Reduction of Incoming Material Non-conformance Rate

Murali S

ROADMAP

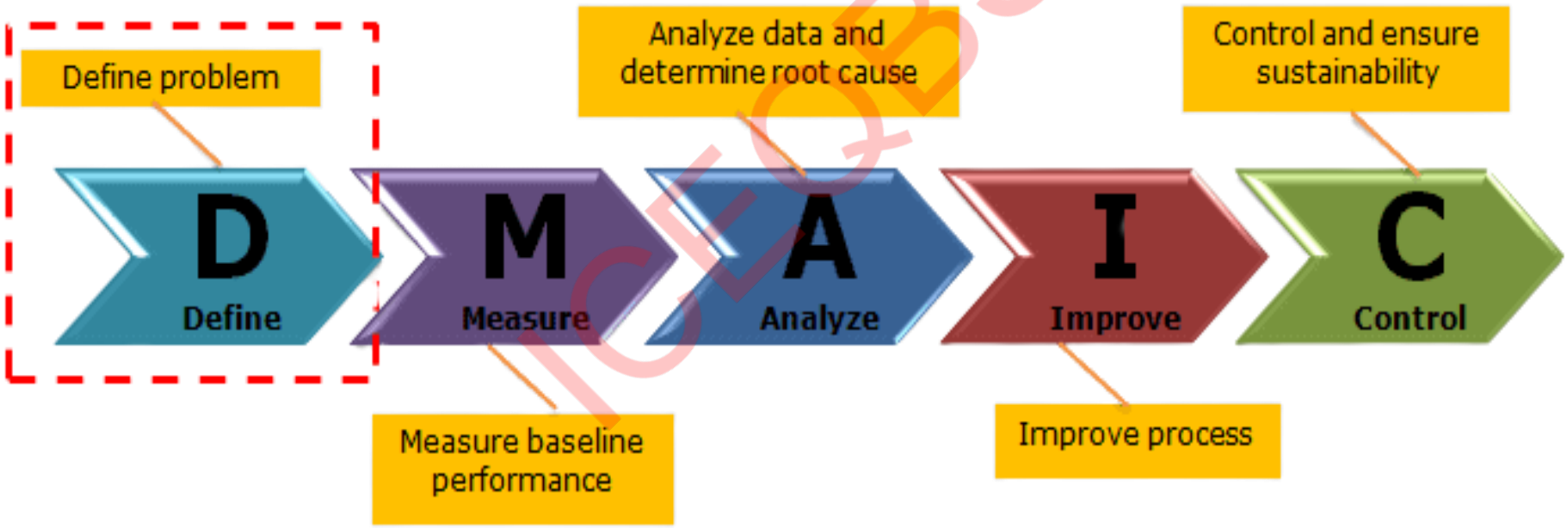
OVERVIEW

Background

•High variability in the incoming material NCR rate has resulted in frequent supplier rejections, inspection delays, and production disruptions, increasing the risk to on-time delivery and overall product quality. With an average acceptance performance of 80% and high process variation, significant effort is spent on re-inspection, material segregation, supplier escalations, and excess inventory handling.

•Reducing the incoming material NCR rate to ≤10% and stabilizing the process by lowering variability ($\sigma \leq 3\%$) will improve material flow, reduce Cost of Poor Quality (COPQ), and minimize production stoppages. These improvements will strengthen supplier quality performance, enhance compliance with AS9100 requirements, and support reliable on-time delivery for critical aerospace programs.

DEFINE PHASE

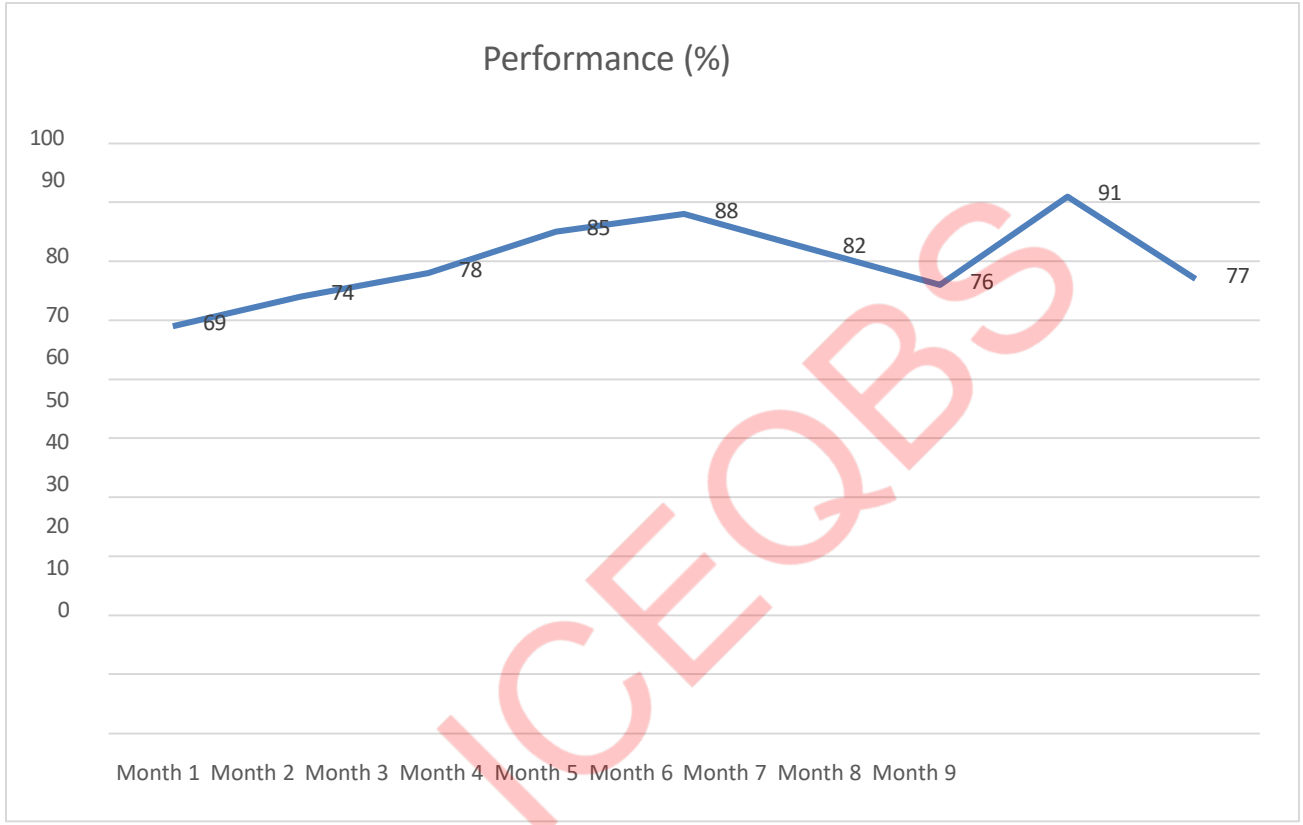


VOC & CTQ

CTQ Tree :

Voice of customer	Critical to X	Primary Metric for improvement
Conforming material received at incoming inspection with zero NCRs and no impact to production	Supplier material conformity to specification and certification requirements	**Primary Metric -** Y = Incoming material NCR rate (%). **Secondary Metric -** Incoming material inspection cycle time

