

LSS CASE STUDY

Applying Lean Six Sigma DMAIC in Public Transport

Systemic Optimization of Logistics & Administrative Workflows in
Public Mobility Network

BACKGROUND & PROBLEM STATEMENT

Context: Public transport agencies face unique challenges balancing regulatory obligations with operational efficiency.

The Challenge: The school subscription process was plagued by systemic inefficiencies:

- Excessive cycle times and processing delays
- Unqualified personnel (e.g. bus drivers) handling data entry
- Manual, paper-based workflows prone to human error
- Low customer satisfaction and fraud risks





Define Phase

DEFINE PHASE: VOICE OF CUSTOMER



Stakeholder Needs

External: Students & Parents expect
<20 min processing time and zero
errors.



CTQ Tree

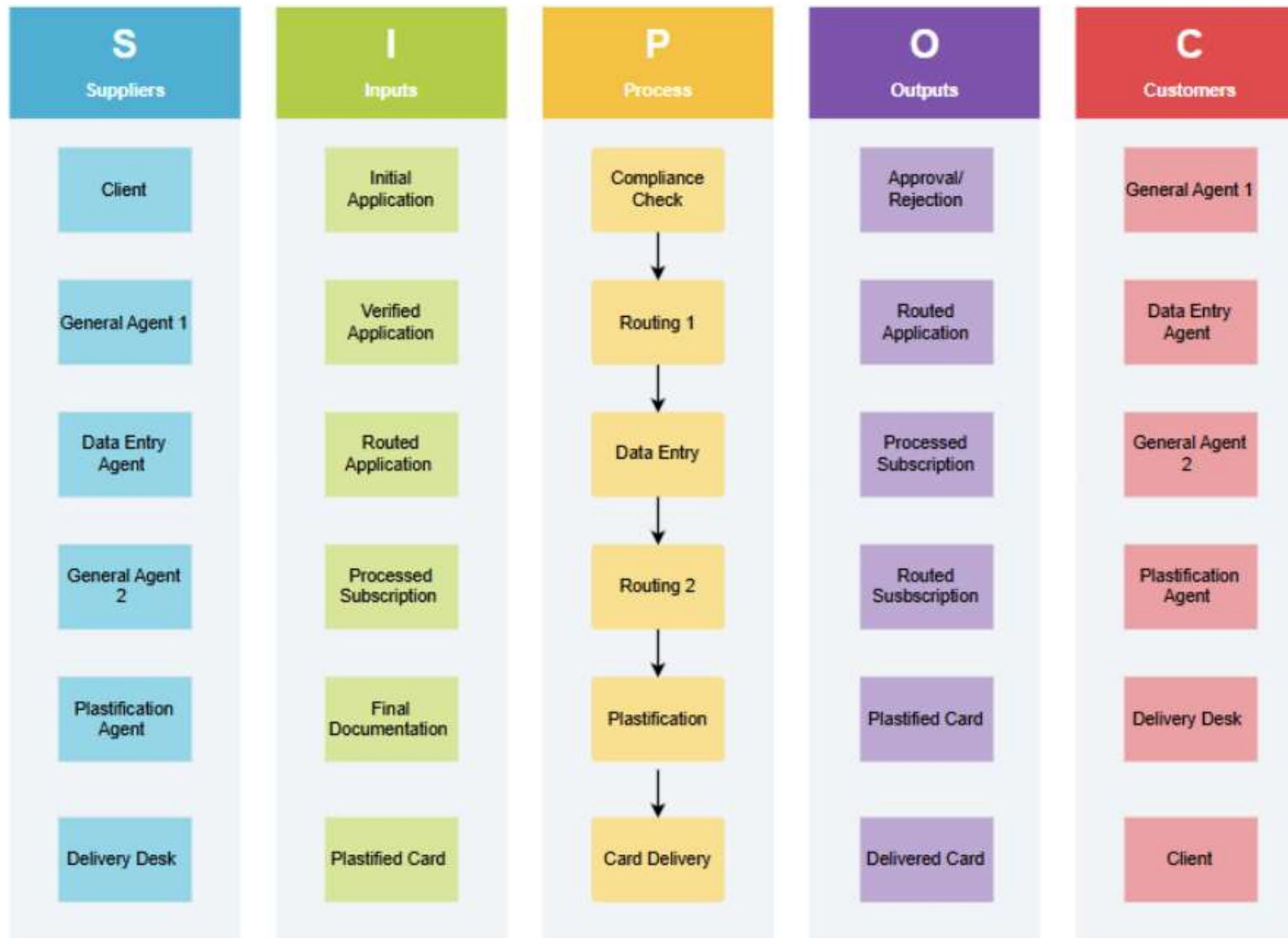
Critical-to-Quality metrics
prioritized: Timeliness (Cycle Time)
and Accuracy (Error Rate).



