

Reduction of Scrap percentage in Baking Process

Abdhul Muneed

ROADMAP



Overview



Define



Measure



Analyse

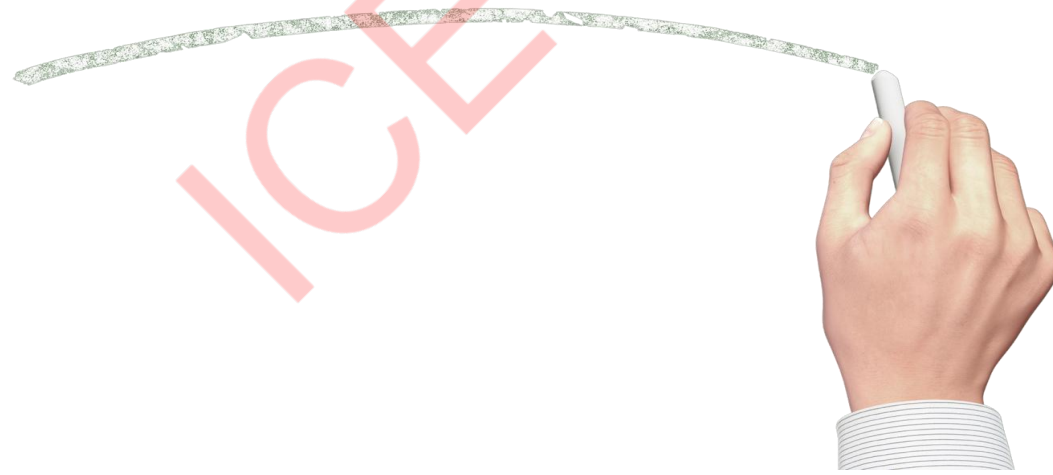


Improve



Control

OVERVIEW

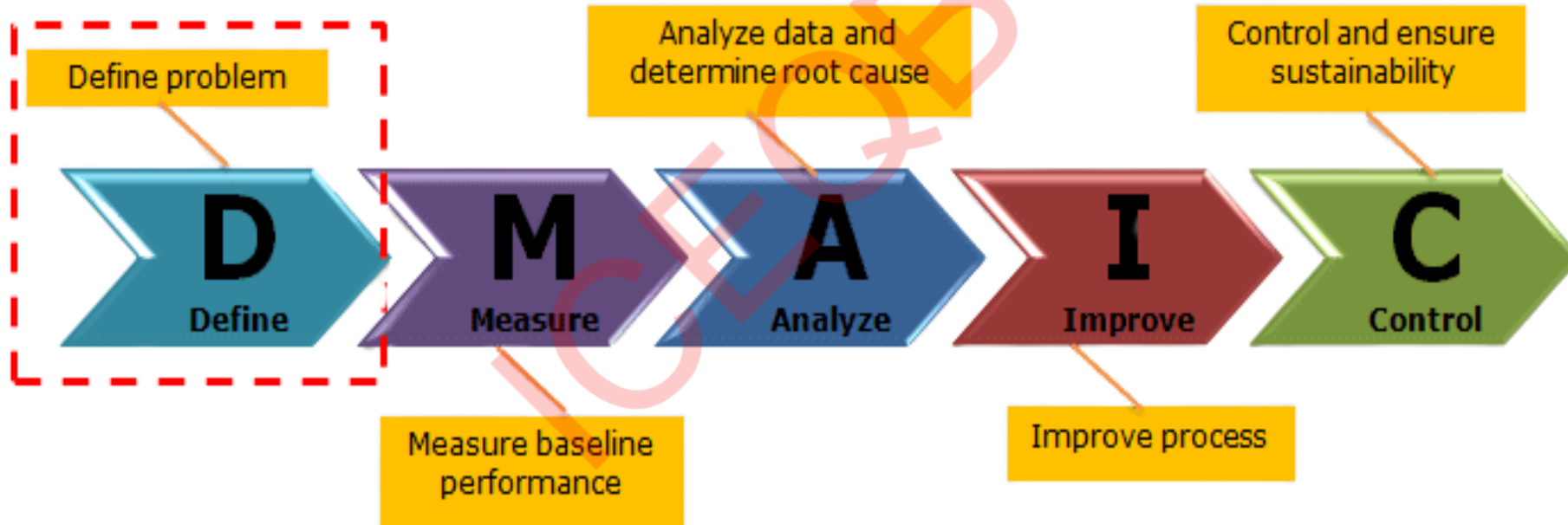


Background

Pizzamania, a rapidly growing pizza chain, invested in modern automated equipment in 2019 to increase production capacity to 600 pizzas per day. However, the expansion brought several challenges, including process instability and quality control issues during the transition phase. By early 2021, the internal scrap rate had risen to 17%, and frequent rework on uncooked pizzas began to reduce the availability of ovens and staff for fresh production.

Simultaneously, customer complaints about burnt and undercooked pizzas increased, with 3% of products being returned, directly impacting both brand reputation and profitability. These quality issues contributed to a sharp revenue decline from USD 2 million to 1.5 million within six months.

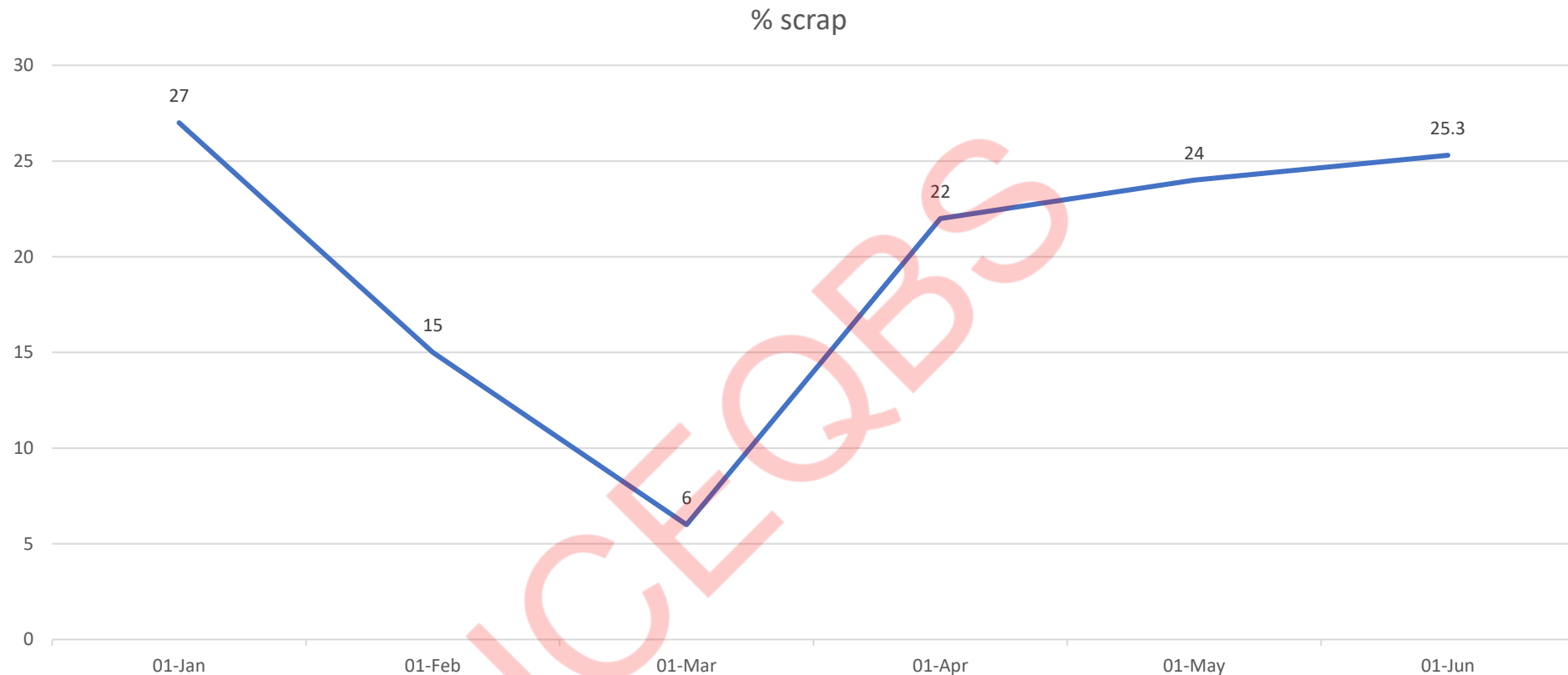
DEFINE PHASE



CTQ Tree :

Voice of customer	Critical to X	Primary Metric for improvement
“Complaints about burnt and uncooked pizzas 3% return rate due to poor product quality Expectation of consistent, properly cooked pizzas	CTQ — Proper cooking	Primary Metric - Y = % Scrap (baking) Secondary Metric - Productivity

