Continuous Process Improvement with Lean Six Sigma
- Getting Started -

Your Facilitator
Jonathan Lane, MPA
LSS Green Belt

Program Manager, Lean Six Sigma Programs
jonlane@rutgers.edu | 856-225-6302

Team Members
Peter McAliney, PhD
Director, Professional and Executive Education at Rutgers (PEER)

Corey Therrien
Program Coordinator, PEER

Rutgers School of Business - Camden Campus

Expected Outcomes

Understand the basics of Lean and Six Sigma and how it can be applied at Luxfer MEL Technologies

Understand the basic D-M-A-I-C improvement process

Know how to identify waste and defects in your daily work

Understand the use of few common continuous improvement tools

Be prepared be supportive co-workers and LSS project team members
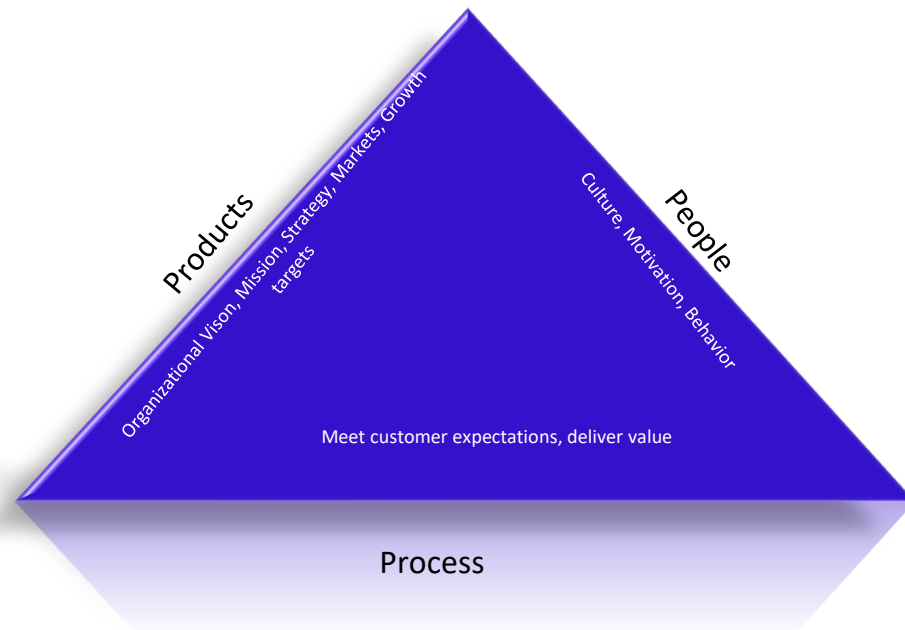
Anything Else?

Today's Agenda

- What is Lean Six Sigma?
- Focus of Lean and Focus of Six Sigma
- Why the integration of lean and six sigma
- Strategy and benefits of Lean Six Sigma
- Does it work in service businesses?
- The Cost of Poor Quality (COPQ)
- Financial impact
- Importance of metrics and accountability
- Lean
- Six Sigma
- Applying Lean Six Sigma to business processes

- D-M-A-I-C overview
- Roles and responsibilities
- LSS Deployment
  - Culture/Behavior
  - Organization
  - Project Selection
- Project Charter Development
- What's In It for YOU?
- Advancement in your LSS knowledge and practice (e.g., Green Belt)
- High-level: what does a LSS implementation look like?

Ground Rules

- Your active participation is critical
- Ask questions
- Openly share your experiences (successes and failures)
- Be a team player
- Listen to others' views

- All ideas are welcome
- No rank in the room
- Be hard on the process, not on the people
- Only you can identify opportunities and implement meaningful changes
- Have fun!

High Level Business Model

Products

Organizational Vison, Mission, Strategy, Markets, Growth targets

People

Culture, Motivation, Behavior

Meet customer expectations, deliver value

Process

Industries Represented in the Rutgers LSS Program

Energy

Aerospace

Logistics

Chemicals

Non-profit

Government

Fashion

Internet

Aviation

Defense

Information Technology

Pharmaceuticals

Financial Services

Consulting

Manufacturing

Law Enforcement

Consumer

Retail

Personal Care

Distribution

Insurance

Food

Government

Telecommunications

Healthcare

Customer Service

Exercise:
Measurable goals – how good can you be?

Instructions

1. Break up into pairs or trios – one person is a technician, other(s) a counter.

2. Supplies:
   1. A cup (fill about 1/3 with water)
   2. A nickel
   3. A dropper

3. With teammates, estimate how may drops of water you can drop onto the nickel before water spills over. Report that number to instructor when asked.

4. Practice for 1 minute dropping water onto your nickel

5. Dry off your nickel and then drop as many as you can, and record the number.

What is poor quality?

- Defective products
- Not meeting schedules
- Delivery delays
- Product returns
- Safety incidents
- Customer dissatisfaction
- Cost overruns
- Product or service too expensive
- Employee dissatisfaction
- Shrinking revenue
- Shrinking profits
- Not meeting regulatory requirements
- Increased legal cost
- Environmental impact
- ??

The Cost of Poor Quality (COPQ)

The cost to the business when it's not done right the first time.

- External Costs *(lost sales, returns, warranties, etc.)*
- Internal Costs *(increased staff hours, rework, etc.)*
- Appraisal Costs *(inspection, lack of compliance)*
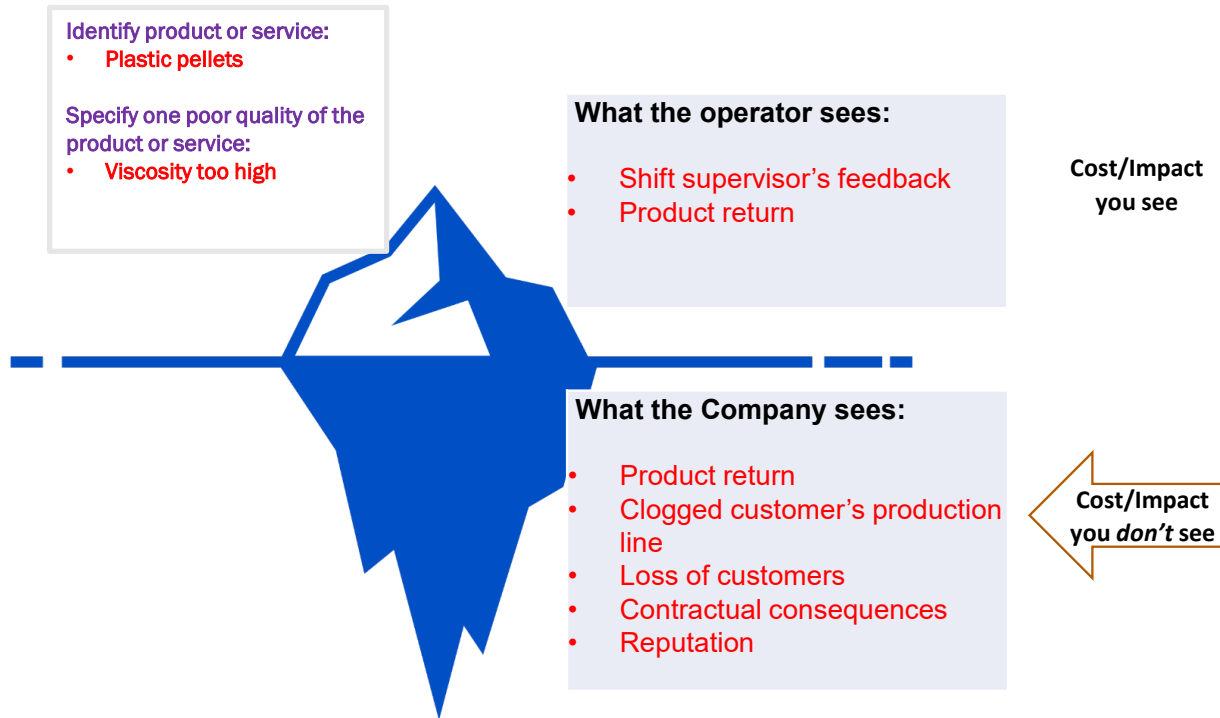- Prevention Costs *(Lean Six Sigma efforts)*
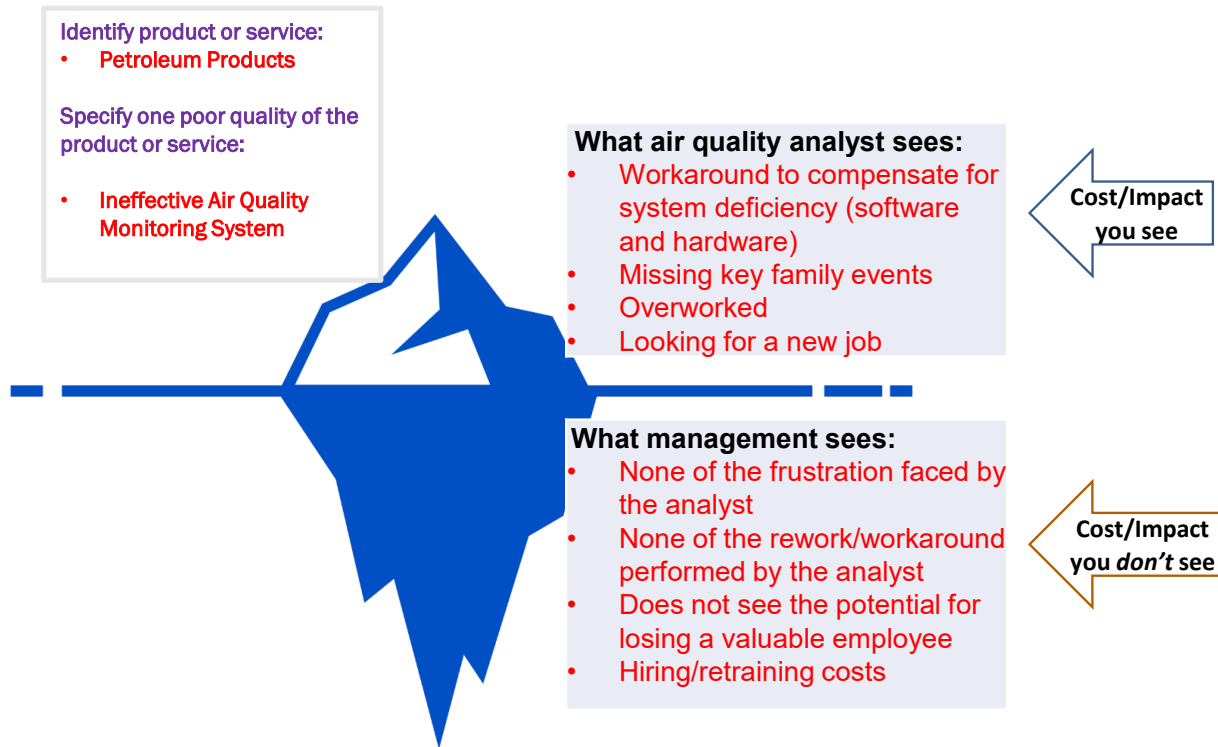
Financial impact:
- Lost revenue
- Cost of time
- Cost of delay (increased cycle time)

Waste you see

Waste you *don't* see
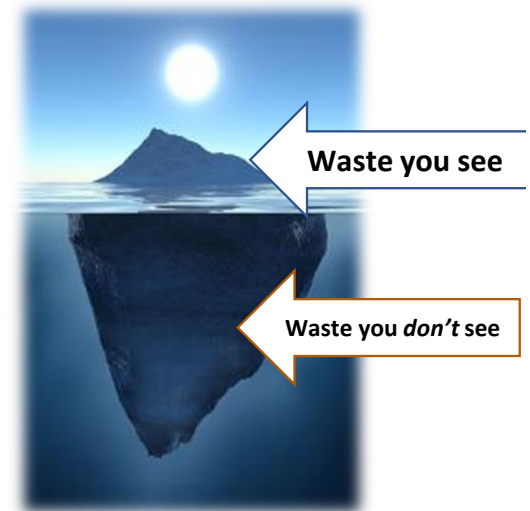
Tables/Teams:

Choose your process

Identify product or service:
- **Plastic pellets**

Specify one poor quality of the product or service:
- **Viscosity too high**

What the operator sees:

- Shift supervisor's feedback
- Product return

Cost/Impact you see

What the Company sees:

- Product return
- Clogged customer's production line
- Loss of customers
- Contractual consequences
- Reputation

Cost/Impact you *don't* see

S

14

Identify product or service:
- **Petroleum Products**

Specify one poor quality of the product or service:

- **Ineffective Air Quality Monitoring System**

What air quality analyst sees:
- Workaround to compensate for system deficiency (software and hardware)
- Missing key family events
- Overworked
- Looking for a new job

Cost/Impact you see

What management sees:
- None of the frustration faced by the analyst
- None of the rework/workaround performed by the analyst
- Does not see the potential for losing a valuable employee
- Hiring/retraining costs

Cost/Impact you *don't* see

Identify a product or service:

Specify one poor quality of the product or service:

Internal Cost/Impact	
External Cost/Impact	
Appraisal Cost/Impact	
Prevention Cost/Impact	

