

Six Sigma in Operations Management: Concepts, Purpose, and Examples

- Data-driven methodology: reduce defects and process variation
- Goal: near-perfect quality, lower cost, higher customer satisfaction
- Built on DMAIC, statistical tools, and root-cause thinking
- For operations managers, quality pros, improvement teams, analysts
- Agenda: core concepts, strategic purpose, tools, real examples



Background and Evolution

- 1980s Motorola: Bill Smith's defect-counting method, championed by CEO Bob Galvin
- Motorola won the first Malcolm Baldrige National Quality Award in 1988
- 1995: Jack Welch made Six Sigma central to GE strategy, reporting billions in savings
- Three phases: defect reduction (1987–1994), cost reduction (1994–2000), enterprise performance (2000s–present)
- Builds on TQM, SPC, and Lean, with greater emphasis on financial returns and executive ownership



1987 Motorola

Defect-counting method championed by CEO Bob Galvin



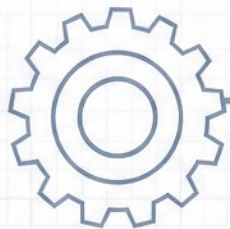
1995 GE

Six Sigma made central to GE strategy

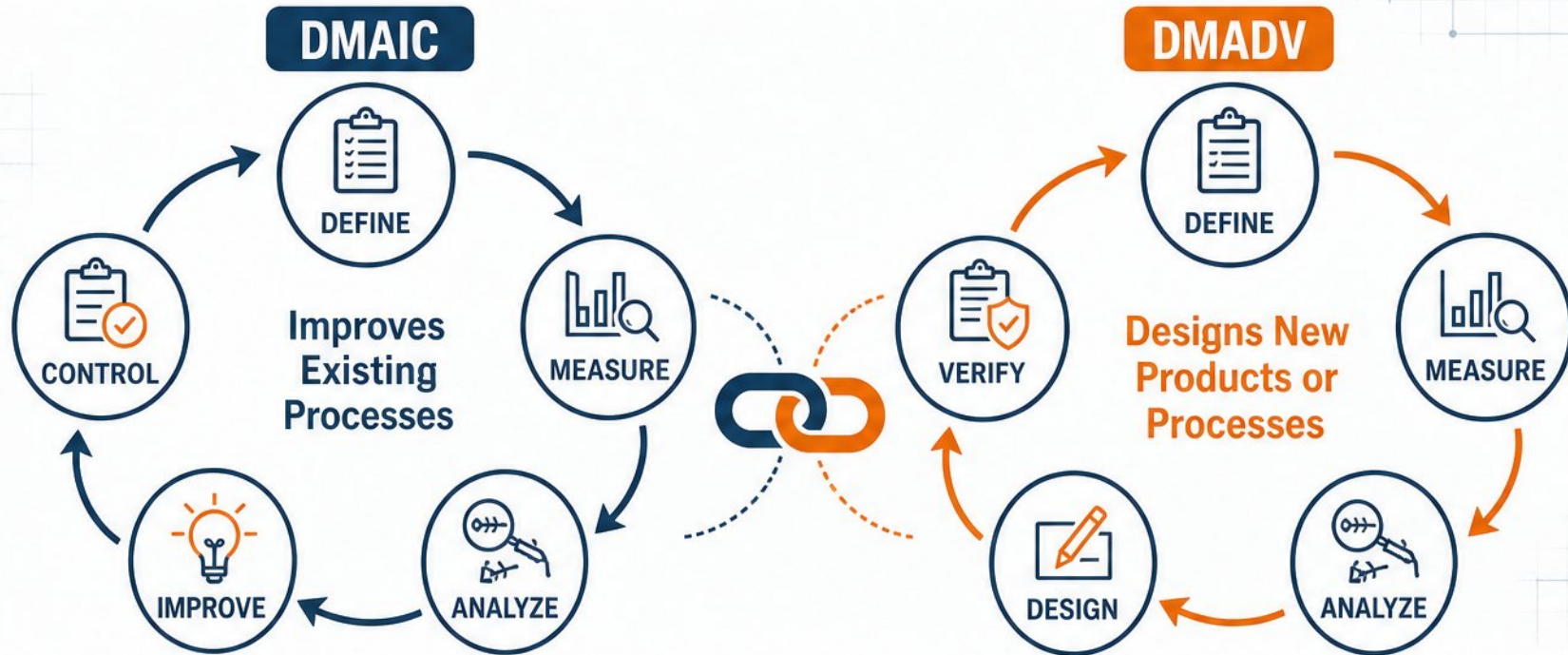
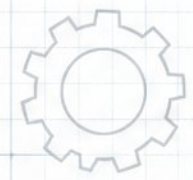


2000s– Present

Digital and enterprise performance focus



Core Methodology: DMAIC and DMADV



- DMAIC improves existing processes: Define, Measure, Analyze, Improve, Control.