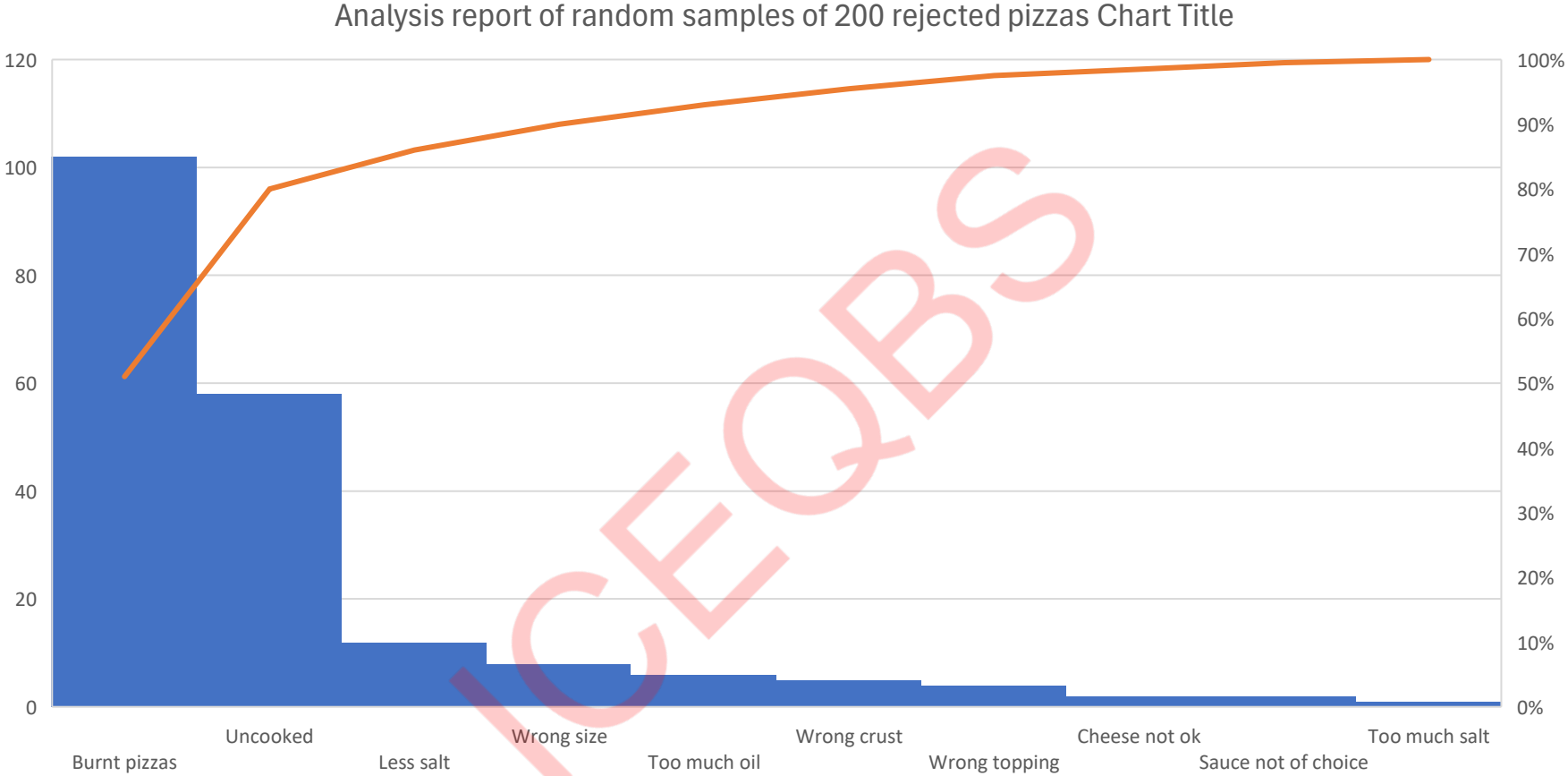
Baseline Performance of Primary Metric (9 months data as Line chart)



Inference :

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

Pareto chart

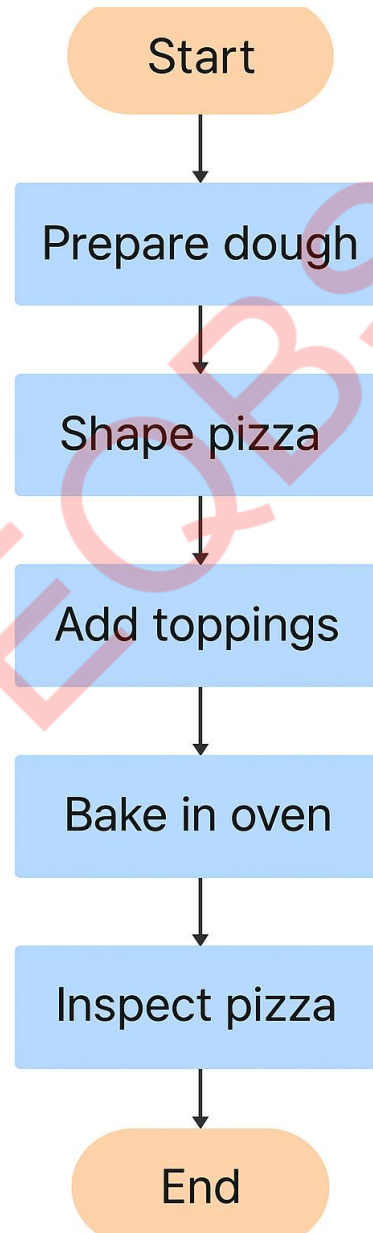


Burnt pizza is the main source of rejection

Scrap Reduction in Pizza

Suppliers	Inputs	Process	Outputs	Customers
Raw material vendors	Flour, cheese, sauce, toppings, packaging	Dough preparation	Prepared dough	Kitchen staff
Equipment suppliers	Automated ovens & mixers	Pizza assembly & topping	Assembled pizzas	Quality control team
Kitchen staff/operators	Recipes, SOPs, work instructions	Baking & monitoring	Cooked pizzas	Retail outlets/customers
Quality team	Inspection checklist, temperature logs	Quality inspection & rework handling	Accepted or rejected pizzas	End consumers
Maintenance team	Equipment uptime, calibration schedule	Equipment cleaning & setup	Operational efficiency reports	Operations manager

Process Flow chart



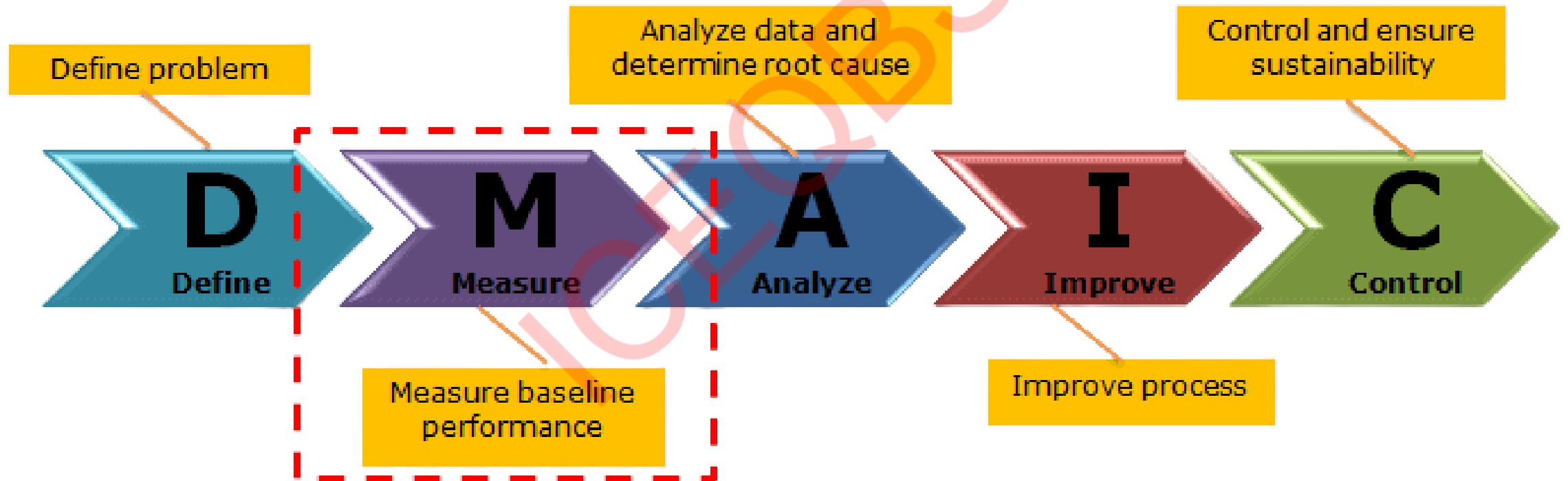
Project Charter

Project Title:		% scrap in baking process		
Project Leader		Project Team Members:		
Abdhul Muneed		Kitchen Staff / Operators, Customer Experience Manager		
Champion/Sponsors:		Key Stake Holders		
Operations Manager		Production SupervisorQuality Assurance LeadSupply Chain Manager		
Problem Statement:		Goal Statement:		
Currently % scrap in baking process is high @16%based on the data from jan to jun 2021		To reduce % scrap in baking process from 16% to 1% by Dec 2021		
Secondary Metric		Assumptions Made:		
Productivity		Machines and automation systems will operate without major breakdowns. Staff will comply with updated SOPs and training schedules. Raw materials from vendors will meet standard quality requirements.		