16

Exercise: Cost Of Poor Quality (COPQ)

Identify a product or service:

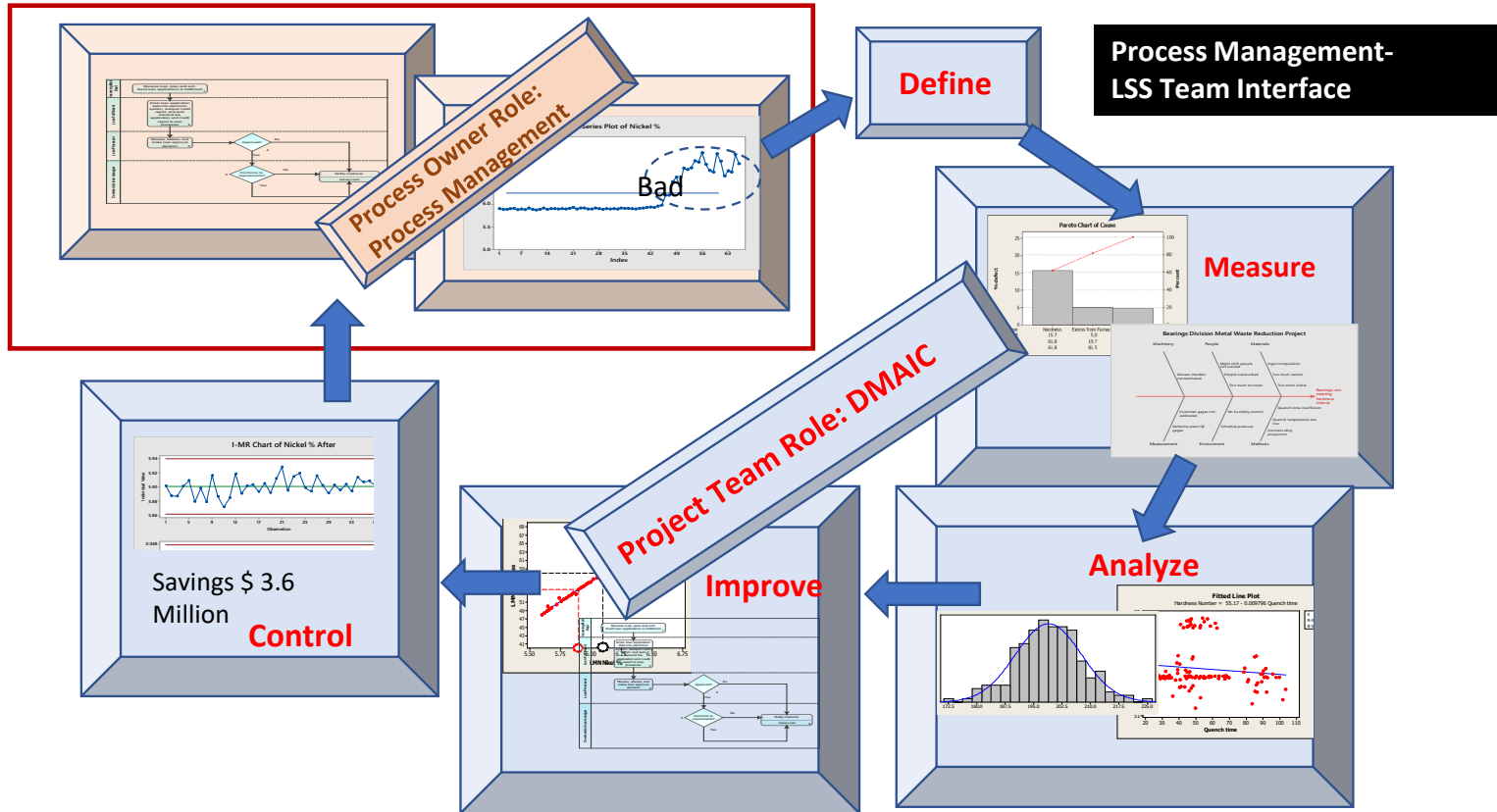Specify one poor quality of the product or service:
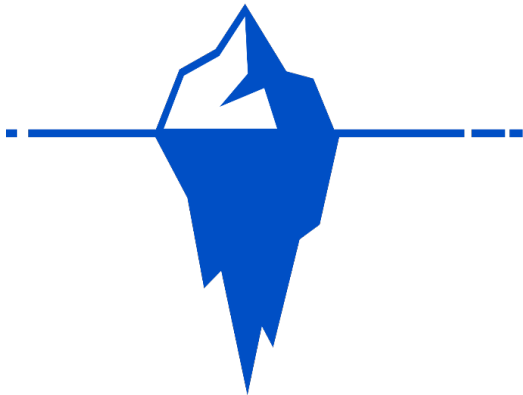
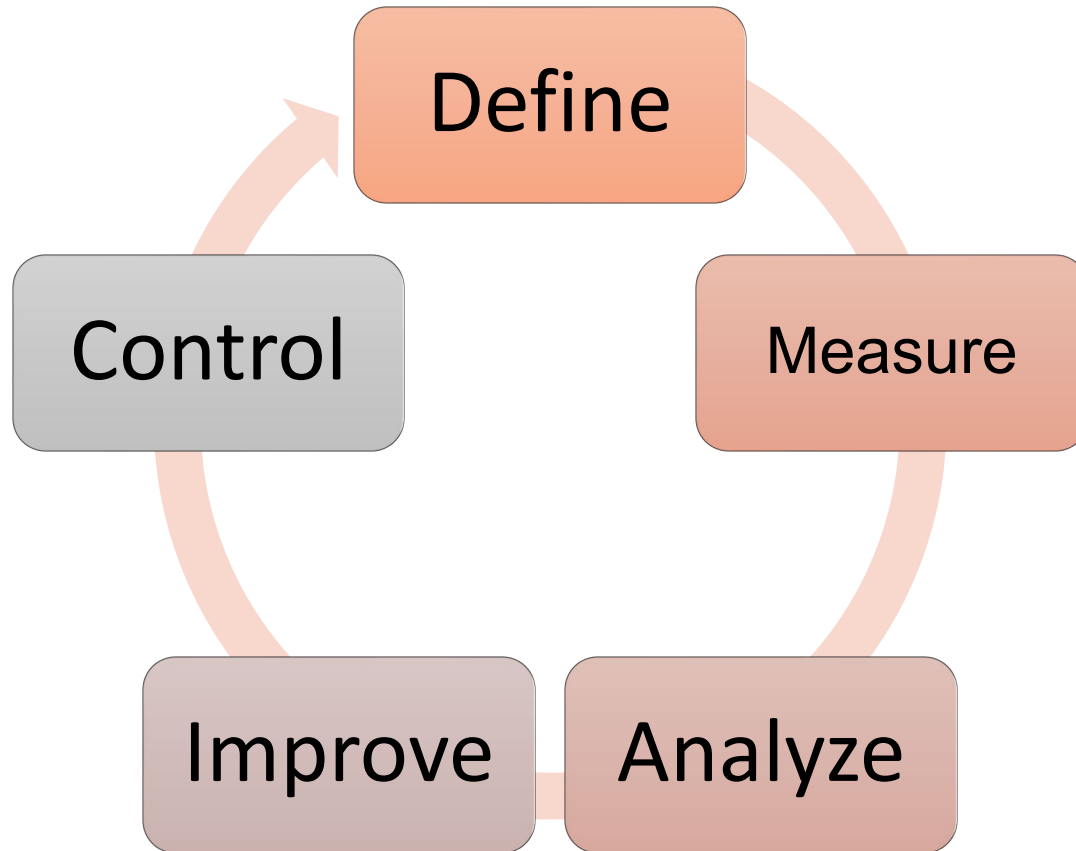**Cost/Impact
seen***

**Cost/Impact
not seen***

* This could be what is seen/not seen by a worker or a manager or by both
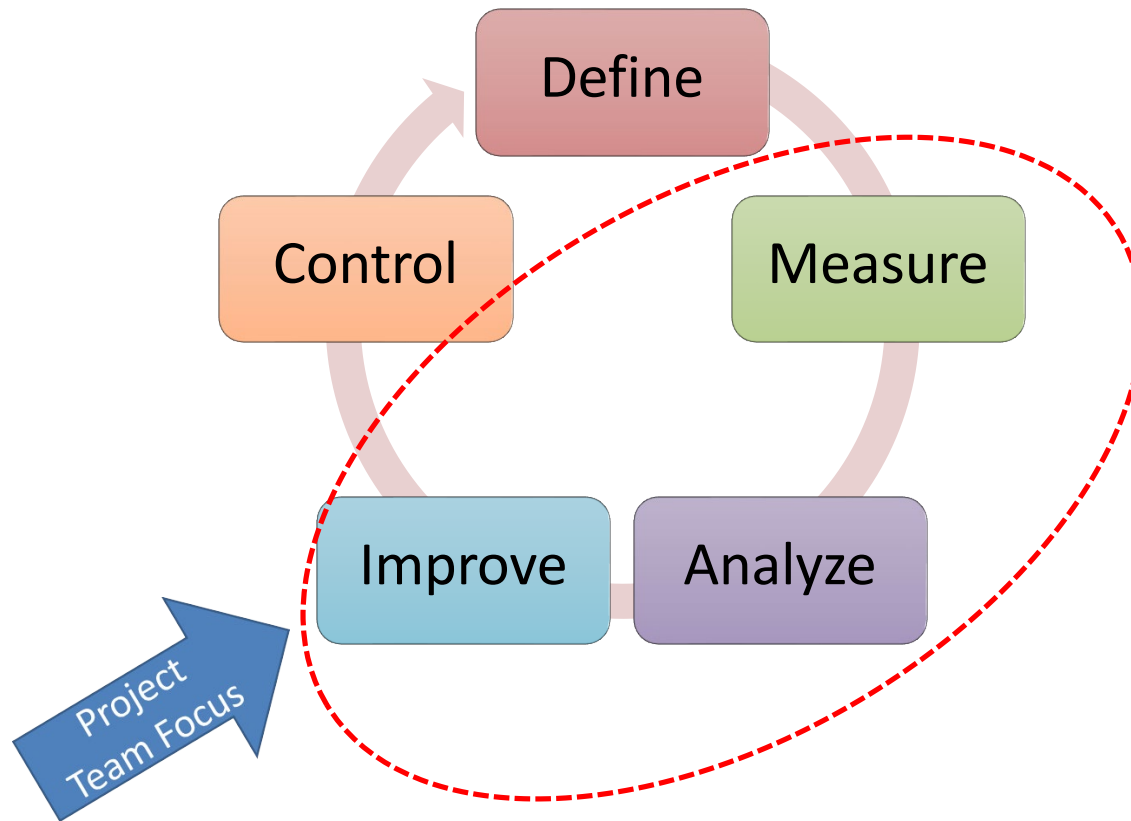
17

The D-M-A-I-C Process
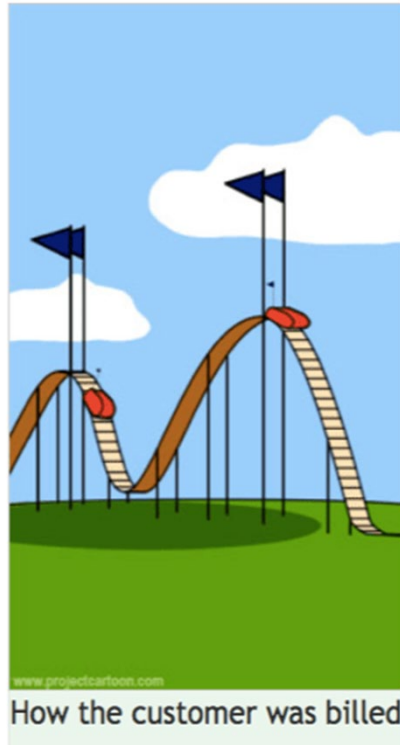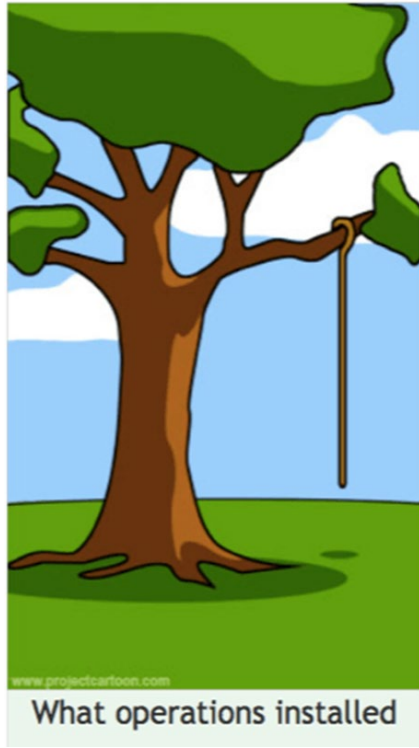
Continuous Process Improvement

An Ongoing Process

Process Owner/LSS Project Team Focus

Voice of the Customer

S

What operations installed

How the customer was billed

What the customer really needed

Who are your customers?

If you are an auto manufacturer, who are your customers?

