

Improve % on-time shipment performance in HDPE Manufacturing

Kiran Basme

ROADMAP



OVERVIEW

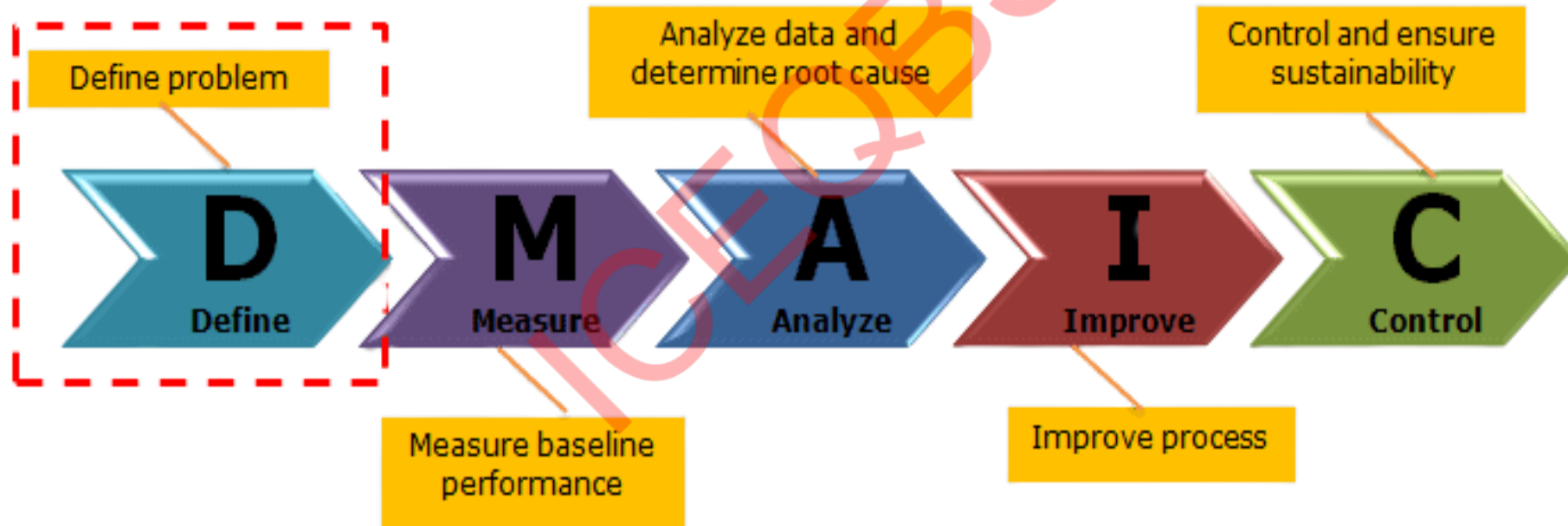


Background

This project, implemented in the manufacturing and supply chain, focuses on improving the on-time shipment performance from the current 89% to a target of 95% within six months.

Timely shipment is vital for sustaining customer trust, satisfaction, and repeat business, as delivery reliability directly influences market competitiveness. Enhancing shipment performance will not only reduce re-shipment and expedited logistics costs but also improve production planning, packaging accuracy, and logistics coordination. Achieving this goal is expected to result in higher customer retention, operational efficiency, and brand credibility in a competitive marketplace.

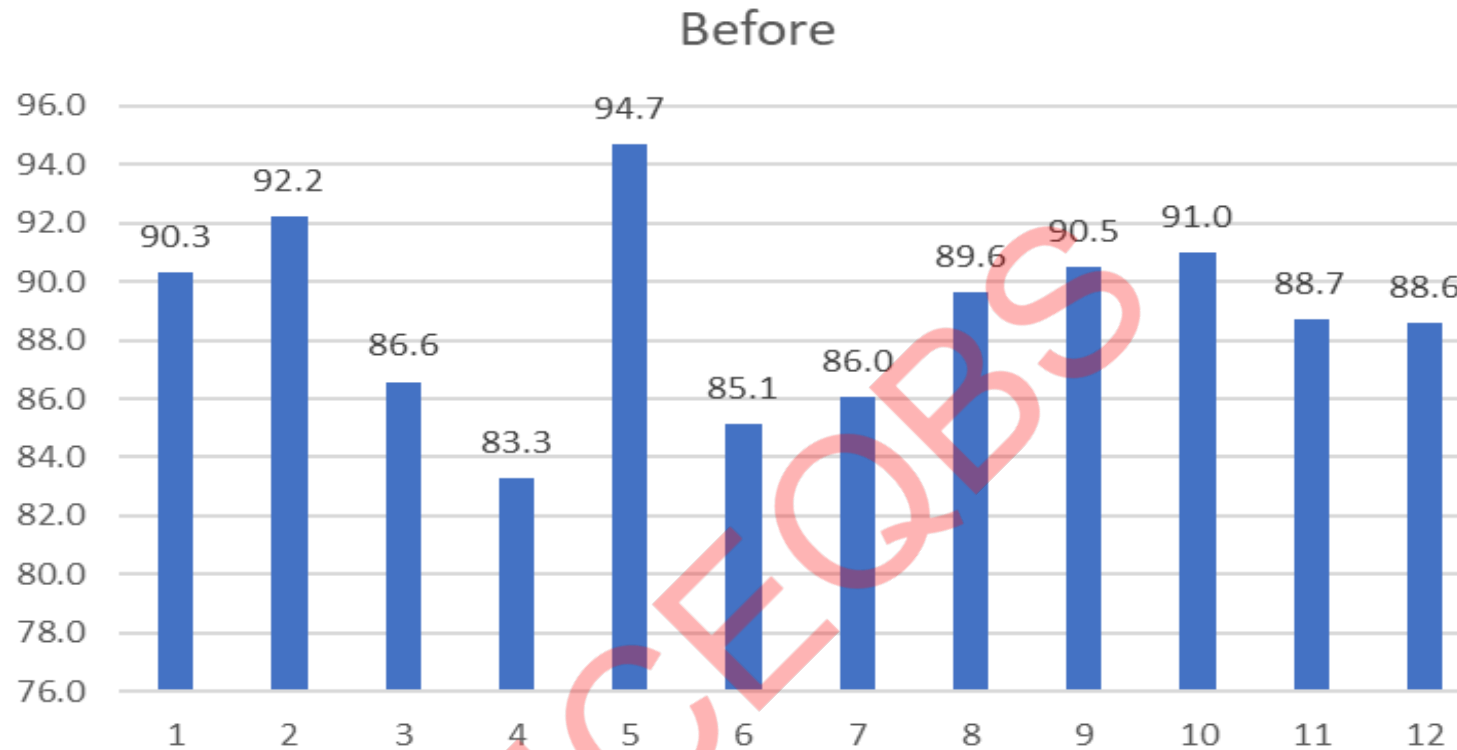
DEFINE PHASE



CTQ Tree :

Voice of customer	Critical to X	Primary Metric for improvement
<i>"We need ordered Material on requested time and with requested quality with consistency in quality requirements."</i>	CTD – Delivery	Primary Metric - Y = % OTS (On Time Shipment) Secondary Metric - % E&O

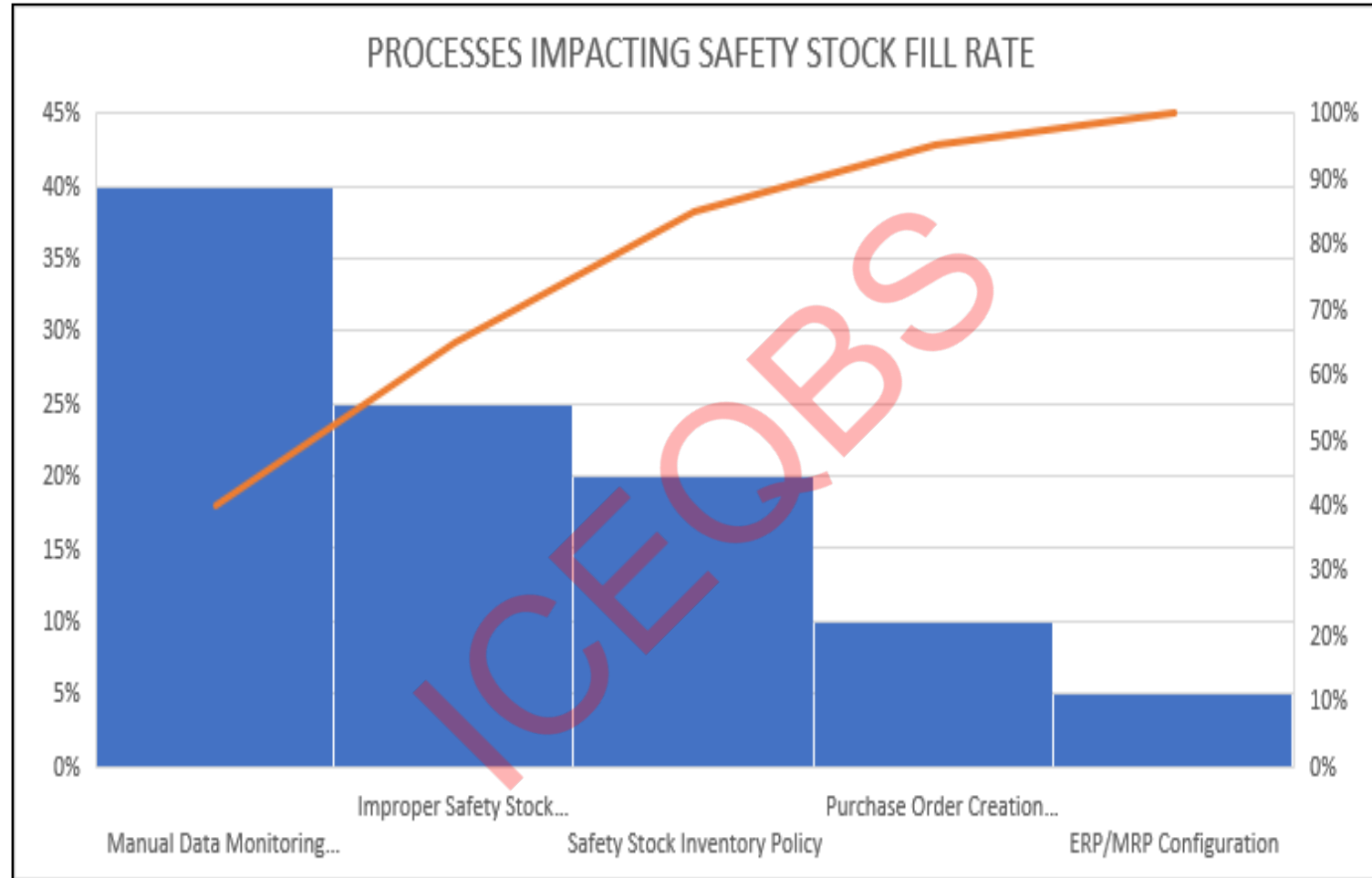
Baseline Performance of Primary Metric (9 months data as Line chart)



Inference :

- Last 9 months data shows a significant variation and hence ideal problem to be taken up as a Six Sigma Project.