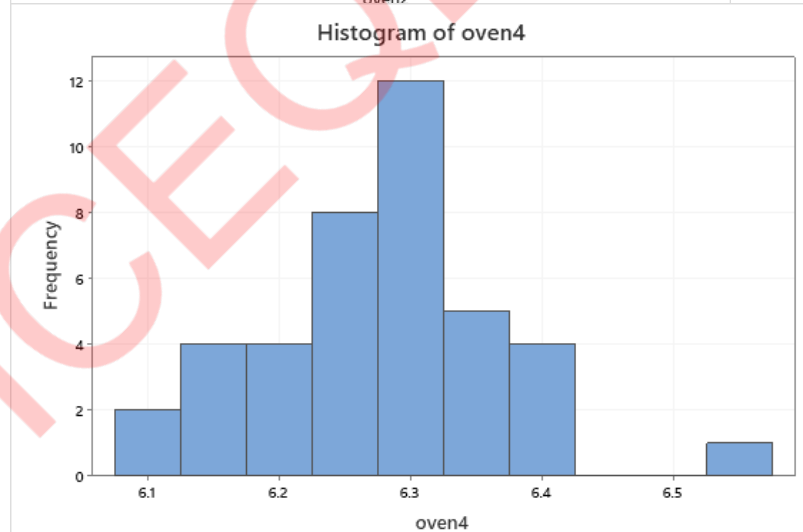
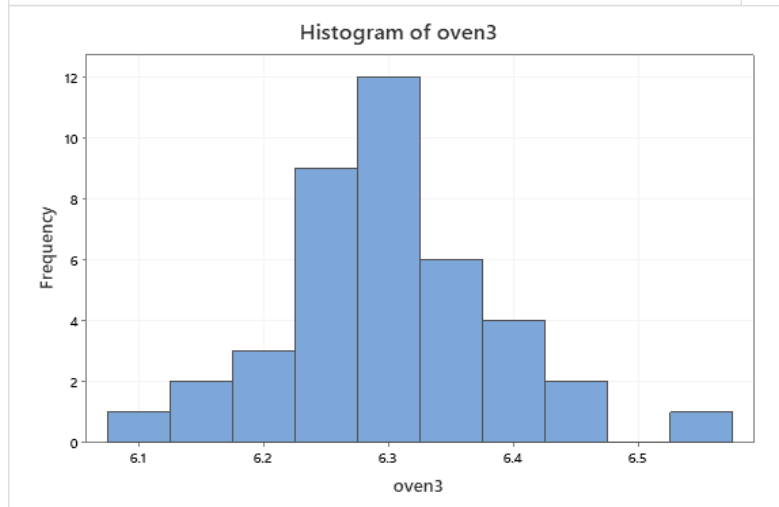
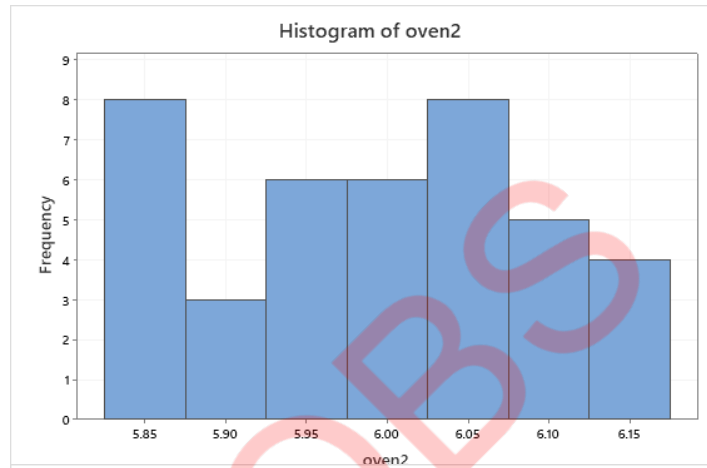
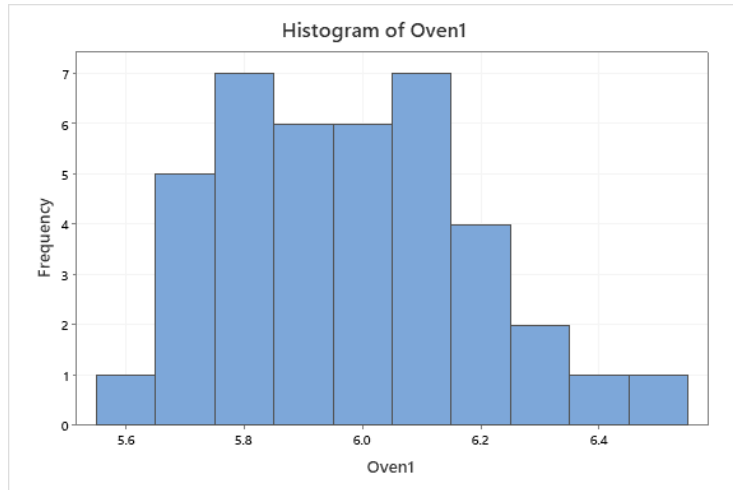
Project Charter

Tangible and Intangible Benefits:		Risk to Success:	
Reduction in internal scrap from 17% to ≤5% . Increased production capacity by minimizing rework. Intangible: Improved customer satisfaction and reduced complaints. Stronger brand trust and product reliability .		Operator resistance to adopting new procedures or process changes. Inconsistent raw material quality (flour, cheese, toppings) affecting output consistency. Machine calibration or maintenance delays impacting production timelines.	
In Scope:		Out of Scope:	
baking process improvements. Rework and scrap analysis of internal production. Operator training and process standardization. Machine setup, calibration, and preventive maintenance		New product development or recipe changes. Marketing or promotional campaigns. Supplier replacement or procurement policy changes. Delivery logistics beyond production dispatch.	
Signatories:		Project Timeline:	
Project Head : Abdhul Muneed Sponsor : Operations Manager		6 Months	

MEASURE PHASE



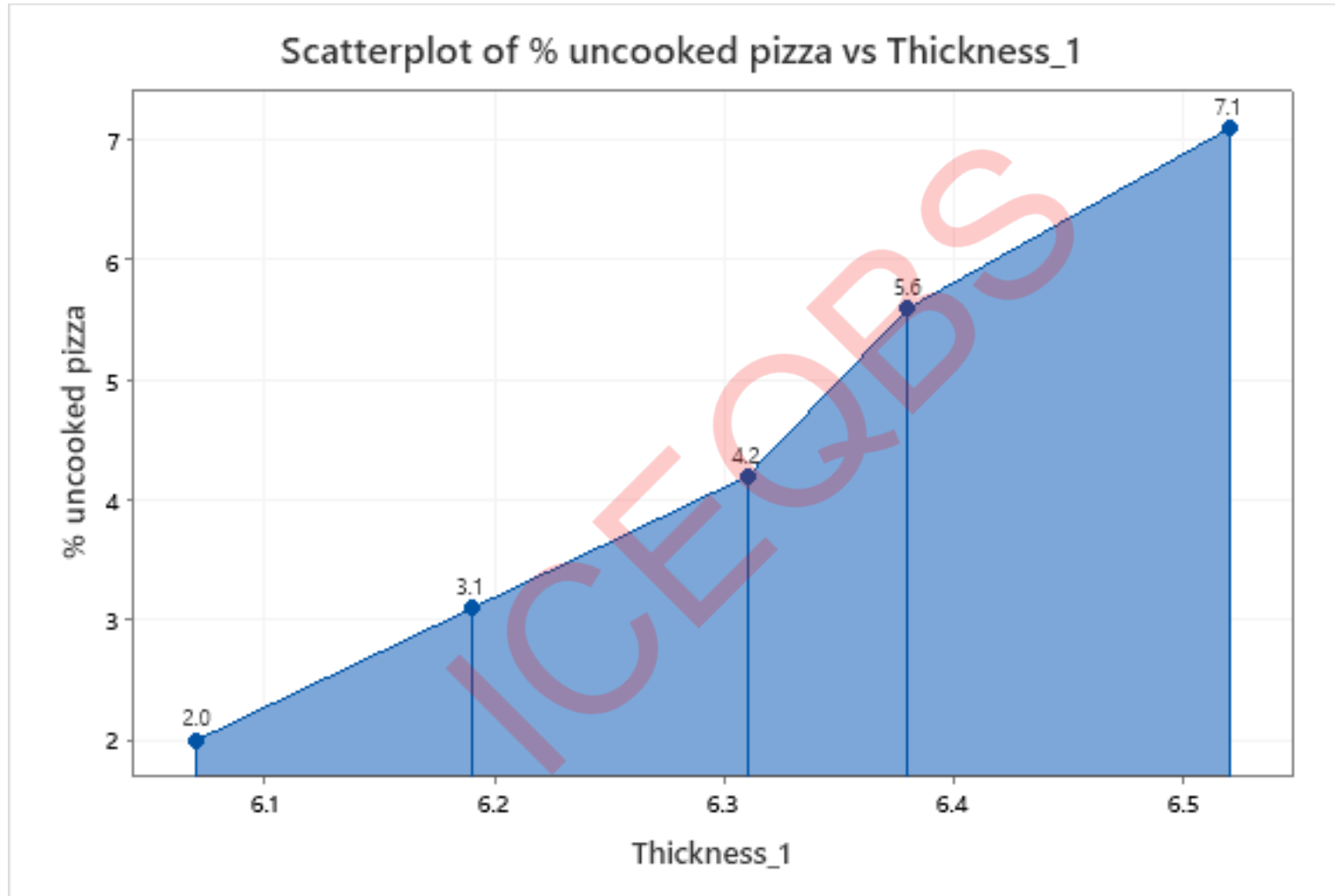
Data collection – Histogram (Before improvement)