- **External Customers**
- Direct Customers
    - Auto dealers
    - Rental car companies
    - Customers who buy cars from you???
- Secondary Customers
    - Travelers who rent cars from rental companies
- Indirect Customers
    - Regulatory and policy setting agencies that speak on behalf of the customers:
        - National Highway Traffic Safety Administration (NHTSA)
        - Environmental Protection Agency (EPA)

- **Internal Customers**
- Employees, other departments

- **Other Stakeholders**
- Unions, local communities, stockholders, insurance companies

Capturing the Voice of the Customers (Example: Cars)

- Identify the customers and each one's voice
- Confirm customer requirements
- Rank customer requirements
- Quantify customer requirements

Customer	Requirement	Rank (1-10)	Specification
Direct Customer	Economy, Value	9	MPG, annual maintenance cost, Drive out Cost
Rental company	Robustness	8	User friendly, easy to operate
NHTSA	Safe car	10	Crash test results
EPA	Low emissions	10	Average MPG
Stockholder	Good investment	10	Stock value

s

Exercise: Who are the customers and what they want?

List YOUR PRODUCT OR SERVICE:

List various types of customers and what they want (VOC) in the Table below:

EXTERNAL			INTERNAL	OTHER STAKEHOLDERS
Direct	Secondary	Indirect	Internal	Other Stakeholders
VOC	VOC	VOC	VOC	VOC

VOC - Voice Of the Customer (what the customers want)

26

Kano Model

Customer Satisfaction

Delighter/
Exciter

Excellent Execution

Poor Execution

Performance Feature
(Satisfier)

Basic Feature
(Dissatisfier)
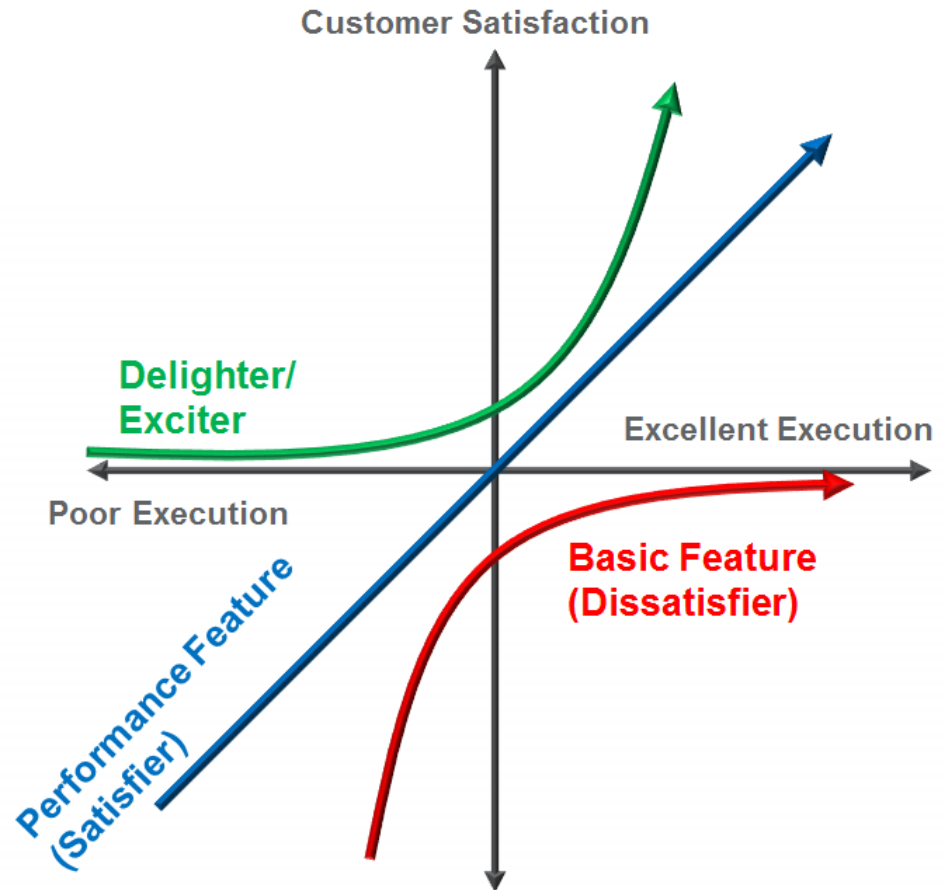
Cause and Effect

$$Y = f (X)$$

- Y = process output
- X = process input(s)
- f = is the function that relates the inputs to outputs

$$Y = f(Xs)$$

- Y = Output
- Xs = Inputs
- f = the function or the process that converts inputs to output
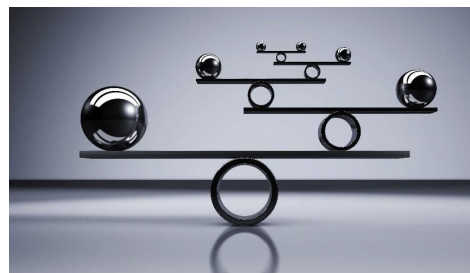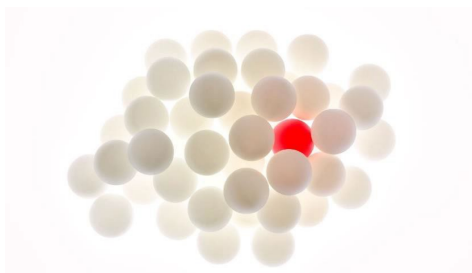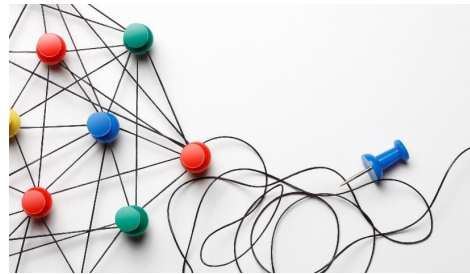
- Coffee quality = coffee bean, water, other ingredients, temperature, brewing equipment

- Airline travel rating = safety, comfort, service, ontime arrival, baggage handling, cost, convenience (flight timing, airport location)

- Identification of critical inputs (X's) is the key to improving the output (y)
- Lean Six Sigma helps to identify critical inputs to implement process improvements

Identify Improvement metric 'Y'

X1 X2. X3 …

X's
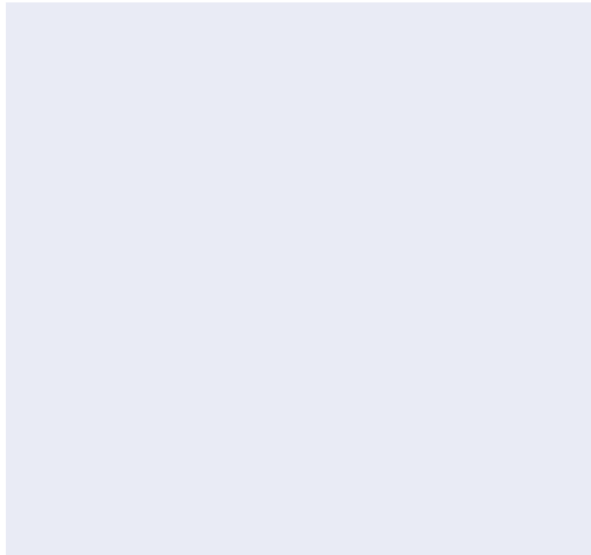
Y

YOUR PRODUCT OR SERVICE

30

Value-Added – Non-Value-Added

• <u>Value Added (VA) Activity</u>: Contributes to what our customers want from our product or service (& they would pay for if they knew about it)

• <u>Business Non-Value Added (BNVA):</u> Activities our customers don't want to pay for (it does not add value in their eyes) but that are required for some reason (accounting, legal, regulatory, etc.)

• <u>Non-Value Added (NVA) Activity (Waste)</u>: The work that adds no value in the eyes of your customers and that they would not want to pay for, nor is it required

It's human nature for all of us to think everything we do is "Value Added."
(That's why it's so difficult for us to see the waste in processes we work on everyday.)

32
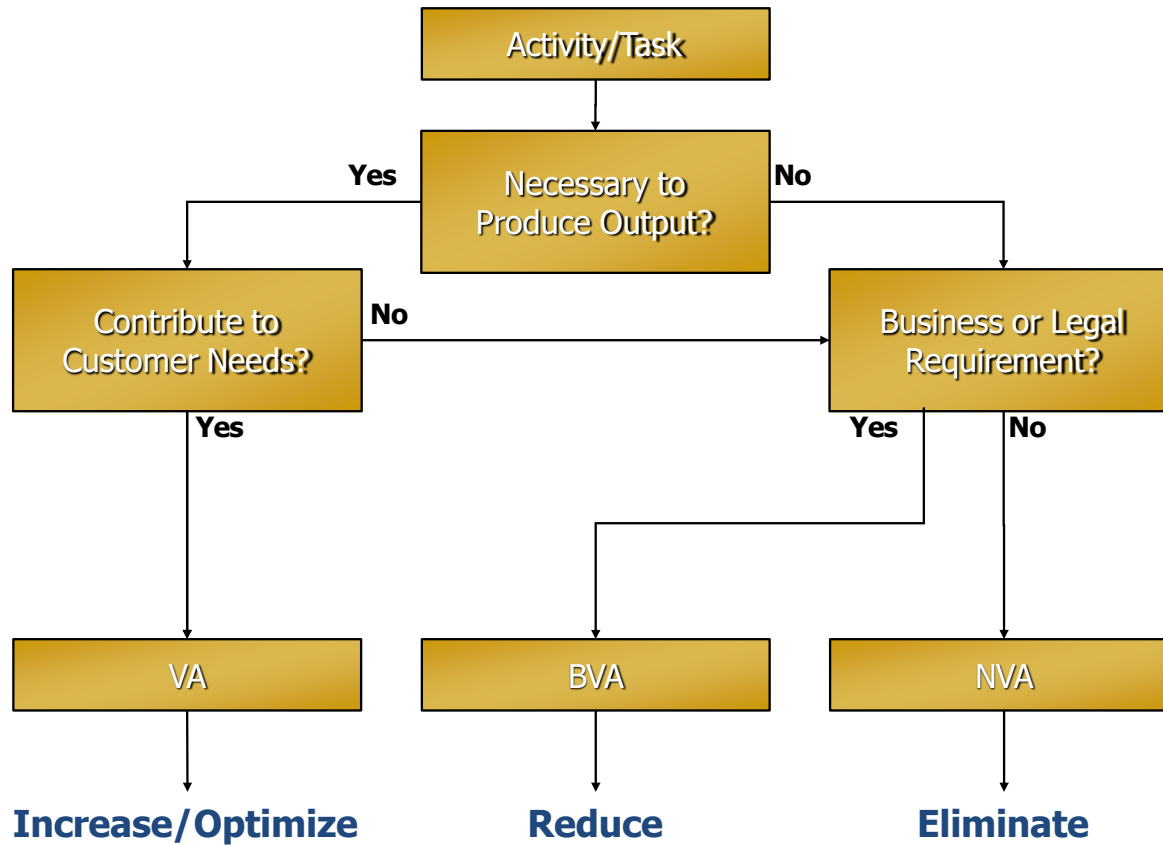
LSS: Two Methodologies Blended Into One

Lean

- Visual approach (process map/workplace view)
- Focused on quick wins
- Works best by focusing on waste removal (often associated with time) with time as the primary metric
- Change agents are the entire company, which tends to build a culture of empowerment

Six Sigma

- Systematic data driven approach
- Fixes may be more comprehensive
- Works best with defects, variation, throughput, and cost as the primary metric
- The change agents are typically Six Sigma trained process owners and Belts
- Built on statistical analysis
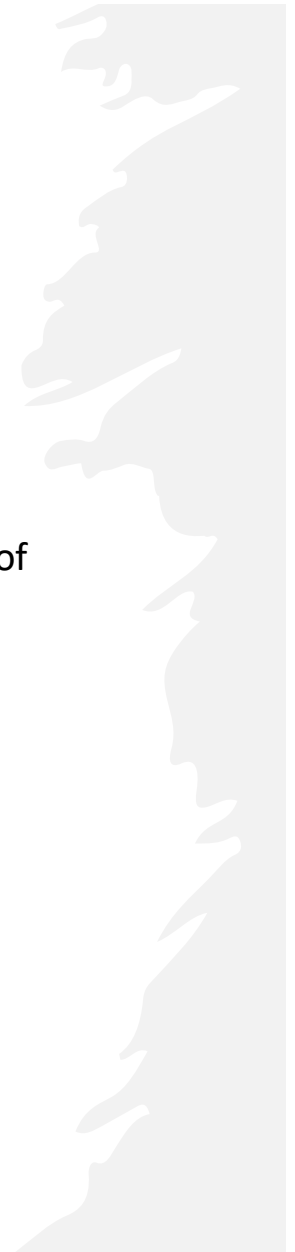
What is Lean?

Lean focuses on Non-Value Added (NVA) time and the Wait Time. Six Sigma focuses on reducing variation and defects in the Value Added (VA) activities

The process shown in the graphics below has 6 steps. 1, 4, and 6 are VA steps, 2 is a NVA step, and 3 and 5 are "wait times".