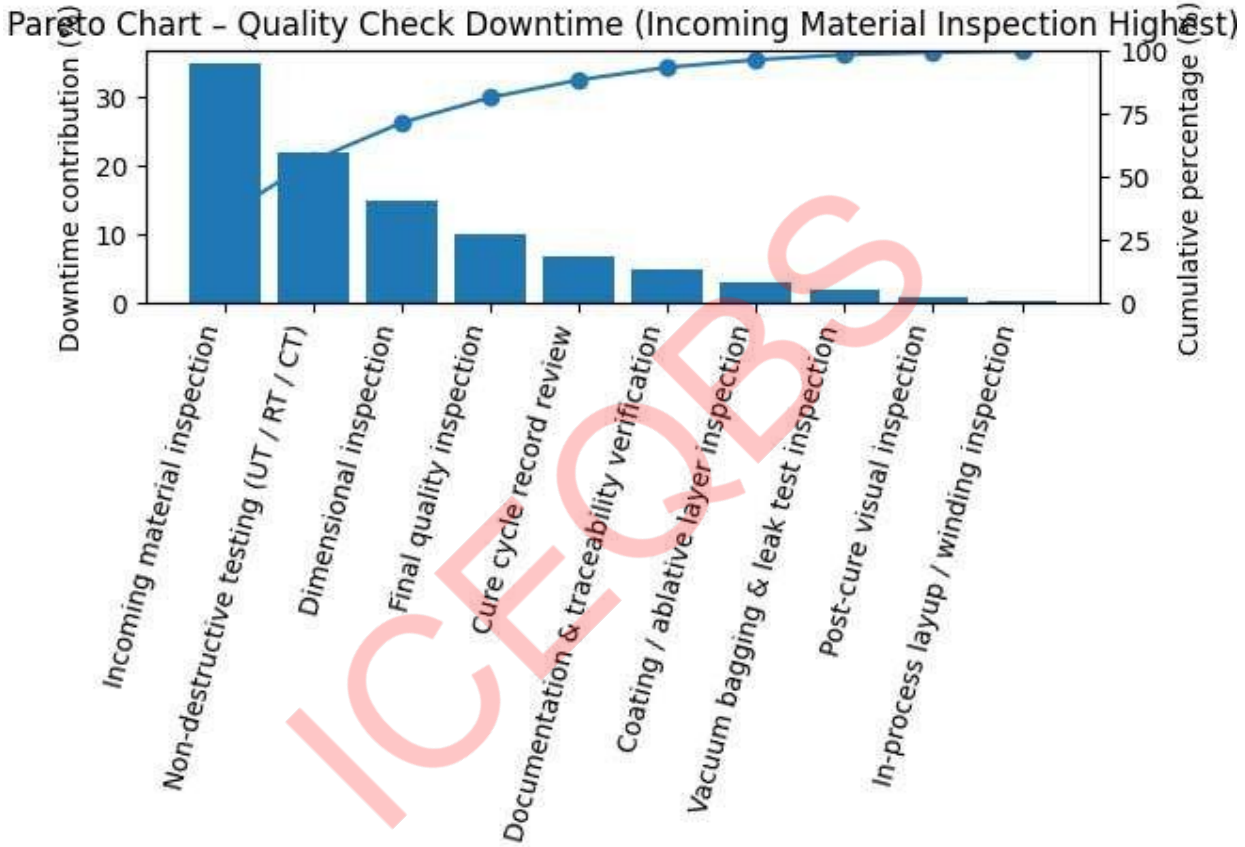
Baseline Performance of Primary Metric (9 months data as Line chart)



Inference :

- Performance shows an overall improving trend with fluctuations

Pareto chart



Inference :

- **incoming material inspection and non-destructive testing (UT/RT/CT)** contribute the majority of quality check downtime, making them the primary focus areas for reducing inspection delays.

Project Charter

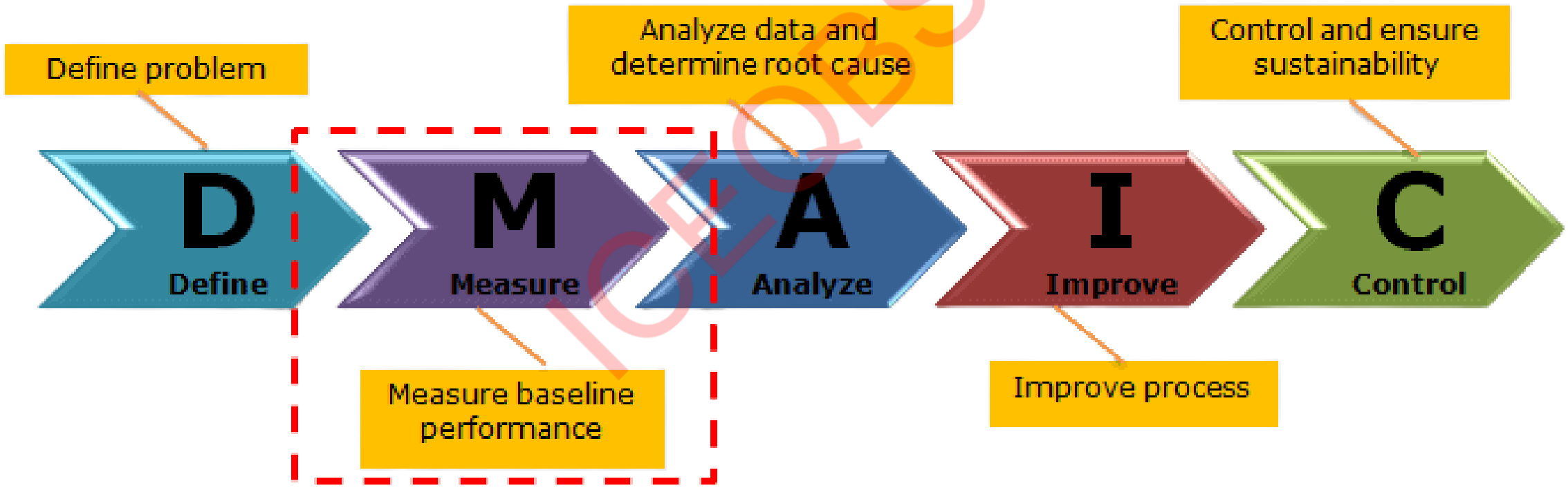
Project Title:	Reduction of Incoming Material Non-conformance Rate

Project Leader	Project Team Members:
Murali S	Supplier Quality Engineer Production Representative Stores / Inventory Representative Process Engineering Representative
Champion/Sponsors:	**Key Stake Holders**
Head – Quality	
Problem Statement:	**Goal Statement:**
Over the last 9 months, the incoming material NCR rate has shown high variability with an average performance of 80% acceptance and a standard deviation of 7%.	Reduce the incoming material NCR rate from an average of 20% to ≤10%, while stabilizing the process by reducing variability (standard deviation) from 7% to ≤3%, within 4 months
Secondary Metric	**Assumptions Made:**
Incoming material inspection cycle time	Incoming inspection data and NCR classification are accurate and consistently recorded.

Project Charter

Tangible and Intangible Benefits:	Risk to Success:
Reduction in inspection rework, material rejections, and supplier escalation costs. Improved production continuity through reduced material shortages and delays.	Supplier resistance or slow response to corrective action requests. Inconsistent application of updated inspection criteria across shifts.
In Scope:	**Out of Scope:**
Incoming material inspection process Supplier-provided composite raw materials Inspection methods, criteria, and documentation NCR generation and closure related to incoming inspection	In-process manufacturing defects Design changes Customer-originated material issues
Signatories:	**Project Timeline:**
Head – Quality Quality Engineer	6 months