Inference :

- Data is normally distributed over the mean

Data collection – Scatter Plot (Before improvement)



Inference :

The plot shows a **clear negative linear relationship**.

As **thickness decreases**, the **percentage of uncooked pizzas increases**.

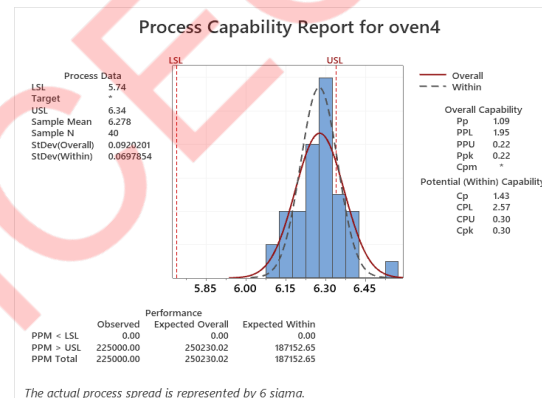
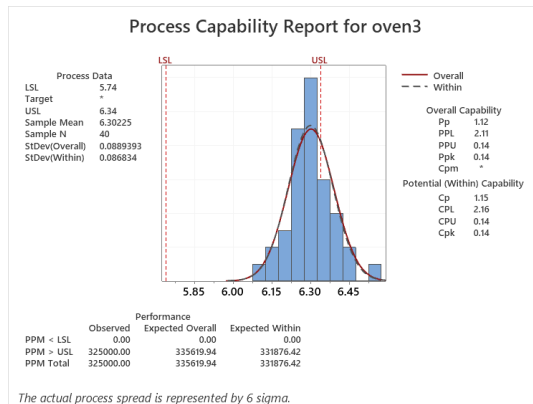
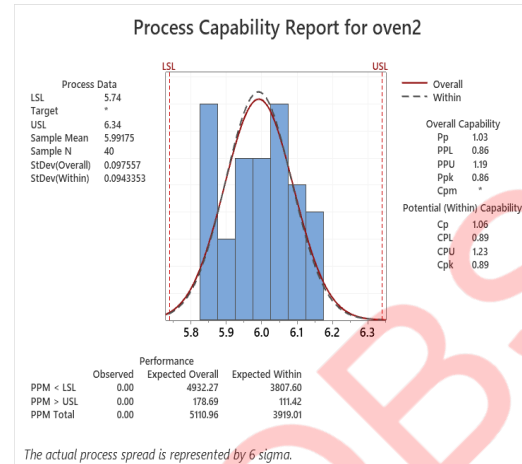
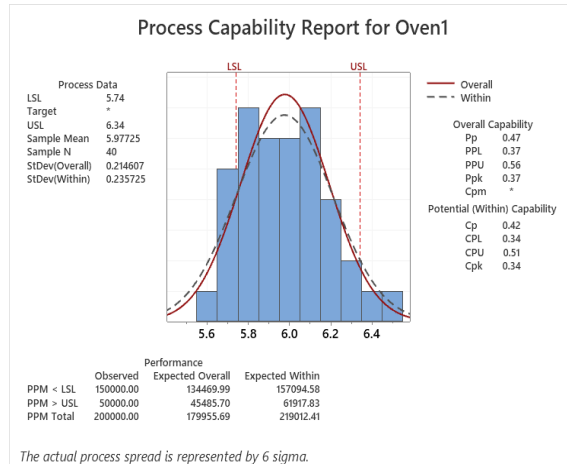
Data collection – Normality plot (Before improvement)



Inference :

The plot shows a **clear negative linear relationship** between **thickness** and **% burnt**.
As **thickness increases**, the **percentage of burnt pizzas decreases**.

Process Capability (Before improvement)



Inference :

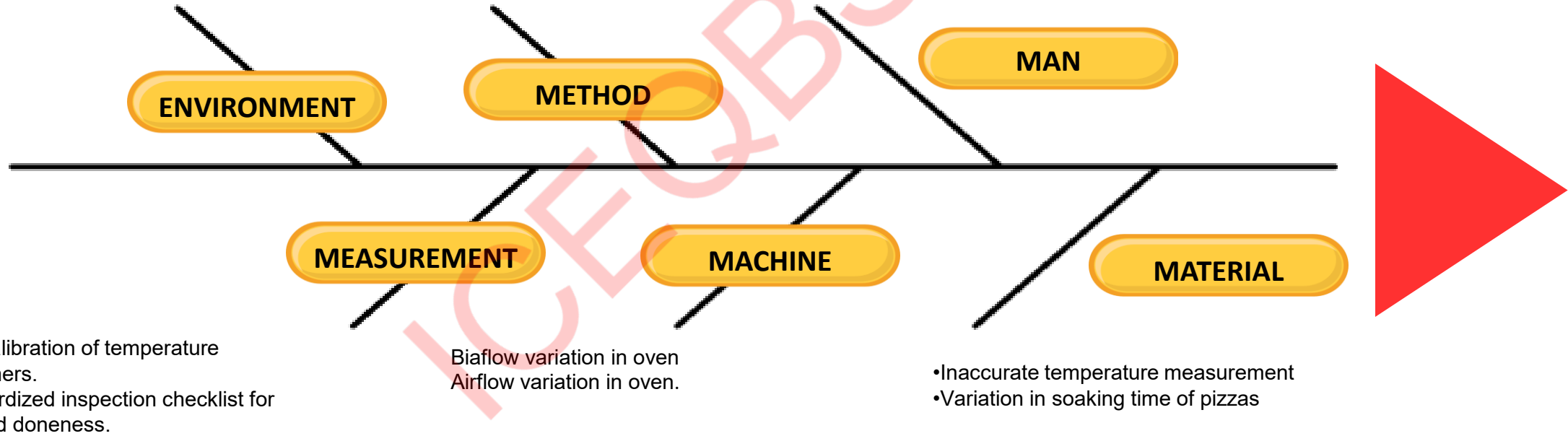
- Process is highly not capable

Fish Bone Diagram

Inaccurate temperature measurement
Ambient temperature

- Improper loading in oven
- Blockage in air pipes
- Pizza loading trays not clean
- Variation in thickness of pizzas

- Inexperienced man loading the oven
- Temperature variation in the oven



3M Analysis for Waste

MUDA

- Excess dough, cheese, and toppings wasted due to burnt or undercooked pizzas.
- Rework and remakes of defective pizzas consuming extra time, energy, and raw materials

MURA

- Uneven baking times and temperature variations across ovens leading to inconsistent product quality.
- Fluctuating daily production rates due to rework and downtime

MURI

- Operators overloaded during peak hours, leading to fatigue and handling errors.
- Equipment overused without proper cooling or maintenance cycles, causing breakdowns and inefficiency

8 Wastes Analysis

Defects

Burnt or undercooked pizzas due to temperature variation in ovens.
Incorrect pizza size or topping distribution leading to rework or rejection.

Overproduction

Preparing extra pizzas during low-demand hours to “stay ahead.”
Making additional dough or sauce batches beyond daily requirement.

Waiting

Operators waiting for ovens to reach correct temperature.
Production halted due to delayed ingredient supply or machine setup.

Non-Utilized Talent

Skilled staff not involved in process improvement or root cause discussions.
Lack of operator feedback loop for identifying process inefficiencies.