Start   **End**

1.VA Task	2.NVA Task	3.Waiting for resource	4.VA task	5.Waiting for approval	6.VA Task
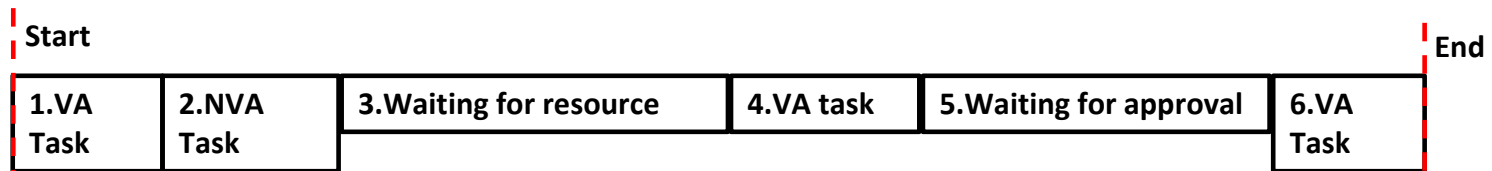
Let us say, with the leaning process, we eliminated the NVA step-2, reduced the wait time for step-3, and eliminated the wait time for step-5, the leaned process will look like the graphics shown below.

Start   **End**

1.VA Task	3.Waiting	4.VA task	6.VA Task

Cycle time reduction from Lean Activities
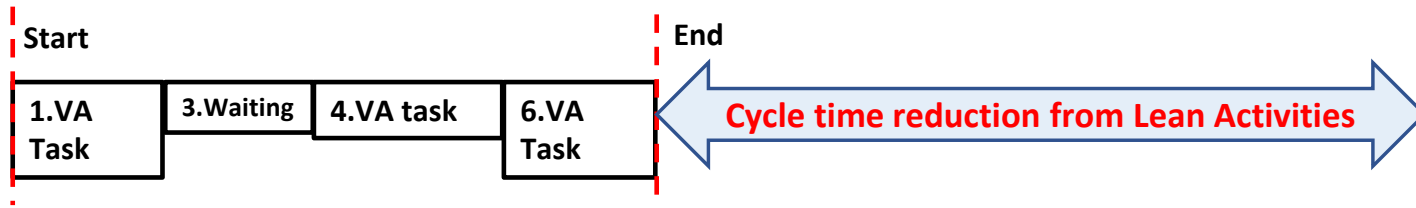
After the Lean improvement, Six Sigma process may be used to reduce the defects and variation in the remaining process steps.

Lean Concepts and Fundamentals

Standard Work	8 Forms of Waste	6S	Process Mapping
Value Stream Map (VSM)	Spaghetti Diagram	Mistake Proofing	Rolled Throughput Yield (RTY)
	Single piece vs. Batch Process	Kaizen and Continuous Improvement	

Standard Work – Potential Results

Lots of planning, practice and standard work results in stunningly fast tire changes: https://youtu.be/bLehbCYiJmE

More about how teams prepare and use standard work to produce results near 2 seconds and less: https://youtu.be/K6u7hvBW6P0

May, 2023

Standard Work

- Standard detailed documented work processes
- Reflects best practice
- Allows ease of training
- Rotational opportunity between work centers
- Workload balancing
- Consistent collection of data

Standard Work - Exercise

Instructions

The Eight Wastes of Lean

Talent

Underutilizing people's talents, skills, & knowledge.

Inventory

Excess products and materials not being processed.

Motion

Unnecessary movements by people (e.g., walking).

Waiting

Wasted time waiting for the next step in a process.

Transportation

Unnecessary movements of products & materials.

Defects

Efforts caused by rework, scrap, and incorrect information.

Overproduction

Production that is more than needed or before it is needed.

Overprocessing

More work or higher quality than is required by the customer.

Waste (for example):
Do we always see what's right in front of us?

Re-watch video [here](#) (links to YouTube)

6S – A Lean Workspace

Sort	Identify what is needed and not needed
Set in Order	Arrange & organize: A place for everything, everything in its place
Shine	Cleaning and looking for ways to keep the workspace looking great
Standardize	Everyone trained & methods consistently applied
Sustain	Once it's good, keep it good, and also continue to improve

6S is a powerful, yet simple methodology for organizing cluttered or inefficient workspaces, software routines, and process steps.
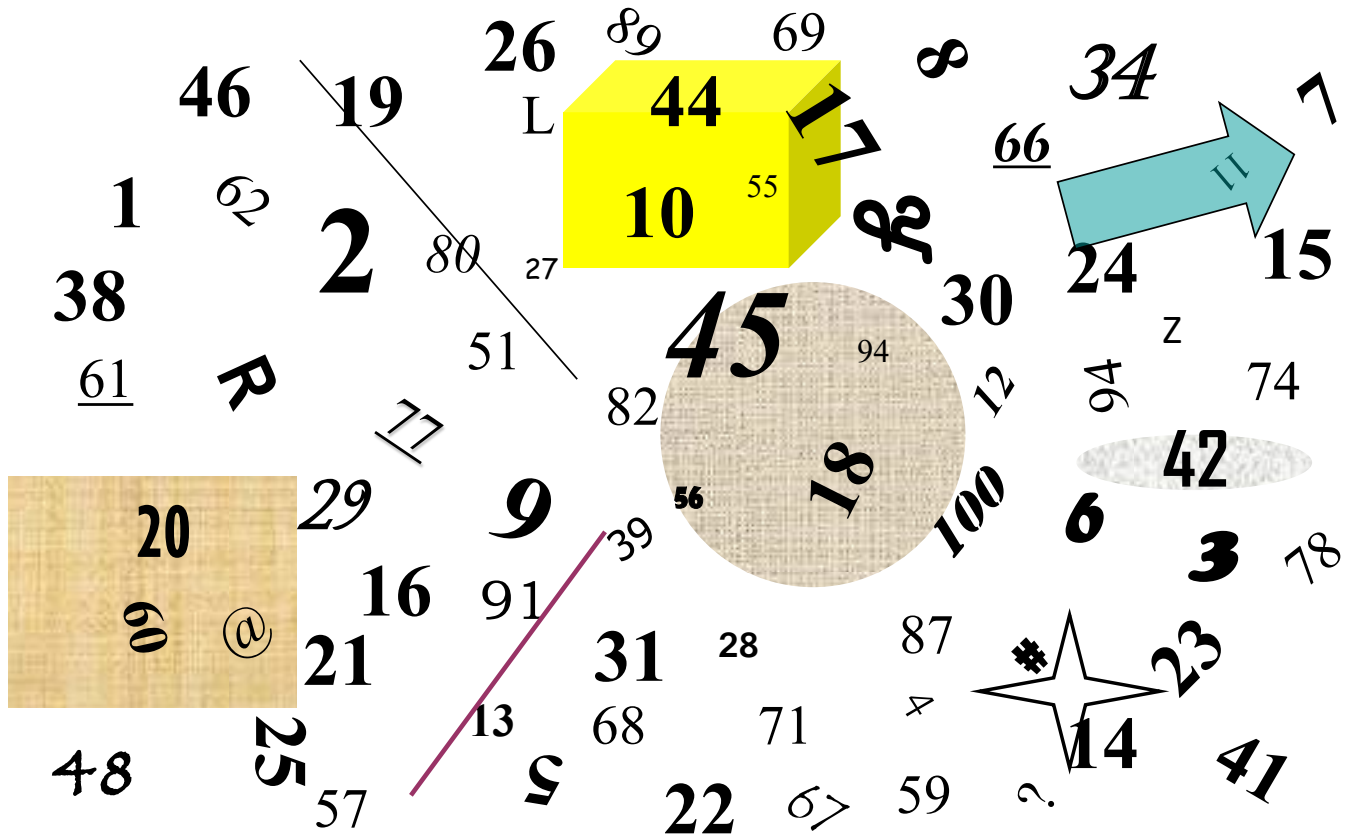
Your workplace uses numbers 1 through 30. In 15 seconds see how many numbers you can find in order from 1 to 30.

42

SORT

26

19

8

7

1

2

10

17

11

20

29

9

16

21

25

13

5

22

27

30

24

15

12

18

6

3

28

23

4

14
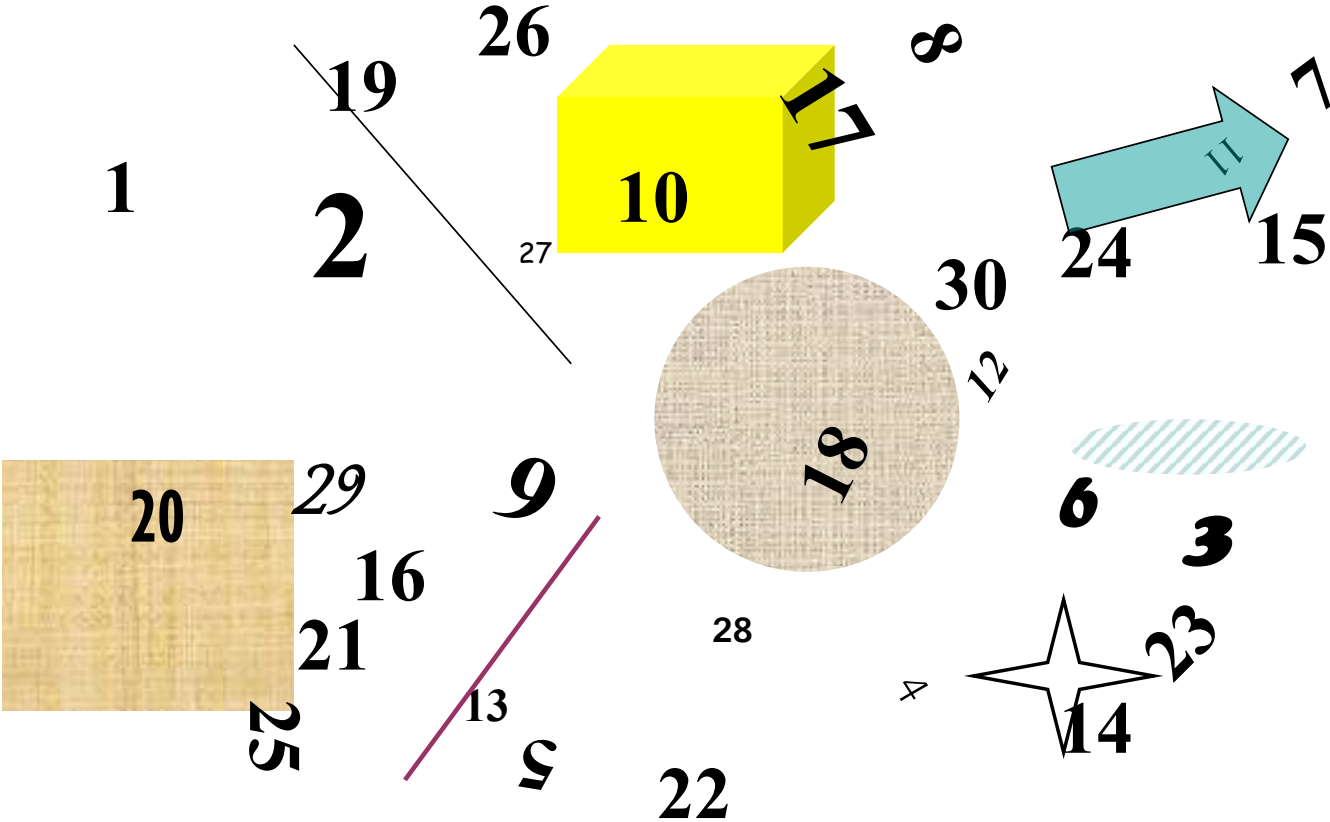
You *SORTED* your workplace by removing what is not needed. In 15 seconds see how many numbers you can find in order from 1 to 30.