- Define: charter, scope, SIPOC; Measure: baseline data, DPMO; Analyze: root causes, FMEA.



- Improve: solutions, DOE, pilot; Control: SPC, control plan.



- DMADV designs new products or processes: Define, Measure, Analyze, Design, Verify.



- Each phase delivers an output the next phase depends on, such as a signed charter.



- Duration: Green Belt 3–4 months; Black Belt 4–6 months; live data can compress to 8–12 weeks.

Key Metrics: DPMO, Sigma Level, and Process Capability



- DPMO normalizes defects per million opportunities, enabling fair comparison across processes



- $6\sigma = 3.4$ DPMO; $5\sigma = 233$ DPMO; $4\sigma = 6,210$ DPMO under the 1.5σ shift



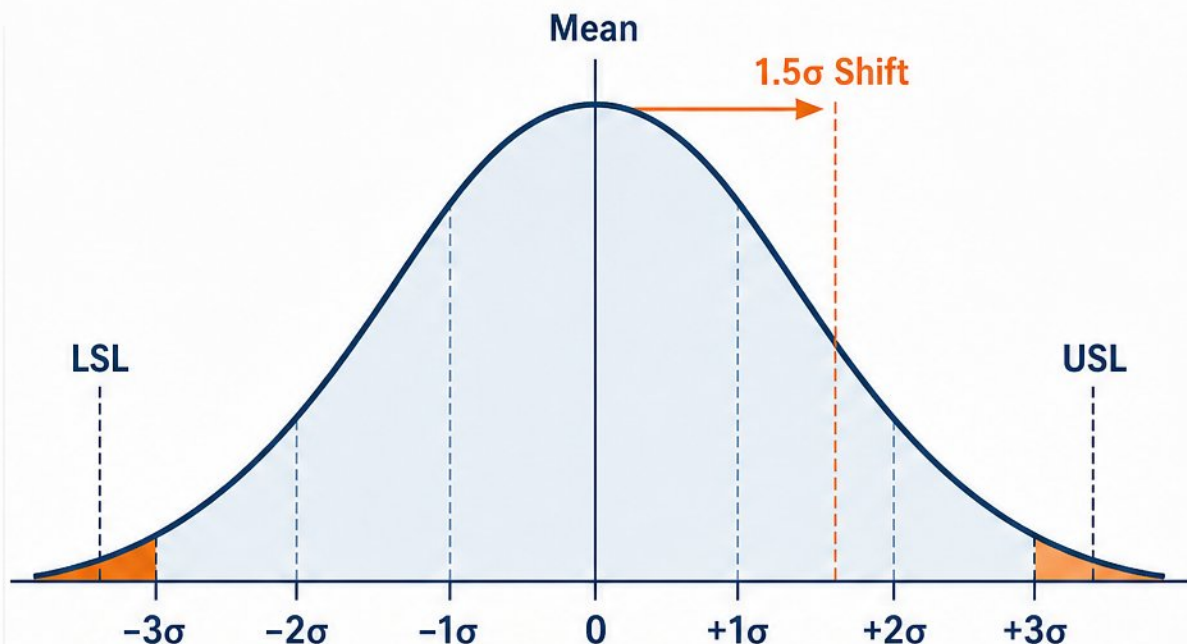
- The 1.5σ shift accounts for long-term drift versus short-term capability



- C_p/C_{pk} measure centering and spread; $C_{pk} \geq 1.33$ is a common target



- Use sigma level to compare and track improvement—not every process needs 6σ



6σ (with 1.5σ shift)



3.4 DPMO

5σ (with 1.5σ shift)



233 DPMO

4σ (with 1.5σ shift)

