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WEBINAR VI

July 2022

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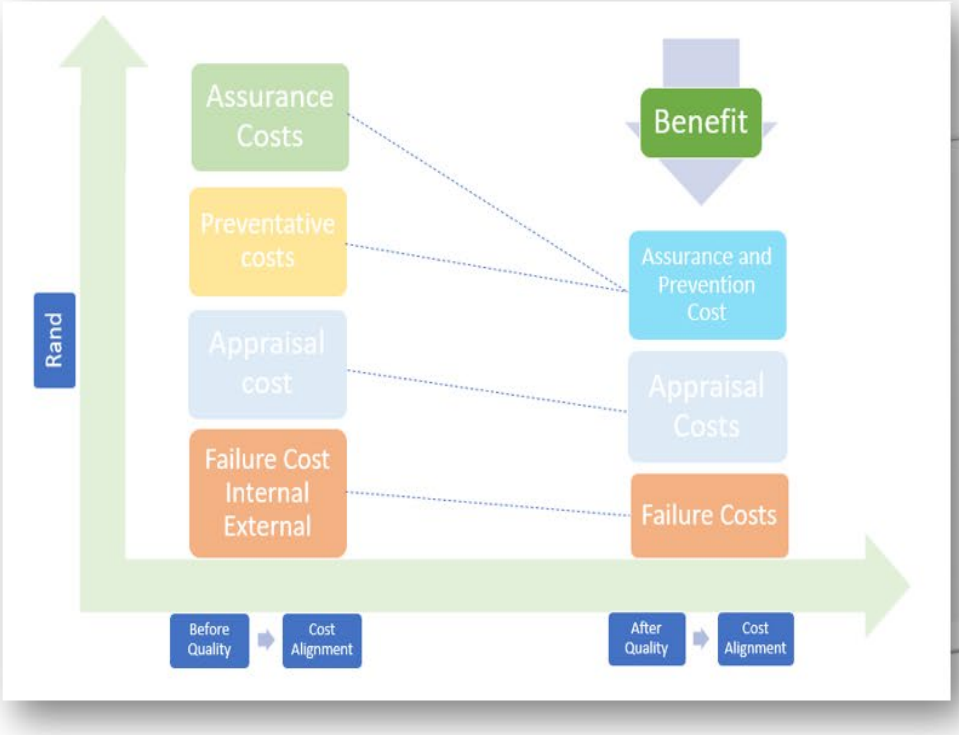
Benefit of preventing Poor Quality in each stage



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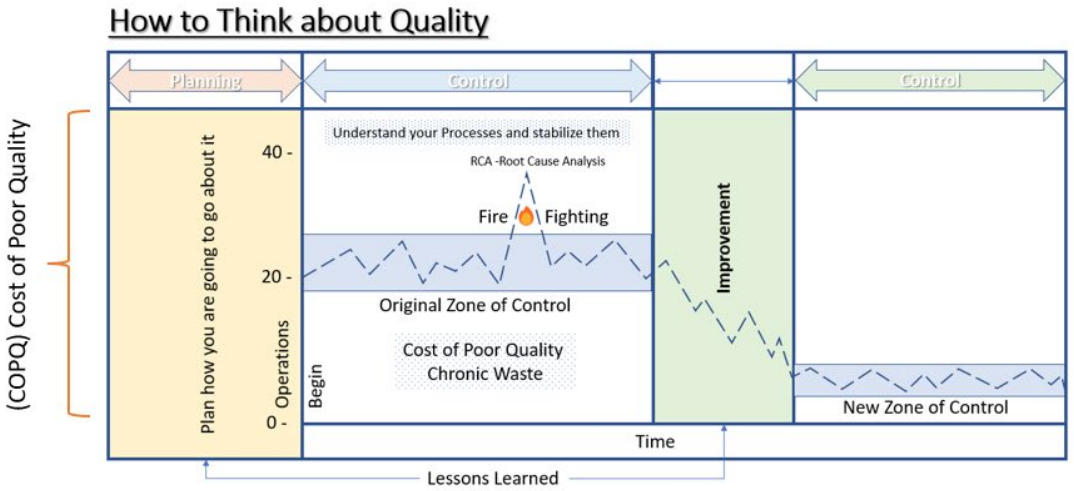
Who are you now? What can you become?



- Planning
- Controlling and Stabilizing
- Improving

Presenter

SAPPMA Webinar VI 2022

21 July 2022

Saravanan Babu TR
Plastics Pipe Testing and QMS Specialist

Quality Excellence – What is it?

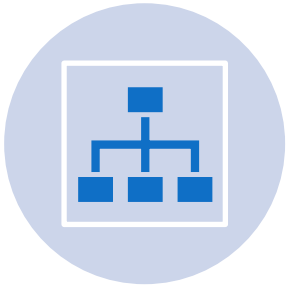
Quality implies a certain level of success in meeting customer needs, providing products and services that meet specifications and expectations, and comply with applicable standards.

Excellence refers to an internal drive to become the best.

Quality Excellence (QE) therefore, is the drive to become a leader in quality.

Benefits of Quality Excellence

helps to reduce variability in products and processes to meet customer needs, turning defects into profits



helps business leaders, quality managers, and functional specialists to systematically improve process capability and consistently meet customer requirements at lowest non-performance cost

It establishes the critical-to-quality (CTQ) parameters that must be controlled to ensure consistent outcomes within specified tolerances, while reducing the cost of poor quality (COPQ) that elevates the bottom line.

4 Strategies to Achieve Zero Defects

- Process Simplification:
  - Defects increase with the difficulty and duration of a task. Process complexity is therefore a cause of both, variability and mistakes, that result in defects
  - By changing the process so that fewer or simpler steps are needed, we reduce the probability of omitting a critical step or uncontrolled variation in a procedure
  - Simplification reduces defects at their source. It must occur first because it is extremely difficult to change a process after it has been institutionalized. It is the main reason why simplification is addressed ahead of variability, speed, and mistakes to bring defect rate to 10% or less

4 Strategies to Achieve Zero Defects

- Process Capability Studies:
  - Defects increase with variability from instable processes and uncontrolled interactions with the operating environment, such as the inability to hold tolerances.
  - Variability is addressed using statistical methods (SQC, SPC) to make processes more stable. It requires an understanding of the science behind processes and also the analysis of variance.
  - Establishing process capability by controlling the characteristics of the product or service, while eliminating the causes of excessive variations brings defect rate down from 10% to 1%.

4 Strategies to Achieve Zero Defects

- Quick Detection Mechanisms:
  - Defects increase with batch size and problem-detection time. The longer it takes to catch a problem, the more often a defect can be reproduced.
  - Problem detection time is minimal when moving from batches to sequential processing (FIFO) using cells and flow lines. It provides instant feedback on infrequently occurring discrete events like tool breakage or mislabeled parts.
  - Separating unprocessed from completed work prevents reproducing defects, while rapid detection brings defect rate down from 1% to 0.1%.