43

SHINE

26
19
8
17
7
1
2
10
11
27
24
15
30
12
20
29
9
18
6
3
16
21
28
23
25
13
4
14
5
22
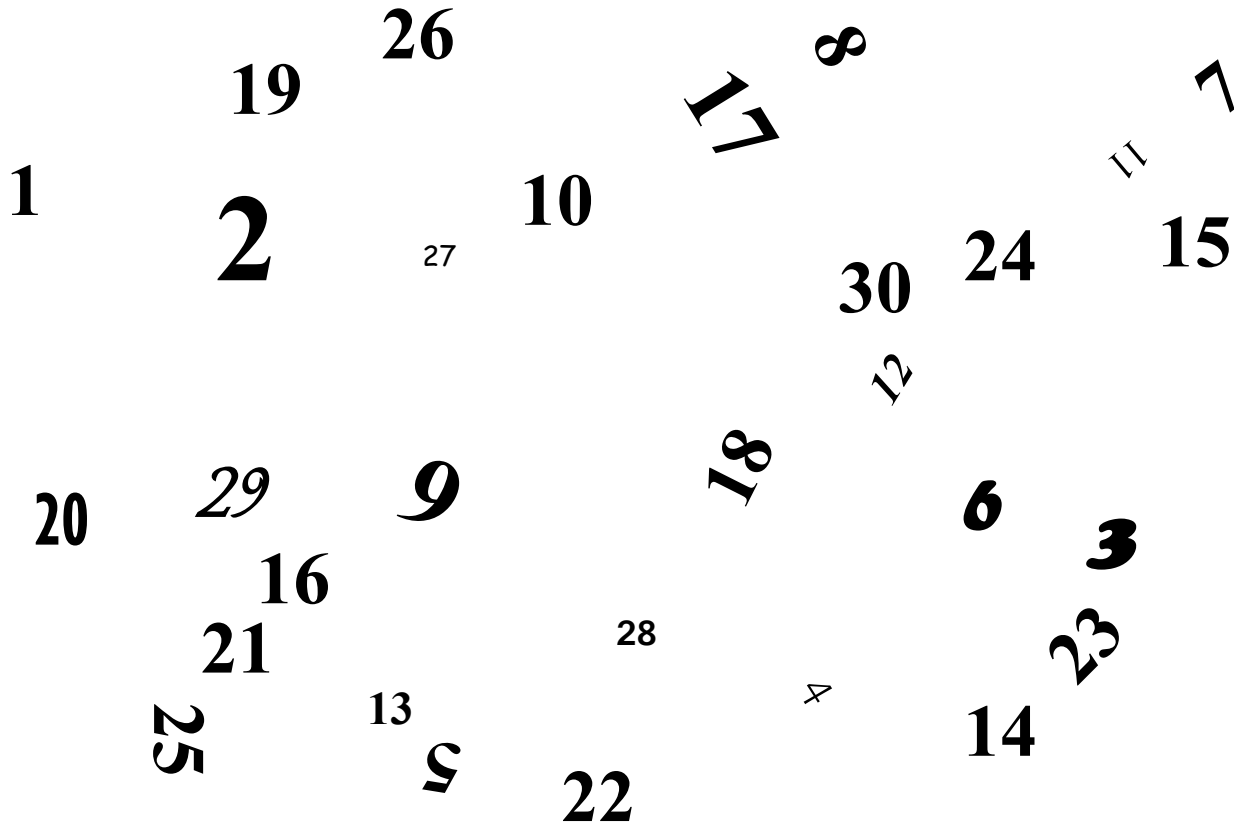
You *SHINED* your workplace by cleaning and removing abnormalities. In 15 seconds see how many numbers you can find in order from 1 to 30.

44

1	19	26	17	8	7
29	2	27	18	30	15
20	9	10	*12*	*6*	24
21	16	22	4	11	*3*
25	13	5	28	23	14

You *SET IN ORDER* items in your workplace . In 15 seconds see how many numbers you can find in order from 1 to 30.

45

STANDARDIZE

1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30

You STANDARDIZED items in your workplace by adjusting for size and sequence. In 15 seconds see how many numbers you can find in order from 1 to 30.

46

SUSTAIN

1	2	3	4	5	
7	8		10	11	12
13	14	15	16	17	18
19		21	22		24
25	26	27	28	29	30

You SUSTAIN items in your workplace by immediately recognizing when the situation is abnormal and correcting it. Can you identify abnormal conditions?

47

Lean Concepts and Tools (continued)

The following concepts and tools are covered later in the "Service Example"

- Process Mapping
- Value Stream Map (VSM)

Process Map

Customers

- Places order — 1
- Delivery made? — 8 (No / Yes)
- Customer satisfied? — 9 (Yes / No)
- Acknowledges receipt — 12

Customer Service

- Recieves order, ensures payment is received and forwards to fulfilment — 2
- Order closed — 13

Fulfilment

- Enters info, verifies stock, picks products, and forwards to Packaging — 3
- Review defects and proposes resolution — 10
- Obtains approval from Customer Service VP — 11

Packaging Dept

- Packages the products ready for shipment — 4
- Quality check. OK? — 5 (Yes / No)

Shipping Dept

- Create shipping label and arrange for shipping — 6
- Shipping company picks the package and delivers to the customer — 7

May, 2023

Value Stream Map

Customers

Places order — 1

Customer Service

Recieves order, ensures payment is received and forwards to fulfilment — 2

-VA
-TT 1 Hour, WT 3 Days
-RFT 90%
-Resources 3
-Inventory 90
-Tools: Manual

Fulfilment

Enters info, verifies stock, picks products, and forwards to Packaging — 3

-VA
-TT 1 hour, WT 4 Days
-RFT 92%
-Resources 4
-Inventory 85
-Tools: In-house software

Packaging Dept

Packages the products ready for shipment — 4

Quality check. OK? — 5

Shipping Dept

-VA
-TT 0.5 hour, WT 3 Days
-RFT 90%
-Resources 3
-Inventory 90
-Tools: Manual

Create shipping label and arrange for shipping — 6

Shipping company picks the package and delivers to the customer — 7

Delivery made? — 8   No / Yes

Customer satisfied? — 9   Yes / No

Acknowledges receipt — 12

Order closed — 13

Review defects and proposes resolution — 10

Obtains approval from Customer Service VP — 11

VSM data: VA/NVA/BVA, TT, WT, RFT %, resources, inventory, tools used are added for three process steps. These are shown for all process steps in the Table -1

May, 2023

Leaning Opportunities

Consolidate

Consolidate

Customers

Places order
1

Customer Service

Recieves order, ensures payment is received and forwards to fulfilment
2

Electronic order entry

Fulfilment

Enters info, verifies stock, picks products, and forwards to Packaging
3

Packaging Dept

Packages the products ready for shipment
4

Quality check. OK?
5

Yes

No

Shipping Dept

Create shipping label and arrange for shipping
6

Shipping company picks the package and delivers to the customer
7

No — Delivery made?
8

Yes — Customer satisfied?
9

No

Yes — Acknowledges receipt
12

Order closed
13

Eliminate this step. Use delivery receipt.

Review defects and proposes resolution
10

Obtains approval from Customer Service VP
11

Eliminate this step by providing guidelines to Fulfilment

Spaghetti Diagram

A visual image of the movement required to carry out a process…the <u>actual</u> flow

Example of a spaghetti chart for product flows along value streams.

Component Piece Parts Process

55

Mistake Proofing

Visual

Audible/Tactile

Physical

What applications for mistake-proofing can you think of?

Rolled Throughput Yield (RTY)

Step-1 RFT=0.92	→	Step-2 RFT=0.85	→	Step-3 RFT=0.97	→	Step-4 RFT=0.87

What is the final % of RFT?

Rolled Throughput Yield (RTY)

- RTY is a function of cumulative effects of Right the First Time (RFT) of all process steps.

- For the process shown above, RTY = 0.92x0.85x0.97x0.87 = 0.66 or 66%

- (Exercise later, if time permits)

Rolled Throughput Yield (RTY)

Rolled Throughput Yield

Rolled Throughput Yield (RTY) is the probability that a single unit can pass through a series of process steps free of defects or % of defect free units.

Overall Yield vs. Sigma level as a %: Changes with number of process steps:

# of steps	3σ	4σ	5σ	6σ
1	93.32	99.379	99.9767	99.99966
2	61.63	95.733	99.839	99.9976
10	50.08	93.96	99.768	99.9966
20	25.08	88.29	99.536	99.9932
40	6.29	77.94	99.074	99.9864

Lean reduces NVA steps

Six Sigma reduces defects

Single Piece Flow vs. Batch Processing

Exercise

Customer's desired output:

6 Envelopes stuffed with neatly folded sheet with "Lean Six Sigma" written out, delivered as quickly as possible.

Teams 1, 2, & 4: Batch (B)

Teams 3 & 5: Single-piece flow (SPF)

Results/Conclusions:

1. Both SPF teams beat the completion time of all three B teams

2. SPF in a multi-step process will almost always beat B

3. There are some necessary exceptions where Batch is necessary

Kaizen Process – Continuous Improvement

"Where there is no standard, there can be no kaizen (continuous improvement)." —Taiichi Ohno

The Kaizen Process:

a) Establish the existing standard work

b) Analyze the current process

c) Make improvements (D-M-A-I-C)

d) Document the new standard work

Importance of Metrics/Accountability

- What is measured gets improved
- In all aspects of life, personal and business, data plays a key role
  - Health data, financial data, cultural/environmental data
- Without data, performance , accountability, change cannot be defined and managed
- Data quality
  - Relevance
  - Accuracy
  - Timeliness
  - Completeness
  - Accessibility
  - Security

Sources of Variation

Who: People (education, training, experience, state of mind, age, gender, certification, morale, in-house, outsourced, customers, suppliers, organizational structure …)

What: Components of a process (Regulatory, industry, in-house, new product…)

Where: Environment (industry, competition, weather, season, country, region; Location: urban, rural…)

When: Time (month of the year, week of the month, day of the week, shift, holiday season…)

OTHERS?

60

Defects, Defectives and Variation

Exercise

Open M&M's bag

Measure and record:

- Total Count

- Count by color

- # Of defects

- # Of defective M&M's

Conclusions included:
1. Measurement system error: Definition of "defect" is subjective – if we'd agreed ahead of time on this, the number of defects reported would have been different.

2. The big variation in piece count per bag is another example of measurement system error: conclusions about variation in M&M's produces could be distorted without specifying that different kinds of & M&M's will come in the same sized bags.

2. Depending on who's using or eating the M&M's, defects identified might be unimportant. We have to make sure we have clear, specific definitions of what represents an error or defect and what doesn't, according to the customer.

