (the difference in means with a confidence interval), because significance alone is not the same as practical importance.

HOW TO READ THE RESULT

Use p-values whenever you compare two groups, test a process change, or validate a Designed Experiment. They are the closing test in any Lean Six Sigma improve phase.

COMMON MISTAKES TO AVOID

- Treating $p < 0.05$ as proof — it is evidence against the null, not certainty.
- Confusing statistical significance with practical significance — a tiny effect can be statistically significant with a huge sample.
- Running multiple tests without correcting α — every additional test increases the chance of a false positive.
- Reporting only the p-value and not the effect size or confidence interval.
- Choosing the test direction (one- vs two-tailed) after seeing the data — this inflates false positives.

YOUR WORKSHEET

BLANK WORKSHEET

Z-statistic	
Sample mean ($\bar{x}$)	
Hypothesised mean (μ_0)	
Population std dev (σ)	
Sample size (n)	
T-statistic	
Degrees of freedom (df)	
Sample std dev (s)	
Chi-square statistic (χ^2)	

P-Value = ______

STATISTICS & SAMPLING

Correlation Calculator

Paste two columns of paired data to instantly calculate Pearson's correlation coefficient (r) — with a live scatter plot, regression line, R-squared, and a plain-English interpretation of strength and direction.

WHAT IT IS

Correlation measures the strength and direction of a linear relationship between two variables. Pearson's r ranges from −1 (perfect negative) through 0 (no linear relationship) to +1 (perfect positive). It does not prove causation — only that the two variables move together in a predictable way.

FORMULA

$$\text{Pearson's } r = \Sigma((x - \bar{x})(y - \bar{y})) \div \sqrt{(\Sigma(x - \bar{x})^2 \times \Sigma(y - \bar{y})^2)}$$

Pearson's $r = \Sigma((x-\bar{x})(y-\bar{y})) \div \sqrt{(\Sigma(x-\bar{x})^2 \times \Sigma(y-\bar{y})^2)}$. The calculator standardises both variables, then computes the average product of their deviations from the mean. R-squared (r^2) is the proportion of variation in one variable explained by the other.

WORKED EXAMPLE

A QA team plots oven temperature against defect rate across 30 batches. Pearson's r comes back at −0.78 — a strong negative correlation. $R^2 = 0.61$, meaning 61% of the variation in defects is associated with temperature variation. The team has a credible hypothesis: holding temperature tighter should reduce defects. They follow up with a designed experiment to confirm causation. Correlation pointed them at the right variable; the DOE proved the relationship was causal, not coincidental.

HOW TO READ THE RESULT

Use correlation in DMAIC Analyse to screen candidate root causes before launching a full Designed Experiment. It is also the first tool in Measurement System Analysis and regression studies.

COMMON MISTAKES TO AVOID

- Confusing correlation with causation — r tells you variables move together, not that one causes the other.
- Reporting r without R^2 — R^2 is the more useful number for explaining how much variation is shared.
- Using Pearson's r on non-linear relationships — it only detects linear association.
- Drawing conclusions from very small samples ($n < 20$) — small samples produce unstable r values.
- Ignoring outliers, which can either inflate or hide a real correlation.

YOUR WORKSHEET

BLANK WORKSHEET

Paired data (one pair per line: x, y) ______________________

Correlation = ______________________

STATISTICS & SAMPLING

Binomial Distribution Calculator

Calculate exact and cumulative binomial probabilities for pass/fail processes — with a full probability mass function chart, distribution table, and Six Sigma acceptance sampling context.

WHAT IT IS

The binomial distribution describes the probability of obtaining exactly k successes in n independent trials, where each trial has the same probability p of success. It is the foundation of attribute-sample acceptance plans, defect-rate inference and many quality control techniques.

FORMULA

$$P(X = k) = C(n, k) \times p^k \times (1 - p)^{(n-k)}$$

$P(X = k) = C(n,k) \times p^k \times (1-p)^\wedge(n-k)$, where C(n,k) is the number of ways to choose k from n. The cumulative version sums probabilities for $X \leq k$ or $X \geq k$. The calculator handles both, plus the practical question "what is the chance of zero defects given this defect rate?".

WORKED EXAMPLE

A supplier claims a 2% defect rate. You inspect 100 units. The probability of finding zero defects: $P(X = 0) = C(100,0) \times 0.02^0 \times 0.98^{100} \approx 0.133$, or 13%. There is an 87% chance of seeing at least one defect — useful context for acceptance decisions. If the actual rate is 5%, P(X = 0) drops to 0.6%. A zero-defects result from 100 units is very strong evidence the rate is well below 5% — but not below 1%. The binomial lets you calculate exactly what the data says.

HOW TO READ THE RESULT

Use the binomial for any pass/fail data with a constant success probability — supplier audits, sample acceptance, A/B test results, machine reliability and survey response.

COMMON MISTAKES TO AVOID

- Using the binomial when trials are not independent (e.g. defects clustered in batches).
- Using the binomial when p changes during sampling — switch to a hypergeometric model.
- Using the normal approximation when np or n(1−p) is small (under 5).
- Confusing exact $P(X = k)$ with cumulative $P(X \leq k)$ — the difference matters for acceptance plans.
- Forgetting that the binomial assumes a fixed n; for variable-stopping sampling, the negative binomial is correct.

YOUR WORKSHEET

BLANK WORKSHEET

Number of trials (n) ____________________

Probability of success (p) ____________________

Number of successes (k) ____________________

Lower bound (a) ____________________

Upper bound (b) ____________________

Binomial Distribution = ____________________

BEFORE YOU GO

Put these to work

1

Run the live versions

Every calculator in this toolkit has an interactive version online that does the maths instantly — use this PDF to understand what the numbers mean, then run the live tool when you need the answer.

2

Measure before and after

Capture a baseline with the relevant calculator before you change anything, then re-measure after. The gap is your evidence of improvement.

3

Pair the tools

These calculators are stronger together — size your sample, capture the data, test capability, then track control limits over time.

4

Keep it honest

Mind the common mistakes on each page. A confident number from a flawed input is more dangerous than no number at all.

ALL 25 CALCULATORS, LIVE

simplicityhub.co.uk/tools.html

Interactive versions of every tool in this guide — free to use, no sign-up required.

SIMPLICITYHUB™ ESSENTIALS

Tools for the people who use the tools

Built for practitioners who live in the data. Carry the SimplicityHub kit — a notebook for your Gemba walks, a mug for the morning stand-up, and everyday essentials that keep the continuous-improvement mindset close at hand.

NOTEBOOK

MUG

HOODIE

WATER BOTTLE

T-SHIRT

SCAN TO EXPLORE

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