4 Strategies to Achieve Zero Defects

- Error Proofing Mechanisms:
  - Defects are also caused by human mistakes and errors, such as omitting steps, doing them incorrectly, or processing them in the wrong order.
  - Mistakes cannot be controlled by statistical methods that focus on variability. We therefore need to implement error-traps, go/no-go fixtures, and inline validation checks.
  - Because mistakes are inevitable and their consequences are often severe, they must be prevented. Protecting the process from human mistakes, using error-traps and validation checks brings defect rate further down from 0.1% to 0.01%.

Total Quality Management Principles

Methodologies to Achieve QEx

Lean Manufacturing:

The core focus of lean manufacturing is eliminating waste in a production system, thereby reducing costs. Inspired by the Toyota Production System (TPS), lean manufacturing identifies eight types of waste – or non value-added activities – that must be eliminated if an organization wishes to achieve operational excellence:

Overproduction	Variable processing methods
Excess inventory	Too much motion
Too many defects	Unused human creativity
Long wait times	Excess transportation

Methodologies to Achieve QEx

Six Sigma:

- A comprehensive and flexible system for achieving, sustaining and maximizing business success.
- Six Sigma is uniquely driven by close understanding of customer needs, disciplined use of facts, data, and statistical analysis, and diligent attention to managing, improving, and reinventing business processes.

Six Sigma Tools and Techniques

- DMAIC & DMADV
- Project Charters
- Project Deliverables
- Process Maps
- SIPOC
- Process Capability Indices
- Repeatability, reproducibility, stability
- Value stream mapping
- Cause and Effect diagrams

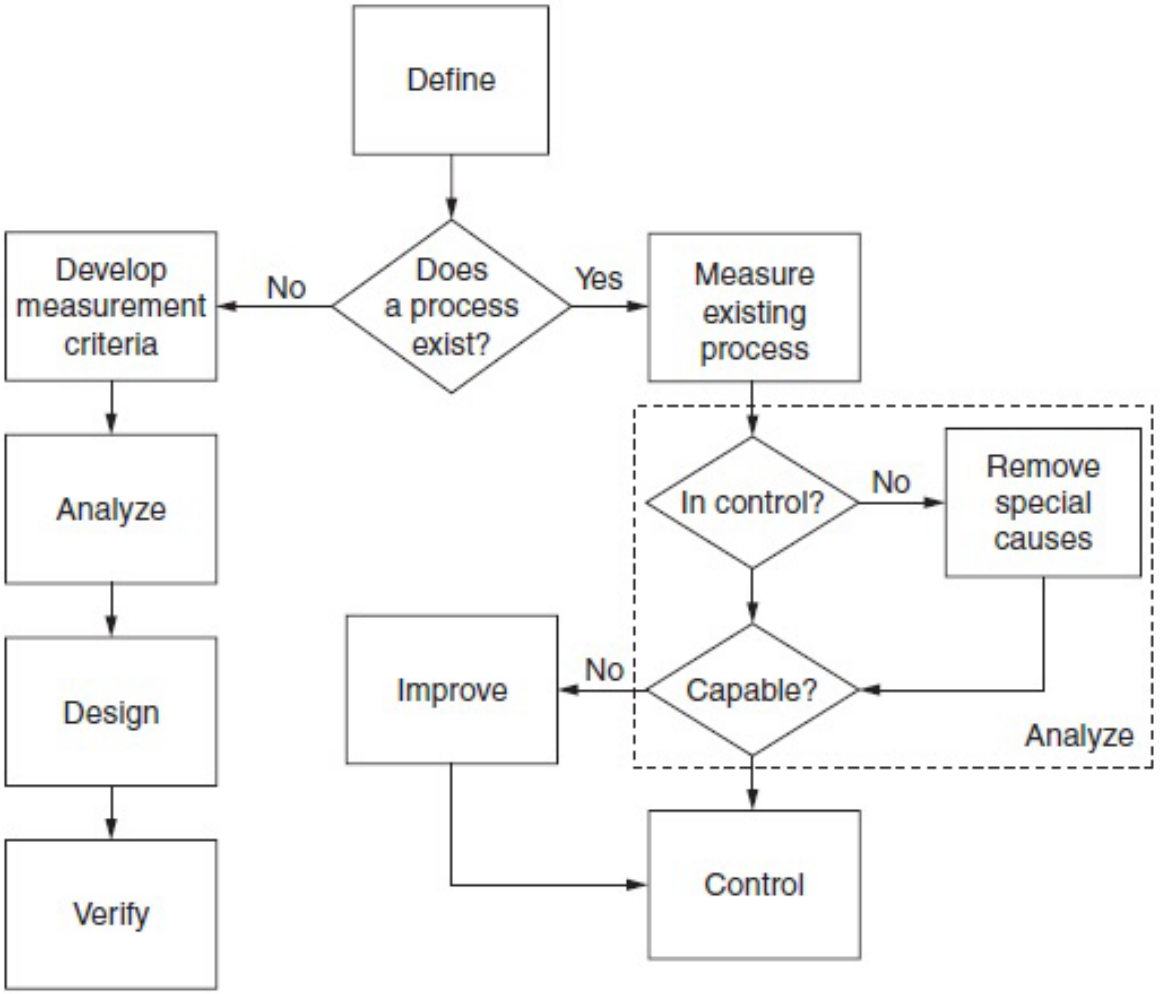
DMAIC

D	Define the goals of the improvement activity, and incorporate into a Project Charter. Obtain sponsorship and assemble team.
M	Measure the existing system. Establish valid and reliable metrics to help monitor progress toward the goal(s) defined at the previous step. Establish current process baseline performance using metric.
A	Analyze the system to identify ways to eliminate the gap between the current performance of the system or process and the desired goal. Use exploratory and descriptive data analysis to help you understand the data. Use statistical tools to guide the analysis.
I	Improve the system. Be creative in finding new ways to do things better, cheaper, or faster. Use project management and other planning and management tools to implement the new approach. Use statistical methods to validate the improvement.
C	Control the new system. Institutionalize the improved system by modifying compensation and incentive systems, policies, procedures, MRP, budgets, operating instructions and other management systems. You may wish to utilize standardization such as ISO 9000 to ensure that documentation is correct. Use statistical tools to monitor stability of the new systems.

DMADV

Define	**Define** the goals of the design activity.
Measure	**Measure** customer input to determine what is critical to quality from the customers' perspective. Use special methods when a completely new product or service is being designed (see the Kano Model discussions in Chap. 2). Translate customer requirements into project goals.
Analyze	**Analyze** innovative concepts for products and services to create value for the customer. Determine performance of similar best-in-class designs.
Design	**Design** new processes, products and services to deliver customer value. Use predictive models, simulation, prototypes, pilot runs, etc. to validate the design concept's effectiveness in meeting goals.
Verify	**Verify** that new systems perform as expected. Create mechanisms to ensure continued optimal performance.