Transportation

Unnecessary movement of pizza trays between workstations.
Repeated shifting of ingredients from storage to prep area due to poor layout.

Inventory

Excess dough and toppings stored beyond usage capacity leading to spoilage.
Overstocking of packaging materials occupying workspace.

Motion

Extra walking by staff to fetch utensils or ingredients due to poor workstation design.
Repetitive bending and reaching during pizza loading and unloading.

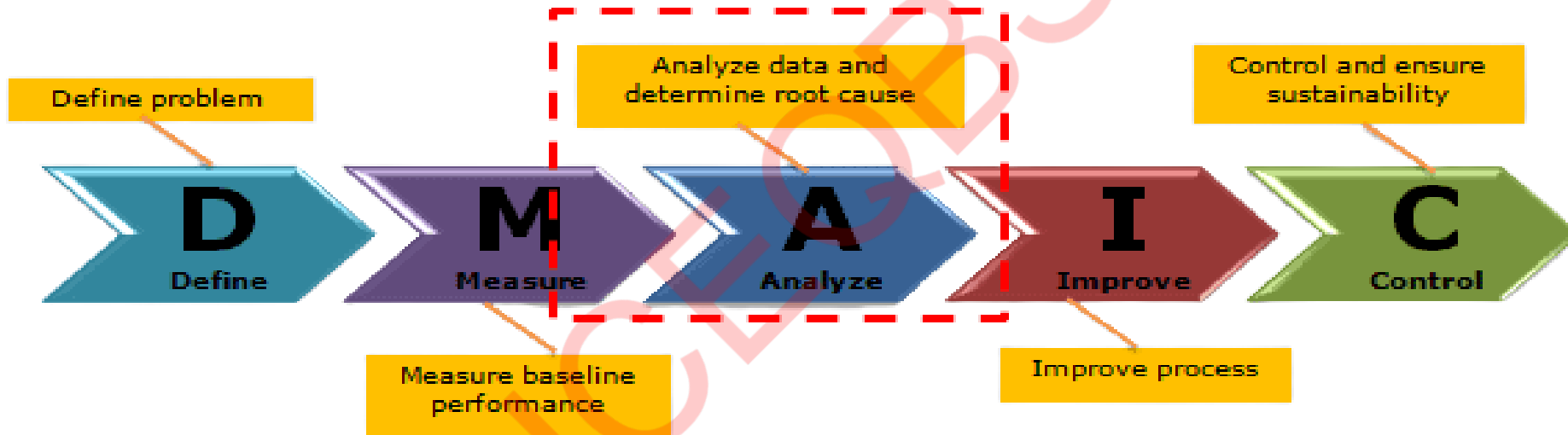
Overprocessing

Reheating or re-baking pizzas to correct undercooked items.
Double-checking finished pizzas due to lack of trust in inspection accuracy.

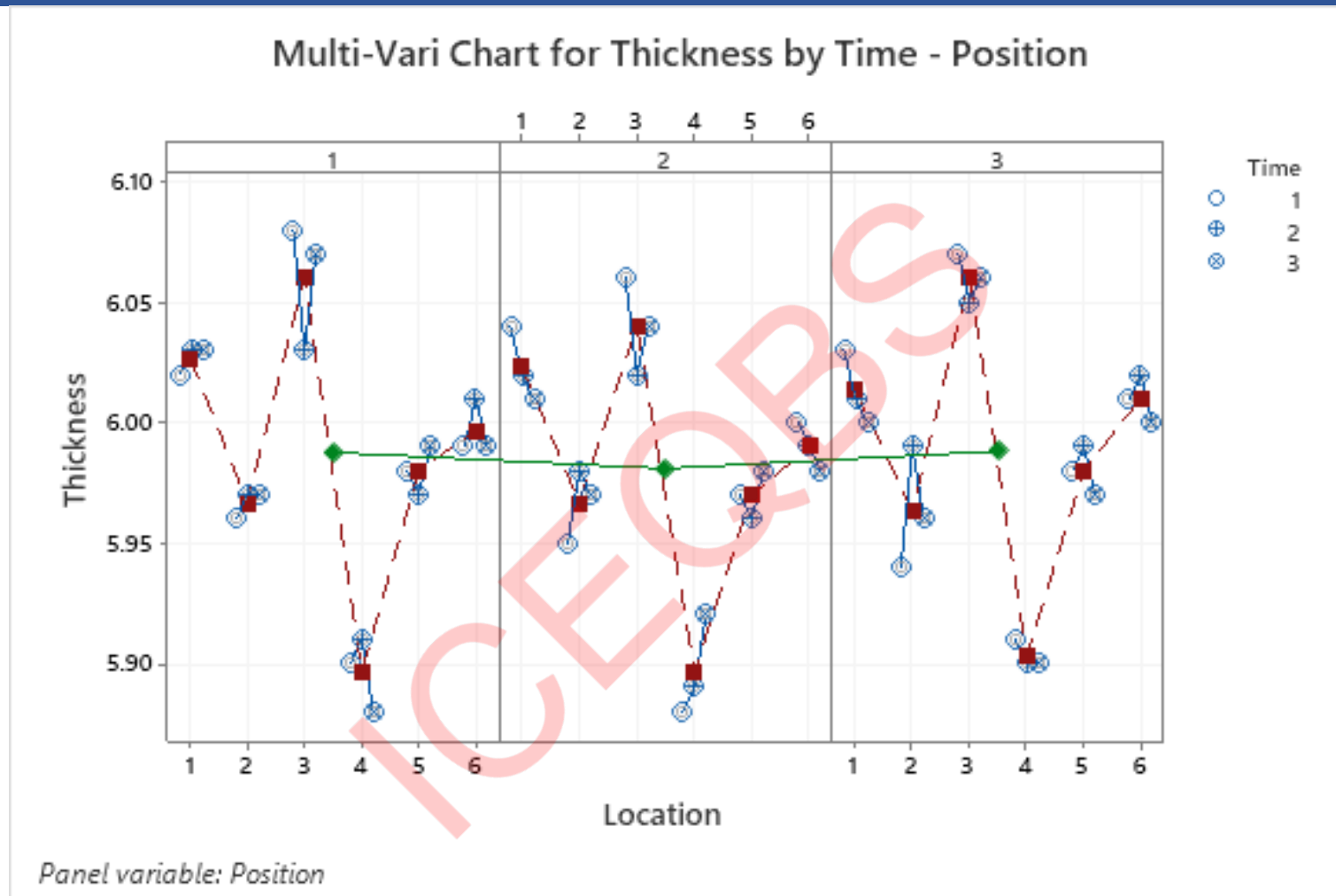
Top Prioritized Root Causes (Based on Net Score)

- Temperature variation in the oven
- Improper loading in oven
- Inexperienced man loading the oven
- Variation in thickness of pizzas in rolling

ANALYSE PHASE



Analyse – Hypothesis testing



Inference :

- There is a noticeable difference in thickness across different oven locations. Some locations consistently show higher or lower thickness values.

Analyse – Hypothesis testing

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
-8.85	52	0.000

Method

Null hypothesis All means are equal

Alternative hypothesis Not all means are equal

Significance level $\alpha = 0.05$

Equal variances were assumed for the analysis.

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Factor	3	3.752	1.25074	69.53	0.000
Error	156	2.806	0.01799		
Total	159	6.558			