Pareto chart



Inference : The project is going to focus only on **Manual Data Monitoring and Improper Safety Stock Calculation Processes.**

Suppliers	Inputs	Process (High-Level Steps)	Outputs	Customers
- Suppliers/vendors of raw materials or products - Inventory management system - Demand forecasting team - Procurement team	- Historical consumption data - Lead time data - Minimum order quantity (MOQ) - Reorder point (ROP) - Safety stock formula	- Analyse consumption and demand variability - Calculate safety stock levels based on service level targets - Identify items requiring safety stock - Raise procurement requests for stock - Approve and place purchase orders - Receive and store items - Update inventory system	- Replenished safety stock - Updated inventory levels - Procurement records - Reduced stockouts	- Production/Operations team - Sales/Customer service - Warehouse/inventory team - Finance (for budget tracking) - End customers (indirectly)

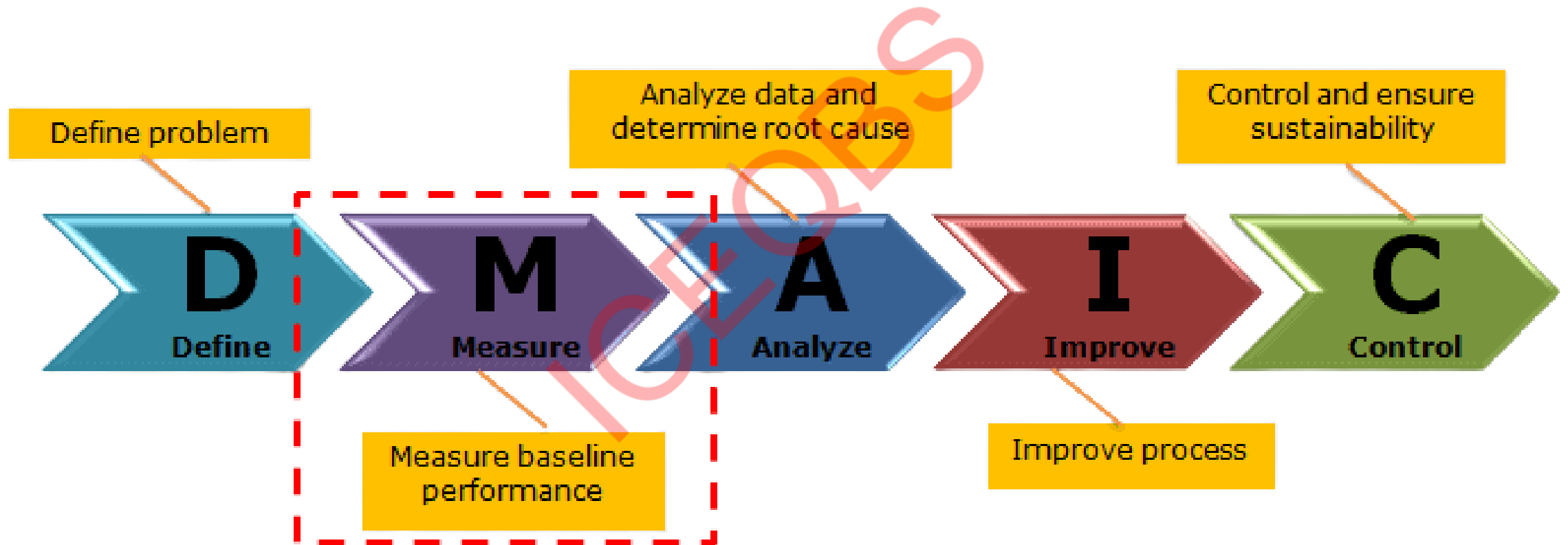
Project Charter

Project Title:		Improvement of On-Time Shipment to 95% Average	
Project Leader		Project Team Members:	
Kiran Basme		• Ravi S • Nandish K • Basu V • Arun P	
Champion/Sponsors:		Key Stake Holders	
Satish K, VP, Operations		Raw material Planning Team Production Team Management Committee. Quality Team	
Problem Statement:		Goal Statement:	
Currently, the average on-time shipment performance stands at 89% . This shortfall from the expected benchmark has resulted in customer dissatisfaction, increased complaints, and potential loss of repeat business. Root causes have not been fully identified, but early indicators point toward delays in production scheduling, packaging errors, and logistics inefficiencies.		Increase the on-time shipment performance from the current average of 89% to a minimum of 95% within the next 6 months by identifying and eliminating the key causes of delays across the order fulfilment process.	

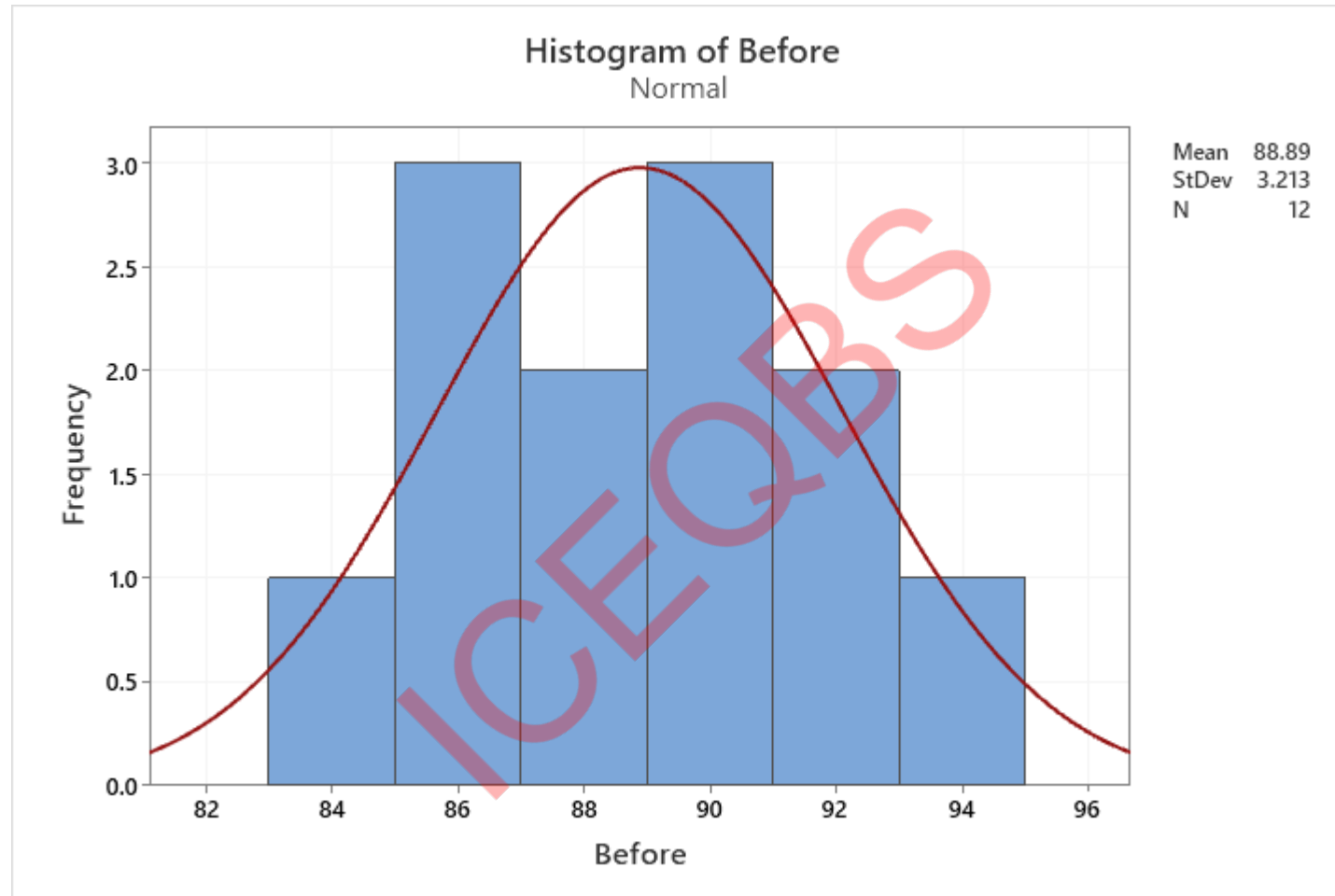
Project Charter

Tangible and Intangible Benefits:		Risk to Success:	
Reduction in logistics and re-shipment costs due to fewer delays. Improved on-time delivery rate from 89% to 95%, enhancing process efficiency. Lower inventory holding costs through better production and dispatch alignment.		Inconsistent data tracking Unforeseen supply chain disruptions Resistance to process change	
In Scope:		Out of Scope:	
All Export orders. Only third Party Customers		Inter Entity Orders	
Signatories:		Project Timeline:	
Project Head : Kiran Basme = Sponsor : Satish K		6 Months	