DMAIC vs DMADV

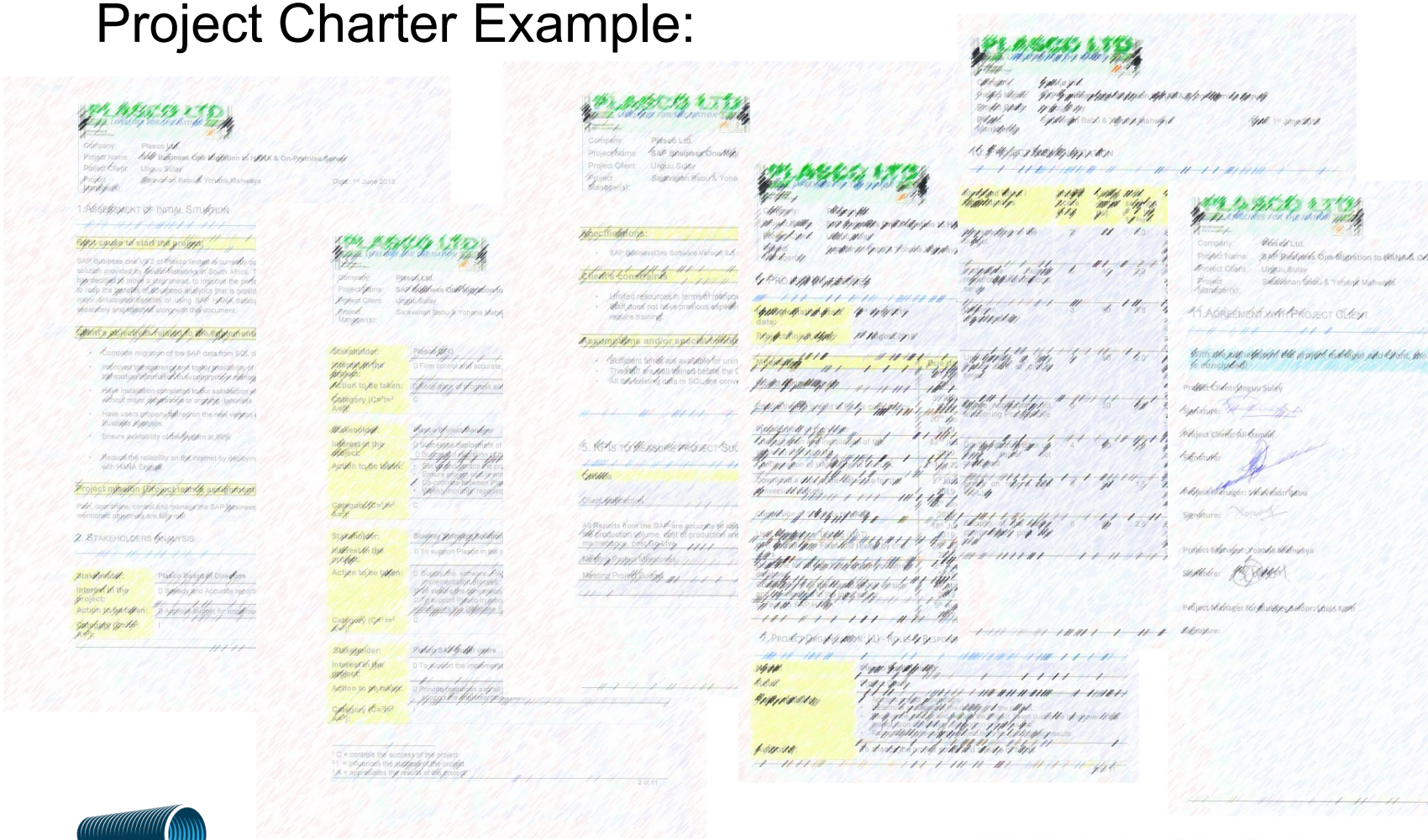


Project Charters

- documents the why, how, who, and when of a project, include the following elements:
  - Problem statement
  - Project objective or purpose, including the business need addressed
  - Scope
  - Deliverables (i.e., objective measures of success that will be used to evaluate the effectiveness of the proposed changes)
  - Sponsor and stakeholder groups
  - Team members
  - Project schedule
  - Other resources required

Project Charters

Project Charter Example:



Deliverables

The 3 Major Project Deliverables – Cost, Quality and Schedule.

1. Critical to Cost (CTC), include parameters that impact work in progress, finished goods inventory, overhead, delivery, material and labor, even when the costs can be passed on to the customer.
2. Critical to Quality (CTQ), include factors which are functional requirements specified by the internal and external customers.
3. Critical to Schedule (CTS), include factors that impact the delivery time of the product or service.