Continuous Process Improvement

Process Owner Role: Process Management

Bad

Project Team Role: DMAIC

Define

Process Management- LSS Team Interface

Measure

Analyze

Improve

Control

Savings $ 3.6 Million
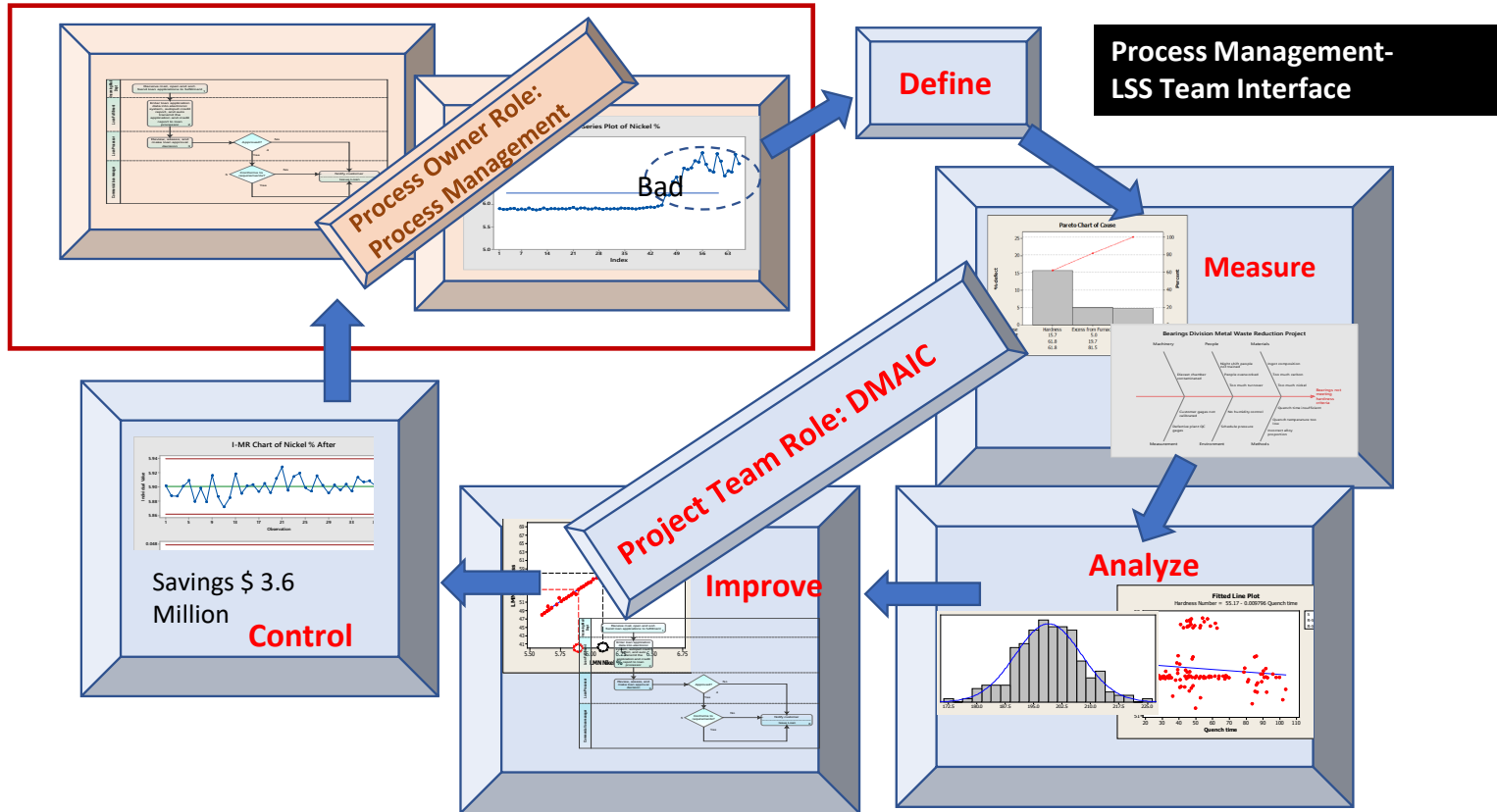
An Ongoing Process
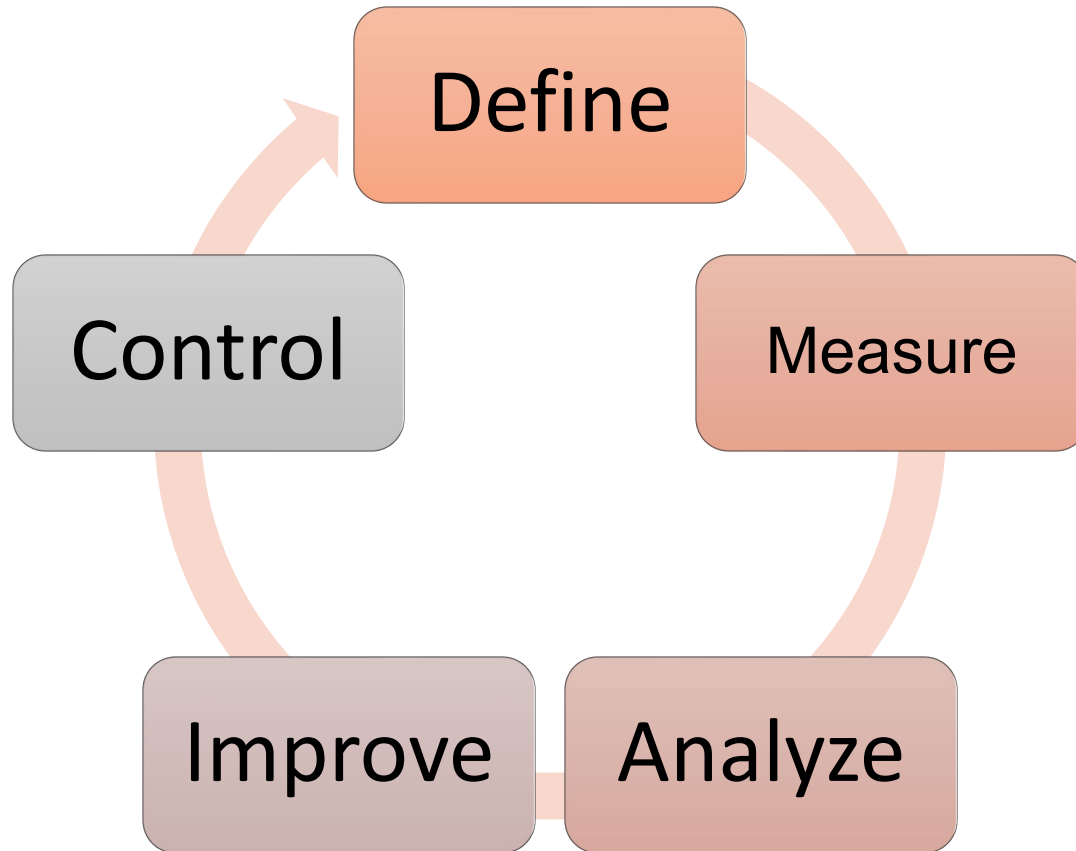
Process Owner/LSS Project Team Focus
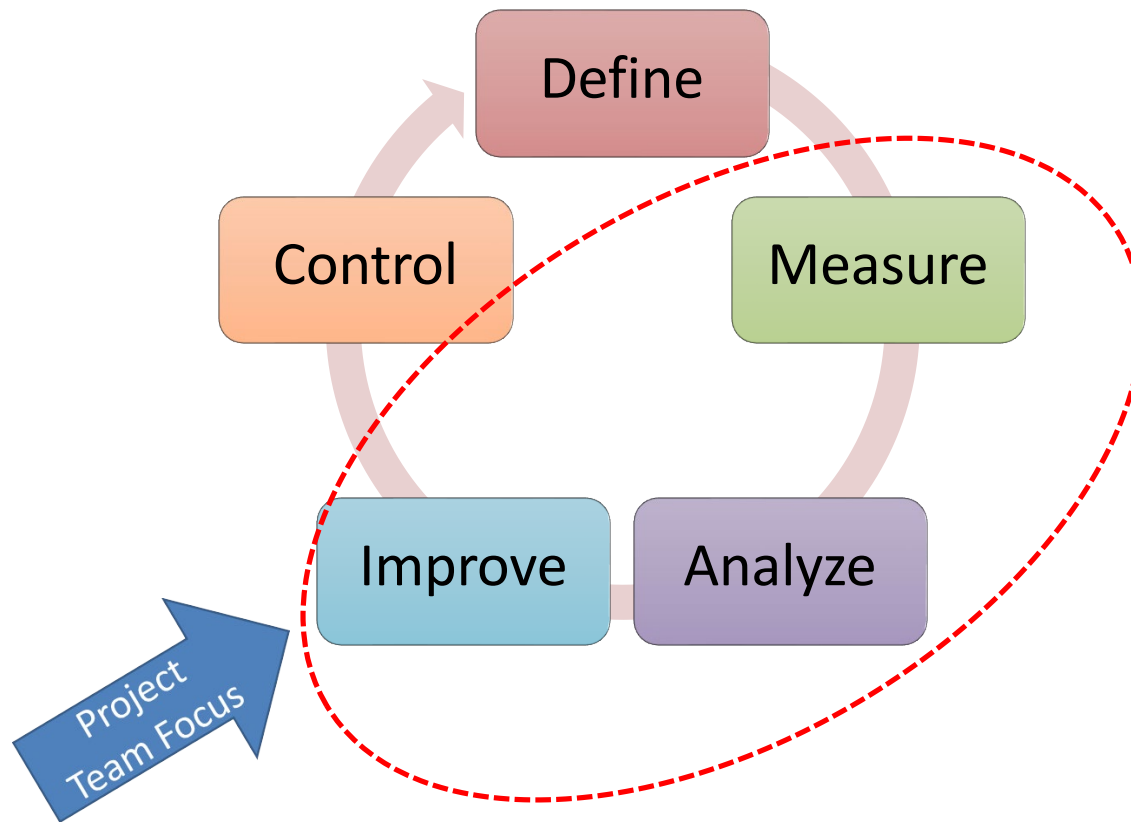
DMAIC: Purpose
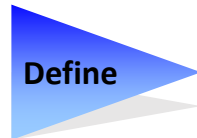
Define — What is the high priority performance gap in our process output (Y) in meeting customer expectations and company goals?

Measure — What is the current state process and baseline performance? What are the possible causal factors (Xs) impacting the performance (Y)?

Analyze — Based on data analysis, what are the critical causal factors (Xs) that impact the result (Y)?

Improve — What are the improvements that will eliminate or control the critical causal factors (Xs) to obtain the desired result (Y)?

Control — How to implement, monitor, and control the improved process to sustain the gains?

DMAIC Activities

Define
- σ Describe the Problem
- σ Define the Project scope
- σ Establish the team
- σ Select and explore the output characteristic (the Y)
- σ Assess the performance specification

Measure
- σ Map the Process
- σ Validate the measurement systems
- σ Brainstorm and rank Possible X's
- σ Lean Concepts and Kaizen Exercise

Analyze
- σ Analyze the Process/Analyze the Data
- σ Conduct Graphical/Statistical Analyses of the X's
- σ Document the Probable X's
- σ Quantify the contributions of X's to the issues being examined

Improve
- σ Screen the potential solutions
- σ Identify the appropriate improvements
- σ Update the Process

Control
- σ Implement improvements with process controls
- σ Document what you have learned

DMAIC Roadmap & Key Tools

Define → **Measure** → **Analyze** → **Improve** → **Control**

Define
- Six Sigma Fundamentals
- Problem/Objective Statement
- Primary/Secondary Metric
- Voice of the Customer (VOC)
- Project Plan
- Team selection and alignment

Measure
- Process Mapping/VSM
- Measurement System Analysis
- Fishbone Diagram
- Process FMEA
- Lean Tools:
    - 8 forms of waste/5Ss
    - Kaizen
    - Pull
    - VSM – Analysis

Analyze
- Analysis of Distributions
- Analyze the Process
- Graphical Data Analysis
    - Histogram
    - Box Plot
    - Scatter Plot
- Inferential Statistics
    - Confidence Intervals
    - Sample Size
- Hypothesis Tests
- Regression
- Model Validation

Improve
- Design of Experiments (DOE):
- Simulation DOE (RapiDOE)
- Lean Concepts
- Mistake Proofing
- Standard Work
- VSM – Future State
- Solution Selection

Control
- Solution Implementation
- Control Charts
- Control Plans
- Solution Validation

Role	Who are they?	What they do?
Sponsors/Champions	▪ Members of Senior Mgmt. ▪ Change Agents	▪ Establish Project Selection Process ▪ Establish Project Review Process ▪ Set financial targets for benefits ▪ Remove organizational barriers ▪ Visible support to the project team
Process Owners / Yellow Belts	▪ Those who "own" the processes to be improved ▪ Project will be turned-over to them when complete	▪ Know the real process as it works day-to-day ▪ Key to project support / commitment ▪ Should be identifying projects in their area ▪ Responsible for "Process Management".
Green Belts/Black Belts	▪ Trained in LSS process ▪ Skilled in application of Lean Six Sigma tools and methodology. ▪ Full time or part time ▪ Potential future leaders	▪ Lead and complete projects. Skilled in project management, team leadership. ▪ Handover projects to Process Owners when process improvements are in place
Master Black Belts	▪ Experts in Lean Six Sigma technology, tools, methodology and application. ▪ Recognized, highly credible leaders.	▪ Develop/deliver training (Yellow/Black/Green Belts) ▪ Coach and counsel Black Belts and Green Belts. ▪ Ensure success of 'mission-critical' projects.
Team Members	▪ Mostly from the work area ▪ Cross-functional representation ▪ Customer representation ▪ Suppliers/partner representation	▪ Generally, 4-10 active participants ▪ Knowledgeable in the process we are trying to improve ▪ Time available to support LSS project ▪ Energy and enthusiasm for embracing the changes and implementing improvements
Other Stake Holders	▪ Executive Management ▪ Functional Management ▪ Finance & Accounting ▪ Human Resources ▪ Other departments managers	▪ Show visible support to the project team ▪ Provide funding ▪ Ensure the projects are aligned with organizational objectives and high priority ▪ Celebrate success

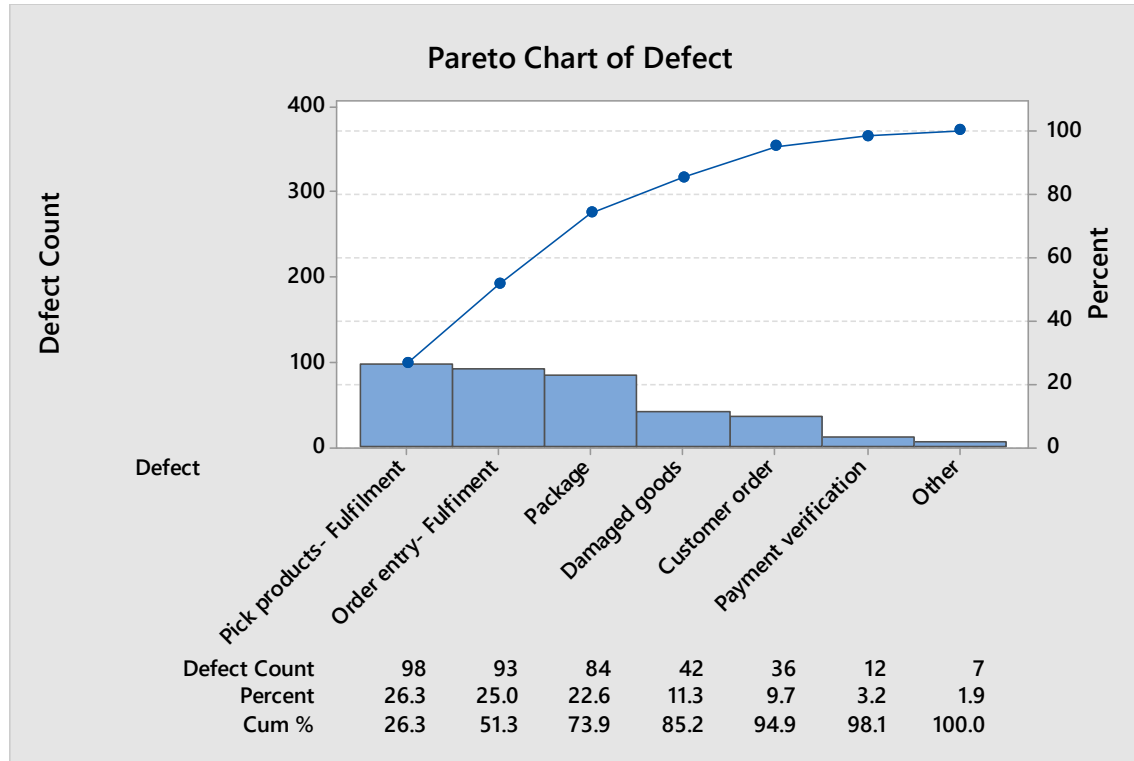# High-Level Improvement Project Overview