SIPOC Scope

Covers boundaries from Initial
Application Receipt to Final
Plastified Card Delivery.

DEFINE PHASE: SIPOC



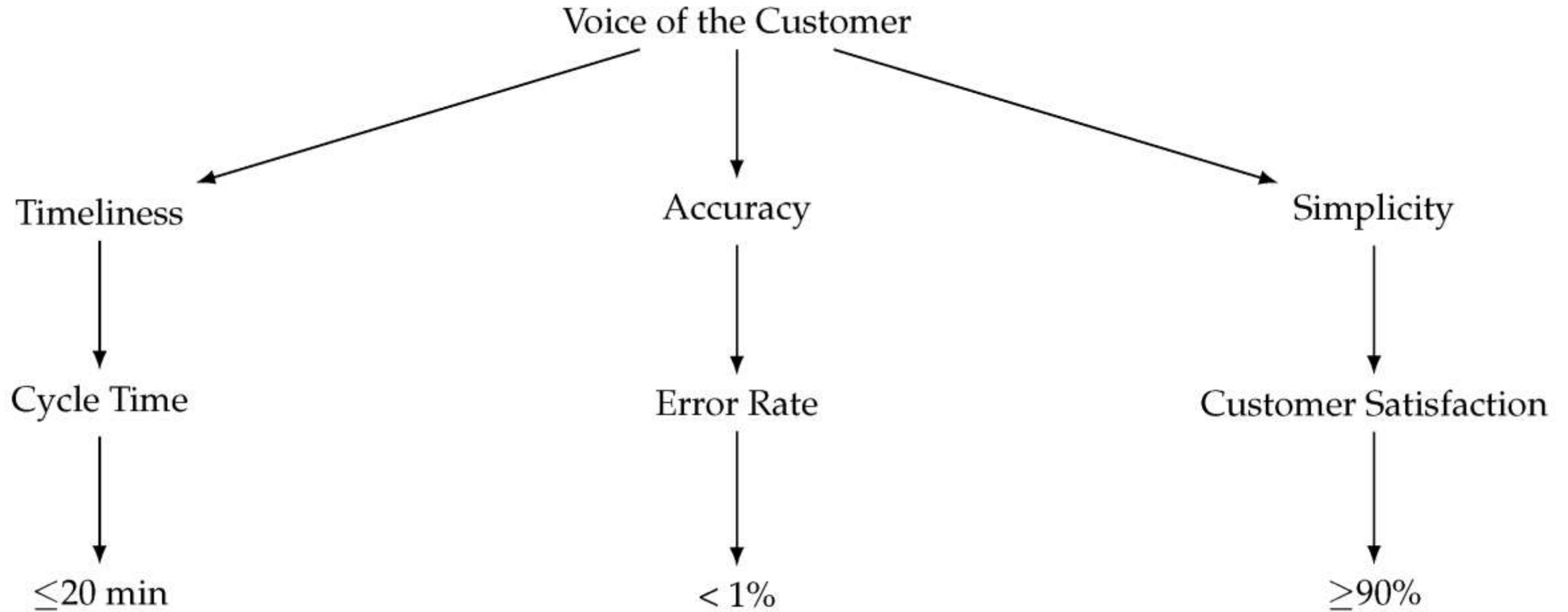
DEFINE PHASE: Stake Holder Analysis

Respondent Group	Role in Process	Type of Data Collected
Subscription Office Agents	Execute and record each production step	Cycle time per operation, process delays
Supervisors	Validate compliance and oversee operations	Verification logs, performance observations
IT Support Staff	Maintain data-entry systems	Downtime duration, idle time analysis
Quality/Process Manager	Lead the improvement initiative	Documentation of workflow and defects
Customers (Students/Parents)	Provide service experience feedback	Waiting times, satisfaction ratings, complaints