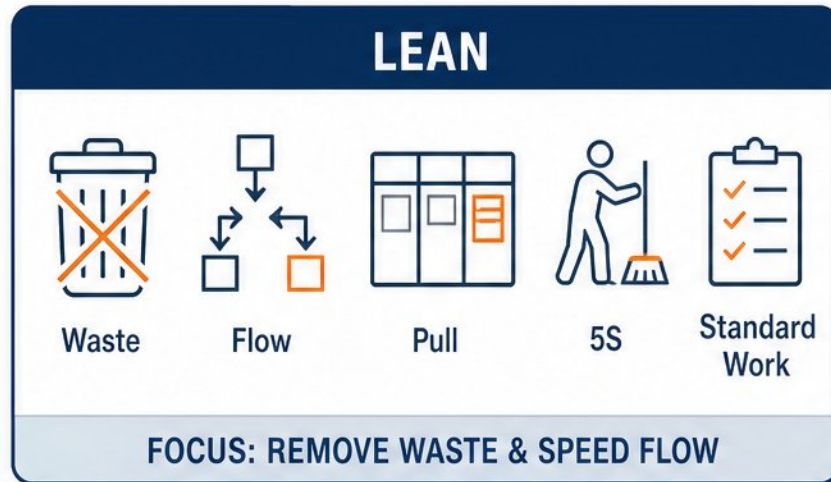


6,210 DPMO



The 1.5σ shift reflects the difference between short-term performance (study variation) and long-term performance (process variation).