Project Charter: Improve Product Shipping Process

Project Background: Customers expect a high level of service. In the last 12 months, customer complaints related product delivery (packaging and shipping) have increased and appear to have an impact on the reputation of our brand. The complaints relate to packaging and shipping and not related to product quality. However, the negative impacts are marketing concerns.	**Champion / Sponsor:** US Operations Manager **Process Owner:** Manager, Packaging and Shipping
Problem Statement: In the last 12 months ending Sep 30, 2022, 26% of all shipments had received customer complaints for various reasons. In addition to the brand image, the rework and reshipping costs are estimated at $2.6 Million.	**Team Members:** Packaging Supervisor Packaging specialist Shipping Supervisor Customer order processing agent Customer complaints department employee Packaging material purchase agent
Goal Statement: Reduce shipping quality issues from 26% to under 5% by March 31, 2023.	**Primary Metric (the project is improving):** Shipping complaints as a % of all shipments **Secondary metrics:** Shipping cost as a % of revenue.
Scope and Process Boundaries: All product shipments in the US. The process starts when the confirmed customer order is received and ends when the customer confirms receipt of product in good condition.	**Key Milestones: (D-M-A-I-C completion schedule)** Define-Nov 30, 2022 Measure-December 31, 2022 Analyze-January 31, 2023 Improve-February 28, 2023 Control-March 31, 2023

SIPOC

Suppliers (internal and external)	Inputs (use nouns)	Process (use verbs)	Outputs (use nouns)	Customers (internal and external)
External Customers	Orders	Customer Service receives customer orders	Completed orders	External Customers
Customer Service	Product list	Customer Service sends order to fulfilment	Resent orders	Customer Service
Fulfilment Dept	Shipping instructions	Fulfilment picks products and delivers to packaging dept	Customer acknowledgement of product receipt	Fulfilment Dept
Procurement Dept	Products	Packaging dept sends the package to shipping dept	Defect data	Procurement Dept
Package suppliers	Packaging material	Packaging dept ships the package to the customer		Package suppliers
Packaging Dept	Package list	Package returned by the shipping company undelivered or returned by the customer if the product is damaged, incorrect product, etc.		Packaging Dept
Product suppliers	Shipping label	Customer service, fulfilment, packaging, shipping reships the package		Product suppliers
Shipping Dept	Returns	Document defects in the data base		Shipping Dept
Shipping company				Shipping company

Pareto Chart of Defects

Pareto Chart of Defect

Defect	Pick products- Fulfilment	Order entry- Fulfiment	Package	Damaged goods	Customer order	Payment verification	Other
Defect Count	98	93	84	42	36	12	7
Percent	26.3	25.0	22.6	11.3	9.7	3.2	1.9
Cum %	26.3	51.3	73.9	85.2	94.9	98.1	100.0

Takeaway: Focus on Fulfilment and Packaging

Fishbone (Cause and Effect) Diagram

Cause-and-Effect Diagram

Transport   Packaging   Customer Service

Night Shift

Inadequate staffing

Poor lighting

Company-A

Flimsy boxes

No training

Old packaging tools

Cusotmers dissatisfied by shipping quality and cycle time

Too many interfaces

Product knowledge

Unclear procedures

Congested area

Manual process

Turnover

DOR

Methods   Shipping   Fulfilment
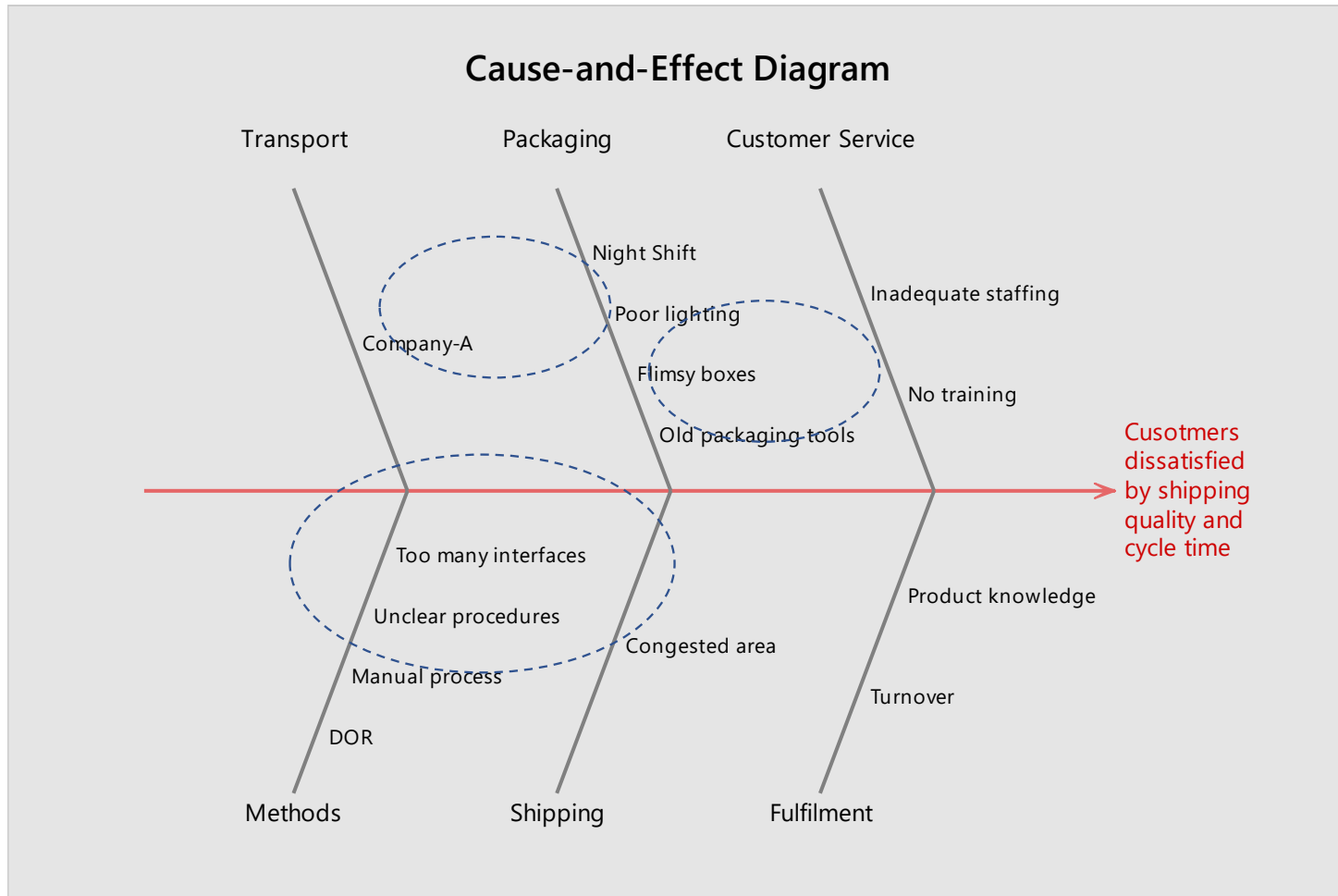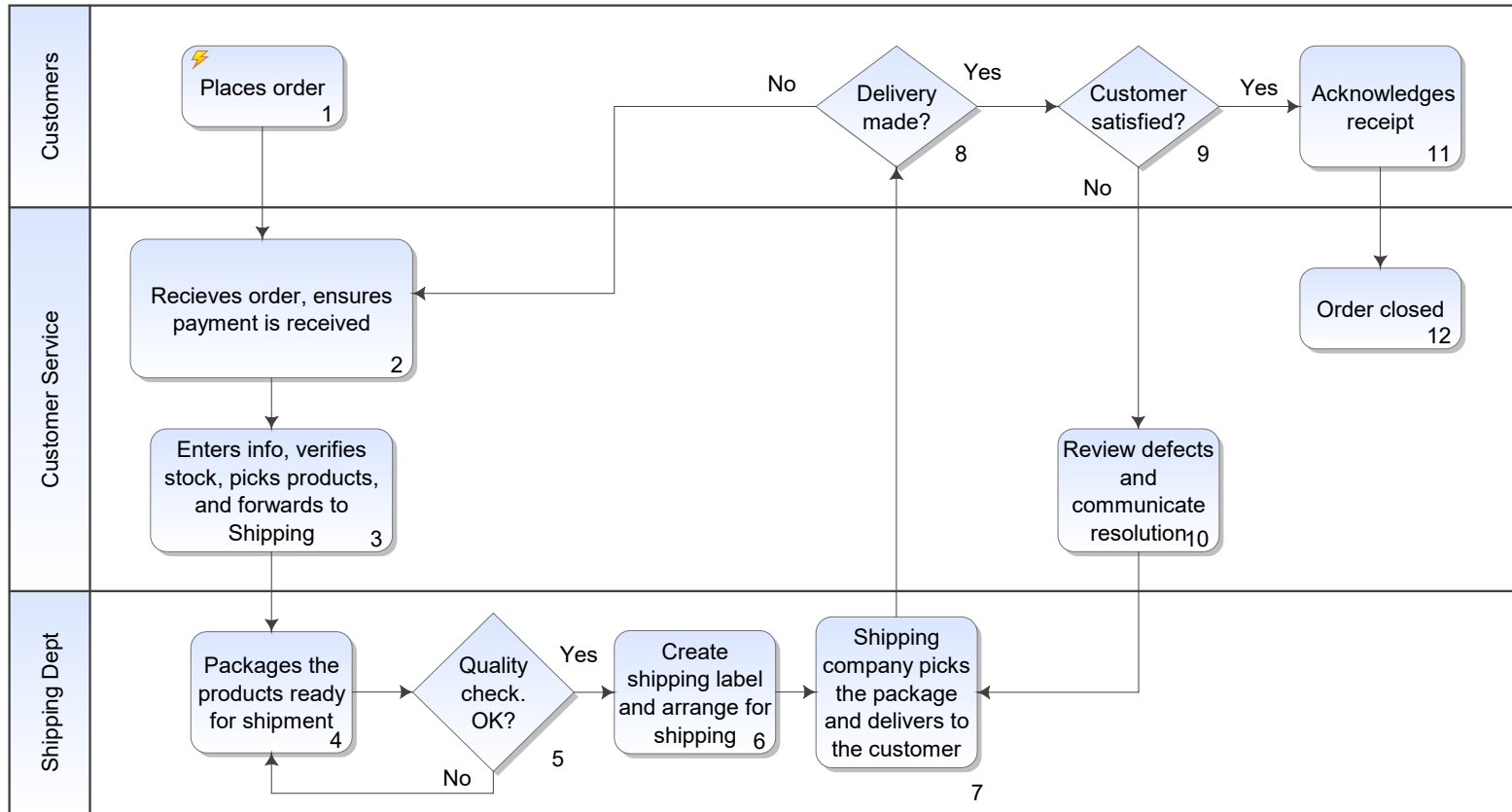
Improvements