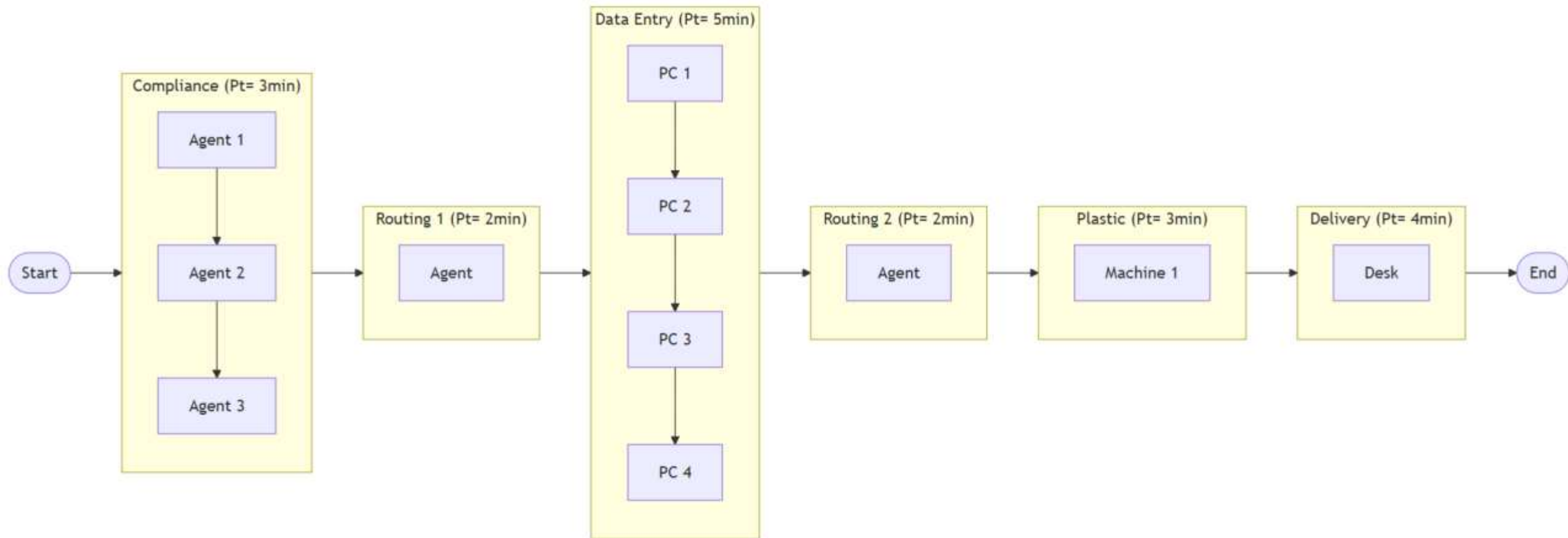
DEFINE PHASE: Customer Needs to CTQ Mapping.

Customer Need (What Do Our Customers Most Expect?)	Quality Driver (How Can We Satisfy This Need?)	CTQ (How Can We Measure Each Quality Driver?)
Faster service; the current process feels slow and inconvenient.	Prompt and efficient processing at every stage of the subscription process.	Cycle Time: Ensure the average subscription processing time is ≤ 20 min.
Accurate subscriptions without errors that require corrections.	A robust verification process to minimize mistakes.	Error Rate: Maintain an error rate of $< 1\%$.
A simple and straightforward process for obtaining subscriptions.	Streamlined steps and improved accessibility for customers.	Customer Satisfaction: Achieve a satisfaction rating of $\geq 90\%$ in surveys.

DEFINE PHASE: Critical-to-Quality (CTQ) Tree



DEFINE PHASE: PROCESS FLOW





Measure Phase

MEASURE: BASELINE PERFORMANCE

Process Capability Analysis

The baseline data revealed a process that is statistically stable but **incapable** of meeting specifications.