Lean vs. Six Sigma: Complementary Operational Tools



- Lean removes waste and speeds flow: VSM, kanban, 5S, standard work



- Six Sigma reduces defects and variation: control charts, capability, DOE



- Lean attacks time problems; Six Sigma attacks variation problems



- Lean Six Sigma combines both: most operations need speed and quality



- Lean tools are visual; Six Sigma relies on data and statistics



Strategic Purpose and Business Value



- Drives lower rework, cost of poor quality, and cycle times



- Motorola: over \$16 billion in cumulative savings



- GE: \$12 billion in five years; ASQ: 1.7% of revenue, >\$2 per \$1

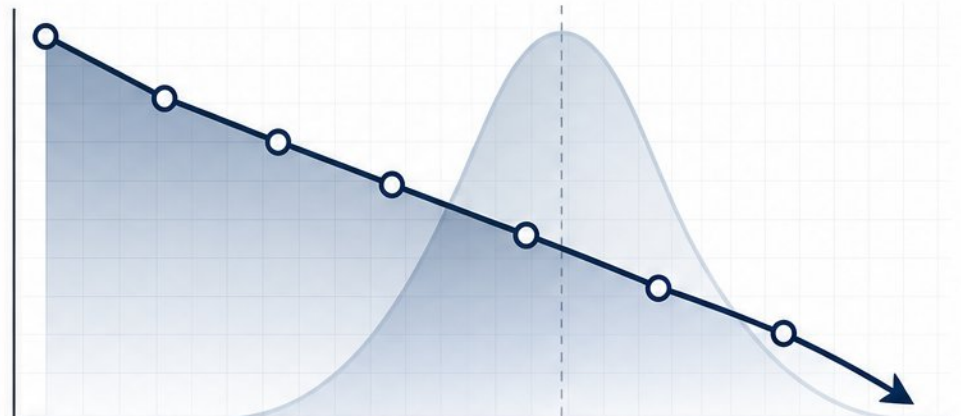


- Gains take time — often over a year to materialize



- Balance operational, financial, and customer metrics, not just ROI

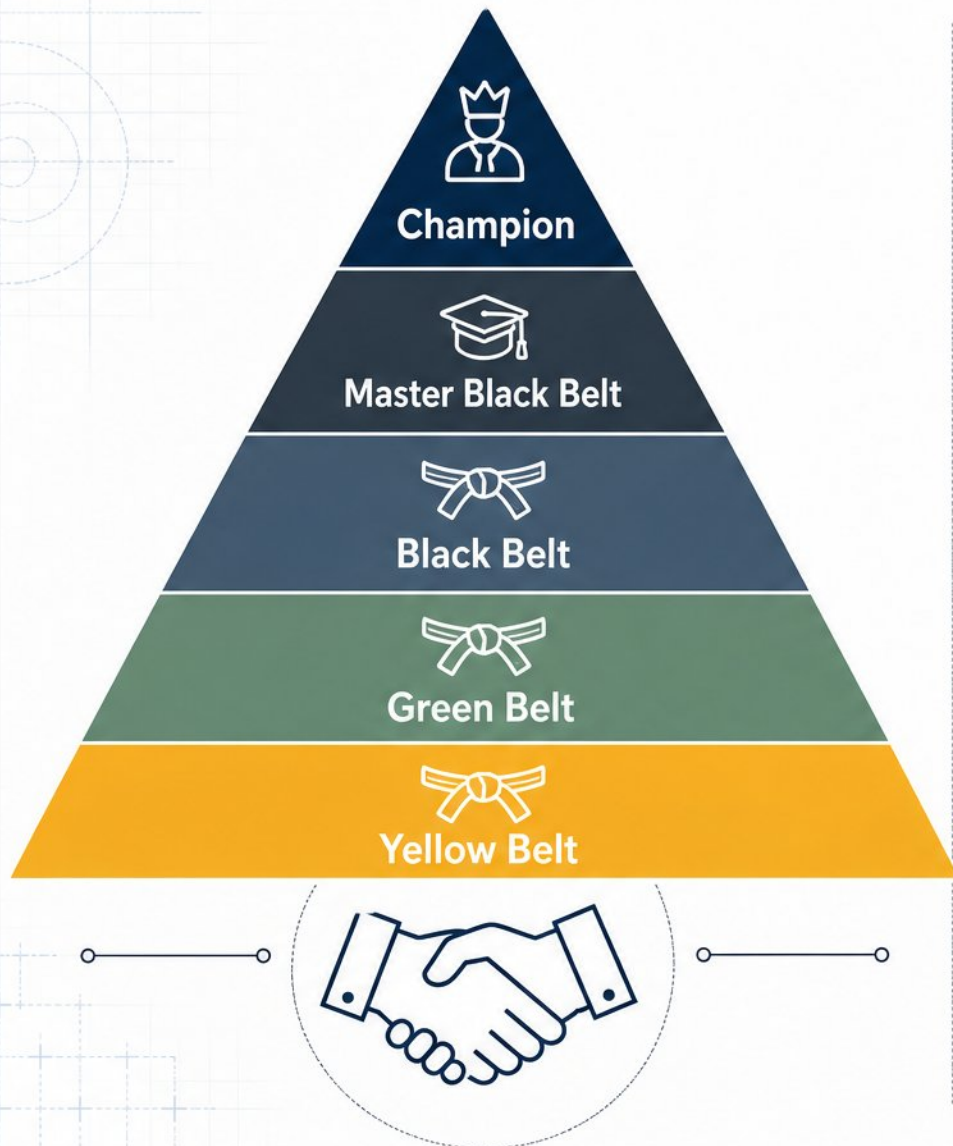
COST OF POOR QUALITY TREND



BUSINESS VALUE IMPACT



Operational Roles and Governance



- Belt hierarchy: Champion, Master Black Belt, Black Belt, Green Belt, Yellow Belt



- Champion: strategic sponsor, selects projects, removes roadblocks, not a certified Belt



- Black Belts lead DMAIC full-time; Green Belts split time (20–50%)



- Governance: steering committees, tollgate reviews, charters, RACI matrices



- Common failures: missing process owner, vague authority, overloaded Green Belts



- Typical time: Champion 2–3 hrs/month; Sponsor 2 hrs/week

Key Operational Tools and Techniques



DEFINE



VOC



CTQ tree



project charter

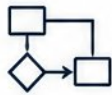


SIPOC

- **Define:** VOC, CTQ tree, project charter, SIPOC



MEASURE



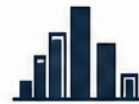
process mapping



check sheets



Gage R&R



histograms

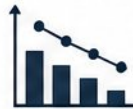


DPMO

- **Measure:** process mapping, check sheets, Gage R&R, histograms, DPMO



ANALYZE



Pareto



fishbone



5 Whys

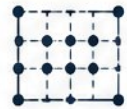


FMEA and RPN

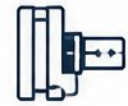
- **Analyze:** Pareto, fishbone, 5 Whys, FMEA and RPN