Means

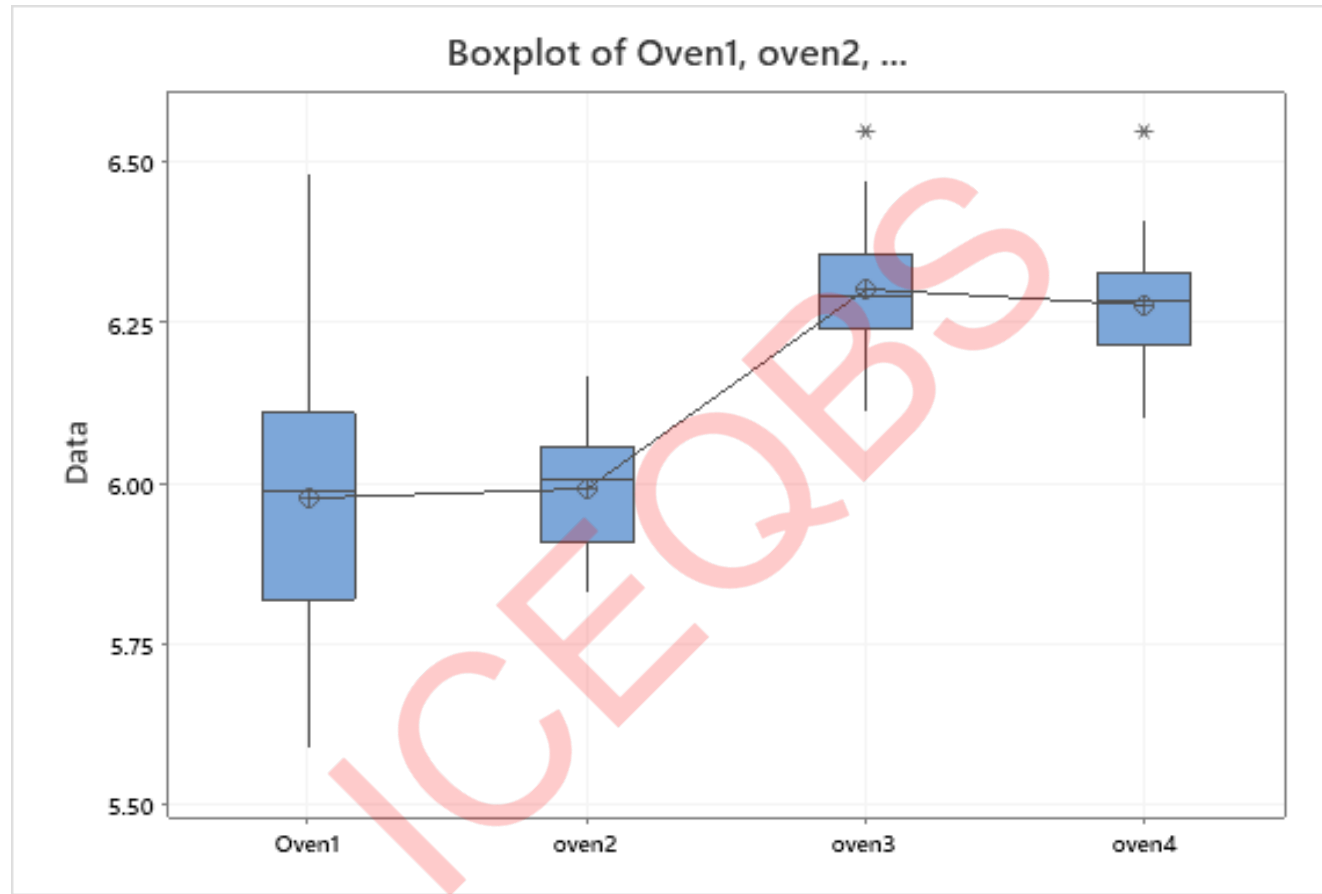
Factor	N	Mean	StDev	95% CI
Oven1	40	5.9772	0.2146	(5.9354, 6.0191)
oven2	40	5.9918	0.0976	(5.9499, 6.0336)
oven3	40	6.3022	0.0889	(6.2604, 6.3441)
oven4	40	6.2780	0.0920	(6.2361, 6.3199)

Pooled StDev = 0.134119

Inference :

- H_a is true, significant difference in thickness from O1 and O3, oven type is critical root cause for difference in thickness

Analyse – Hypothesis testing



Inference :

- we conclude that oven type significantly affects pizza thickness.

Analyse – Hypothesis testing

WORKSHEET 1

Regression Analysis: Thickness_1 versus Temp, airflow

Thickness_1 = 6.8584 - 0.003449 Temp + 0.03252 airflow

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	6.8584	0.0609	112.71	0.000	
Temp	-0.003449	0.000127	-27.06	0.001	4.95
airflow	0.03252	0.00618	5.26	0.034	4.95

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.0018781	99.96%	99.92%	98.96%

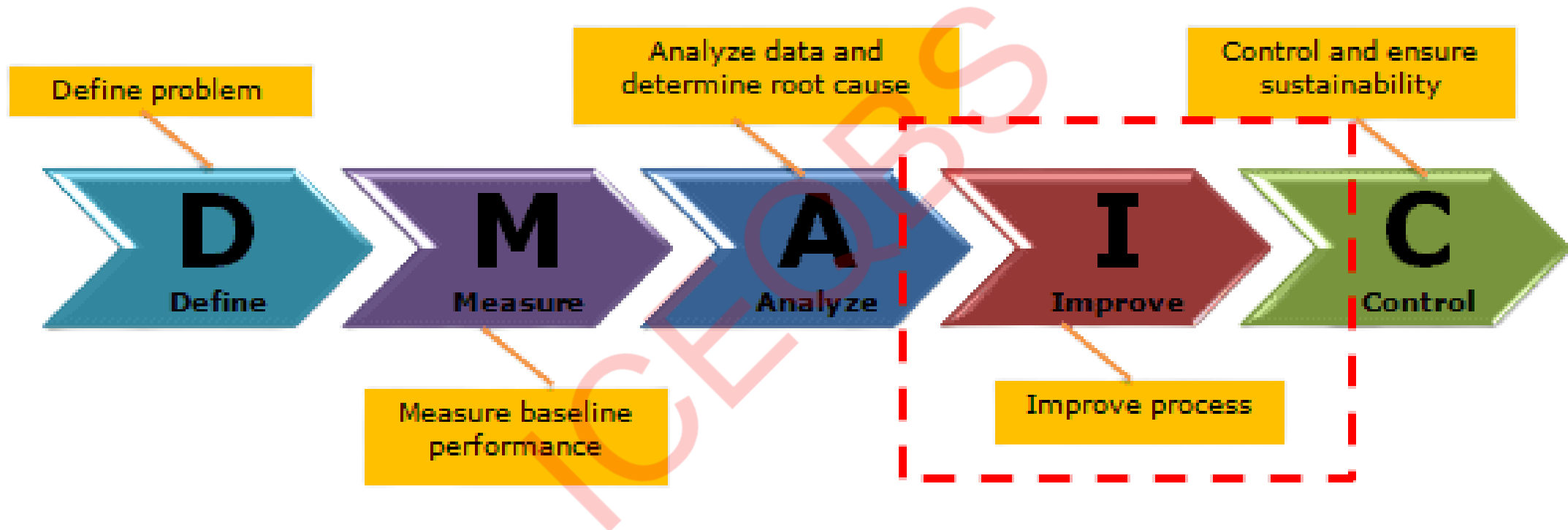
Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	2	0.017713	0.008856	2510.74	0.000
Temp	1	0.002584	0.002584	732.45	0.001
airflow	1	0.000098	0.000098	27.70	0.034
Error	2	0.000007	0.000004		
Total	4	0.017720			

Inference :

- we conclude that oven type significantly affects pizza thickness.

IMPROVE PHASE



Regression Equation

Thickness = 6.8438 - 0.003375 Temperature + 0.03125 Airflow

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	6.8438	0.0614	111.40	0.000	
Temperature	-0.003375	0.000177	-19.09	0.000	1.00
Airflow	0.03125	0.00884	3.54	0.038	1.00

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.0070711	99.21%	98.68%	96.87%

