MASTER BLACK BELT – DMAIC PROJECT

Student Project Preparation Guide

Define • *Measure* • *Analyse* • *Improve* • *Control*

Author: rkmaths

Purpose: A student-facing MBB guide for project preparation, evidence collection, tool selection and DMAIC phase-gates. The structure is based on the supplied MBB DMAIC project presentation material and the approved teaching structure.

DEFINE — Establish the Project

Learning Objectives

Identify a meaningful business/process problem; define Project Y; establish baseline and business impact; set target and scope; identify team/governance; understand the process boundary.

Introduction to DEFINE

Define establishes the foundation: Business Need → Problem → Project Y → Baseline → Target → Scope → Team → Process Boundary.

Problem Statement — 4W1H

State What is the gap, Where and When it occurs, Who/what is affected, and How much the gap is. Base the statement on facts, not assumptions.

Define the Primary Project Y

Give Y an operational definition, unit, data source, measurement frequency and responsible owner. The definition should allow another person to measure Y consistently.

Establish the Baseline

Show representative current performance using an appropriate trend or bar chart and quantify the business impact.

Set the Target and Scope

Show Current → Target → Target Date → Basis/Rationale. Define both In Scope and Out of Scope using the relevant product, process, place and period boundaries.

Team, Governance and Schedule

Identify sponsor, project leader, members, facilitator, responsibilities and review cadence. Use a realistic project schedule, such as a Gantt chart or RACI.

SIPOC / Process Boundary

Map Supplier → Input → Process → Output → Customer. Mark where Y is created, measured or detected and use the actual Gemba process.

Student Preparation Checklist

- ☐ Project title
- ☐ Business problem
- ☐ 4W1H statement
- ☐ Primary Y
- ☐ Operational definition
- ☐ Baseline
- ☐ Business impact
- ☐ Target/date
- ☐ Scope/exclusions
- ☐ Team/roles

- ☐ Schedule
- ☐ SIPOC/process boundary
- ☐ Gemba understanding

DEFINE Phase-Gate

We know what the problem is, how it is measured, how large the gap is, why it matters, what we intend to achieve and what process boundary the project covers.

MEASURE — Establish the Current State

Learning Objectives

Understand the actual process; compare standard versus actual; confirm Y measurement; establish measurement-system suitability and data integrity; stratify data; locate the vital few; refine the problem for Analyse.

Introduction to MEASURE

Measure establishes what is actually happening: Actual Process → Measurement System → Data → Stratification → Priority Problem → Analyse.

Standard vs Actual and Gemba

Before searching for deeper causes, compare the required standard with actual practice. Use dated Gemba evidence, records, audits and check sheets.

Measurement System and Data Integrity

Define what is measured, unit, sampling method and frequency. Consider calibration, MSA/Gage R&R for variable data and agreement/Kappa for attribute data where applicable. Document period, sample size and exclusions; avoid selective sampling.

Data Collection

Record What, Why, Where, When, Who, How and How much. The purpose is a reliable factual picture of the current process.

Stratification

Study Time (shift/day/week/month), Place (line/machine/station/location), Type (model/part/defect/supplier) and Symptom (failure mode/condition).

Prioritise the Problem

Use Pareto, multi-vari, boxplot or trend as appropriate. Quantify how much the selected stratum contributes to Y and explain why other strata are lower priority.

Important Boundary

Do not introduce causes at the end of Measure. Measure closes with a refined Y and prioritised problem; Analyse investigates why.

Define & Measure Outcome

Freeze the primary pain metric, current and desired state, business impact and guardrail metrics that must not deteriorate.

Student Preparation Checklist

- ☐ Actual process observed
- ☐ Standard vs actual compared
- ☐ Gemba evidence
- ☐ Y operationally defined
- ☐ Measurement method
- ☐ Sampling/frequency

- ☐ Measurement system checked
- ☐ MSA/Gage R&R/Kappa considered
- ☐ Data period/sample/exclusions documented
- ☐ Stratification
- ☐ Vital few identified
- ☐ Selected problem quantified
- ☐ Guardrails identified
- ☐ No assumed causes

MEASURE Phase-Gate

Reliable data + clearly defined Y + prioritised problem + guardrails = readiness to investigate WHY.