$$P_{pk} = -0.19, C_p = 0.24$$

**Negative Ppk indicates the process mean (27.57 min) significantly exceeds the Upper Specification Limit (25 min).*

Current Mean

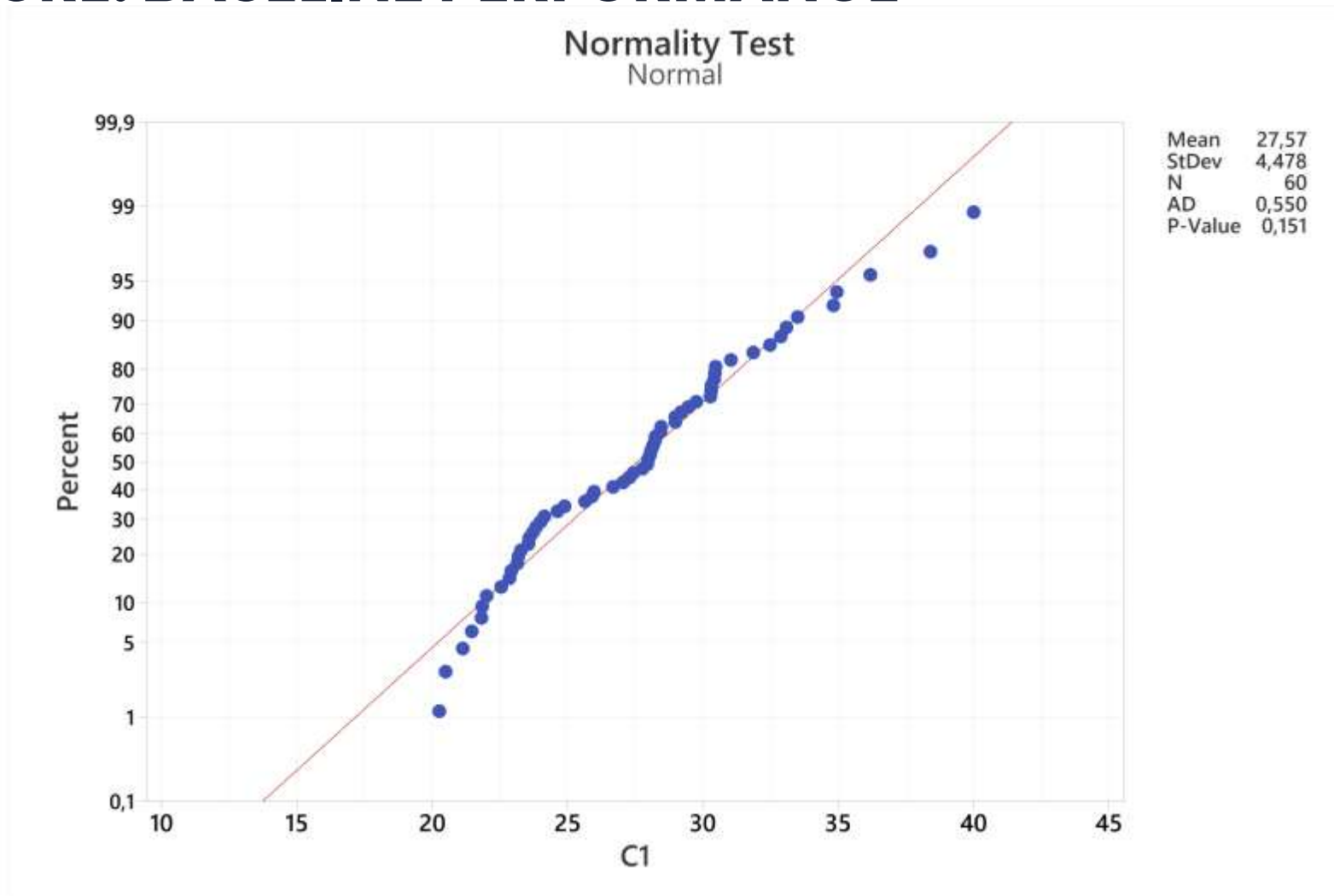
27.57 min

Target Limit (USL)

20.00 min

Baseline Yield: ~35% (650,000 PPM Defect Rate)