Analysis of Variance

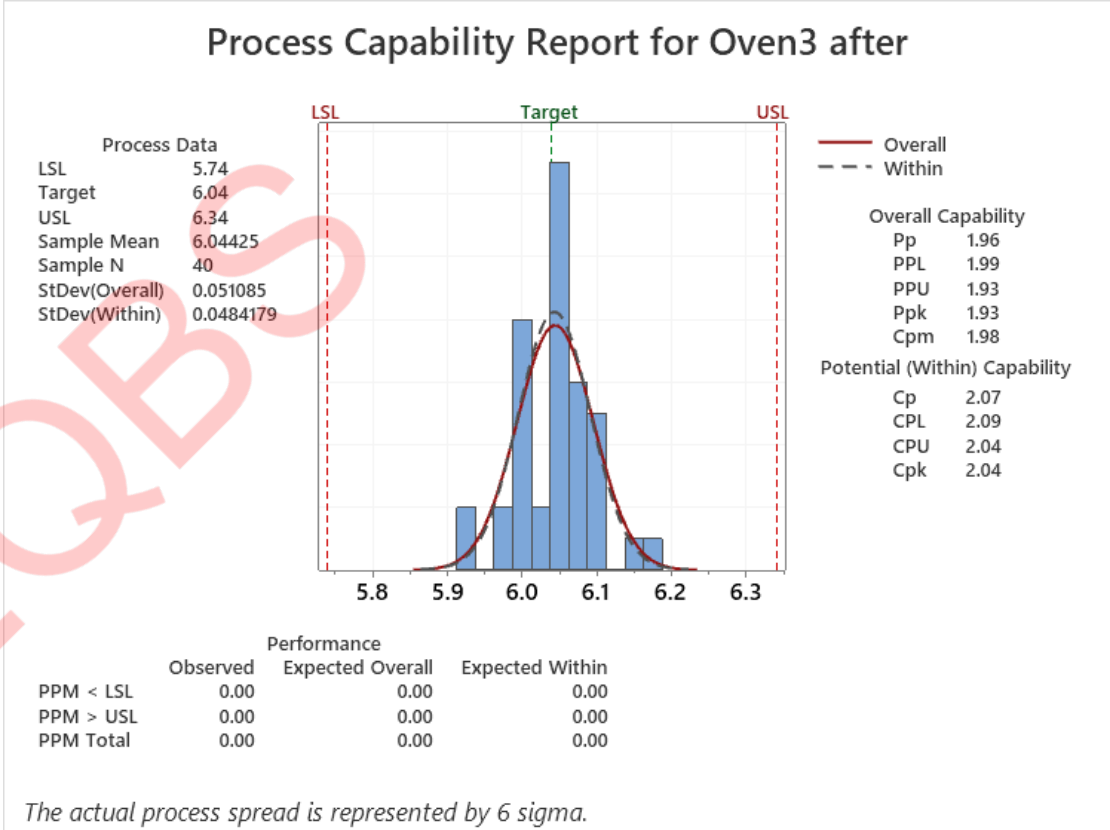
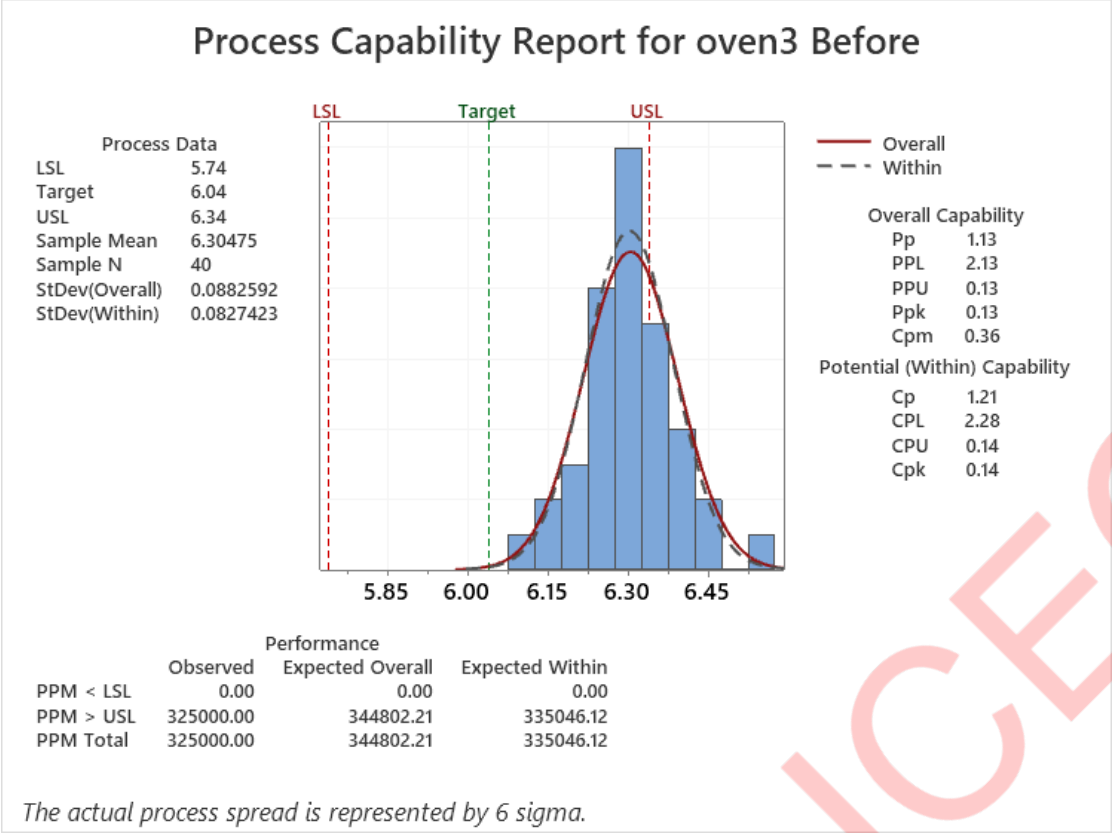
Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	2	0.018850	0.009425	188.50	0.001
Temperature	1	0.018225	0.018225	364.50	0.000
Airflow	1	0.000625	0.000625	12.50	0.038
Error	3	0.000150	0.000050		
Lack-of-Fit	2	0.000100	0.000050	1.00	0.577
Pure Error	1	0.000050	0.000050		
Total	5	0.019000			

Inference:

p-values is < 0.05 so the variable is statistically significant

R-squared value is 99.21%

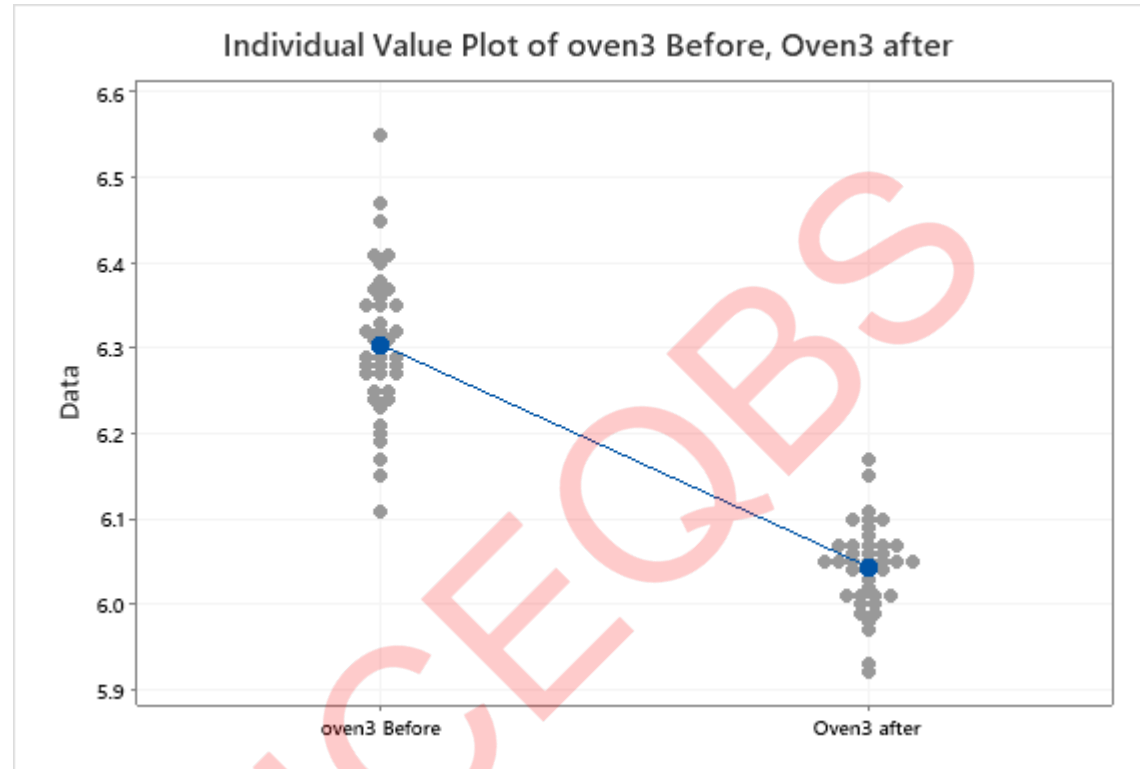
Improve – Process capability – Before & After Improvement



Inference :

Oven 3 thickness data before and after improvement, with USL = 6.34 mm, LSL = 5.74 mm, and the target = 6.04 mm clearly marked

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

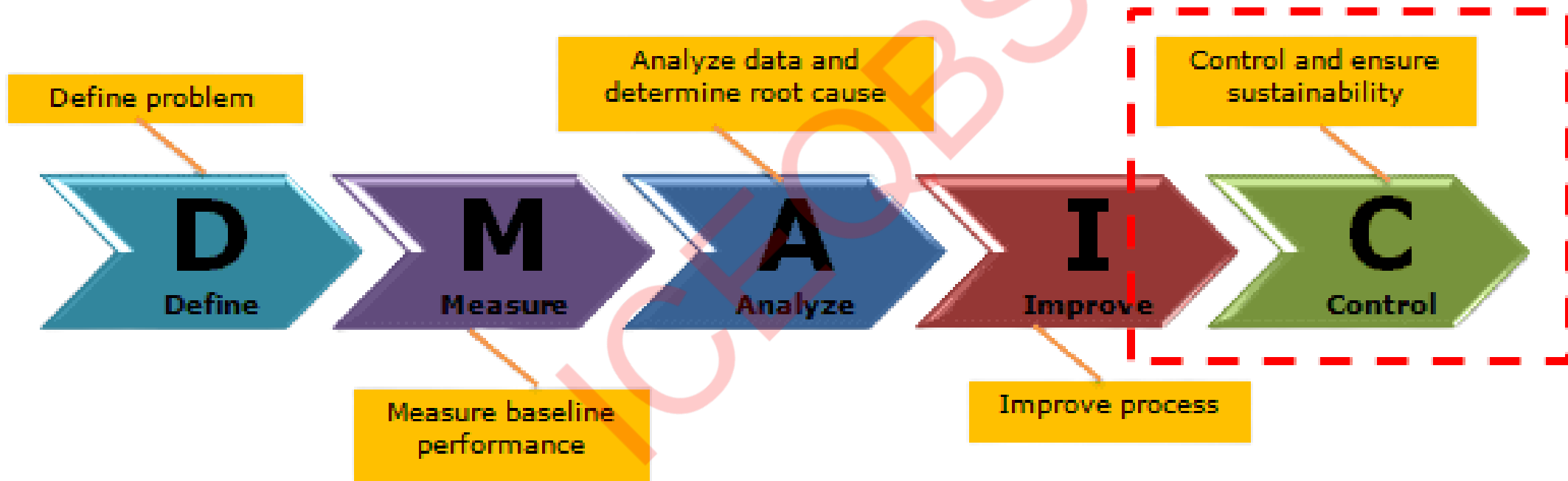


Inference:

The **p-value** is far below 0.05, indicating a **statistically significant difference** in mean thickness.