ANALYSE — Validate the Root Causes

Learning Objectives

Generate possible causes; screen probable causes; formulate testable hypotheses; select appropriate validation; use means or proportion hypothesis testing where appropriate; distinguish statistical from practical significance; validate X → Y.

Introduction to ANALYSE

Analyse asks Why? The sequence is Possible Causes → Probable Causes → Hypothesis → Test → Evidence → Decision → Validated Root Cause.

Cause-and-Effect Diagram

Use the Fishbone/Cause-and-Effect Diagram to generate and organise possible causes. Typical branches include Man, Machine, Method, Material, Measurement and Environment, or process-specific branches. A Fishbone entry is not proof of root cause.

Possible → Probable Cause Screening

For each candidate record reason/mechanism, existing evidence, need for validation and priority. Refine vague terms such as operator issue or machine problem into testable factors.

Root-Cause Validation Plan

Predefine hypothesis/cause, validation method, data/sample, acceptance criterion and owner/date. Decide the evidence rule before examining results.

Selecting the Statistical Test

For continuous/variable Y with suitable groups, hypothesis testing for means may be appropriate. For attribute/proportion Y, an appropriate proportion test may be appropriate. Depending on the project, ANOVA, regression, DOE or controlled trials may also be appropriate.

Statistical vs Practical Significance

Report statistical evidence where appropriate, but also ask whether the observed effect is large enough to matter to the process or business.

Non-Statistical Validation

Where statistics are not suitable, use controlled trial, physical evidence, simulation correlated to actual results or repeated Gemba verification, with reproducible evidence.

Cause Classification and Handoff

Classify each tested cause as VALIDATED, REJECTED or INCONCLUSIVE. Carry only validated root causes into Improve and link each root cause to the intended countermeasure.

Student Preparation Checklist

- ☐ Possible causes
- ☐ Fishbone

- ☐ Testable cause statements
- ☐ Screening
- ☐ Mechanism
- ☐ Validation plan
- ☐ Appropriate means/proportion test considered
- ☐ Other methods considered
- ☐ Acceptance criteria predefined
- ☐ Statistical significance
- ☐ Practical significance
- ☐ X→Y evidence
- ☐ Validated/Rejected/Inconclusive classification
- ☐ Only validated causes carried forward

ANALYSE Phase-Gate

No assumed root causes: only evidence-supported root causes proceed to Improve.

IMPROVE — Develop, Select and Validate Solutions

Learning Objectives

Generate countermeasures for validated causes; evaluate alternatives; assess risk; pilot; validate effectiveness and side effects; prepare implementation.

Introduction to IMPROVE

Improve asks what should change: Validated Root Cause → Generate Options → Evaluate → Risk → Pilot → Validate → Implement.

Generate Countermeasures

Generate multiple options for each validated root cause. Prefer actions that remove/control the cause at source. Consider engineering, process, standard, digital and poka-yoke options where relevant.

Selection

Evaluate effectiveness, cost, feasibility and risk. Use Pugh matrix, cost-benefit analysis or FMEA as appropriate. Make the selection transparent.

Implementation Risk

Identify failure mode/risk, impact, likelihood, mitigation and owner before the pilot. Use FMEA or a risk matrix.

Pilot / Trial

Compare Before → Pilot Condition → Pilot Result → Decision. Check primary Y, secondary metrics and safety/quality.

Solution Validation

Prove effectiveness and side effects before full implementation. Appropriate methods may include pilot, controlled trial, before-after test, DOE, capability, reliability or simulation plus physical validation.

5W1H Implementation

Convert the selected solution into accountable actions: What, Why, Where, When, Who, How/Status.

Improve Outcome

Show Validated Root Cause → Solution → How it addresses the cause → Pilot Result → Status. State expected Project Y and guardrail impact.