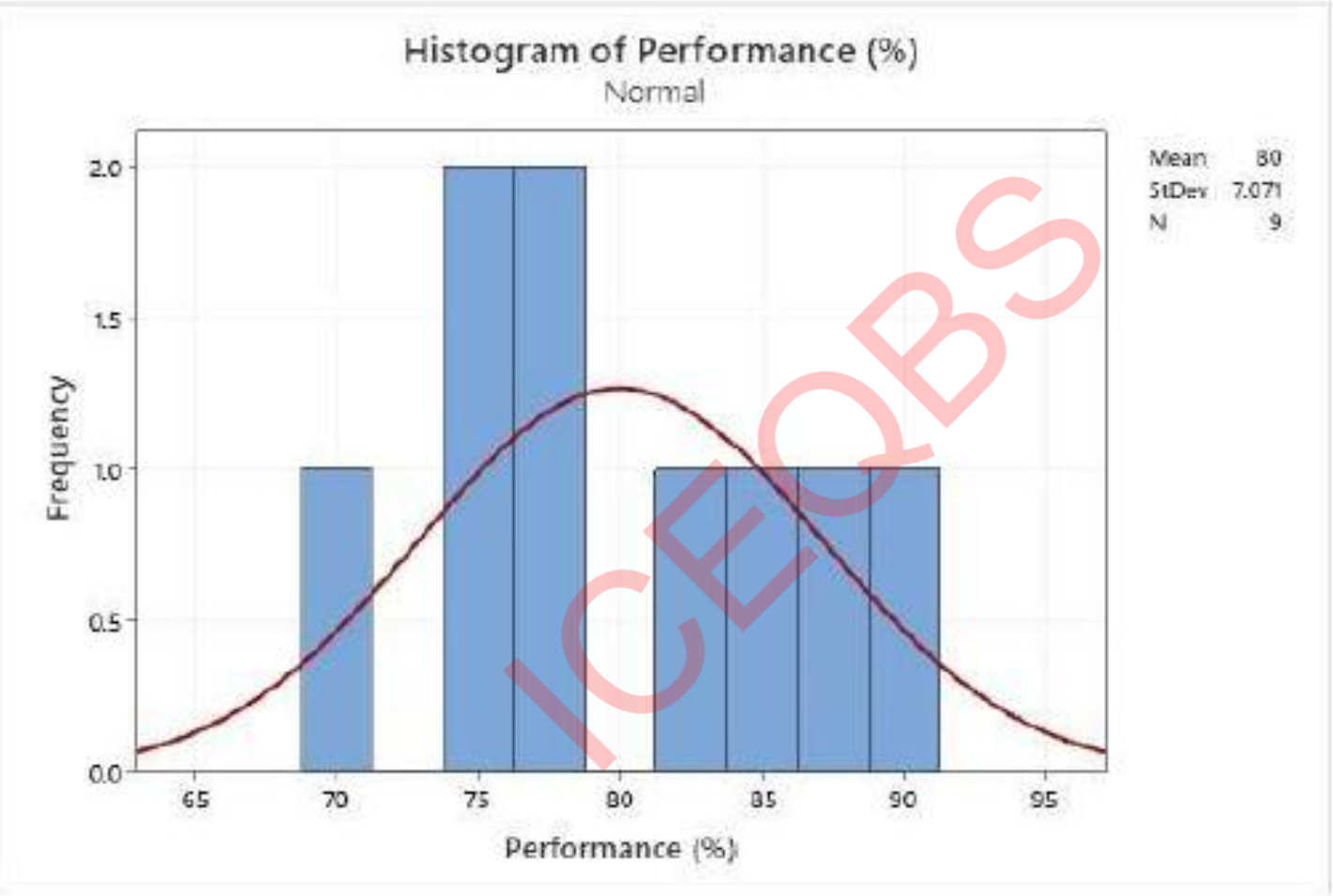
MEASURE PHASE



SIPOC

Suppliers (S)	Inputs (I)	Process (P)	Outputs (O)	Customers (C)
Approved raw material suppliers (fiber, resin, prepreg)	Raw materials (prepreg, fibers, resins, cores)	Receive incoming material	Accepted material released to stores	Production / Manufacturing
Chemical & consumable suppliers	Supplier material certifications (CoC, test reports)	Verify documentation and certification	Rejected material with NCR raised	Stores / Inventory Management
Logistics & transportation providers	Purchase order & specifications	Perform visual and dimensional inspection	Inspection records and reports	Quality Assurance
Internal procurement / sourcing team	Applicable standards and drawings	Conduct material property verification (as applicable)	Supplier feedback / rejection notifications	Supplier Quality Engineering
	Inspection procedures & acceptance criteria	Record inspection results		Program / Operations Management
		Accept material or raise NCR		
		Segregate and disposition nonconforming material		

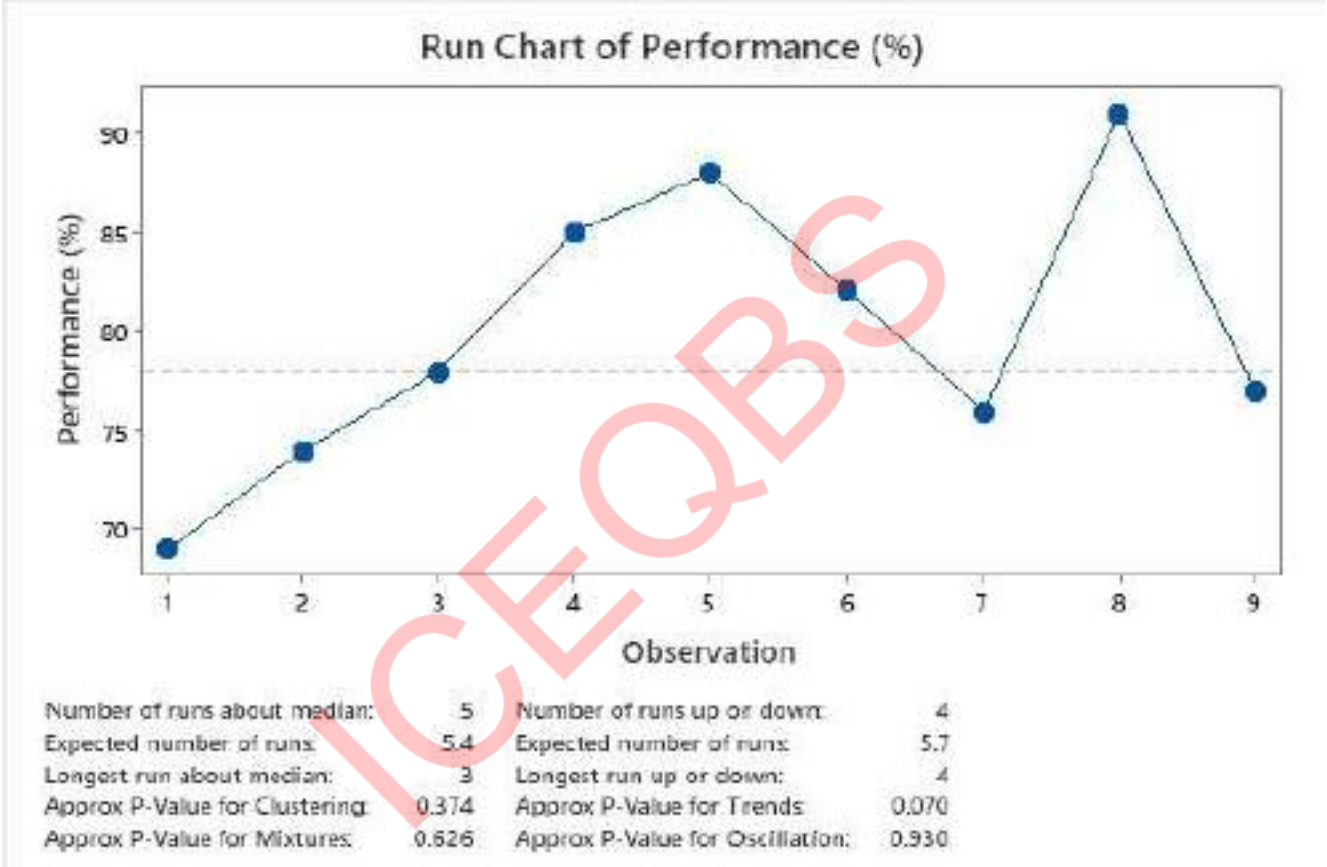
Data collection – Histogram (Before improvement)



Inference :

- Data is normally distributed over the mean

Data collection – Run Chart (Before improvement)



Number of runs about median:	5	Number of runs up or down:	4
Expected number of runs:	5.4	Expected number of runs:	5.7
Longest run about median:	3	Longest run up or down:	4
Approx P-Value for Clustering:	0.374	Approx P-Value for Trends:	0.070
Approx P-Value for Mixtures:	0.626	Approx P-Value for Oscillation:	0.930

Inference :