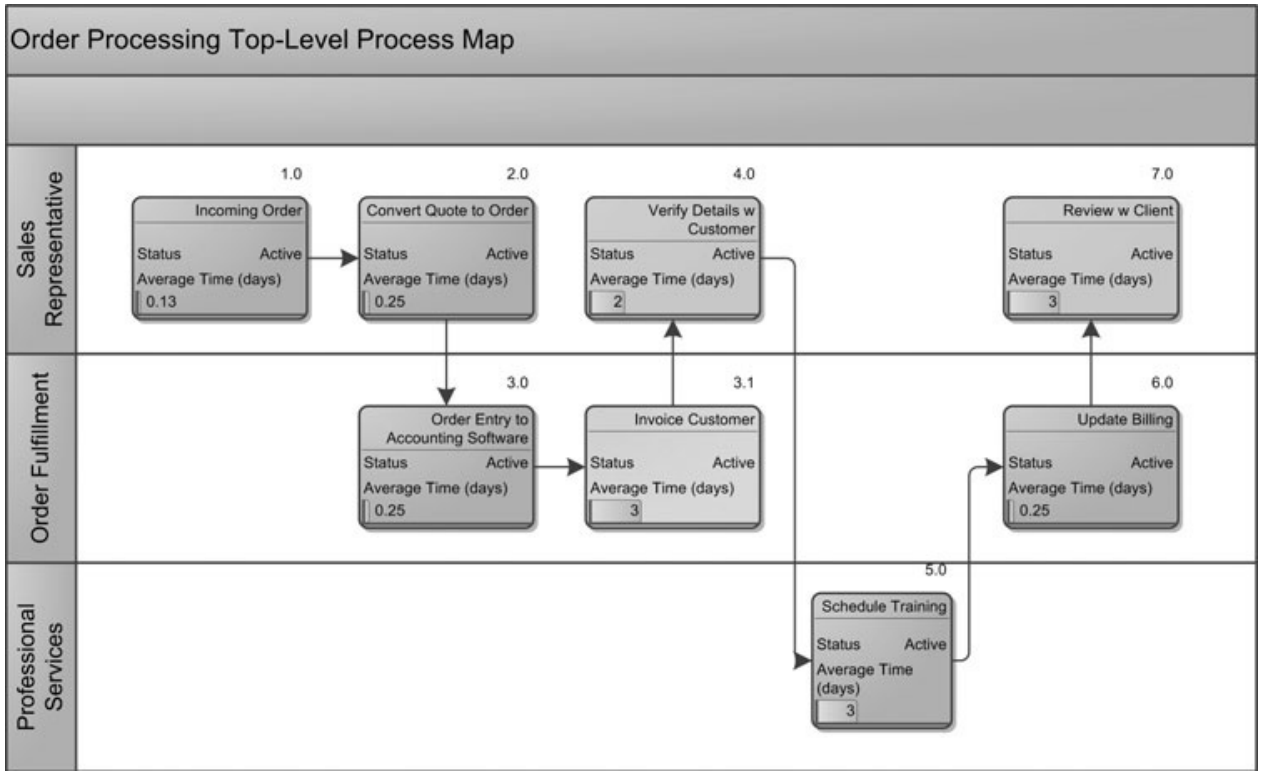
CTQ Table

CTQ Operation 30	Defect defination	Measure	Kano Status
Bore **12.2+0.2** o/s & u/s	Bore more than 12.4 Bore less than 12.2	No.of defects / Total produced	Lower the better
Bore length **23.15 -0.15** variation	Bore length more than 23.15 Bore length less than 23.00	No.of defects / Total produced	Lower the better
OD **28.7 -0.05/-0.1**	OD less than 28.6 OD more than 28.65	No.of defects / Total produced	Lower the better

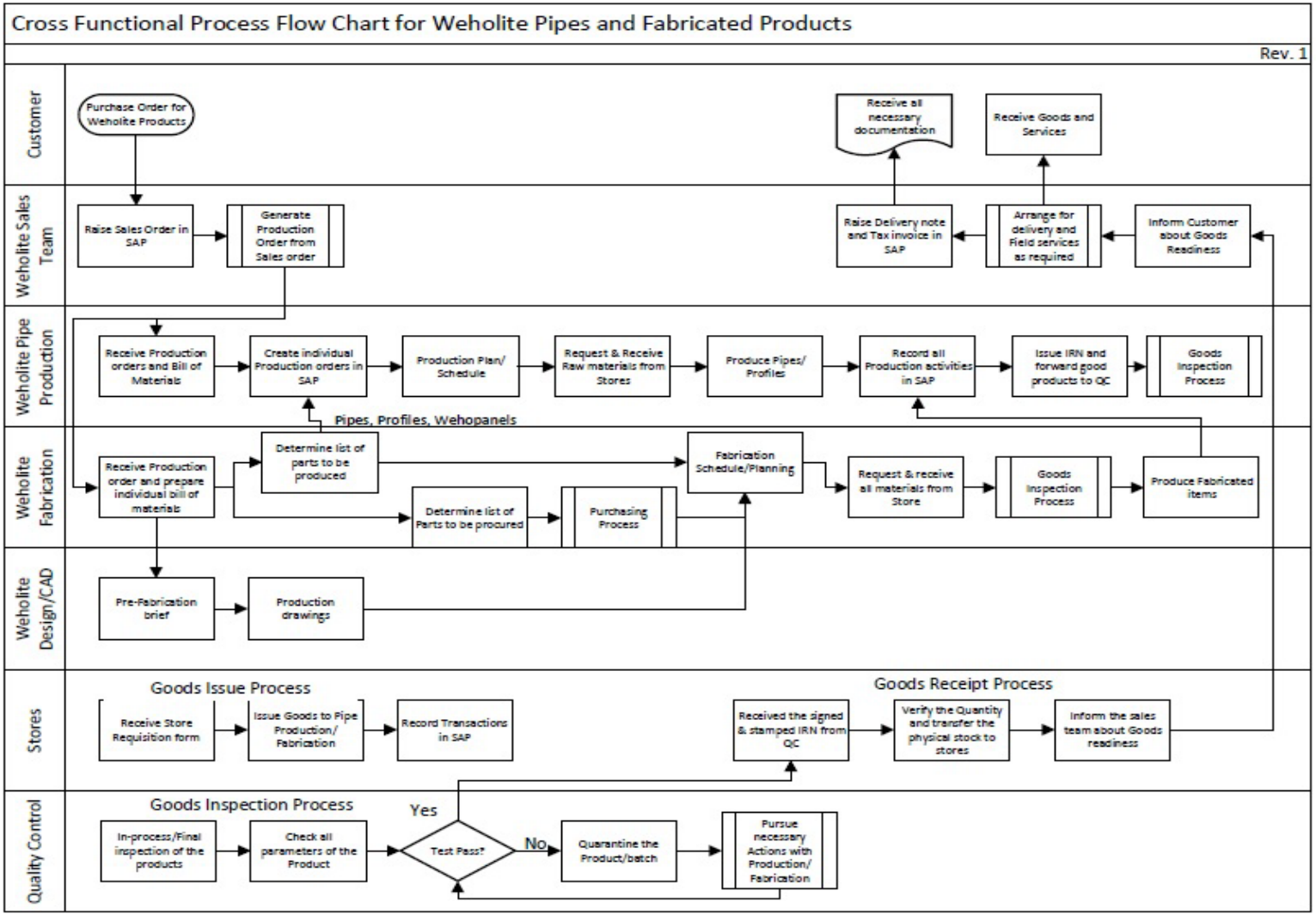
CTQ Operation 40	Defect defination	Measure	Kano Status
Distance **18.95 -0.15** oversize	Measures more than 18.95 Measures less than 18.80	No.of defects / Total produced	Must be