IMPROVE



DOE



poka-yoke



kaizen events



pilot testing

- **Improve:** DOE, poka-yoke, kaizen events, pilot testing



CONTROL



SPC charts



control plans



SOPs



reaction plans

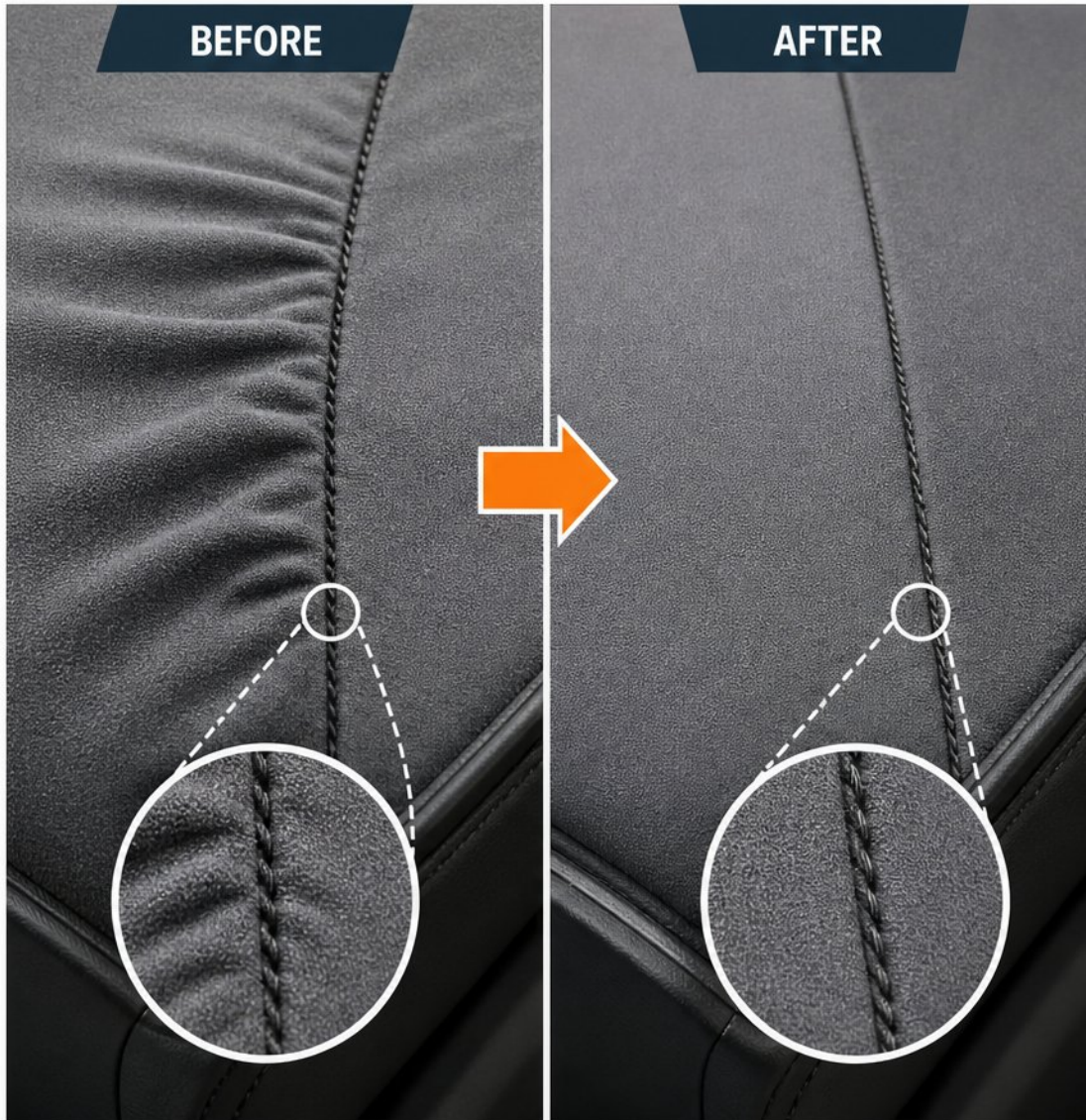
- **Control:** SPC charts, control plans, SOPs, reaction plans



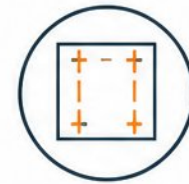
- Choose tools by DMAIC phase and the question being answered



Manufacturing Example: Defect Reduction in Practice



- Automotive seat maker cut wrinkling defects 60% (312 to 187 pieces); defect rate fell 4.05% to 1.61%