MEASURE PHASE



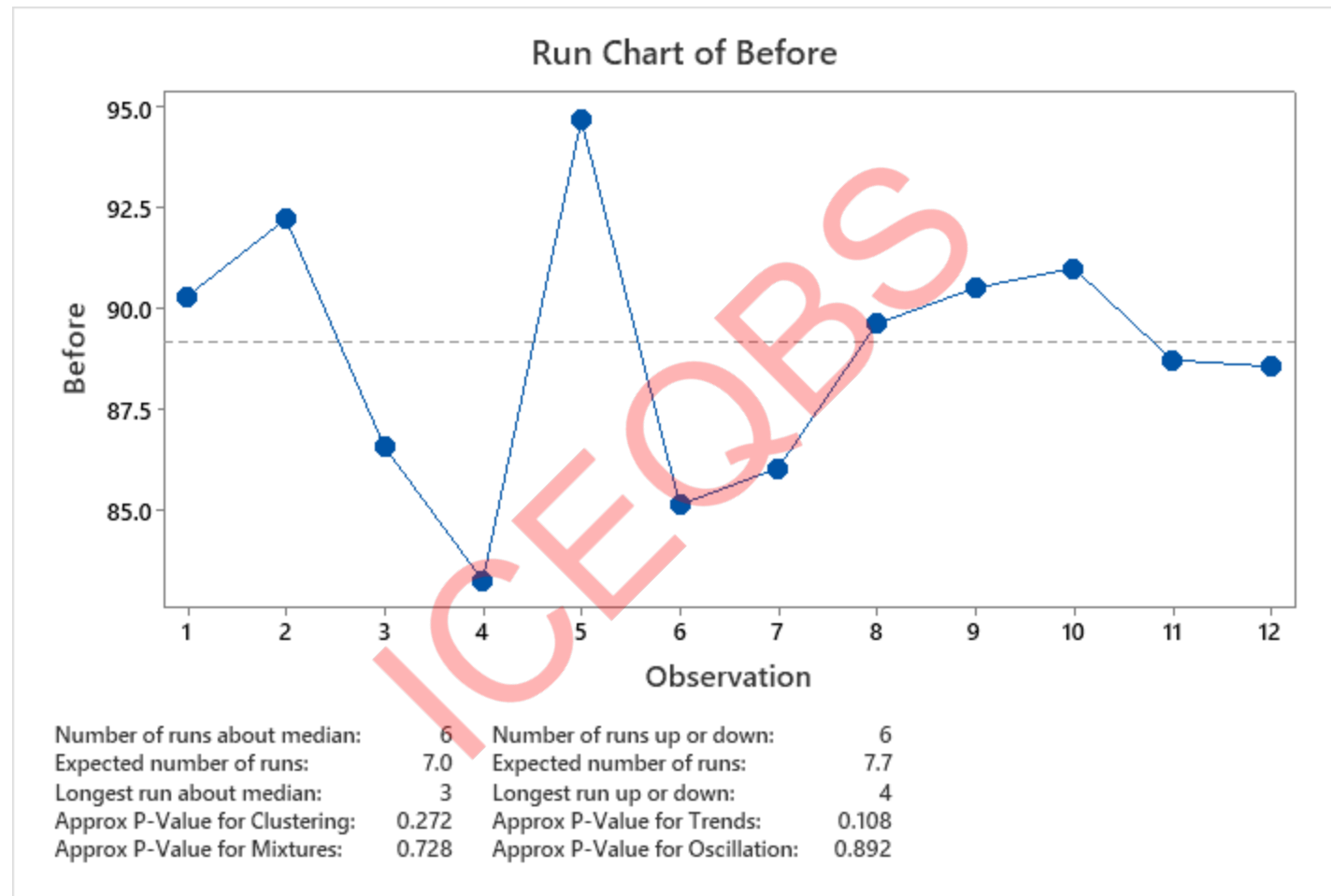
Data collection – Histogram (Before improvement)



Inference :

- Data is normally distributed over the mean

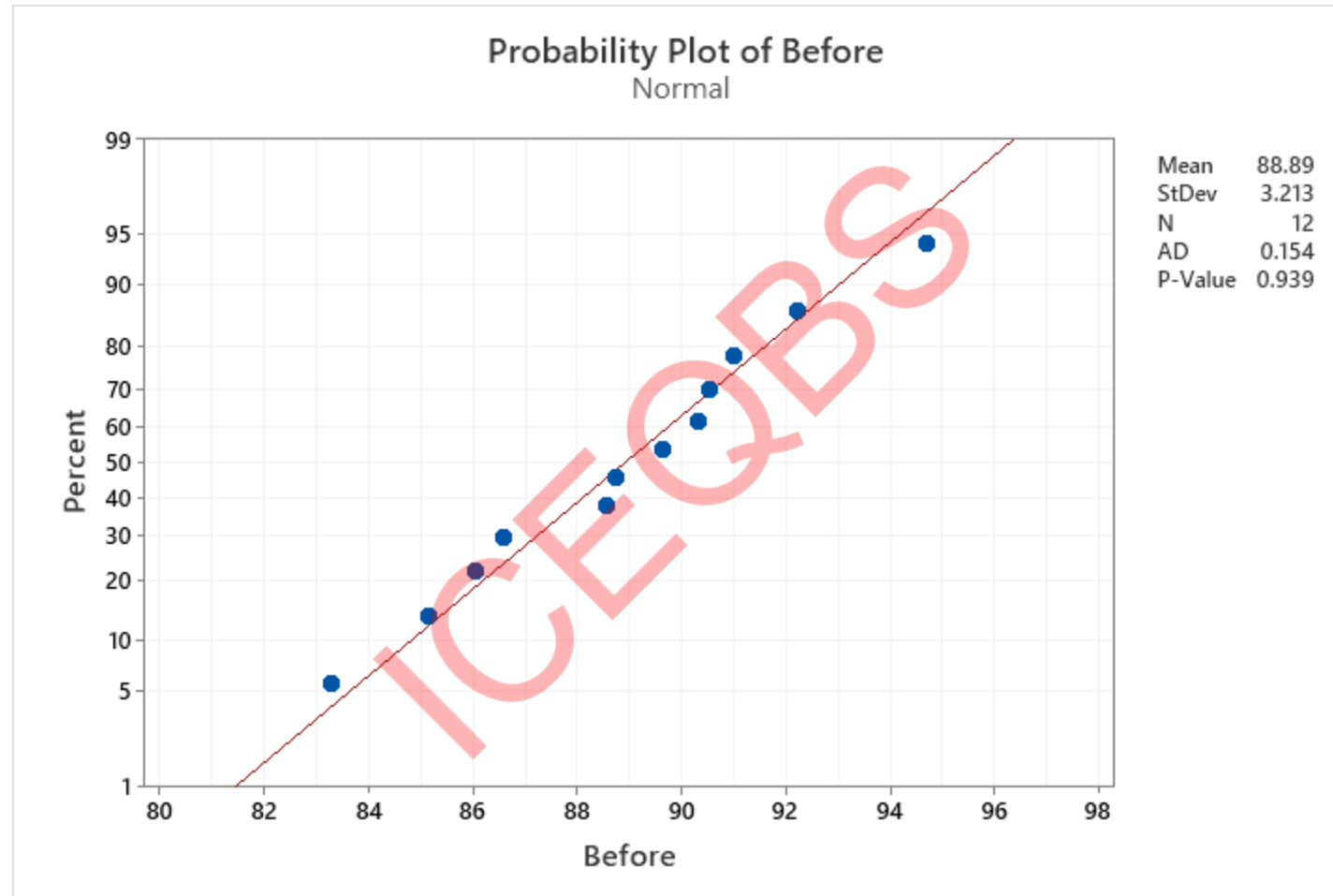
Data collection – Run Chart (Before improvement)



Inference :

$P > 0.05$ – No special causes in the process. Data can be used for further analysis

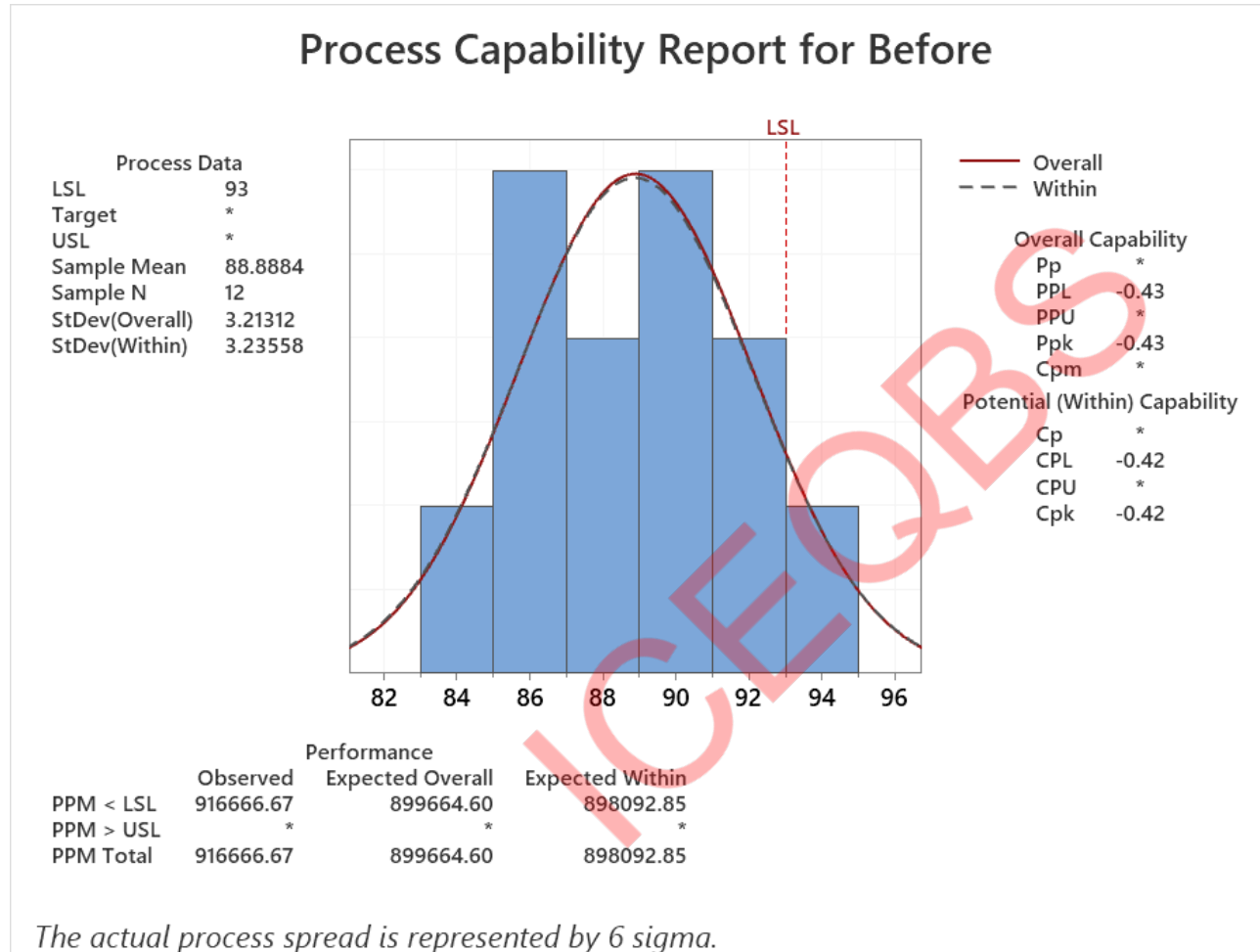
Data collection – Normality plot (Before improvement)



Inference :