Process Maps

- documents the top-level process activities and their stakeholders



Flowcharts

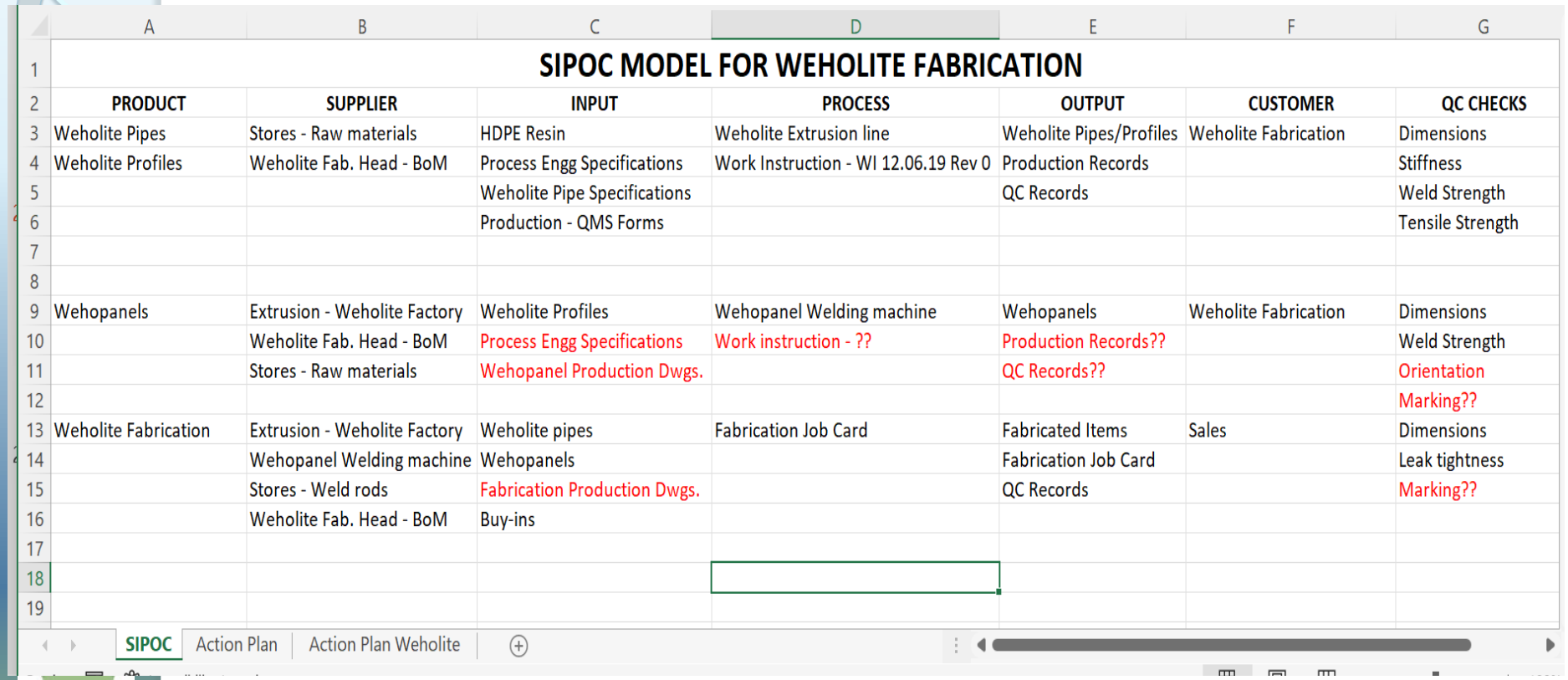

Cross Functional Process Flow Chart for Weholite Pipes and Fabricated Products
Rev. 1
Customer
Purchase Order for Weholite Products
Receive all necessary documentation
Receive Goods and Services
Weholite Sales Team
Raise Sales Order in SAP
Generate Production Order from Sales order
Raise Delivery note and Tax invoice in SAP
Arrange for delivery and Field services as required
Inform Customer about Goods Readiness
Weholite Pipe Production
Receive Production orders and Bill of Materials
Create individual Production orders in SAP
Production Plan/ Schedule
Request & Receive Raw materials from Stores
Produce Pipes/ Profiles
Record all Production activities in SAP
Issue IRN and forward good products to QC
Goods Inspection Process
Pipes, Profiles, Wehopanels
Weholite Fabrication
Receive Production order and prepare individual bill of materials
Determine list of parts to be produced
Determine list of Parts to be procured
Purchasing Process
Fabrication Schedule/Planning
Request & receive all materials from Store
Goods Inspection Process
Produce Fabricated items
Weholite Design/CAD
Pre-Fabrication brief
Production drawings
Stores
Goods Issue Process
Receive Store Requisition form
Issue Goods to Pipe Production/ Fabrication
Record Transactions in SAP
Goods Receipt Process
Received the signed & stamped IRN from QC
Verify the Quantity and transfer the physical stock to stores
Inform the sales team about Goods readiness
Quality Control
Goods Inspection Process
In-process/Final inspection of the products
Check all parameters of the Product
Test Pass?
Yes
No
Quarantine the Product/batch
Pursue necessary Actions with Production/ Fabrication

SIPOC

SIPOC Mapping:

- SIPOC stands for Suppliers-Inputs-Process-Outputs-Customers.
- Steps for SIPOC Mapping:
  - Name the process
  - Identify the outputs, customers, suppliers & inputs
  - Identify customer requirements for primary outputs
  - Identify process steps

Example of SIPOC Mapping



	A	B	C	D	E	F	G
1	SIPOC MODEL FOR WEHOLITE FABRICATION						
2	PRODUCT	SUPPLIER	INPUT	PROCESS	OUTPUT	CUSTOMER	QC CHECKS
3	Weholite Pipes	Stores - Raw materials	HDPE Resin	Weholite Extrusion line	Weholite Pipes/Profiles	Weholite Fabrication	Dimensions
4	Weholite Profiles	Weholite Fab. Head - BoM	Process Engg Specifications	Work Instruction - WI 12.06.19 Rev 0	Production Records		Stiffness
5			Weholite Pipe Specifications		QC Records		Weld Strength
6			Production - QMS Forms				Tensile Strength
7							
8							
9	Wehopanels	Extrusion - Weholite Factory	Weholite Profiles	Wehopanel Welding machine	Wehopanels	Weholite Fabrication	Dimensions
10		Weholite Fab. Head - BoM	Process Engg Specifications	Work instruction - ??	Production Records??		Weld Strength
11		Stores - Raw materials	Wehopanel Production Dwgs.		QC Records??		Orientation
12							Marking??
13	Weholite Fabrication	Extrusion - Weholite Factory	Weholite pipes	Fabrication Job Card	Fabricated Items	Sales	Dimensions
14		Wehopanel Welding machine	Wehopanels		Fabrication Job Card		Leak tightness
15		Stores - Weld rods	Fabrication Production Dwgs.		QC Records		Marking??
16		Weholite Fab. Head - BoM	Buy-ins				
17							
18							
19							

SIPOC | Action Plan | Action Plan Weholite

Process Capability Indices

A major reason for quantifying process capability is to compute the ability of a process to hold product tolerances. A measure of this relationship is process capability ratio or Cp. Process capability is also known as potential capability.

The Cp index is given by:-

$$Cp = \frac{\text{Tolerance}}{6\ SD}$$

Where Tolerance = USL - LSL

SD = Standard Deviation

Process Capability Indices

Interpretations of Cp:

- Cp > 1 The process is quite capable
- Cp = 1 The process is just capable
- Cp < 1 The process is incapable
- The recommended value of Cp is 1.33 minimum)
- In order to achieve Six Sigma quality in the organization, we must reduce the variation in the process so as to achieve the value of Cp= 2

Process Capability Indices

Calculating Defective PPM at various levels of Sigma

Quality level	Cp	z	Defective PPM
2 Sigma	0.67	2	22750
3 Sigma	1.00	3	1350
4 Sigma	1.33	4	32
5 Sigma	1.67	5	0.3
6 Sigma	2.00	6	0.001

Refer normal distribution table for finding defective parts per million (PPM) for corresponding z values.