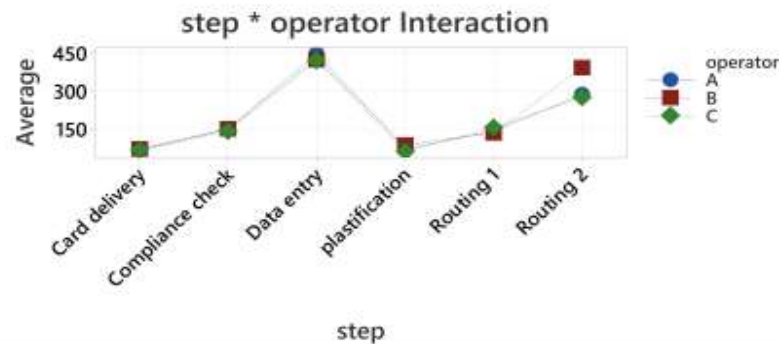
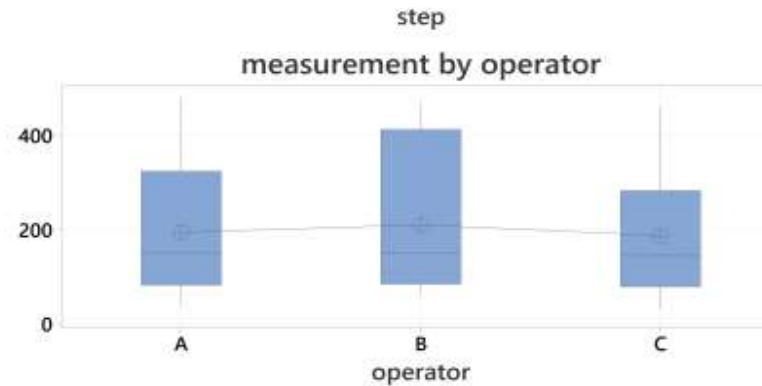
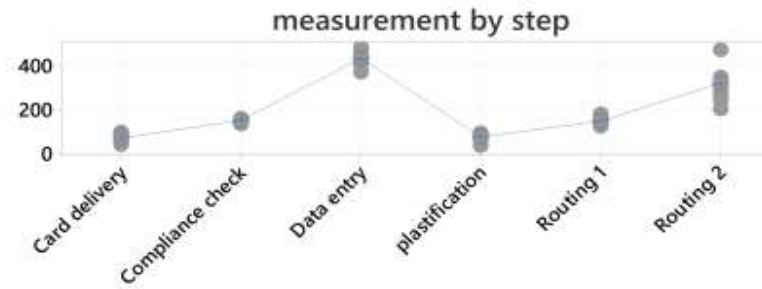
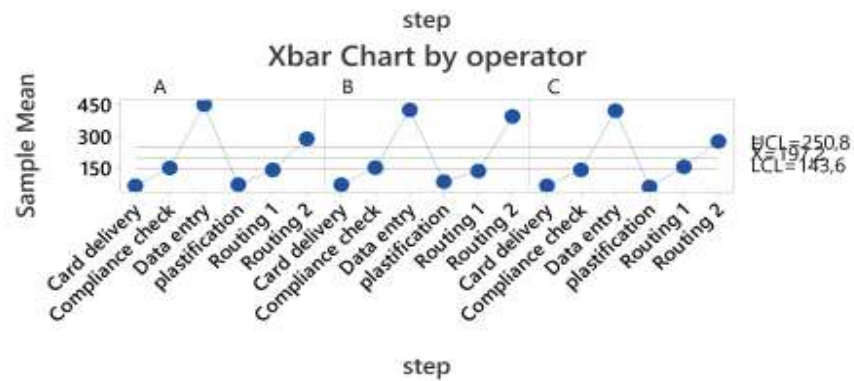
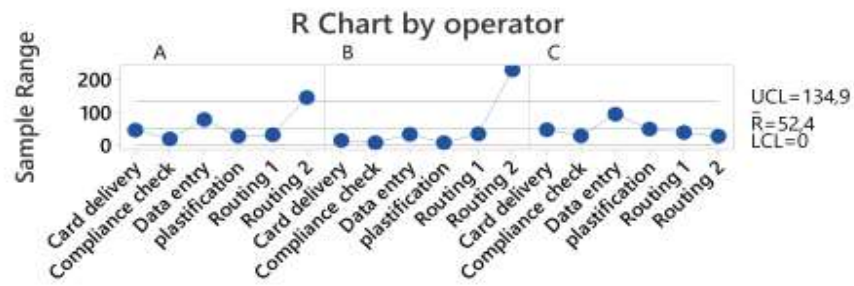
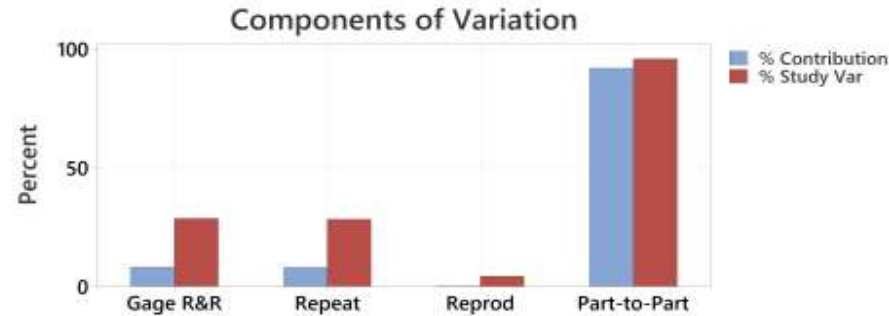
MEASURE: BASELINE PERFORMANCE