- $P > 0.05$ in all scenarios, thus all the data is normally distributed

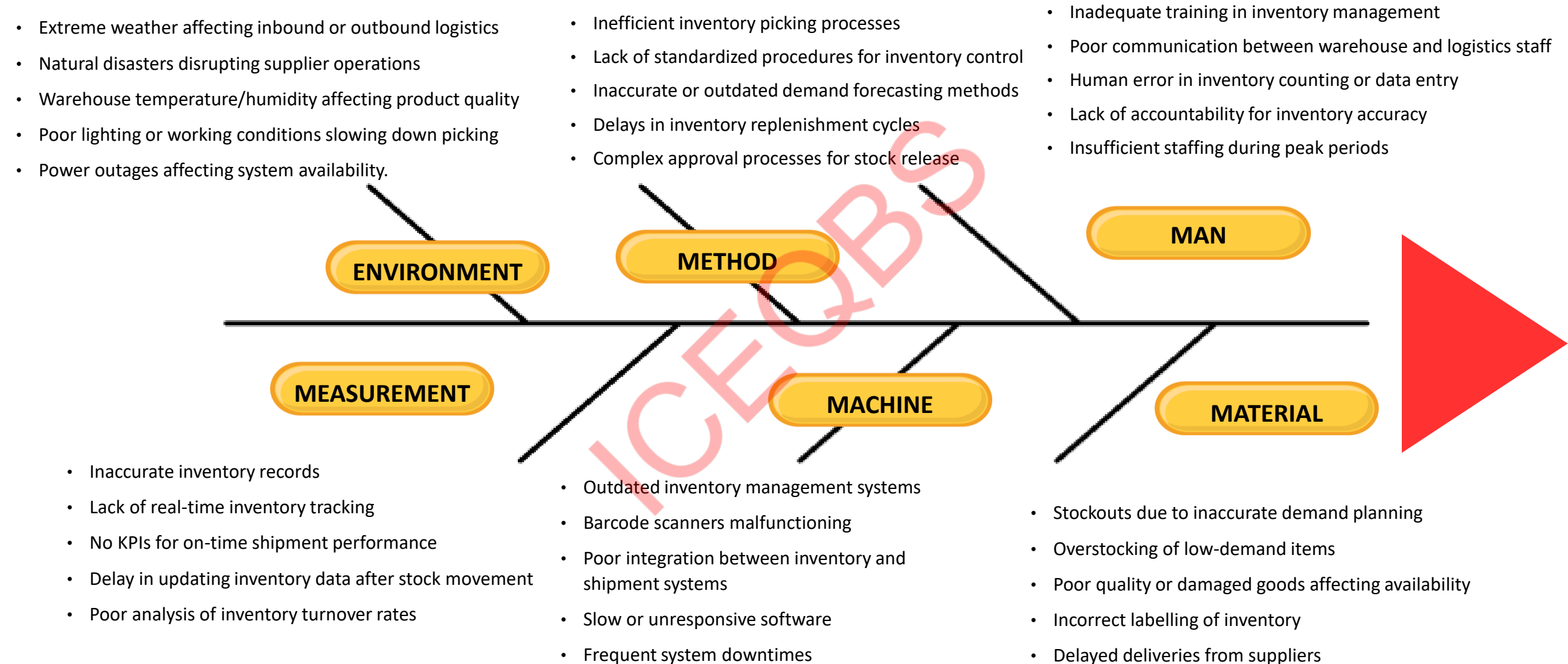
Process Capability (Before improvement)



Inference :

- Process is highly not capable

Fish Bone Diagram



3M Analysis for Waste

MUDA

- Holding excess stock leads to high carrying costs and risk of obsolescence.
- Unnecessary movement of inventory
- Frequently relocating items due to Space constrain.
- Products sitting unused until they expire or become unsellable represent pure waste.

Mura

- Sharp peaks and troughs in customer orders cause uneven inventory replenishment and staffing issues.
- Some suppliers deliver early, others late, disrupting inventory flow and planning.
- Poor forecasting accuracy leads to overstock in some periods and stockouts in others.

Muri

- Relying on humans to input stock changes causes fatigue and errors, especially during busy periods.
- Forcing staff to work in cramped areas increases physical strain and slows picking efficiency.
- Purchase team will be under stress due to priority issues/Urgency of orders and OTS pressure.

8 Wastes Analysis

Defects

Incorrect stock counts leading to sudden shortage scenarios.
Mislabeling products resulting in delays and manual correction

Overproduction

Ordering bulk inventory without demand to “get a better price”
Producing promotional stock not aligned with actual sales forecasts

Waiting

Staff walking long distances to retrieve items due to poor layout and Poor system knowledge
Repeated manual data entry across systems instead of using integrated tools

Non-Utilized Talent

Not involving concerned staff in process improvement or layout design
Assigning highly skilled employees to routine manual stock checking

Transportation

Moving inventory between multiple storage locations without value-adding purpose
Shipping products to incorrect warehouses and reshipping to correct ones

Inventory

Overstocking slow-moving items leading to space and capital waste
Holding safety stock well beyond required levels due to fear of stockouts

Motion

Technicians walking long distances to fetch tools or parts
Excessive movement during inspection due to poor layout

Overprocessing

Rechecking inventory multiple times due to lack of trust in system accuracy
Printing and filing physical inventory reports that are already stored digitally

Action Plan for Low Hanging Fruits

Special Causes (sudden failures / abnormalities)

Issue Category	Observed Problem (Gemba)	Lean Tool	Action Item	Owner	Timeline	Expected Benefit
Special Cause	Supplier Machine Breakdown	VSM	Consider Additional Processing time in Total LT	Purchase	1 week	Prevent shipment delays due to system failure
Special Cause	Delays from customs clearance	Visual Management	Set up visual flags for international orders needing documentation	purchase	1 week	Reduce lastminute customs-related shipment delays
Muda	Overstock of low-demand Items	5S / ABC Analysis	Reclassify SKUs using ABC and Order Accordingly	Store	2 weeks	Free up space; reduce holding cost
Muda	Excess walking to find items	5S / Layout Optimization/AI	Reorganize shelves based on picking frequency/Kanban	Store	1 week	Reduce motion waste, improve picking speed
Mura	Fluctuating inventory arrival times	Heijunka (Level Loading)	Schedule supplier deliveries on fixed days	Purchase	2 weeks	Reduce inventory bursts and shortages
Mura	Peaks in warehouse workload	Standard Work / Cross-training	Cross-train staff to shift roles during high-volume days	HR & Ops	3 weeks	Balance workload, avoid late shipments
Muri	Manual counting during peak periods	Cycle Counting / Digital Tools	Implement rolling cycle counts using handheld scanners	Inventory Team	2 weeks	Reduce stress and improve inventory accuracy
Muri	Dependency on one experienced staff	Standard Operating Procedures (SOPs)	Document & train staff on key inventory processes	Training	2 weeks	Minimize risk, spread workload

Action Plan for Low Hanging Fruits

Special Causes (sudden failures / abnormalities)

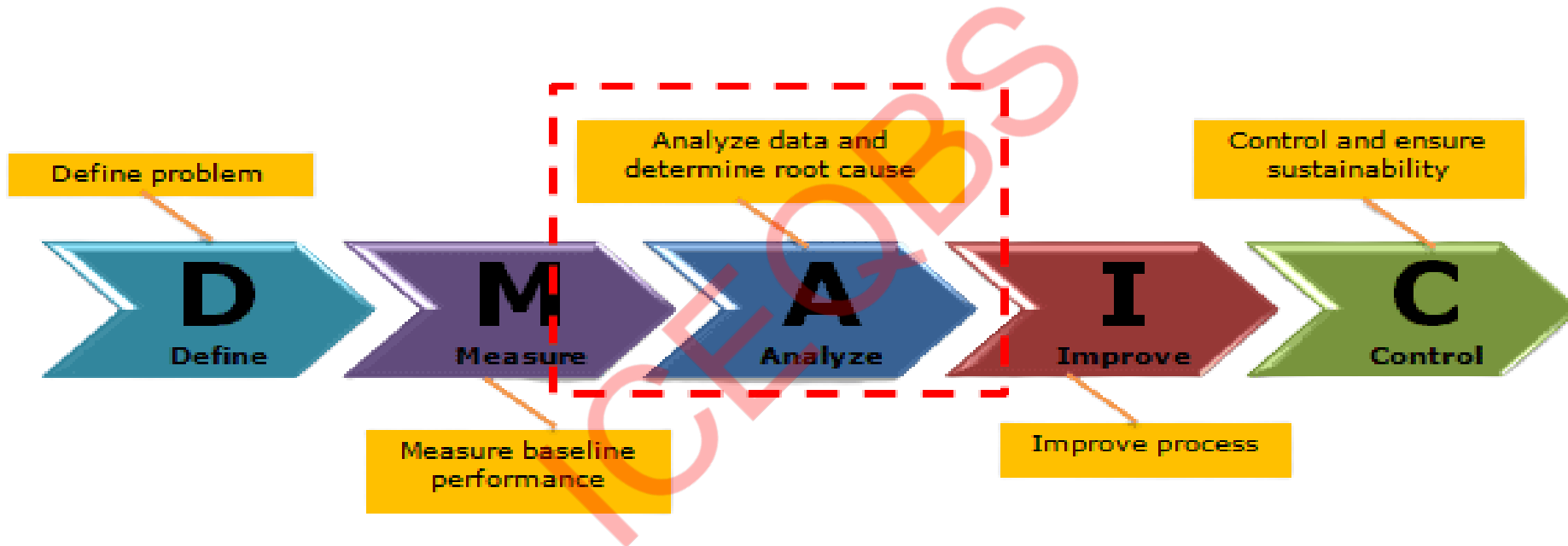
Issue Category	Observed Problem (Gemba)	Lean Tool	Action Item	Owner	Timeline	Expected Benefit
Waste: Waiting	Waiting for inventory updates	Kanban System	Use Kanban cards/signals for real-time inventory tracking	Store	1 week	Improve stock visibility and reduce idle time
Waste: Defects	Mislabelled inventory	Visual Controls / Barcode Validation	Implement barcode verification during put-away	Store	1 week	Reduce shipment errors and returns
Waste: Transportation	Double handling of inventory	Value Stream Mapping (VSM)	Map current flow and eliminate unnecessary transfers	Lean Peer	2 weeks	Improve flow, reduce non-value-added handling
Waste: Overprocessing	Double checking orders manually	Standard Work + Automation	Automate order verification within WMS	IT / Ops	2 weeks	Save time and reduce errors

Top 12 Prioritized Root Causes (Based on Net Score)		
Rank	Root Cause Description	Net Score
1	Inaccurate stock counts	268
2	No real-time inventory visibility	253
3	Delays in supplier deliveries	241
4	Stockouts of high-demand items	241
5	Ineffective demand forecasting	238
6	Mislabelling of inventory	238
7	Manual inventory updates	234
8	Long replenishment lead time	225
9	System downtime	216
10	No barcode scanning system	213
11	Poor warehouse layout	206
12	Lack of cycle counting	199