- Fleece redesign with slots saved an estimated 852,500 THB



- Brushless motor case: sigma level rose 5.11 to 5.44; supplier defects down 43%

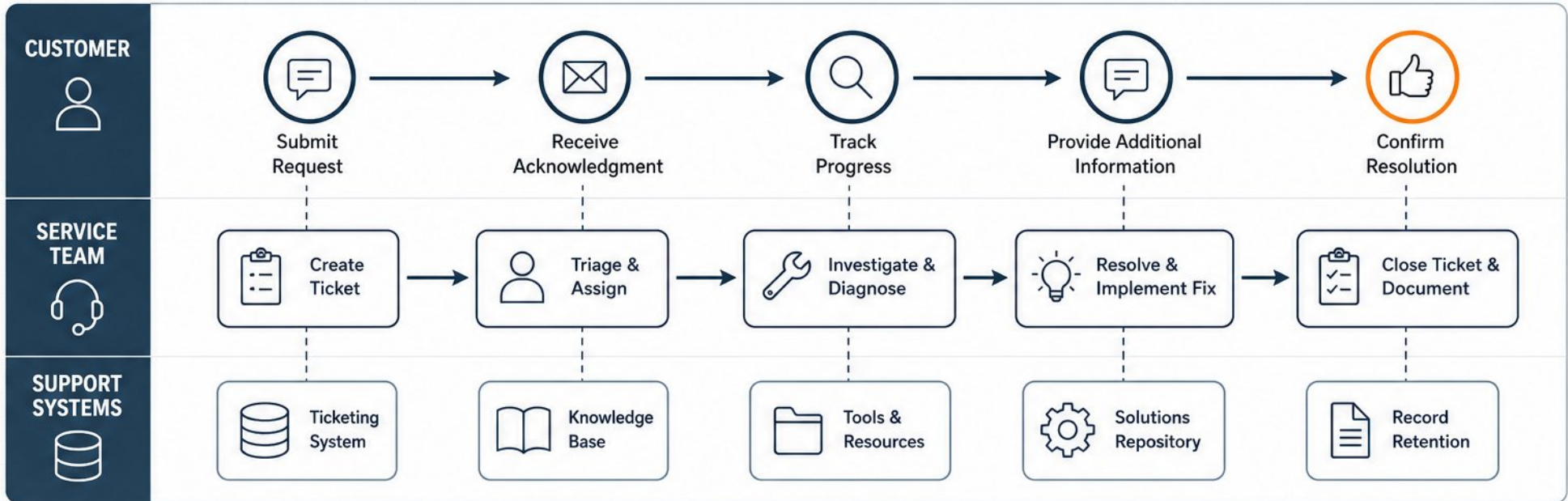


- Botswana shade net plant: defects dropped 60% to 0.025%; sigma 1.25 to 4.98



- Tenneco halved steel tubing scrap via standardized tooling and weld temperature control

Service and Transactional Example: Reducing Resolution Time



- Kensington cut keyboard defect resolution time from 15.5 toward 12.5 days
- 20% customer satisfaction drop triggered the DMAIC project
- Root causes: outdated communication, weak training, inventory, no standard workflows
- Fixes: modern communication platform, certified training, standardized workflows
- FMEA ranked training highest risk at RPN 160; X-bar and R charts confirmed stability



ROOT CAUSES

outdated communication,
weak training, inventory,
no standard workflows



FIXES

modern communication platform,
certified training,
standardized workflows



ANALYSIS

FMEA ranked training highest
risk at RPN 160; X-bar and
R charts confirmed stability

Implementation Considerations

 SUCCESS FACTORS	 FAILURE MODES
 Success factors: top management commitment, strategy alignment, strong project selection	 Failure modes: weak buy-in, poor scoping, resource constraints, resistance to change
 Align with ISO 9001, Lean, and digital analytics to avoid duplication	 Around 60% of Six Sigma initiatives are abandoned or fail
 In SMEs, leadership commitment and customer linkage are critical	 Failures stem mostly from organizational and change management issues



- Align with ISO 9001, Lean, and digital analytics to avoid duplication



- In SMEs, leadership commitment and customer linkage are critical



- Live PLC and sensor data speed baselines and enable automated SPC alerts



Measuring and Sustaining Results



- Control plans, SPC charts, and dashboards hold gains after project closure



- Control limits at ± 3 sigma; out-of-limit or non-random points trigger investigation