1. Automate order taking process

2. Consolidate Customer Service and Fulfilment roles related to order processing

3. Consolidate Packaging and Shipping

4. Improve transport Company-A's performance or replace

5. Establish clear Division of Responsibility

6. Procure high quality shipping containers

Future State Process Map

Risk Analysis & Mistake Proofing
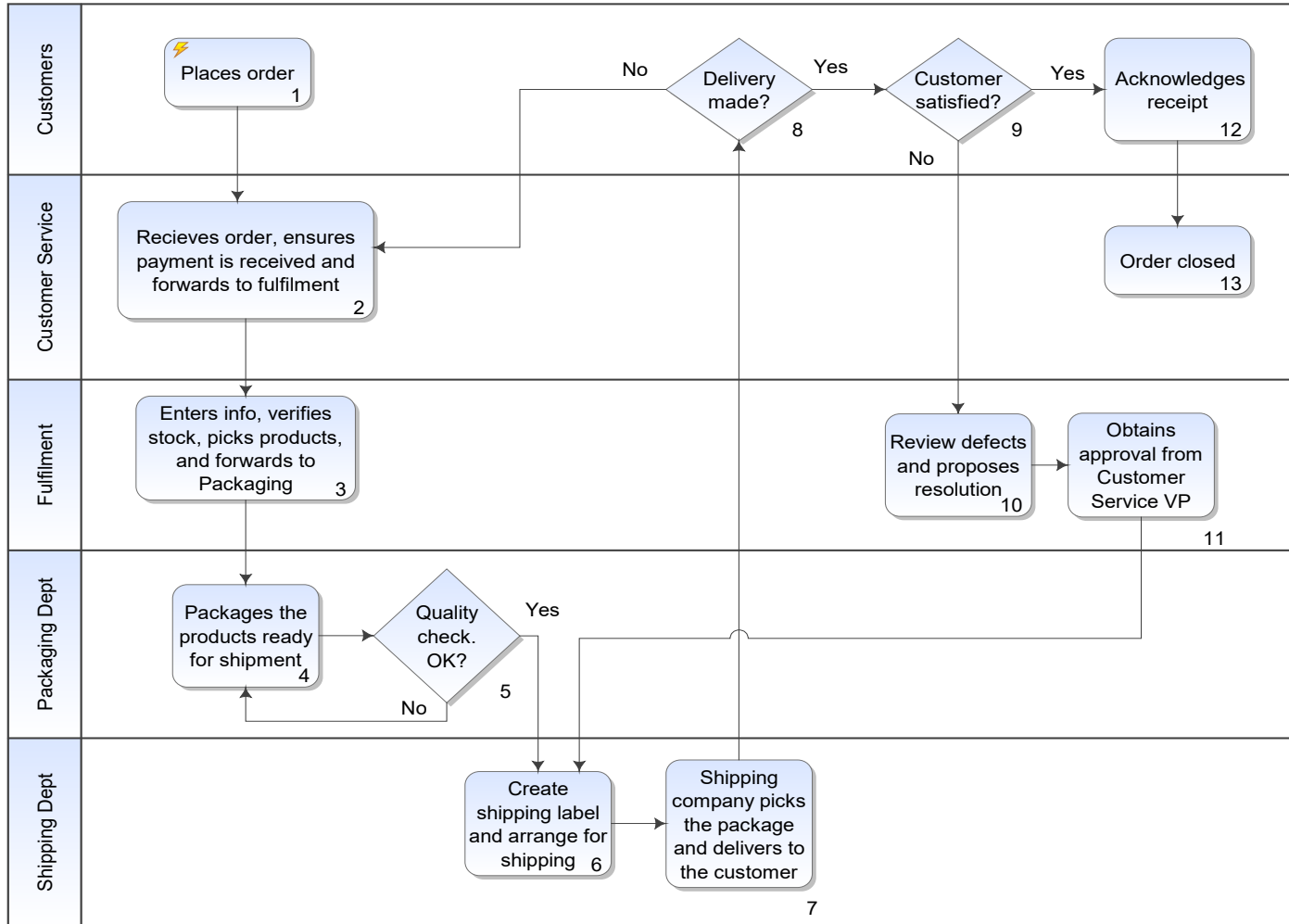
Failure Modes and Effects Analysis (FMEA)

#	Process Function (Step)	Potential Failure Modes (process defects)	Potential Failure Effects (Y's)	S E V	Potential Causes of Failure (X's)	O C C	Current Process Controls	D E T	R P N	Recommend Actions	Responsible Person & Target Date	Taken Actions	S E V	O C C	D E T	R P N
10	Provide guidelines and empower Fulfilment to take actions to process customer returns due to damaged products	Fulfilment replacing damaged products returned by the customer even if it is the customer's fault	Increased cost to the company	8	Ineffective understanding and implementation of the new responsibility by Fulfilment	3	None	10	240	Training modified with hands-on test examples and review of actions by sampling	VP Sales	Completed	8	1	2	16
4,5, 6, and 7	Consolidation of packaging and shipping departments	Team dynamics: Individuals not embracing the change	Poor performance: Shipping delays and other defects	10	Ineffective communication of reasons for department consolidation and employee training	4	None	10	400	Mangement communicating the value of the change and what are the benefits for the team, HR monitoring by getting team's feedback	CEO	Completed	10	1	2	20

Notes about FMEA:
- **SEV- Severity rating (1-10). Higher the severity, the rating is higher.**
- **OCC- Occurrence rating (1-10). Higher the occurrence, the rating is higher.**
- **DET- Detection capability (1-10). Higher the detection capability, the rating is lower.**
- **RPN- Risk Priority Number = SEVxOCCxDET = a range of 1-1000. Higher the number, this cause of failure needs to be addressed.**
- **To be effective and consistent, organizations need to set rating criteria for SEV, OCC, and DET.**
- **The team may be encouraged to think rating in terms of High (8-10), Medium (4-7), Low (1-3) to avoid difficulty in selecting a rating.**

I

May, 2023

Document As-is Process Map

Customers
- Places order (1)
- Delivery made? (8)
- Customer satisfied? (9)
- Acknowledges receipt (12)

Customer Service
- Recieves order, ensures payment is received and forwards to fulfilment (2)
- Order closed (13)

Fulfilment
- Enters info, verifies stock, picks products, and forwards to Packaging (3)
- Review defects and proposes resolution (10)
- Obtains approval from Customer Service VP (11)

Packaging Dept
- Packages the products ready for shipment (4)
- Quality check. OK? (5)

Shipping Dept
- Create shipping label and arrange for shipping (6)
- Shipping company picks the package and delivers to the customer (7)

Value Stream Map

Customers

Places order **1**

Delivery made? **8** —No— —Yes—

Customer satisfied? **9** —Yes—

Acknowledges receipt **12**

No

Customer Service

Recieves order, ensures payment is received and forwards to fulfilment **2**

-VA
-TT 1 Hour, WT 3 Days
-RFT 90%
-Resources 3
-Inventory 90
-Tools: Manual

Order closed **13**

Fulfilment

Enters info, verifies stock, picks products, and forwards to Packaging **3**

-VA
-TT 1 hour, WT 4 Days
-RFT 92%
-Resources 4
-Inventory 85
-Tools: In-house software

Review defects and proposes resolution **10**

Obtains approval from Customer Service VP **11**

Packaging Dept

Packages the products ready for shipment **4**

Quality check. OK? **5** —Yes—

No

Shipping Dept

-VA
-TT 0.5 hour, WT 3 Days
-RFT 90%
-Resources 3
-Inventory 90
-Tools: Manual

Create shipping label and arrange for shipping **6**

Shipping company picks the package and delivers to the customer **7**

VSM data: VA/NVA/BVA, TT, WT, RFT %, resources, inventory, tools used are added for three process steps. These are shown for all process steps in the Table -1

May, 2023

Identify Leaning Opportunities

Consolidate

Consolidate

Customers
Places order — 1

Customer Service
Recieves order, ensures payment is received and forwards to fulfilment — 2

Fulfilment
Enters info, verifies stock, picks products, and forwards to Packaging — 3

Packaging Dept
Packages the products ready for shipment — 4
Quality check. OK? — 5

Shipping Dept
Create shipping label and arrange for shipping — 6
Shipping company picks the package and delivers to the customer — 7

Delivery made? — 8 (No / Yes)
Customer satisfied? — 9 (Yes / No)
Acknowledges receipt — 12
Order closed — 13

Review defects and proposes resolution — 10
Obtains approval from Customer Service VP — 11

Electronic order entry

Eliminate this step. Use delivery receipt.

Eliminate this step by providing guidelines to Fulfilment
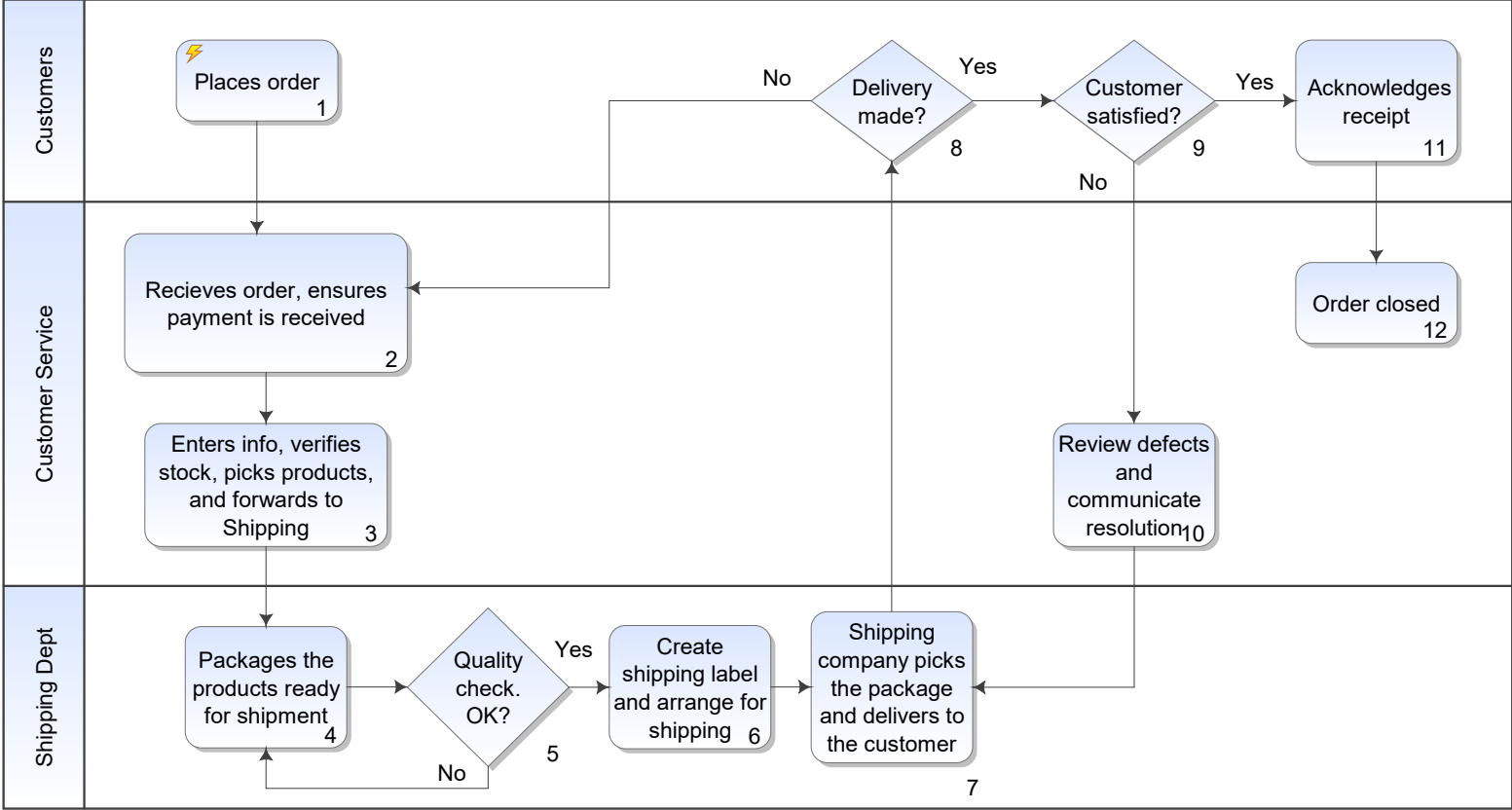
Identify Improvements

- Automate order taking process

- Consolidate Customer Service and Fulfilment roles related to order processing

- Consolidate Packaging and Shipping

- Improve transport Company-A's performance or replace

- Establish clear Division of Responsibility

- Procure high quality shipping containers

Develop Future State Process Map

Perform Risk Analysis & Mistake Proofing

Failure Modes and Effects Analysis (FMEA)

#	Process Function (Step)	Potential Failure Modes (process defects)	Potential Failure Effects (Y's)	SEV	Potential Causes of Failure (X's)	OCC	Current Process Controls	DET	RPN	Recommend Actions	Responsible Person & Target Date	Taken Actions	SEV	OCC	DET	RPN
10 and 11	Provide guidelines and empower Fulfilment to take actions to process customer returns due to damaged products	Fulfilment replacing damaged products returned by the customer even if it is the customer's fault	Increased cost to the company	8	Ineffective understanding and implementation of the new responsibility by Fulfilment	3	None	10	240	Training modified with hands-on test examples and review of actions by sampling	VP Sales	Completed	8	1	2	16
4,5, 6, and 7	Consolidation of packaging and shipping departments	Team dynamics: Individuals not embracing the change	Poor performance: Shipping delays and other defects	10	Ineffective communication of reasons for department consolidation and employee training	4	None	10	400	Mangement communicating the value of the change and what are the benefits for the team, HR monitoring by getting team's feedback	CEO	Completed	10	1	2	20

Notes about FMEA:
- **SEV- Severity rating (1-10). Higher the severity, the rating is higher.**
- **OCC- Occurrence rating (1-10). Higher the occurrence, the rating is higher.**
- **DET- Detection capability (1-10). Higher the detection capability, the rating is <u>lower</u>.**
- **RPN- Risk Priority Number = SEVxOCCxDET = a range of 1-1000. Higher the number, this cause of failure needs to be addressed.**
- **To be effective and consistent, organizations need to set rating criteria for SEV, OCC, and DET.**
- **The team may be encouraged to think rating in terms of High (8-10), Medium (4-7), Low (1-3) to avoid difficulty in selecting a rating.**

I

Develop Control Plan

#	Metric	In process or outcome metric?	Specification	Frequency	Responsibility	Action
1	Defect data	Outcome	<5%	Review defect data: • Every day in the first week of implementation • Every Monday during the next 4 weeks • Once a month after 4 weeks	Fulfilment	Ensure training and compliance. Take corrective action if non-compliance is identified
2	Track Training: Ensure all current and future employees are trained	In process	100%	Monthly	Fulfilment	Review and take corrective action
3	Customer survey	Outcome	>95% satisfaction	With every order	Fulfilment	Review and take corrective action

Project Complete: Handed back to Process Owner

Process Management- LSS Team Interface

Process Owner Role: Process Management

Project Team Role: DMAIC

Define

Measure

Analyze

Improve

Control

Bad

Savings $ 3.6 Million