Data Collection Plan

Data Category	Specific Data Points	Source	Frequency	Responsible	Collection Method	Validation
Inventory Accuracy	Physical count vs system variance (%) Cycle count errors	Cycle count logs, physical audits	Weekly	Warehouse staff, Inventory control team	Barcode scanning, manual count	Weekly physical audits vs system data
Stock Availability	Stockouts by SKU Overstocked SKUs Safety stock levels	Warehouse Management System (WMS)	Daily	Inventory control	ERP/WMS reports, system dashboard	Monthly reconciliation
Order Fulfilment	Pick errors Late shipments due to inventory Fill rate (%)	Order processing system / ERP	Daily	Fulfilment team, QA	Order system reports, manual checks	Weekly error report reviews
Supplier Performance	On-time delivery rate Lead time variability Quantity accuracy	Procurement records, GRNs	Per shipment	Procurement, Inbound logistics	Purchase order and delivery tracking	Reconcile PO vs GRN per shipment
Process Efficiency	Data Monitoring Method purchase Process Inventory update Process	Observations, system logs	Weekly	Lean team, Warehouse supervisor	Time-motion studies, system logs	Supervisor verification
Technology Reliability	System downtime frequency/duration Barcode scan success rate	IT system logs	As occurred	IT Department	Automated monitoring tools	Monthly IT review
Labor Utilization	Tasks per labour hour Time on non-value activities (searching, rework)	Time tracking systems, observation	Weekly	Operations supervisor, HR	Time tracking software, observation	Cross-check with shift reports
Space Utilization	Storage capacity vs usage Inventory density (SKUs per shelf/bin)	Warehouse records, Gemba walks	Monthly	Warehouse manager, Lean team	Physical measurement, Gemba observations	Monthly space audit

ANALYSE PHASE



Analyse – Hypothesis testing

Regression Equation

OnTime_Delivery = 96.439 - 4.342 Supplier_Delivery_Delay - 1.5154 Stockouts

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	96.439	0.873	110.46	0.000	
Supplier_Delivery_Delay	-4.342	0.196	-22.10	0.000	1.02
Stockouts	-1.5154	0.0374	-40.50	0.000	1.02

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
1.75873	95.19%	95.09%	94.85%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	2	5939.4	2969.69	960.10	0.000
Supplier_Delivery_Delay	1	1511.1	1511.07	488.53	0.000
Stockouts	1	5073.2	5073.22	1640.16	0.000
Error	97	300.0	3.09		
Total	99	6239.4			

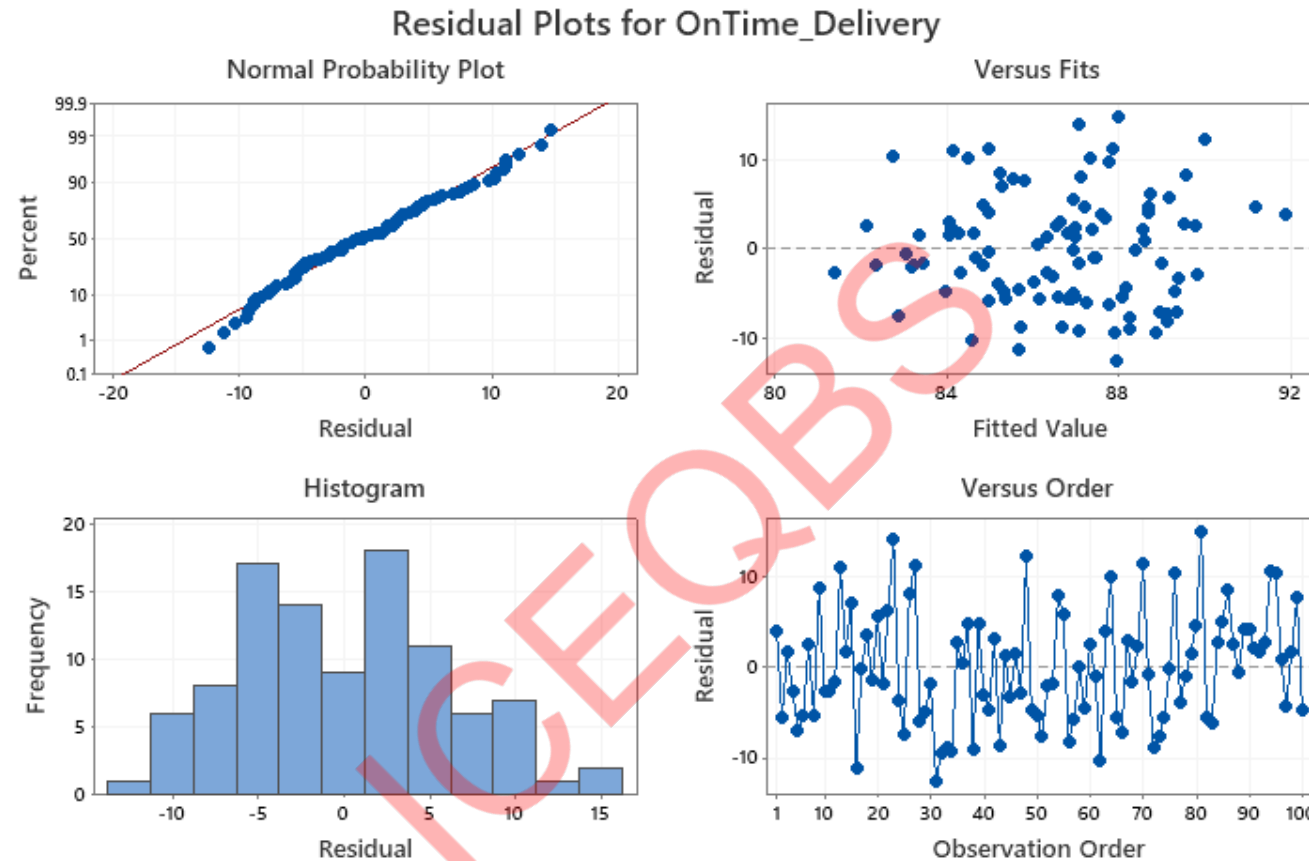
Conditions to meet and analyse:

- 1) All VIFs are less than 5 (if any VIF is more for any root cause then both are inter connected directly/indirectly) .So now here all X's are <5 so no one is inter connected.
- 2)R-sq-Adj- 85> . Now here its 95.09 . Model is ok . Increased from previous model
- 3) Regression p value $5 <$. Its meeting requirement.
- 4) individual p values should be $5 <$. now all of p values are more less 0.05 so all considered X's are critical and impacting output -OTS.

Inference :

- Since $p < 0.05$, thus not all means are equal

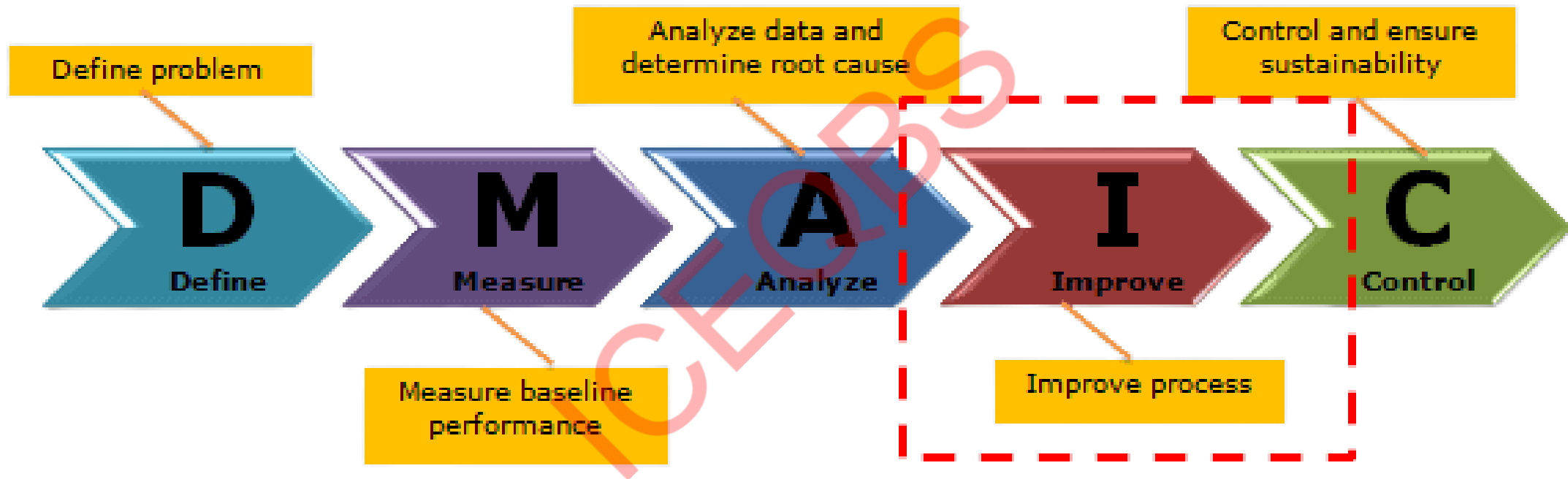
Analyse – Hypothesis testing



Inference :

- Both plots confirm that the residuals are normal, independent, and random — meaning the model fits the data well, and the underlying assumptions for regression or process analysis are satisfied.

IMPROVE PHASE



Improve

Root Cause 2: Inventory Stockouts or Inaccurate Inventory Data

Impact: Orders cannot be fulfilled on time due to unavailability of stock or mismatched data.