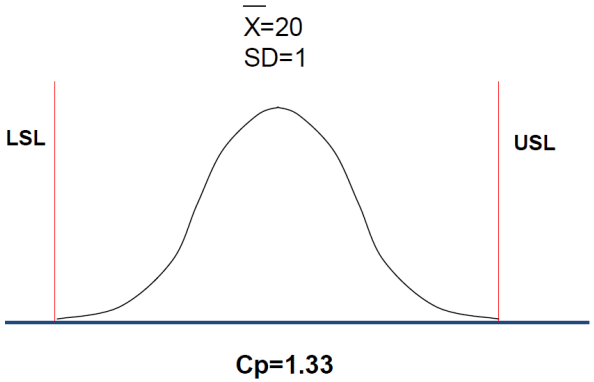
Process Capability Indices

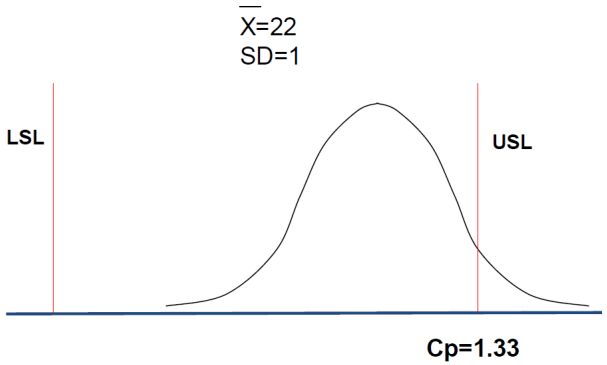
Calculating Defective PPM at various levels of Sigma (Practical Situation)

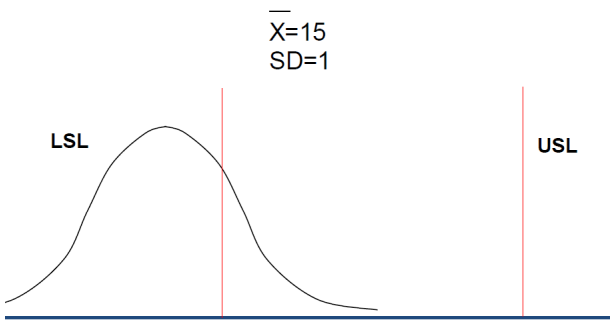
Quality level	Cp	z	Defective PPM
2 Sigma	0.17	0.5	308538
3 Sigma	0.50	1.5	66807
4 Sigma	0.83	2.5	6210
5 Sigma	1.17	3.5	233
6 Sigma	1.50	4.5	3.4

Process Capability Indices

Drawbacks of looking at Cp alone – does not predict the process shift.







Process Capability Indices

The process performance index Cpk is given by:-

$$Cpk = \text{Min}\left[\frac{USL - \bar{x}}{3SD}, \frac{\bar{x} - LSL}{3SD}\right]$$

Example :
Specification : 20 +/- 4, SD = 1
Cp = Tol/6 SD = 8/6 = 1.33

$\bar{x}$ = 20, Cpk = Cp = 1.33

$\bar{x}$ = 22, Cpk = 0.67

$\bar{x}$ = 15, Cpk = -0.33

Process Capability Indices

Process Performance Capability Index (CpK)

Thus Cpk = Cp means the process is centered

Cpk < 1 means non conformances are being produced

Cpk < 0 indicates that the process has been set beyond either of the two specification limits

Note:

Cpk is always less than or equal to Cp

Repeatability, Reproducibility, Stability

Repeatability - variation in measurements obtained with one measurement instrument when used several times by one appraiser, while measuring the identical characteristic on the same part.

Reproducibility: Reproducibility is the variation in the average of the measurements made by different appraisers using the same measuring instrument when measuring the identical characteristic on the same part.

Stability: Stability is the total variation in the measurements obtained with a measurement system on the same master or parts when measuring a single characteristic over an extended time period.

Repeatability, Reproducibility, Stability

Part	Reading 1	Reading 2	Average	Range
Inspector 1				
1	111.9	112.3	112.10	0.4
2	108.1	108.1	108.10	0.0
3	124.9	124.6	124.75	0.3
4	118.6	118.7	118.65	0.1
5	130.0	130.7	130.35	0.7
Inspector 2				
1	111.4	112.9	112.15	1.5
2	107.7	108.4	108.05	0.7
3	124.6	124.2	124.40	0.4
4	120.0	119.3	119.65	0.7
5	130.4	130.1	130.25	0.3

Ranges chart

$$\overline{R} = 0.51$$

$$\text{UCL} = D_4\overline{R} = 3.267 \times 0.51 = 1.67$$

Averages chart

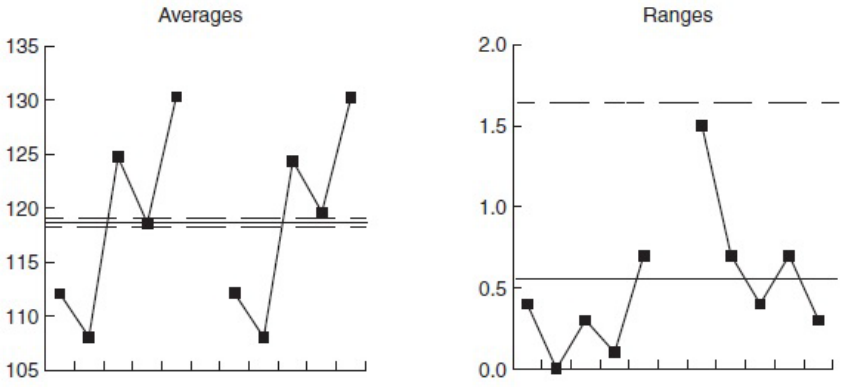
$$\overline{\overline{X}} = 118.85$$

$$\text{LCL} = \overline{\overline{X}} - A_2\overline{R} = 118.85 - 1.88 \times 0.51 = 118.65$$

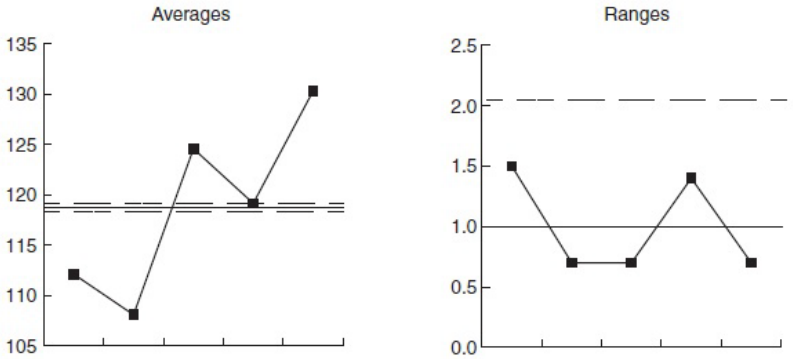
$$\text{UCL} = \overline{\overline{X}} + A_2\overline{R} = 118.85 + 1.88 \times 0.51 = 119.05$$

Repeatability, Reproducibility, Stability

Repeatability Control Charts



Reproducibility Control Charts



Value Stream Mapping

- Value is what customers want or need, and are willing and able to pay for. Waste is any activity that consumes resources but creates no value for the customer, thus waste activities are called “non-value added.”
- A value stream consists of all activities, both value added and non-value added, required to bring a product from raw material into the hands of the customer, a customer requirement from order to delivery, and a design from concept to launch.
- Value stream consists of product and service flows, as well as information flows.
- The Lean approach systematically minimizes waste—called *muda* —in the value stream. Muda includes all types of defective work, not just defective products. Wasted time, motion, and materials are all *muda*.