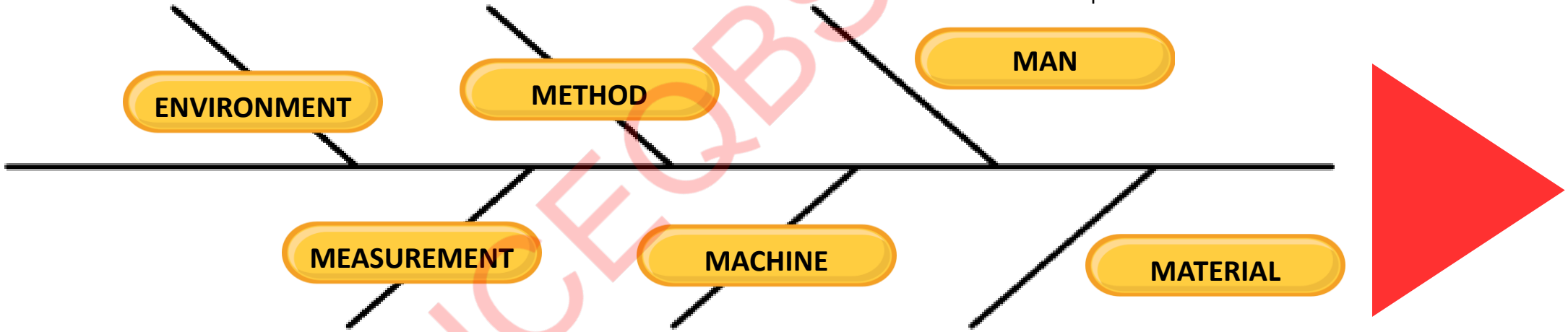
Since all P-values are greater than 0.05, no special causes are detected

Fish Bone Diagram

- Poor lighting affecting visual inspection
- Uncontrolled temperature / humidity affecting material checks
- Congested inspection area causing handling damage

- Non-standardized incoming inspection procedures
- Incomplete or unclear inspection checklists
- Sampling plans not aligned with supplier risk

- Inadequate inspector training on specifications
- Misinterpretation of drawings and acceptance criteria
- Inconsistent inspection judgment between inspectors



- Inadequate measurement system accuracy
- No MSA conducted for critical inspection parameters
- Incorrect measurement methods used

- Uncalibrated or overdue inspection instruments
- Inadequate inspection equipment capability
- Poor condition of gauges and fixtures

- Supplier material variability beyond specification limits
- Incomplete or incorrect material certification (CoC / test reports)
- Mixed lots or incorrect material identification

common and special causes

Common causes

- Inconsistent inspection judgment between inspectors
- High workload leading to inspection oversight
- Manual inspection dependence instead of automated checks
- Non-standardized incoming inspection procedures
- Incomplete or unclear inspection checklists
- Sampling plans not aligned with supplier risk
- Supplier material variability within normal process spread
- Inadequate measurement system accuracy
- No MSA for critical inspection parameters
- Data recording errors during inspection
- Lack of trend analysis on incoming defects
- Time pressure due to production urgency

Special causes

- Inadequate inspector training on specifications
- Misinterpretation of drawings and acceptance c
- Uncalibrated or overdue inspection instruments
- Inadequate inspection equipment capability
- Mixed lots or incorrect material identification
- Incomplete or incorrect material certification
- Damage during transportation or handling
- Shelf-life or out-time violations
- Incorrect measurement methods used
- Poor lighting affecting visual inspection
- Uncontrolled temperature or humidity
- Congested inspection area causing handling dar

3M Analysis for Waste

MUDA

- Re-inspection of incoming material due to unclear acceptance criteria
- Excessive handling and movement of material during inspection
- Waiting time caused by missing or incomplete supplier documentation

Mura

- Fluctuating incoming material quality between supplier lots
- Inconsistent inspection time depending on inspector experience
- Variable NCR rates month-to-month due to irregular supplier performance

Muri

- Inspectors handling high inspection volume during production peaks
- Inspectors expected to meet delivery urgency while performing detailed inspections
- Limited inspection resources stretched across multiple material types

8 Wastes Analysis

Defects

1. NCRs raised due to incorrect or incomplete material certification
2. Acceptance of nonconforming material leading to downstream rejection

Waiting

1. Waiting for missing supplier certificates or test reports
2. Waiting for inspection equipment or gauge availability

Motion

1. Inspectors walking repeatedly to retrieve gauges or documents
2. Searching for correct drawings or specifications during inspection

Inventory

1. Excess incoming material waiting for inspection approval
2. Stockpiling quarantined material pending NCR disposition

Action Plan for Low Hanging Fruits

Gemba Observation	Special Cause Addressed	Lean Tool	Action	3M / 8 Waste Reduced	Expected Benefit
Inspectors interpret specs differently	Misinterpretation of acceptance criteria	Standard Work, Visual SOP	One-page visual checklist with accept/reject photos	Mura, Defects	Fewer inspection-generated NCRs
Overdue / missing calibrated gauges	Uncalibrated instruments	5S, Visual Management	Shadow boards, red-tag overdue gauges	Muda (Waiting, Motion), Defects	Faster inspections, fewer false NCRs
Missing supplier CoC/Test reports	Incomplete documentation	Poka-Yoke, Standard Work	Pre-receipt document checklist; block GRN without docs	Muda (Waiting), Inventory	Reduced queues and rework
Excess walking and handling	Congested inspection layout	5S, Spaghetti Diagram	Re-layout with clear accept/quarantine lanes	Muda (Motion, Transportation)	Shorter cycle time, less damage
Over-inspection during peak loads	Inspector overburden	Risk-based Sampling	AQL by supplier risk; dock-to-stock for A suppliers	Muri, Overprocessing	Balanced workload
Inconsistent inspection time by lot	Uneven work distribution	Heijunka (Work leveling)	Slot inspections by time windows	Mura, Waiting	Predictable flow
Repeat NCRs from same supplier	Supplier quality spikes	Pareto, Supplier Scorecard	Weekly Pareto review & quick corrective calls	Defects	Faster containment
NCR admin delays	Manual data entry	Standard Templates	Pre-filled NCR forms, drop-downs	Muda (Overprocessing)	Quicker NCR closure

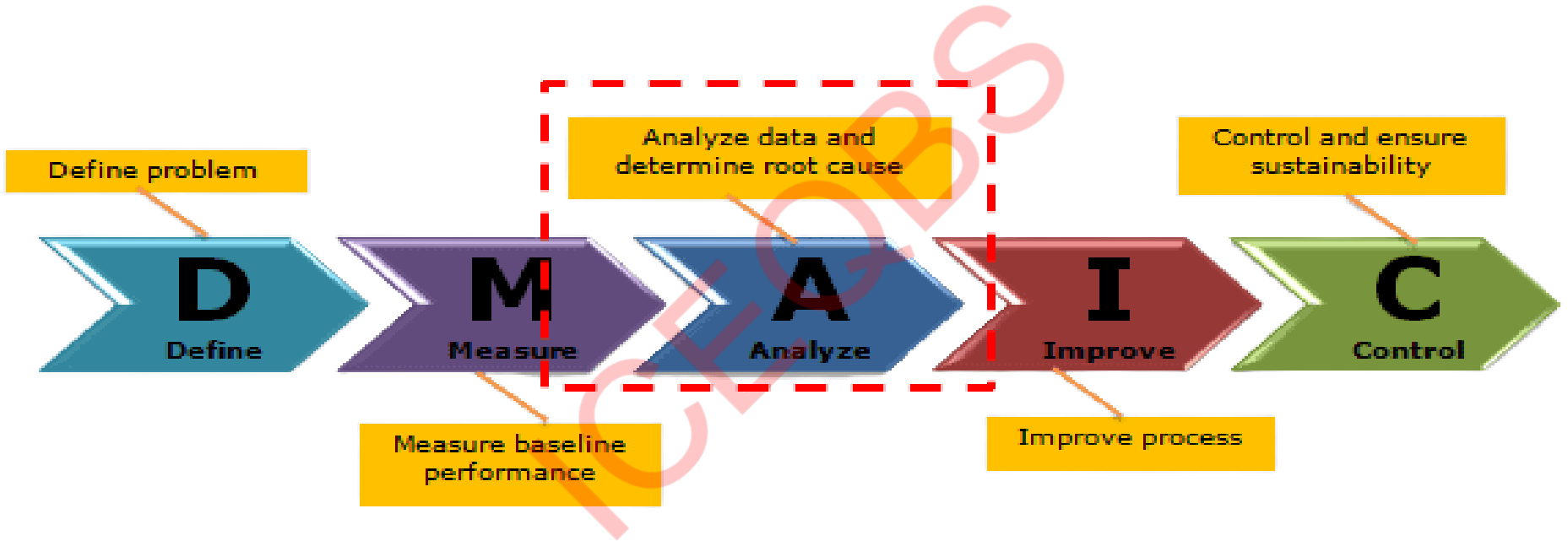
Top 12 Prioritized Root Causes (Based on Net Score)