Action	Responsibility	Timeline	Key Metrics
Conduct cycle counts and reconcile inventory data	Warehouse Manager	Weekly	Inventory accuracy (%)
Implement real-time inventory management system	IT + Inventory Team	2–3 months	System uptime; accuracy rate
Improve demand forecasting to match stock levels	Demand Planning Team	Monthly	Forecast vs. actual variance

Improve

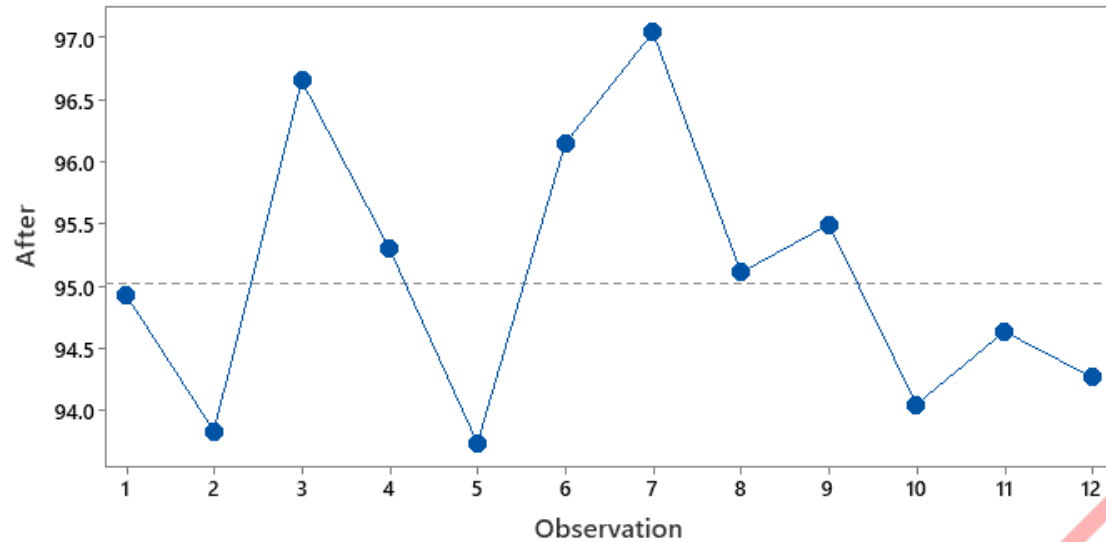
Root Cause 7: Poor Supplier Evaluation and Market Analysis

Impact: Low supplier performance, lack of competition, poor value for money.

Action	Responsibility	Timeline	Key Metrics
Develop and use standardized supplier evaluation criteria	Procurement Quality Lead	1 month	Evaluation form in use
Conduct regular market assessments for key categories	Procurement + Market Analyst	Bi-annually	No. of assessments conducted
Create and update a supplier performance database	Procurement IT Team	2 months	Database update frequency

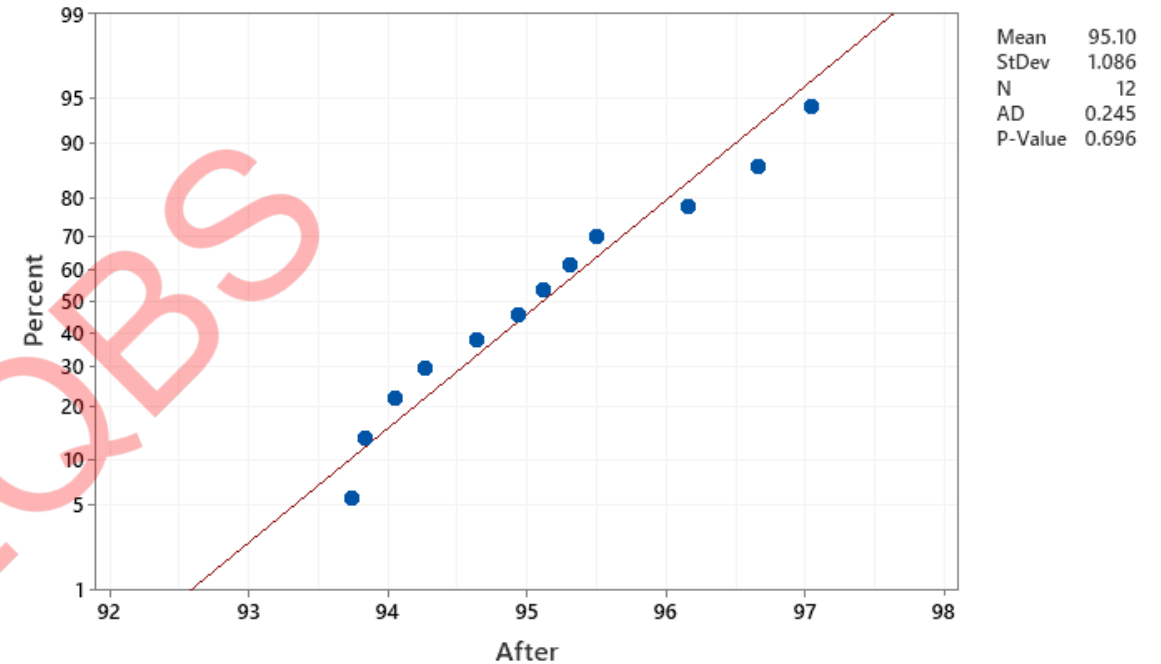
Improve – Run chart and Normality Test (After Improvement)

Run Chart of After



Number of runs about median:	5	Number of runs up or down:	9
Expected number of runs:	7.0	Expected number of runs:	7.7
Longest run about median:	4	Longest run up or down:	2
Approx P-Value for Clustering:	0.113	Approx P-Value for Trends:	0.839
Approx P-Value for Mixtures:	0.887	Approx P-Value for Oscillation:	0.161

Probability Plot of After
Normal



Inference:

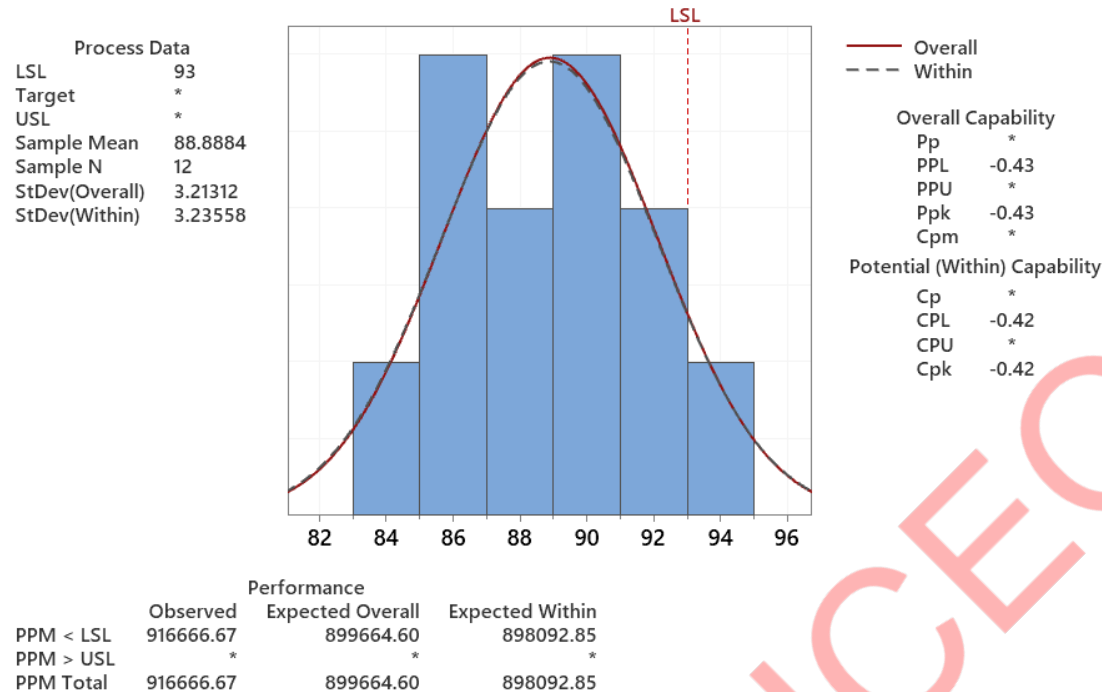
- Run chart – process is stable there is no special causes in the process (p value > 0.05)

Inference:

- Normality test – Data are normally distributed

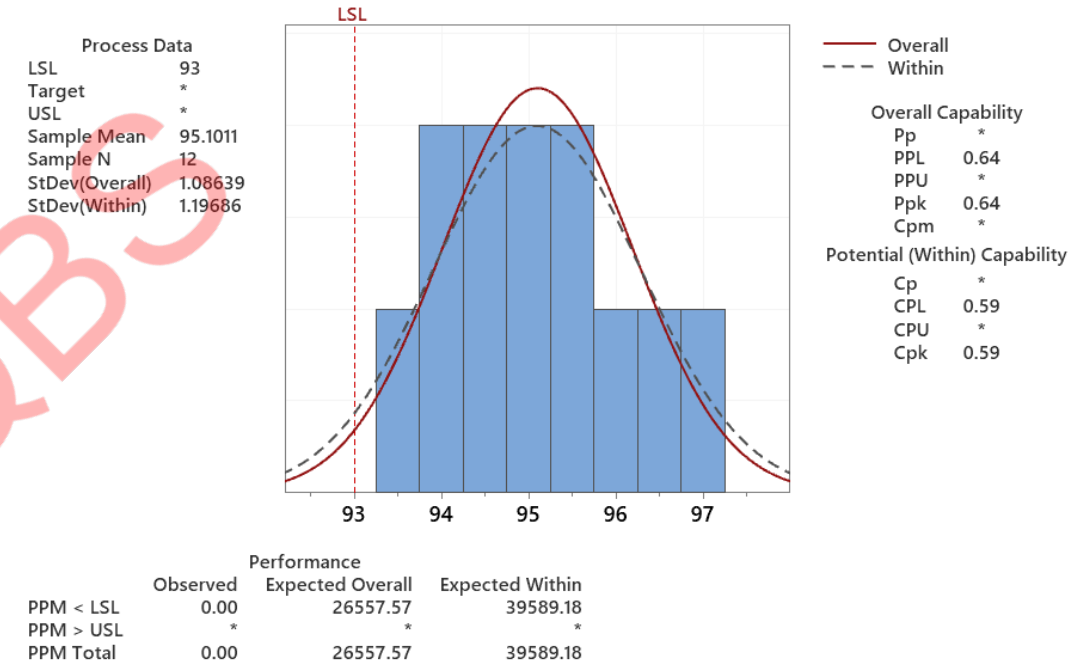
Improve – Process capability – Before & After Improvement

Process Capability Report for Before



The actual process spread is represented by 6 sigma.

Process Capability Report for After



The actual process spread is represented by 6 sigma.

Inference :

- Before $Cpk < \text{After } Cpk$, which shows process is much more capable after improvement
- There is less variability in system since stdev reduced after improvement
- After improvement the data are normally distributed near the target within specified limit

Improve –After Improvement (Statistical validation for Improvement – Hypothesis Testing)

Two-Sample T-Test and CI: Before, After

μ_1 : population mean of Before

μ_2 : population mean of After

Difference: $\mu_1 - \mu_2$

Equal variances are not assumed for this analysis.