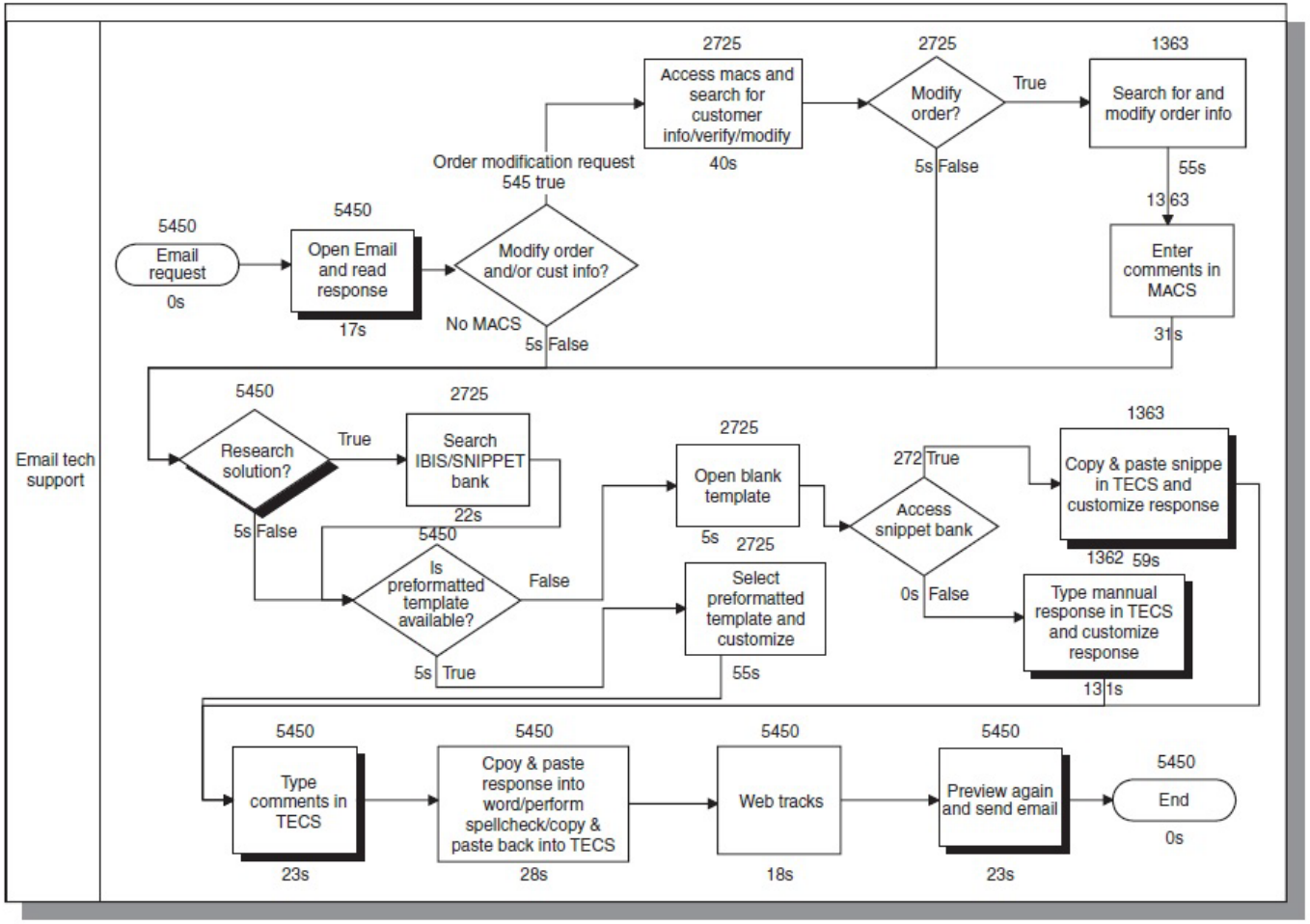
Value Stream Mapping

Value Stream Mapping

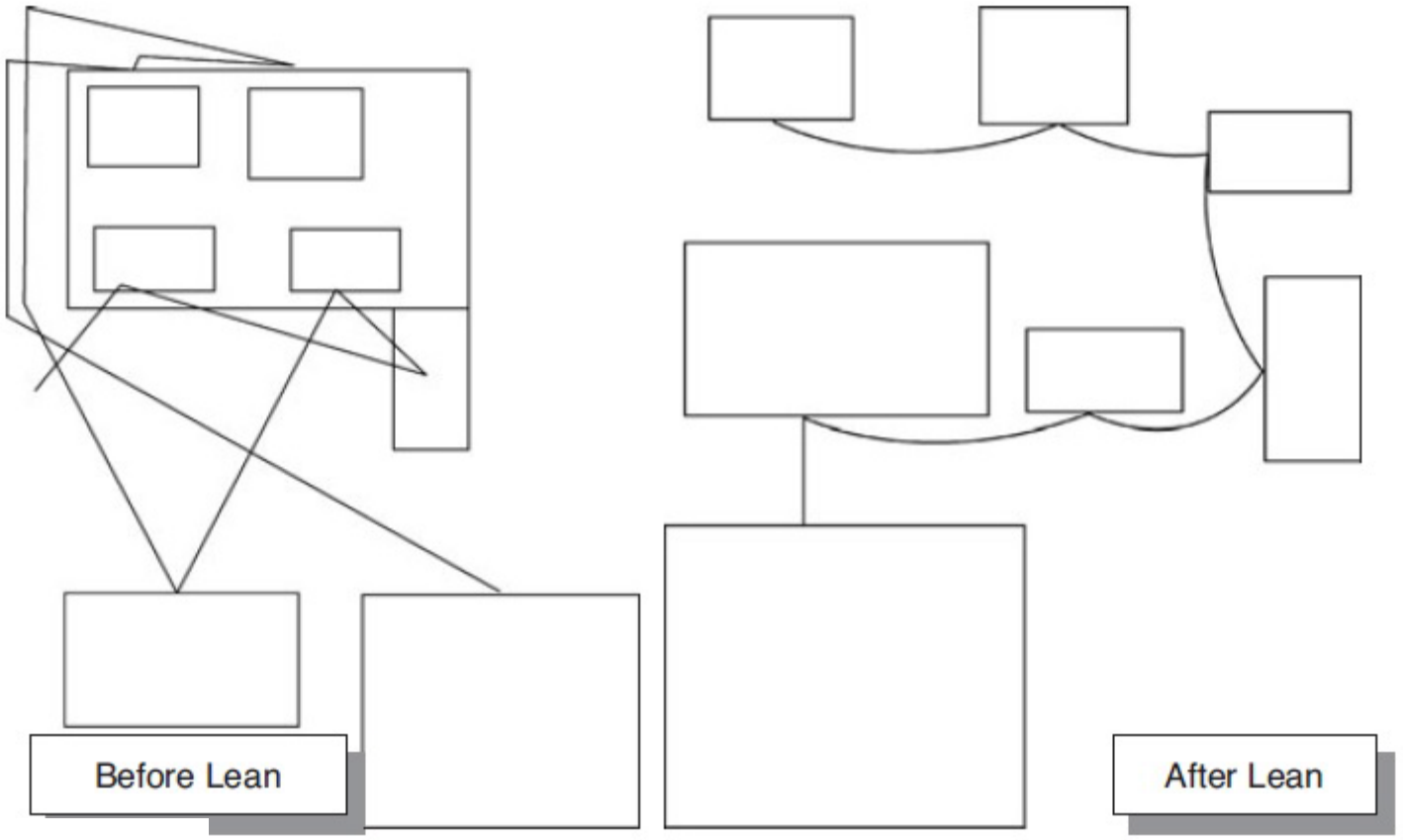
- Value stream mapping, also known as material and information flow mapping, is a variation of process mapping that looks at how value flows into and through a process and to the customer, and how information flow facilitates the workflow.
- Unfortunately, in many cases all of the non-value added steps cannot be immediately eliminated.
- The non-value added and unnecessary steps that can be eliminated without consequence to the business or the customer are sometimes referred to as Type II *muda*.