- SOPs and work instructions make the improved process the new standard



- Track DPMO trend, cost of poor quality, cycle time, and complaints



- Balance leading and lagging indicators with defined reaction plans

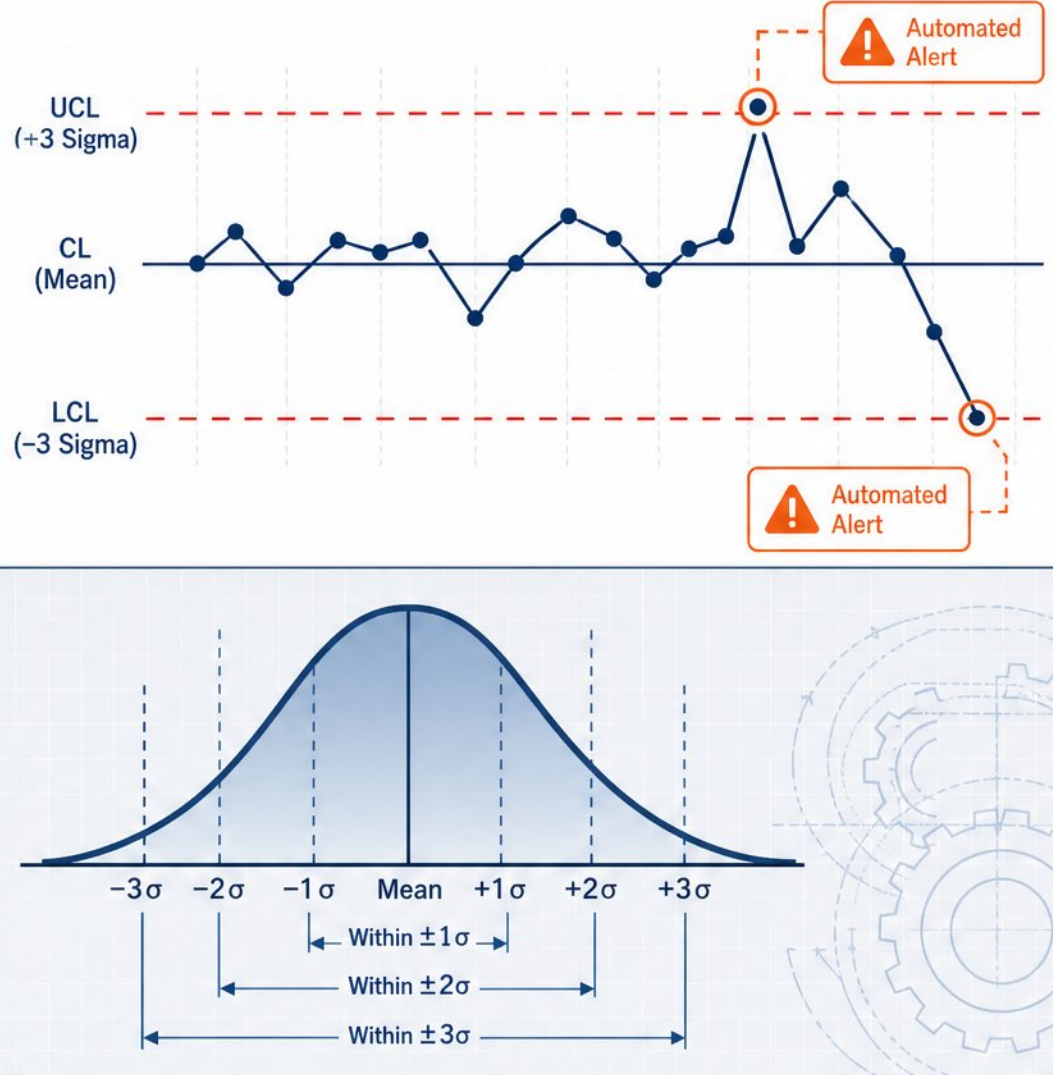


- Transfer ownership to the process owner; audit periodically and embed in leader standard work



- Automated alerts beat paper charts; manual SPC fails within 6 months in 70% of plants

SPC CONTROL CHART



Practical Strategies and Next Steps



- ▶ - Target recurring defects, high rework, long cycle times, customer complaints



- ▶ - First projects: business link, accessible data, 3–6 month scope, engaged sponsor



- ▶ - Stage adoption: pilot unit, build Green Belt capability, monthly steering reviews