Descriptive Statistics

Sample	N	Mean	StDev	SE Mean
Before	12	88.89	3.21	0.93
After	12	95.10	1.09	0.31

Estimation for Difference

Difference	95% CI for Difference
-6.213	(-8.328, -4.097)

Test

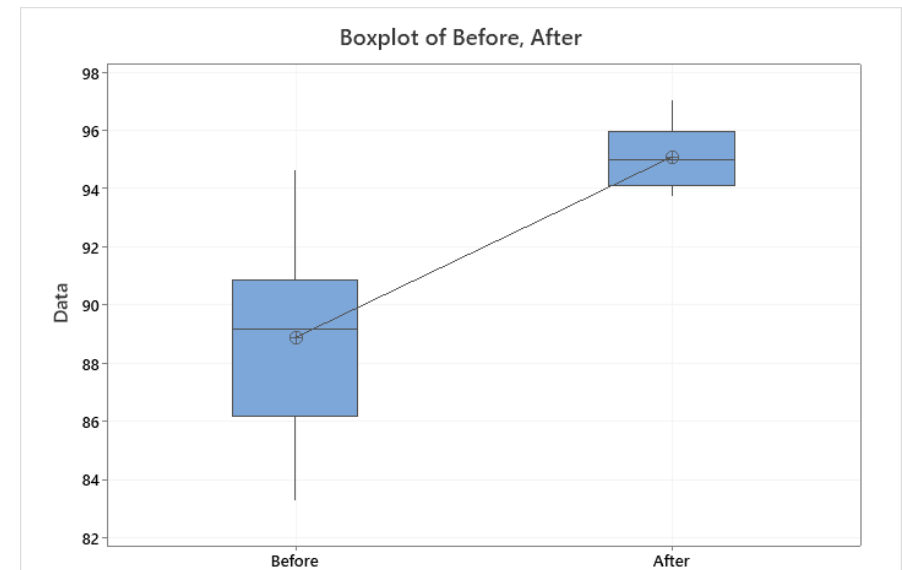
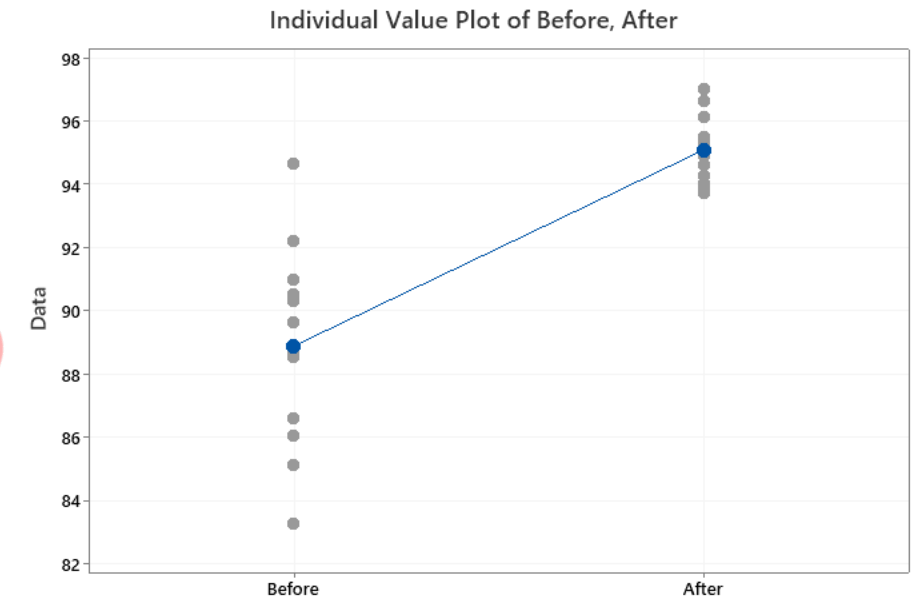
Null hypothesis $H_0: \mu_1 - \mu_2 = 0$

Alternative hypothesis $H_1: \mu_1 - \mu_2 \neq 0$

T-Value	DF	P-Value
-6.35	13	0.000

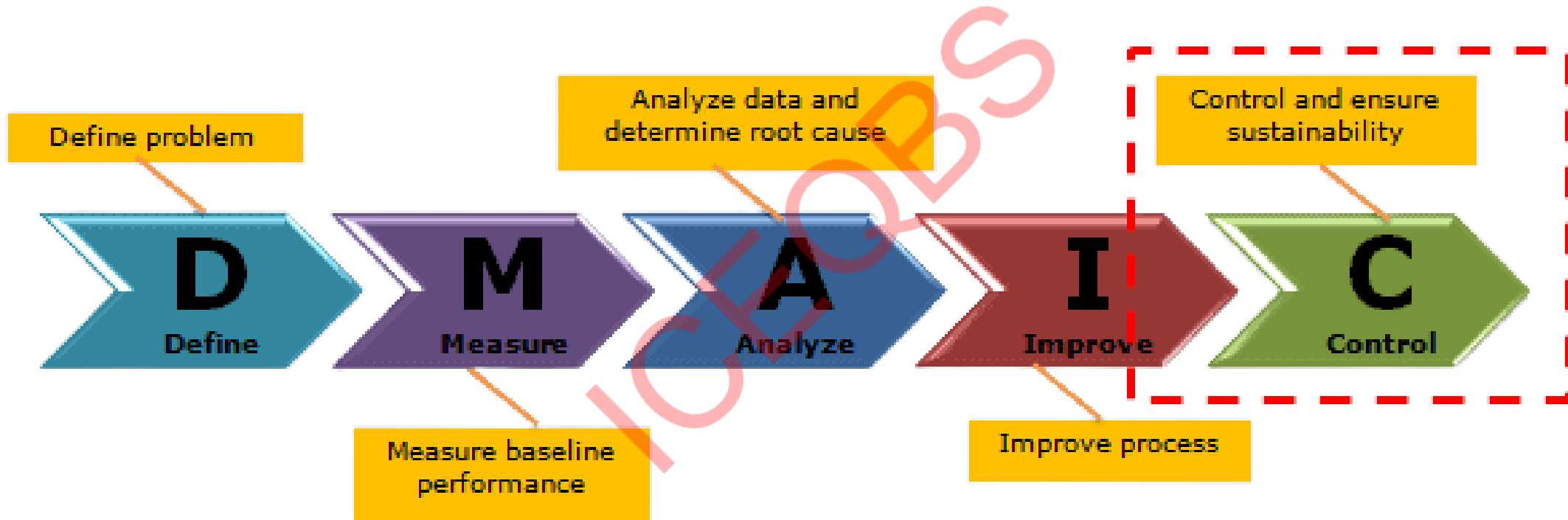
Inference:

- Since P value is less than 0.05, there is enough evidence to reject the null hypothesis and we can conclude that the difference between the population means is statistically significant.
- It is also visible from the individual value plot & box plot, there is clear difference in mean after improvement which is closer to required % scrap

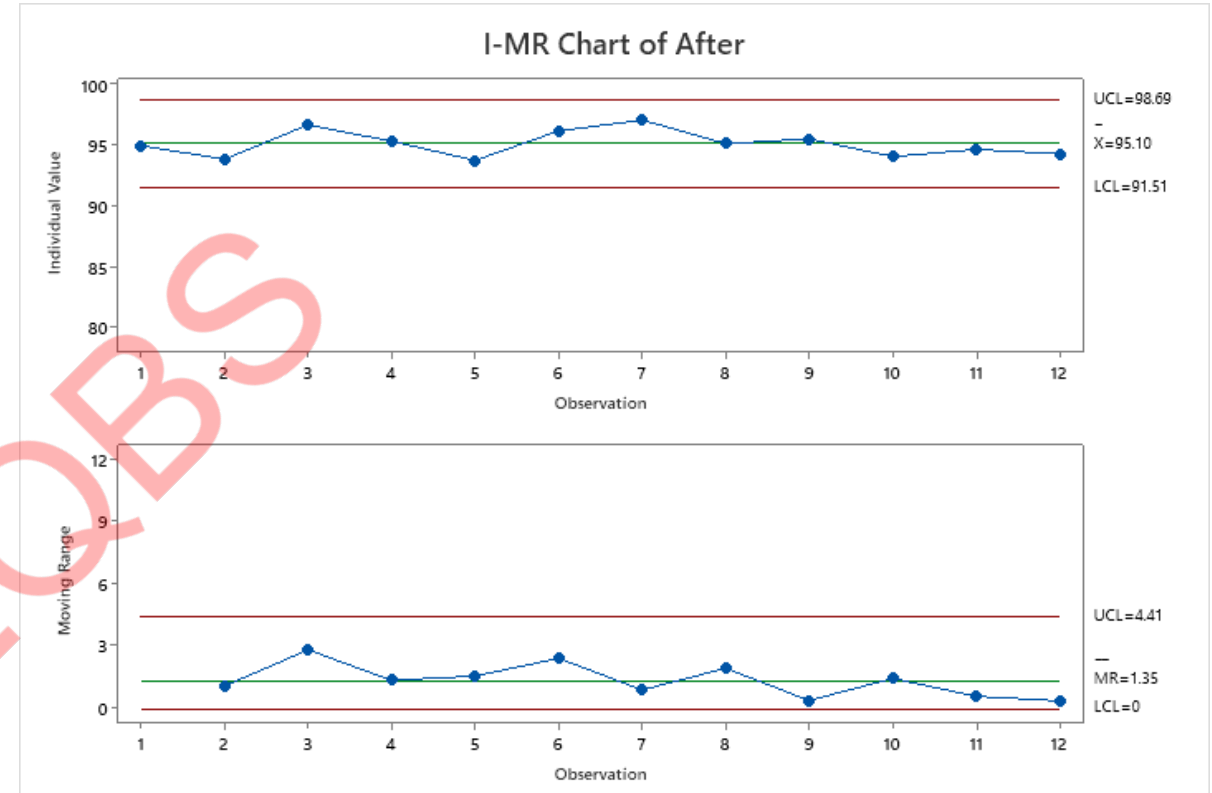
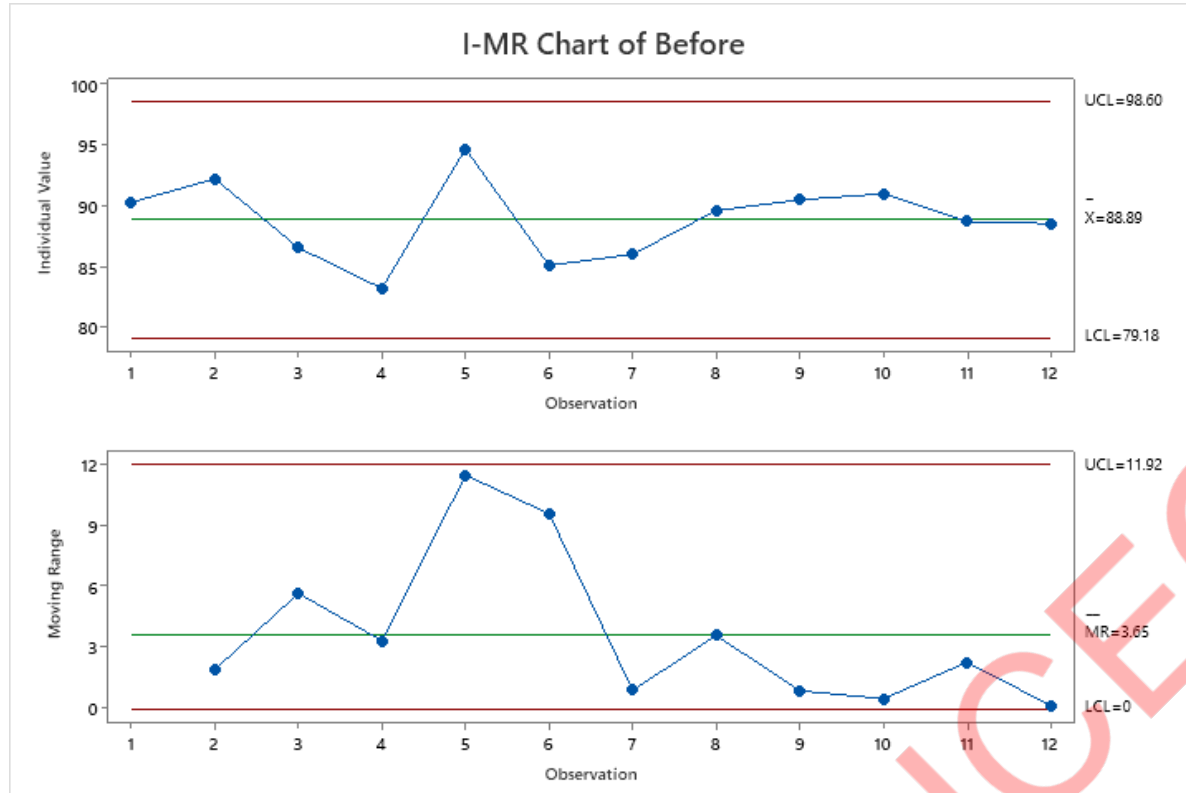