Student Preparation Checklist

- ☐ Validated causes only
- ☐ Multiple countermeasures
- ☐ RC→CM linkage
- ☐ Effect on Y
- ☐ Effectiveness/cost/feasibility/risk
- ☐ Selection evidence

- ☐ FMEA/risk assessment
- ☐ Pilot
- ☐ Y before/after
- ☐ Guardrails
- ☐ Safety/quality
- ☐ Statistical/practical validation where appropriate
- ☐ No unacceptable adverse effect
- ☐ 5W1H implementation plan

IMPROVE Phase-Gate

Validated Root Cause → Validated Solution → Demonstrated Y Improvement → No unacceptable adverse effect → Implementation.

CONTROL — Verify, Sustain and Extend the Improvement

Learning Objectives

Demonstrate improvement; validate credibility and repeatability; quantify business value; assess PQCDSM; standardise; establish control plan and reaction plan; deploy learning; capture lessons.

Introduction to CONTROL

Control asks whether the improvement achieved the desired state and will continue: Before → After → Validate → Standardise → Control → Sustain → Deploy → Learn.

Result — Before vs After

Use the same operational definition and comparable periods. Show Baseline, Target and Achieved prominently, plus a time trend, percentage improvement and gap-to-target.

Statistical / Technical Validation

Use an appropriate before-after test where required: mean, proportion, variance, capability, regression or other suitable method. Report objective, hypotheses, p-value/confidence interval where applicable and practical effect. For capability projects, establish stability before Cp/Cpk or Pp/Ppk.

Business Value

Quantify gross benefit, implementation cost, recurring cost, net annual benefit and BCR where applicable. Use finance-verifiable assumptions.

PQCDSM

Compare Productivity, Quality, Cost, Delivery, Safety and Morale/Sustainability as relevant, looking for benefits and unacceptable trade-offs.

Formal Control Phase-Gate

Validate Primary Y effectiveness, Stability/Repeatability, Guardrail Metrics and Business Benefit. Overall verdict: VALIDATED, PARTIAL or NOT VALIDATED.

Standardisation

Update SOP/WI, drawings/specifications, inspection/control plans and training/skill requirements. Record document number/revision and effective date.

Sustenance / Control Plan

For Primary Y and critical X, define control method, frequency, owner, limits/criteria and reaction plan. Use SPC, audit or layered process audit where appropriate.

Horizontal Deployment

Identify other areas with the same mechanism, expected benefit, owner and target date. Deployment should be based on similarity, not blanket copying; use Yokoten where appropriate.

Learning and Remaining Opportunities

Record technical, teamwork and methodology learning. Document residual gaps and future opportunities with ownership and priority.

Tools Used and Final Management Takeaway

Link every tool to a decision/output. Close with one-line outcome, business value, technical proof, sustenance and replication/next improvement.

Backup Evidence

Retain raw-data summaries, statistical outputs, Minitab reports, photographs, trial conditions, calibration/MSA records, cost assumptions, FMEA/DOE/hypothesis-test calculations, control charts, capability reports, audits and revised standards.

CONTROL Student Preparation Checklist

- ☐ Baseline/target/achieved
- ☐ Comparable period
- ☐ Sustained trend
- ☐ % improvement/gap
- ☐ Statistical/technical validation
- ☐ Stability
- ☐ Capability where applicable
- ☐ Business benefit/BCR
- ☐ PQCDSM
- ☐ No unacceptable trade-offs
- ☐ Standards revised
- ☐ Revision traceability
- ☐ Training
- ☐ Control plan
- ☐ Frequency/owner/limits/reaction plan
- ☐ Deployment
- ☐ Lessons
- ☐ Remaining opportunities
- ☐ Tool-to-output index
- ☐ Final management takeaway
- ☐ Backup evidence

CONTROL Phase-Gate

The improvement is proven, sustained, standardised and ready for responsible deployment: Result → Validation → Business Benefit → Standardisation → Control → Sustain → Deploy → Learn.

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