Priority	Input / Common Cause	Net Score
1	Supplier material variability (normal spread)	280
2	Inadequate sampling plan	276
3	Non-risk-based supplier inspection	276
4	Inconsistent inspection checklist	264
5	Inspector-to-inspector judgment variation	264
6	Poor visibility of acceptance criteria	246
7	Lack of SPC on incoming defects	222
8	High inspection workload (normal condition)	156
9	Manual documentation & data entry	142
10	Inadequate inspection area organization	142
11	Delayed defect trend review	108
12	Normal variation in incoming lot size	64

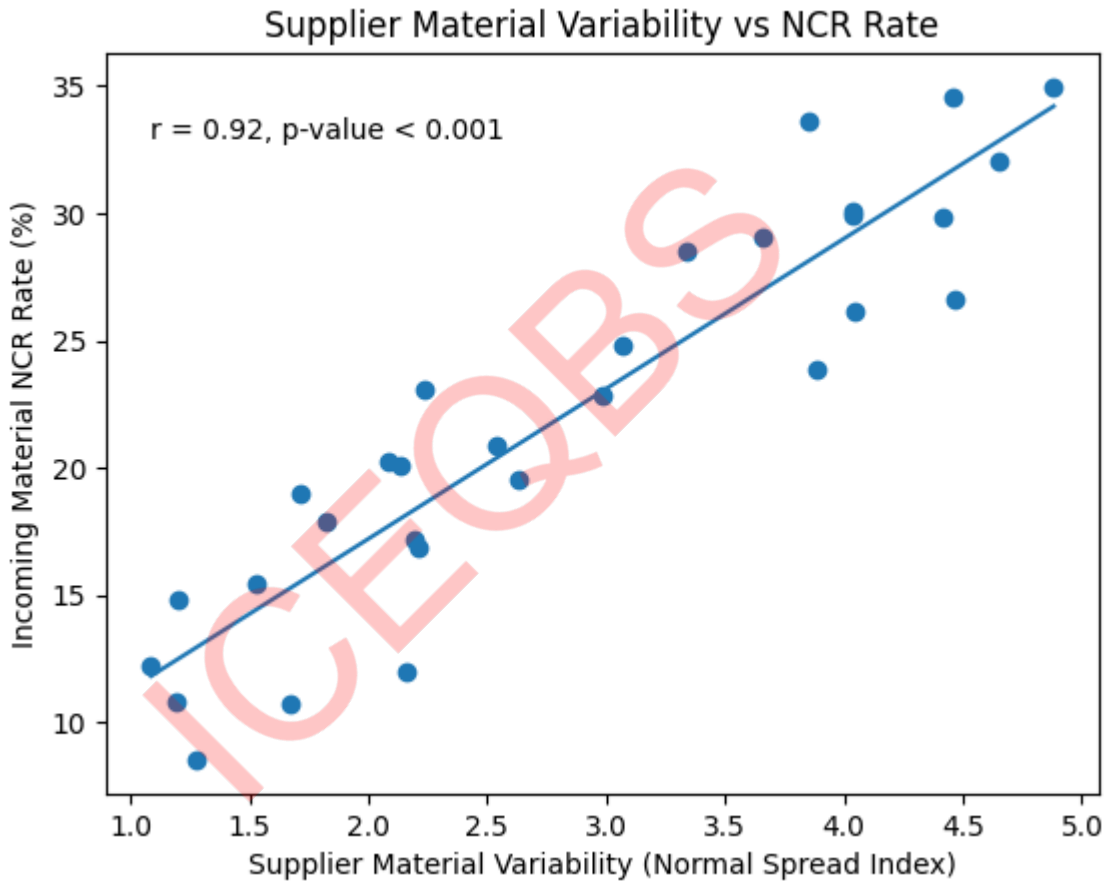
Data Collection Plan

Sl. No.	Cause (X)	Data to be Collected	Metric	Data Source	Measurement Method	Sample Size	Frequency	Responsible	Lean / LSS Tool
1	Supplier material variability	Key material properties vs specs	% lots in spec, Cpk	Incoming inspection records, supplier reports	Verification testing & SPC	All lots (3 months)	Per lot	Incoming QA / SQE	SPC, capability analysis
2	Inadequate sampling plan	Sample size vs defects found	Defects per sample	Inspection logs, NCR data	Attribute inspection	3 months history	Per inspection	Incoming QA	AQL, OC curves
3	Non-risk-based supplier inspection	Supplier NCR history vs inspection level	NCR rate by supplier	Supplier scorecards	Data stratification	All suppliers	Monthly	SQE	Pareto, risk matrix
4	Inconsistent inspection checklist	Checklist usage compliance	% checklist compliance	Audit records	Compliance audit	10 inspections / inspector	Weekly	QA Lead	Standard work audit
5	Inspector judgment variation	Accept / reject agreement	% agreement	Re-inspection study	Attribute MSA	30 samples	Quarterly	Quality Engineer	MSA (attribute)
6	Poor visibility of acceptance criteria	Availability of specs at point of use	% availability	Gemba audit	Visual audit	20 inspections	Weekly	QA Supervisor	Visual management audit