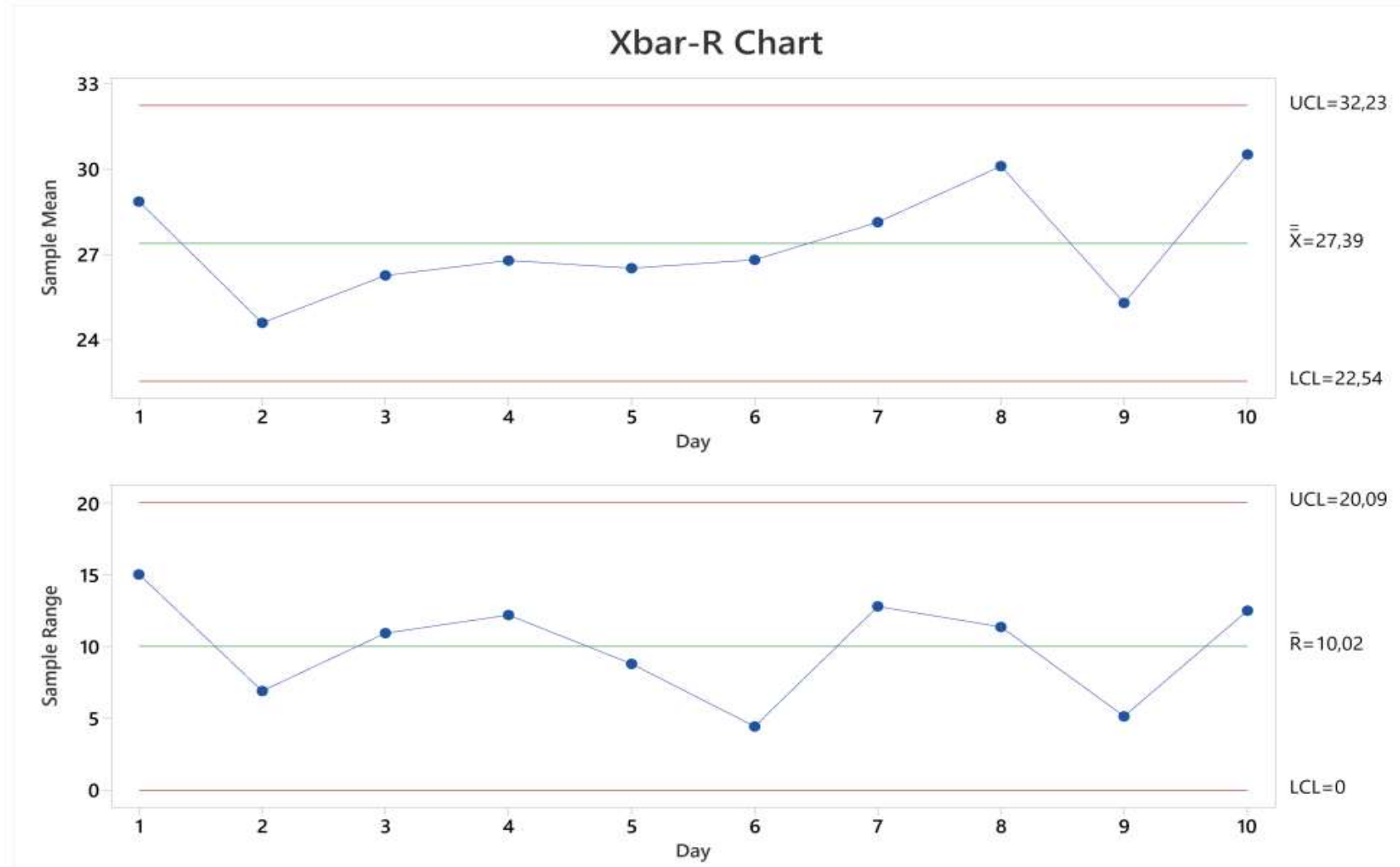
MEASURE: BASELINE PERFORMANCE

Variance Components			
Source	VarComp	% Contribution (of VarComp)	
Total Gage R&R	1887.9	8.22	
Repeatability	1845.2	8.04	
Reproducibility	42.7	0.19	
Operator	42.7	0.19	
Part-To-Part	21075.7	91.78	
Total Variation	22963.6	100.00	
Gage Evaluation			
Source	StdDev (SD)	Study Var (6 × SD)	% Study Var (%SV)
Total Gage R&R	43.450	260.699	28.67
Repeatability	42.956	257.735	28.35
Reproducibility	6.533	39.201	4.31
Operator	6.533	39.201	4.31
Part-To-Part	145.175	871.049	95.80
Total Variation	151.537	909.225	100.00