The **standard deviation decreased**, showing **reduced variation** after the improvement.

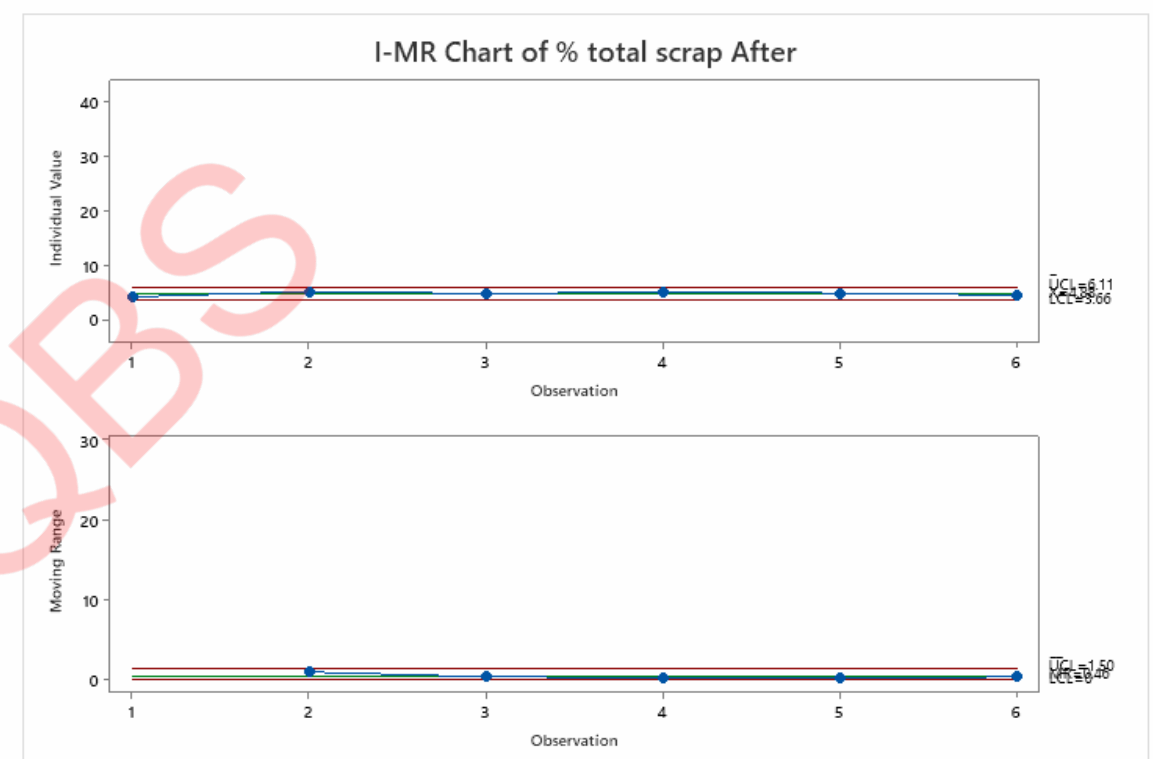
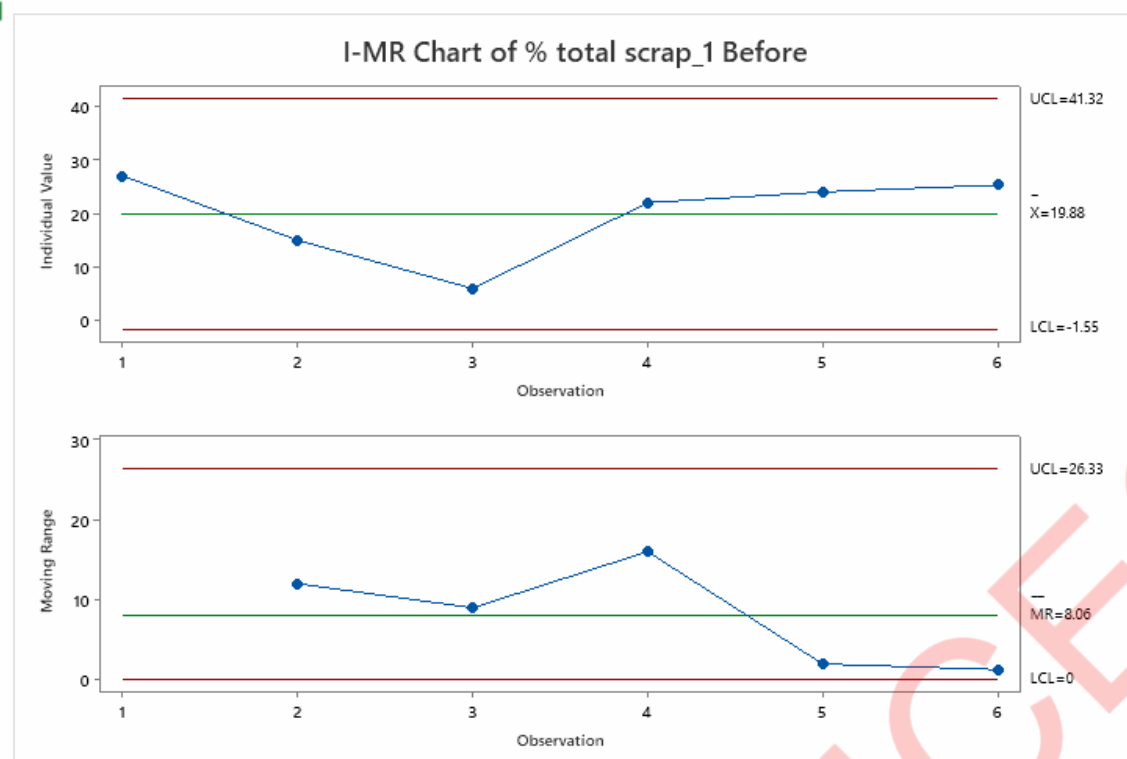
CONTROL PHASE



FMEA

Process Step	Potential Failure Mode	Effect	Cause	S	O	D	RPN	Recommended Action
Oven temperature control	Temperature drift	Overcooked/undercooked pizza	Sensor calibration issue	8	6	4	192	Calibrate sensors monthly
Airflow management	Uneven airflow	Inconsistent baking	Blocked ducts or fan failure	7	5	5	175	Preventive maintenance schedule
Pizza loading	Incorrect placement	Uneven cooking	Operator error	6	7	6	252	Staff training and visual loading guides
Rolling process	Thickness variation	Scrap due to undercooking	Manual rolling inconsistency	7	6	5	210	Introduce rolling thickness templates
Monitoring process	Late detection of issues	High scrap rate	No real-time alerts	8	4	7	224	Install real-time monitoring system

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



Inference:

Mean Scrap %: The green dashed line shows the average scrap rate.

Control Limits (UCL & LCL): Red dashed lines indicate the expected range of variation.

All data points are **within control limits**, suggesting the process is **stable** and **improvement is sustained**.

Control Plan

Process Step	Potential Failure Mode	Control Method	Frequency	Responsible Person	Reaction Plan
Dough preparation	Incorrect dough consistency	Visual check, weight and texture testing	Hourly	Production Operator	Adjust ingredient ratio, retrain operator if repeated
Pizza assembly	Incorrect topping quantity or placement	Standard topping template and checklist	Every batch	Line Supervisor	Correct pizza before baking, review checklist adherence
Baking	Underbaked or burnt pizzas	Oven temperature and timer monitoring	Continuous	Oven Operator	Discard defective pizza, recalibrate oven immediately
Quality inspection	Missed detection of defects	Random sampling and inspection checklist	Every hour	QA Inspector	Re-inspect batch, conduct refresher training
Packaging	Wrong labeling or damaged boxes	Label verification and visual check	Each batch	Packaging Staff	Re-label or re-pack defective units



Results after improvement

- **Project has achieved its intended results**