ANALYSE PHASE



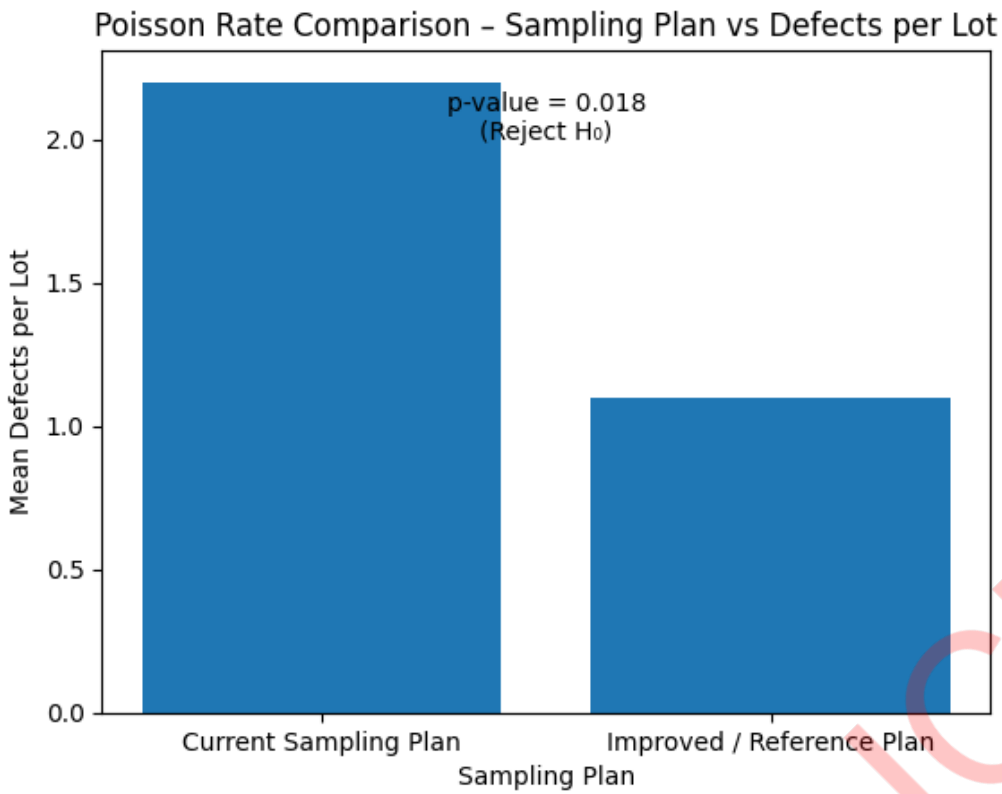
Analyse – Hypothesis testing

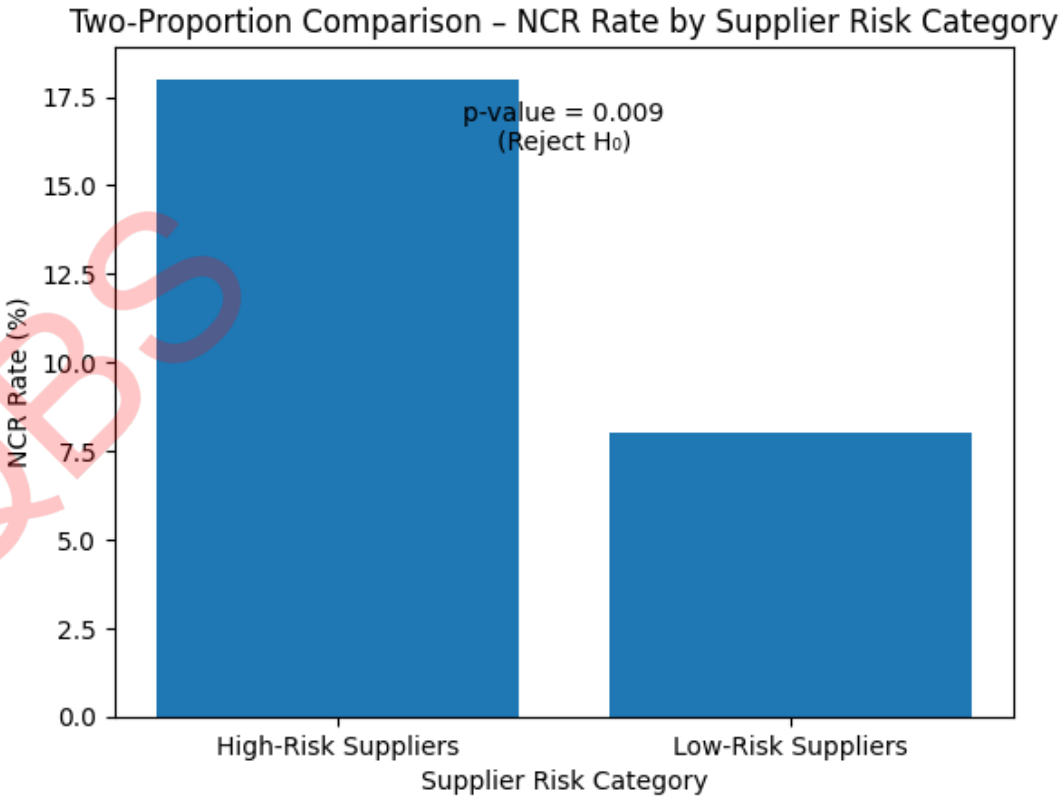


Inference :

Since **p-value < 0.001** and **r ≈ +0.72 (strong positive correlation)**, the null hypothesis is rejected, confirming supplier material variability as a validated critical root cause of incoming NCRs.

Analyse – Hypothesis testing

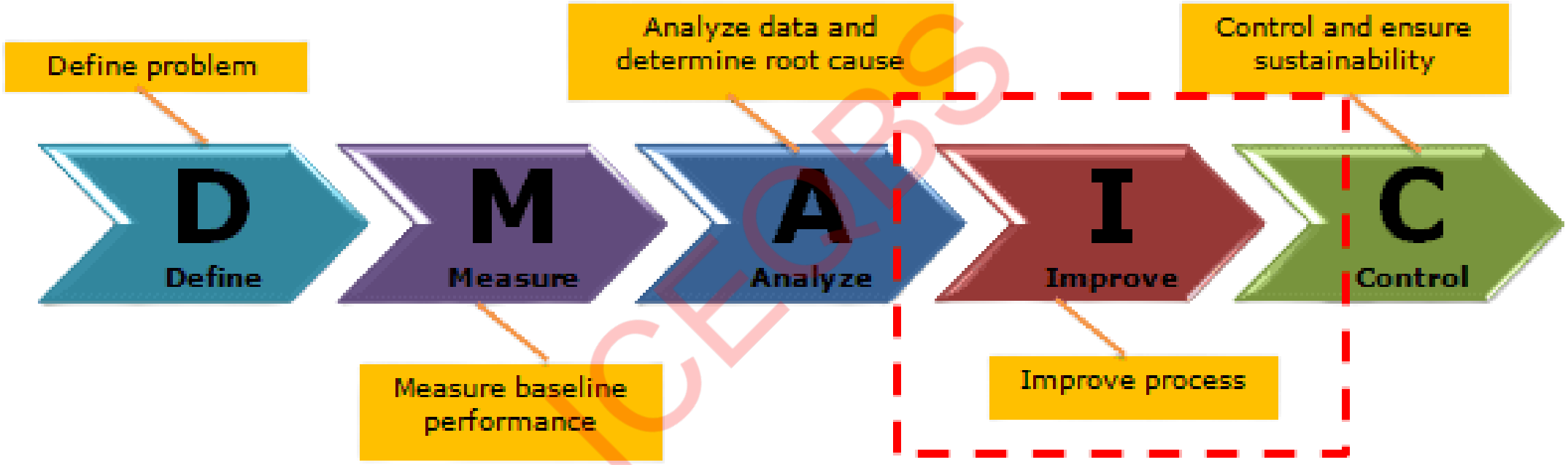




Inference :

Both analyses show statistically significant differences ($p < 0.05$), confirming that inadequate sampling plans and lack of risk-based supplier inspection are critical contributors to higher NCR rates.

IMPROVE PHASE



Improve Design of Experiment

Sl. No.	Critical Root Cause Addressed	Improvement Action	Lean / LSS Tool	Owner	Target Completion	Expected Impact
1	Supplier material variability	Implement supplier capability requirement (Cp/Cpk ≥ 1.33) and monthly supplier SPC review	Supplier SPC, Capability analysis	SQE	Month 1	Reduced lot-to-lot variation
2	Inadequate sampling plan	Introduce risk-based AQL sampling (tightened for high-risk suppliers)	Risk-based sampling, OC curves	Incoming QA	Month 1	Improved defect detection
3	Non-risk-based supplier inspection	Classify suppliers into A/B/C risk categories and apply dock-to-stock for A suppliers	Supplier segmentation, Pareto	SQE	Month 2	Focused inspection effort
4	Inconsistent inspection checklist	Create standardized, visual inspection checklist with accept/reject photos	Standard work, Visual SOP	QA Lead	Month 2	Reduced inspection-generated NCRs