MEASURE: BASELINE PERFORMANCE

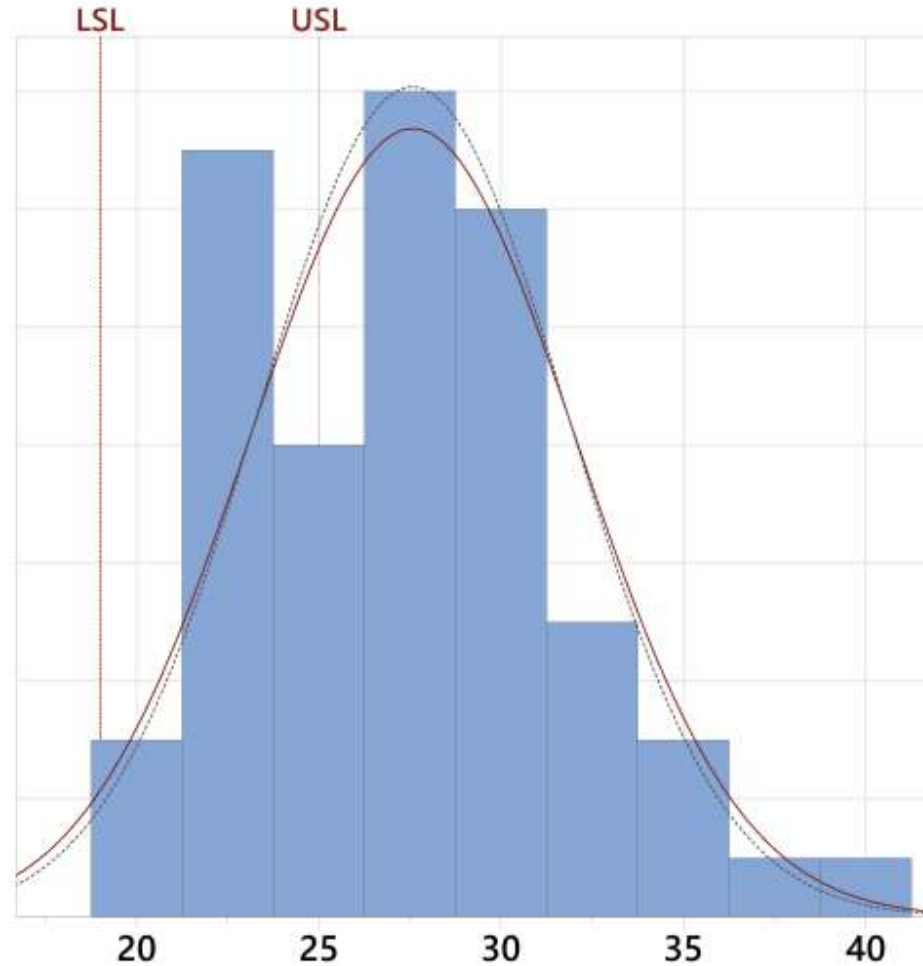


MEASURE: $\bar{X}$ & R Chart for Cycle Time Data.



Process Capability Report

Process Data	
LSL	19
Target	*
USL	25
Sample Mean	27,573
Sample N	60
StDev(Overall)	4,47775
StDev(Within)	4,25114



— Overall
- - - Within

Overall Capability

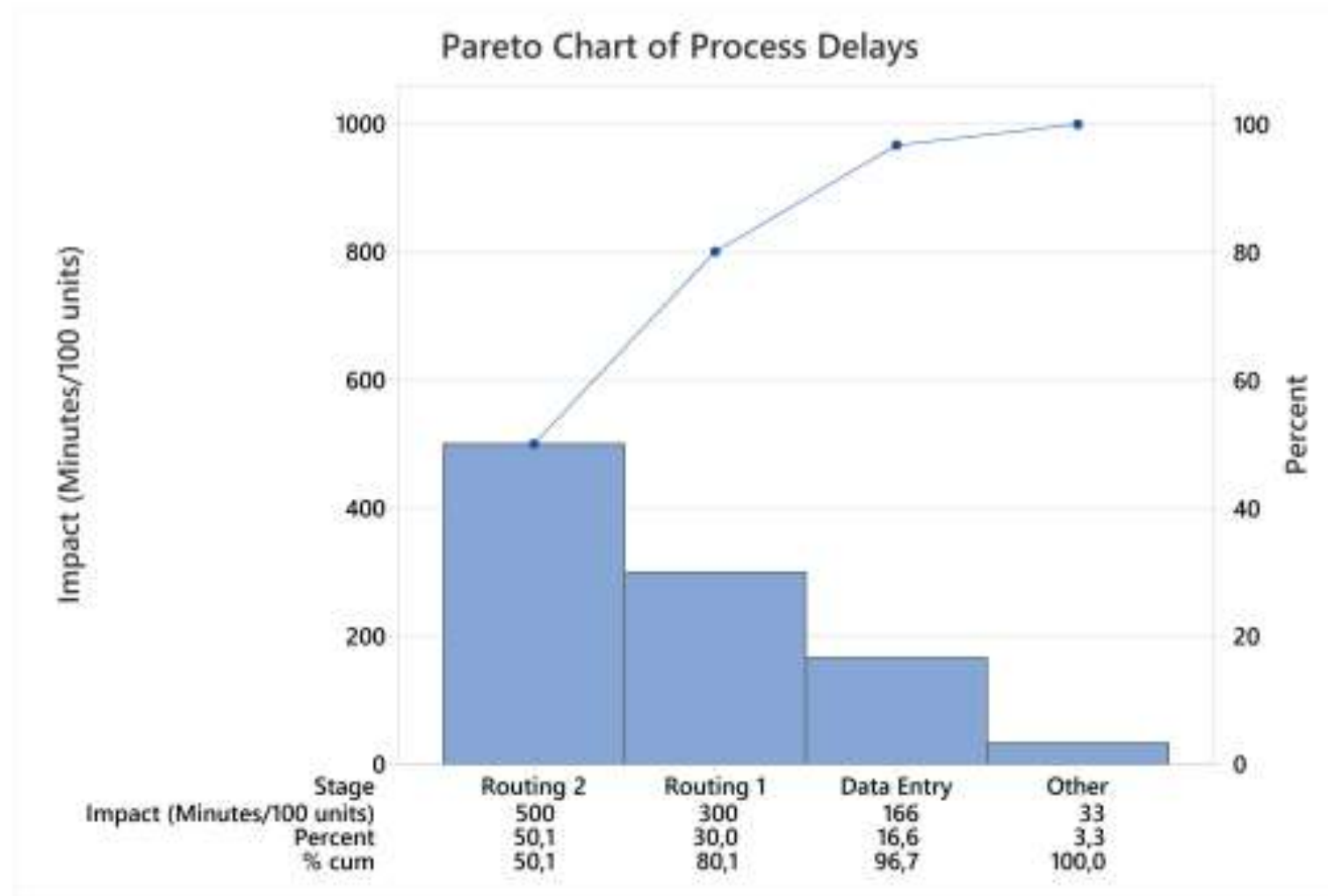
Pp	0,22
PPL	0,64
PPU	-0,19
Ppk	-0,19
Cpm	*