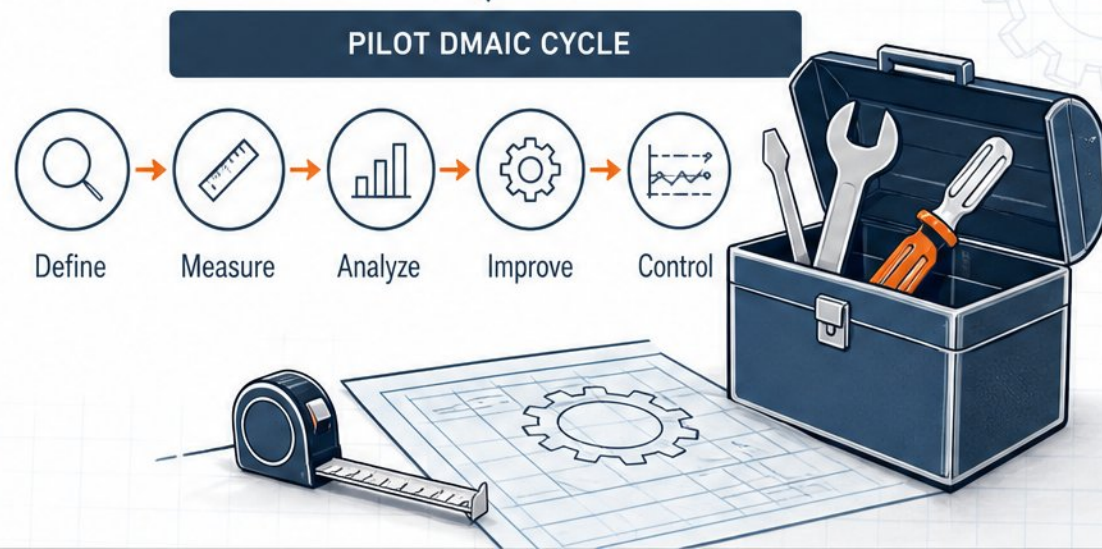
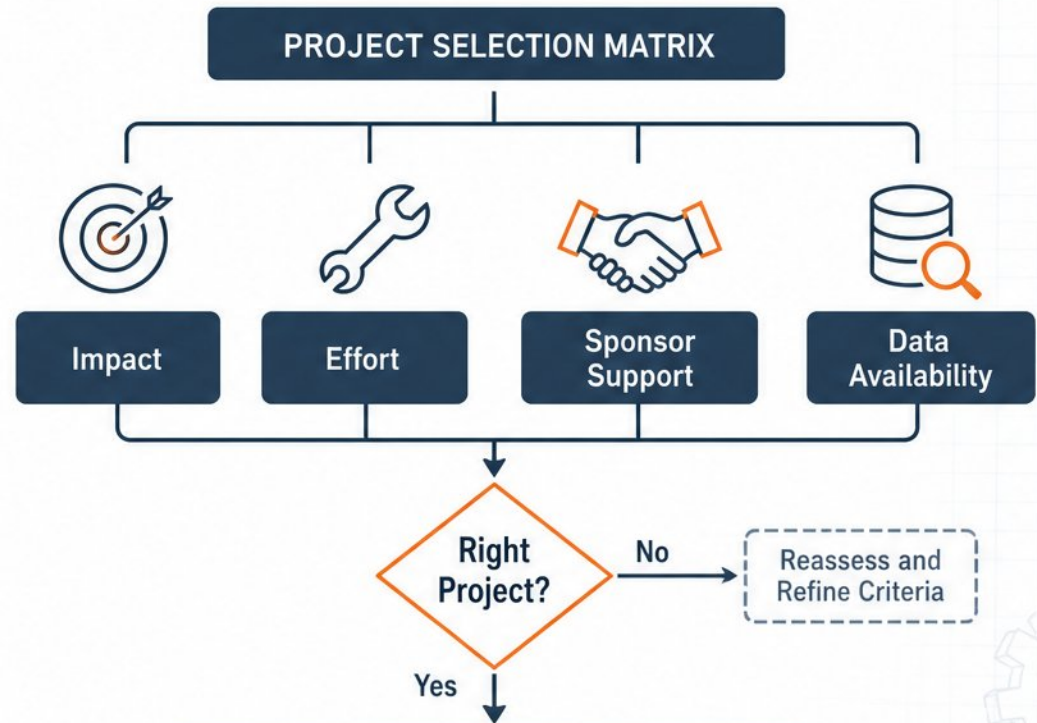
- ▶ - Avoid tiny pilots (weak ROI) and huge ones (scope creep)



- ▶ - Use a selection matrix: impact, effort, sponsor support, data availability



- ▶ - No certification? Learn Pareto, fishbone, SIPOC, control charts; run a small DMAIC cycle



Key Takeaways and Action Plan



- Six Sigma reduces defects and variation via DMAIC; DFSS designs new processes.



- DPMO, sigma level, and Cp/Cpk give a shared performance language.



- Champion-to-Yellow-Belt roles plus tollgate governance sustain results.



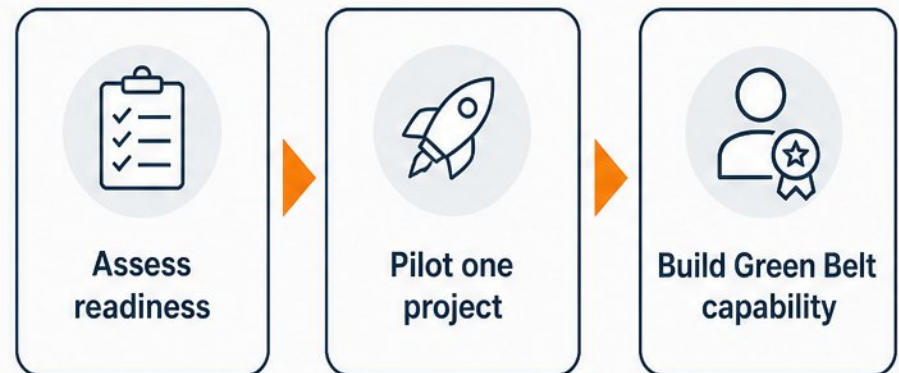
- Lean removes waste; Six Sigma reduces variation—pair both.



- Around 60% of initiatives fail without change management and leadership.



- Next: assess readiness, pilot one project, build Green Belt capability.



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