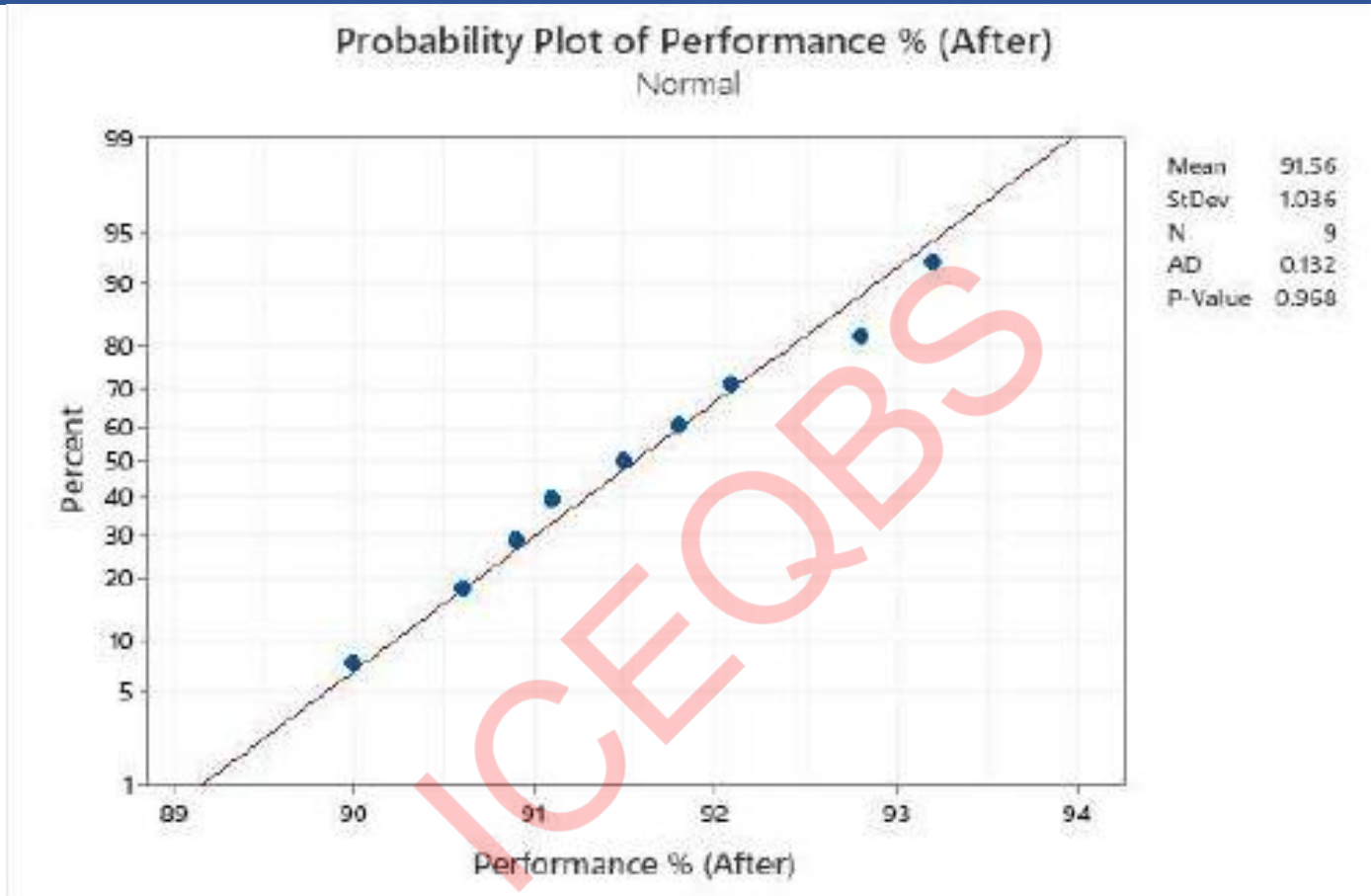
Improve Design of Experiment

Sl. No.	Critical Root Cause Addressed	Improvement Action	Lean / LSS Tool	Owner	Target Completion	Expected Impact
5	Inspector judgment variation	Conduct attribute MSA and certify inspectors to ≥90% agreement	Attribute MSA, Training	Quality Engineer	Month 3	Consistent inspection decisions
6	Poor visibility of acceptance criteria	Display latest drawings/specs at inspection point (digital/visual boards)	Visual management, 5S	QA Supervisor	Month 3	Fewer interpretation errors

Improve

Since all P-values are greater than 0.05, no special causes are detected.

Improve



Since the P-value is greater than 0.05, the data can be considered normally distributed.

Improve

Method

μ_1: population mean of Performance % (Before)
μ_2: population mean of Performance % (After)
Difference: $\mu_1 - \mu_2$

Equal variances are not assumed for this analysis.

Descriptive Statistics

Sample	N	Mean	StDev	SE Mean
Performance % (Before)	9	80.00	7.07	2.4
Performance % (After)	9	91.56	1.04	0.35

Estimation for Difference

Difference	95% CI for Difference
-11.56	(-17.05, -6.06)

Test

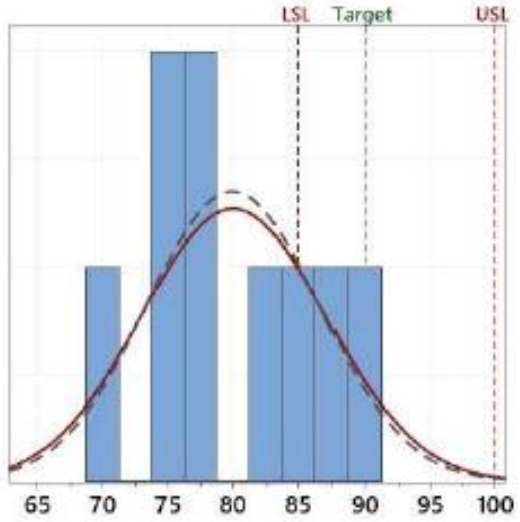
Null hypothesis $H_0: \mu_1 - \mu_2 = 0$
Alternative hypothesis $H_1: \mu_1 - \mu_2 \neq 0$

T-Value	DF	P-Value
-4.85	8	0.001

Since the P-value is less than 0.05, a statistically significant difference is observed between the before and after performance.

Improve – Process capability – Before & After Improvement

Process Capability Report for Performance % (Before)



Process Data	
LSL	85
Target	90
USL	100
Sample Mean	80
Sample N	9
StDev(Overall)	7.07107
StDev(Within)	6.64894

Overall
Within

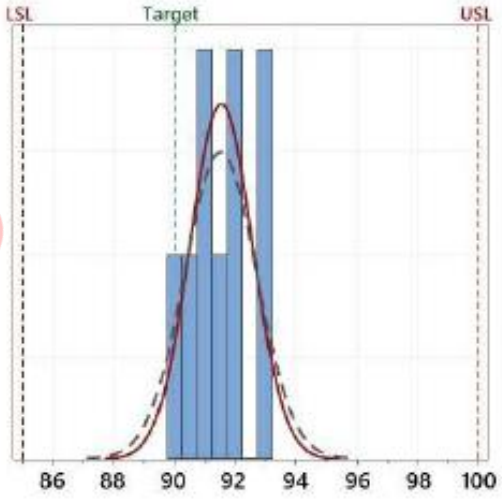
Overall Capability	
Pp	0.35
PPL	-0.24
PPU	0.94
Ppk	-0.24
Cpm	0.14

Potential (Within) Capability	
Cp	0.38
CPL	-0.25
CPU	1.00
Cpk	-0.25

Performance	Observed	Expected Overall	Expected Within
% < LSL	66.67	76.02	77.40
% > USL	0.00	0.23	0.13
% Total	66.67	76.26	77.53

The actual process spread is represented by 6 sigma.

Process Capability Report for Performance % (After)



Process Data	
LSL	85
Target	90
USL	100
Sample Mean	91.5556
Sample N	9
StDev(Overall)	1.03575
StDev(Within)	1.19681

Overall
Within

Overall Capability	
Pp	2.41
PPL	2.11
PPU	2.72
Ppk	2.11
Cpm	0.91

Potential (Within) Capability	
Cp	2.09
CPL	1.83
CPU	2.35
Cpk	1.83

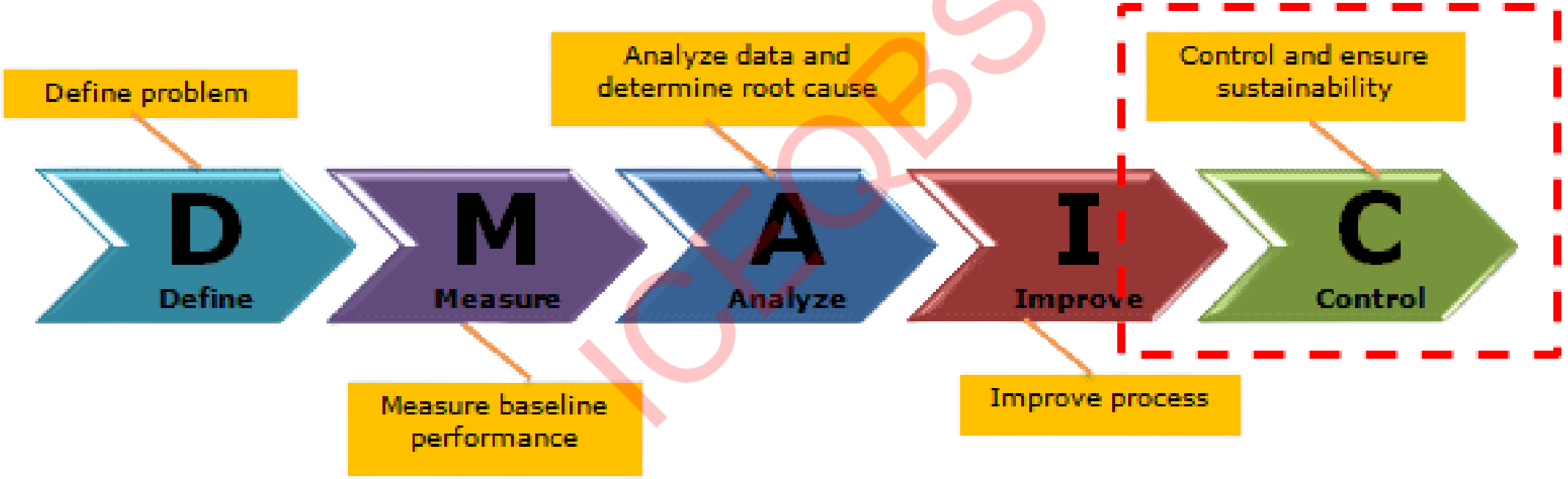
Performance	Observed	Expected Overall	Expected Within
% < LSL	0.00	0.00	0.00
% > USL	0.00	0.00	0.00
% Total	0.00	0.00	0.00

The actual process spread is represented by 6 sigma.