Potential (Within) Capability

Cp	0,24
CPL	0,67
CPU	-0,20
Cpk	-0,20

	Performance		
	Observed	Expected Overall	Expected Within
PPM < LSL	0,00	27773,70	21867,31
PPM > USL	650000,00	717222,65	727490,25
PPM Total	650000,00	744996,35	749357,56

The actual process spread is represented by 6 sigma.



MEASURE: Key Parameters for Production Line Analysis.

Stage	Processing Time	Batching and Delays
Compliance	3 min / unit	3 agents in parallel
Routing 1	2 min / batch	Batches of 3 units
Data Entry	5 min / unit	4 Computers in parallel; 2 h idle/day
Routing 2	2 min / batch	Batches of 3 units
Plastification	3 min / batch	Batches of 5 units; 2 min setup every 15 units
Delivery	4 min / unit	1 desk
Workday Duration	480 min / day	8 h/day



Analyze Phase

ANALYZING CAPACITY & CONSTRAINTS

Process Stage	Availability (A)	Effective Capacity (re)	Bottleneck Status
Compliance Check	100%	1.0 units/min	-
Routing 1 (Batching)	10%	0.05 units/min	PRIMARY BOTTLENECK
Data Entry	75%	0.6 units/min	Network Idle Time Risk
Plastification	64%	0.38 units/min	Setup Delay

Key Finding: Batch processing in Routing 1 and 2 accounts for **80.1%** of all process delays (Non-Value Added Time).



Improve Phase

IMPROVE: STRATEGY

Lean Process Redesign

- **Single-Piece Flow:** Elimination of batching in Routing steps to reduce waiting time.
- **Digital Automation:** Implementation of a Customer Web Portal to automate data entry.
- **Resource Reallocation:** Specialized skilled agents replacing temporary bus driver personnel.
- **Poka-Yoke:** Built-in validation in the new IT platform to prevent errors.



Control Phase

IMPACT & QUANTITATIVE RESULTS

-37.5%

Reduction in Cycle Time

From 29 min down to 18 min per unit.

-80%

Decrease in Process Errors

Error rate dropped from 5% to <1%.

+38.5%

Customer Satisfaction Improvement

+38.9%

Throughput Increase (Daily Capacity)

IMPACT & QUANTITATIVE RESULTS

KPI	Before Improvement	After Improvement	Performance Gain
Cycle Time (min/unit)	29	18	↓ 37.9%
Error Rate (%)	5.0	<1	↓ 82.0%
Customer Satisfaction (%)	65	90	↑ 38.5%
Throughput (units/day)	288	400	↑ 38.9%

CONTROL: SUSTAINABILITY PLAN



**STANDARD OPERATING
PROCEDURES (SOPS)**



**CONTINUOUS
MONITORING
DASHBOARD**



Institutionalizing Excellence

- **Standard Work:** ISO 9001:2015 aligned procedures documented for all staff.
- **Real-Time Monitoring:** Automated dashboards tracking CTQ metrics live.
- **Continuous Training:** Regular skills assessment for subscription office agents.
- **Risk Management:** Integrated ISO 31000 framework to manage transition risks.

Thank you

Case Study Reference: Logistics 2025, 9, 159 (MDPI)

Hajji, M. K., Fekih, A., Bal, A., & Tozan, H. (2025). Applying Lean Six Sigma DMAIC to improve service logistics in Tunisia's public transport.

Logistics, 9(4), 159. <https://doi.org/10.3390/logistics9040159>