FMEA									
Process Step / Action	Potential Failure Mode	Potential Effect(s) of Failure	Severity (S)	Potential Cause(s)	Occurrence (O)	Current Controls	Detection (D)	RPN (S × O × D)	Recommended Action
Streamline order processing workflow	Workflow not updated/used	Orders still delayed	8	Lack of training; resistance to change	6	Process document shared only	7	336	Conduct training + assign process owner
Implement real-time inventory system	System not integrated or not used	Stockouts continue	9	IT delays; poor user adoption	5	Manual checks	6	270	Assign IT lead; pilot test before rollout
Coordinate with logistics providers	Providers don't meet SLAs	Shipments delayed	9	Weak enforcement of SLAs	5	Informal contracts	6	270	Formalize SLA + monthly review meetings
GPS shipment tracking tool	Tool not functional or real-time	No visibility of delays	7	Poor system integration	4	Manual tracking fallback	6	168	Use reliable vendor; test system before launch
Align production with shipment schedule	Production misses deadlines	Late product readiness	8	Lack of sync between production & logistics	5	Weekly meetings only	5	200	Use shared calendar; daily check-ins during peak
Notify customers proactively	Notifications not sent	Poor customer satisfaction	6	CRM/email automation not working	4	Manual calls	6	144	Automate alerts + set escalation protocol
Root cause analysis of delayed shipments	Root causes not identified	Delays keep recurring	7	Poor data capture or analysis	3	Basic delay logs	4	84	Standardize delay codes; assign RCA analyst

CONTROL PHASE



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



Inference:

- As seen in control chart, before improvement mean was high and there was high variability in the **Scrap reduction** and after improvement, it has achieved to target the Scrap reduction
- There is a significant reduction in Scrap reduction

Implementation of Kan Ban system in Work place



At least one consumables area has a replenishment system in place with FIFO and re-order points. This could be using a kanban system or visual trigger (green-yellow-red)

Implementation of Power BI (Automation Report) in Work place

dura-line		Safety Stock Tracking - DLME				orbis Connectivity Solutions	
Plant	Item Code	Description	Open PO Qty	Unit	Minimum Qty	Stock	Difference
9001	70010081	Buckles 13mm	30,000.00	EA	20000	12256	-7,744
9001	70010261	PPCOR BLK-3mm OD2400xID500mm Half Circle	0.00	EA	2000	112	-1,888
9001	70010229	HS END CAP-ADHESIVE-OD-30 - 55-GEC301A	0.00	EA	1000	0	-1,000
9001	70010049	Nylon String 0.8mm	0.00	KG	500	240	-260
9001	70010203	MASTERBATCH - GRAY RAL 7045 10%UV	0.00	KG	500	339	-161
9001	70010195	MASTERBATCH - ORANGE - 2009 RAL 10%UV	1,500.00	KG	1600	1455	-145
9001	70010211	MASTERBATCH FLUORESCENT GREEN-AQUA 10%UV	0.00	KG	50	82	32
9001	70010194	MASTERBATCH - BROWN - 8015 RAL 10%UV	0.00	KG	200	250	50
9001	70010009	Master Batch - Antistatic, Askon 2016	0.00	KG	500	590	90
9001	70010209	PE Foam Sheet-one Al layer-6mm-underlay	0.00	M	500	600	100
9001	70010192	MASTERBATCH -GREEN - 6001 RAL 10%UV	0.00	KG	500	622	122
9001	70010201	MASTERBATCH - PINK RAL 3015 10%UV	0.00	KG	50	181	131
9001	70010193	MASTERBATCH -YELLOW - 1018 RAL 10%UV	0.00	KG	500	675	175
9001	70010042	Master Batch - U.V 20%	0.00	KG	400	687	287
9001	70010226	HS END CAP-ADHESIVE-OD-5 - 11-GEC001A	500.00	EA	1000	1354	354
9001	70010008	Silicone	0.00	KG	2500	2874	374
9001	70010204	MASTERBATCH - TURQUOISE RAL 6027 10%UV	0.00	KG	50	441	391
9001	70010044	Rip Cord 2000 Denier x 4 Ply white	0.00	KG	250	653	403
9001	70010043	Rip Cord 2000 Denier x 3 Ply white	0.00	KG	500	1042	542
9001	70010188	MASTERBATCH RED - 3020 RAL 10%UV	1,200.00	KG	1200	1806	606
9001	70010184	Master Batch - Yellow 10% UV (DEWA)	0.00	KG	100	820	720
9001	70010189	MASTERBATCH -VIOLET - 4005 RAL 10%UV	0.00	KG	50	777	727
9001	70010050	Copper Wire 0.82mm (Annealed ETP Grade)	1,250.00	KG	500	1262	762
9001	70010191	MASTERBATCH -BLUE - 5015 RAL 10%UV	500.00	KG	1000	1796	796
9001	70010227	HS END CAP-ADHESIVE-OD-10 - 20-GEC101A	100.00	EA	1000	1903	903
9001	70010088	Woven Sack Black 600 x 0.15mm GSM 80	241.00	KG	2000	3082	1,082
9001	70010040	Master Batch - PPA	0.00	KG	200	1367	1,167
9001	70010246	ULF SILICONE COMPOUND	0.00	KG	250	1631	1,381
9001	70010228	HS END CAP-ADHESIVE-OD-17 - 35-GEC201	0.00	EA	1000	2641	1,641
9001	70010230	HS END CAP-ADHESIVE-OD-42 - 78-GEC401A	0.00	EA	500	2414	1,914
9001	70010038	Master Batch - White 70% TiO2	0.00	KG	500	2591	2,091
9001	70010202	MASTERBATCH-WATERRIJF RAL 5021 (DG) 10%UV	250.00	KG	2500	2806	2,456

Control Plan							
#	Control Area	Process/Activity	Control Method	Frequency	Responsible Party	Performance Indicator (KPI)	Corrective Action Trigger
1	Demand Forecasting	Monitor forecast accuracy	Compare forecast vs. actual demand	Monthly	Demand Planner / Procurement	Forecast Accuracy ≥ 85%	Variance > ±15%
2	Stakeholder Engagement	Cross-functional planning meetings	Meeting minutes & action tracking	Quarterly	Procurement Manager	Meeting attendance ≥ 90%	Missed meetings or no action follow-up
3	Supplier Evaluation	Performance scoring of suppliers	Supplier scorecard reviews	Quarterly	Supplier Relationship Manager	≥ 80% suppliers rated “Good” or higher	Any supplier scoring < 70%
4	Procurement Plan Compliance	Monitor actual procurement vs. plan	Procurement schedule tracking	Monthly	Procurement Officer	95% adherence to procurement plan	<90% adherence
5	Market Analysis	Regular updates of supplier base & pricing	Category market review	Bi-annually	Category Manager	New suppliers identified; price benchmarking	No market updates >6 months
6	Inventory Management	Stock level tracking and reorder points	Inventory dashboard & alerts	Weekly	Inventory Controller	Stockouts < 2%	Stockouts > 2% per month
7	Order Processing	Monitor order fulfillment cycle	Order-to-ship time tracking	Daily	Order Fulfillment Lead	Orders processed within 24 hrs	Delay > 48 hrs
8	Logistics Coordination	SLA monitoring with carriers	SLA compliance reports	Weekly	Logistics Coordinator	On-time delivery ≥ 95%	< 90% on-time delivery rate
9	Shipment Tracking	Use of real-time GPS / status updates	Shipment tracking dashboard	Real-time	Logistics + IT	100% shipments tracked	Any shipment without tracking
10	Customer Communication	Pre-shipment and delay notifications	Automated email/SMS system	Per shipment	Customer Service	100% of customers notified	Missed notification reports
11	RCA for Delays	Root cause analysis of late deliveries	Delay analysis report	Monthly	Quality or Logistics Analyst	100% of delays analyzed	Repeat delays with same root cause
12	Staff Training	Continuous skill refreshers	Training attendance & post-tests	Semi-annually	HR / Procurement Lead	100% staff trained	Missed sessions or <80% test pass rate
13	Compliance & Audits	Internal procurement audits	Checklist and compliance reports	Bi-annually	Internal Audit	100% compliance with policy	>2 audit findings per period
14	KPI Monitoring	Dashboard of procurement and logistics KPIs	Review and report KPIs	Monthly	Head of Supply Chain	All KPIs within control limits	Any KPI falling below target
15	Continuous Improvement	Regular review of process performance	CI meeting and action plan tracking	Quarterly	Continuous Improvement Team	Action items closed on time	Overdue CI actions



Results after improvement

- Project has achieved its intended results after improving thickness by identifying the variation cause and arresting it with necessary solutions accordingly