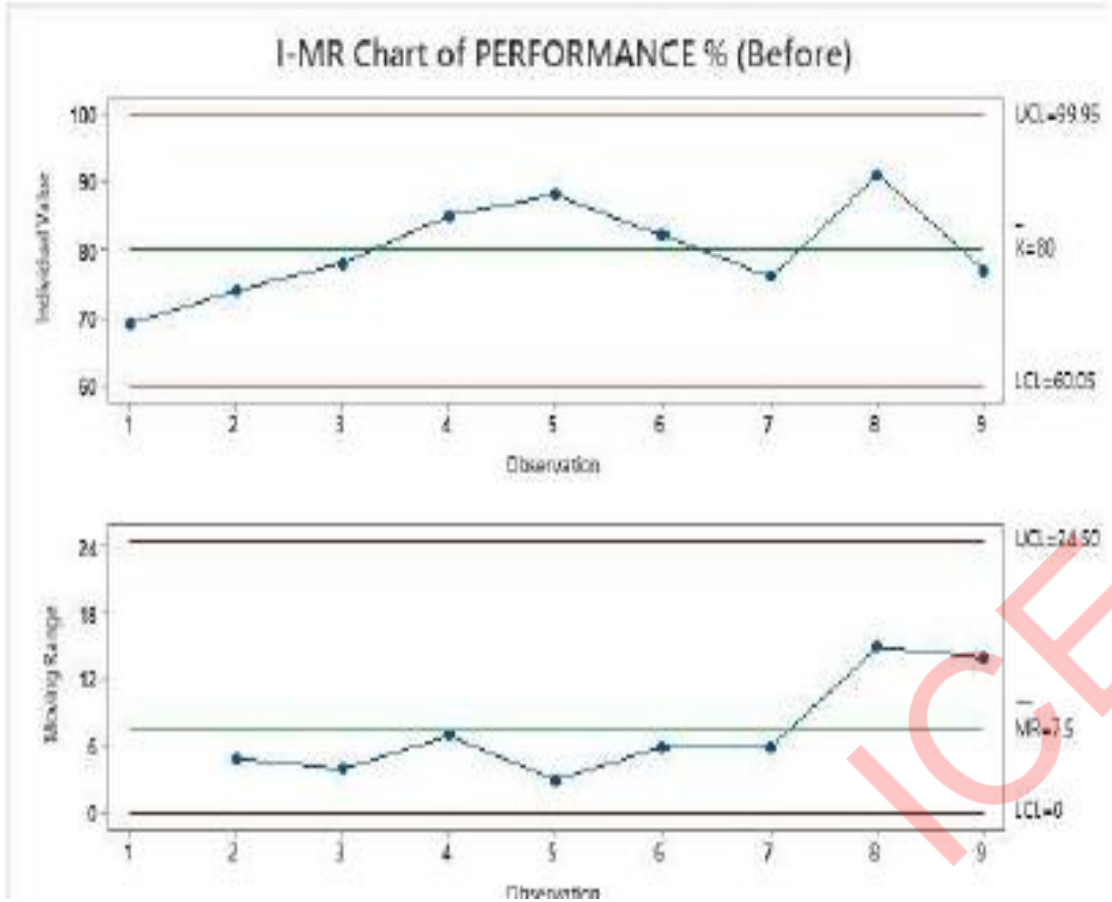
Inference :

- Since Cp is 2.09 and Cpk is 1.83, the process meets Six Sigma capability requirements.

CONTROL PHASE



Improve (Statistical validation for Improvement – I-MR Chart)



The I-MR charts indicate that after improvement the performance process is stable

Control Plan

Sl. No.	Critical Root Cause Addressed	5S Mechanism	Poka-Yoke Mechanism	Sustaining Benefit
1	Supplier material variability	Dedicated, labeled incoming inspection zones by supplier & material type	Block inspection release unless supplier SPC data is uploaded	Prevents mixing of lots and enforces supplier quality discipline
2	Inadequate sampling plan	Visual AQL chart displayed at inspection workstation	ERP auto-populates sample size based on supplier risk	Eliminates wrong sample size selection
3	Non-risk-based supplier inspection	Color-coded tags for A/B/C suppliers at receipt	Dock-to-stock allowed only for A suppliers in system	Prevents over-inspection or under-inspection
4	Inconsistent inspection checklist	Standardized digital checklist at every inspection desk	Mandatory checklist completion before inspection closure	Eliminates missed inspection steps
5	Inspector-to-inspector judgment variation / poor criteria visibility	Shadow boards & single-point lesson sheets with accept/reject photos	Latest drawing/spec auto-opens when material ID is scanned	Prevents interpretation errors and outdated criteria use

Control Plan

Sl. No.	Process Step	Potential Failure Mode	Potential Effect of Failure	Potential Cause	S	O	D	RPN	Proactive Action (Prevention)	Owner
1	Supplier SPC implementation	Supplier does not submit SPC / capability data	Continued high material variability	Lack of supplier capability, poor follow-up	9	5	6	**270**	Make SPC submission mandatory in PO; block material receipt without SPC	SQE
2	Risk-based sampling rollout	Incorrect sampling level applied	Defects missed or over-inspection	Inspector confusion, no system control	8	4	5	**160**	ERP-driven auto-selection of AQL based on supplier risk	Incoming QA
3	Standard checklist deployment	Checklist not consistently used	Missed inspection steps, NCR leakage	Manual process, time pressure	7	5	5	**175**	Digital checklist with mandatory completion before closure	QA Lead
4	Inspector standardization	Inspectors revert to subjective judgment	Inconsistent accept/reject decisions	Inadequate training reinforcement	8	4	6	**192**	Periodic attribute MSA & inspector recertification	Quality Engineer
5	Visual criteria control	Outdated specs used at inspection	Wrong acceptance decision	Poor document control	9	3	4	**108**	Barcode scan auto-links latest drawing/spec	QA Supervisor

Control Plan

Sl. No.	Critical Control Point	What to Control	How to Control	Frequency	Reaction Plan	Owner
1	Supplier material variability	Supplier process capability (Cp/Cpk ≥ 1.33)	Monthly supplier SPC & capability review	Monthly	Escalate to SQE, tighten inspection, initiate supplier corrective action	SQE
2	Risk-based sampling	Correct AQL level by supplier risk	ERP-driven auto sampling selection	Every lot	Stop inspection, reapply correct sampling, retrain inspector	Incoming QA
3	Inspection checklist compliance	Standard checklist usage (%)	Digital checklist with mandatory closure	Every inspection	Reject inspection closure, immediate corrective coaching	QA Lead
4	Inspector judgment consistency	Inspector agreement rate ≥ 90%	Periodic Attribute MSA	Quarterly	Retraining and re-certification of inspectors	Quality Engineer
5	Incoming NCR performance	Incoming material NCR rate (%)	Monthly NCR trend & control chart review	Monthly	Trigger root cause review if NCR >10%	Quality Manager

Conclusion

Results after improvement

- This project successfully stabilized incoming material performance, reduced NCR variability, and established risk-based controls to ensure sustained quality and on-time delivery.