Value Stream Mapping

Value Stream Mapping Example



Spaghetti Charts

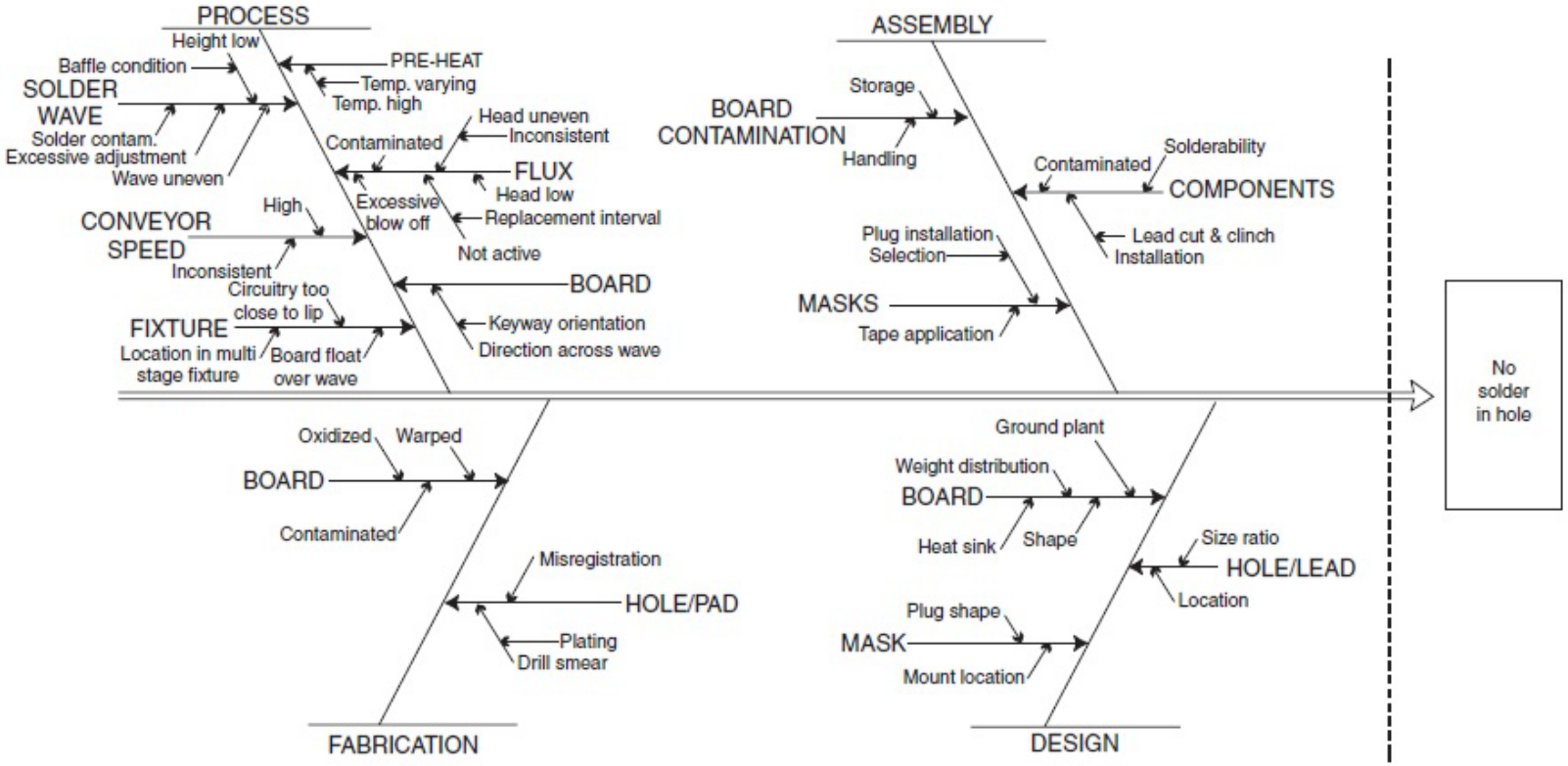


Cause and Effect Diagrams

- Dr. Kaoru Ishikawa developed a simple method of graphically displaying the causes of any given quality problem.
- His method is called by several names, the Ishikawa diagram, the fishbone diagram, and the cause and effect diagram.
- Draw a box on the far right-hand side of a large sheet of paper and draw a horizontal arrow that points to the box. Inside of the box, write the description of the problem to be solved.
- Write the names of the categories above and below the horizontal line. Think of these as branches from the main trunk of the tree.
- Draw in the detailed cause data for each category. Think of these as limbs and twigs on the branches.

Cause and Effect Diagrams

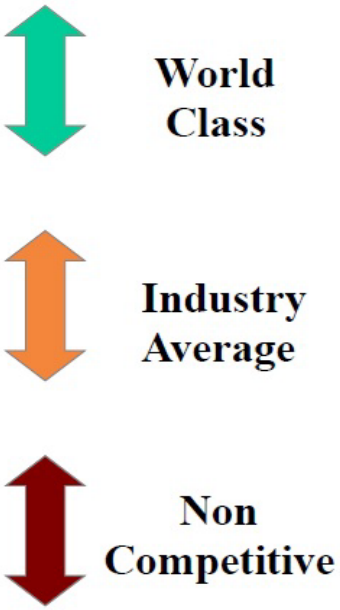
Cause and Effect Diagrams



Significance of Six Sigma

Sigma levels & Cost of quality

Sigma	Defect rate(PPM)	Cost of quality
6	3.4	<10%
5	233	10-15%
4	6210	15-20%
3	66807	20-30%
2	308537	30-40%
1	6,90000	>40%



Presenter

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Plastics Pipe Testing and QMS Specialist

PLASCO LIMITED

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No planning -no implementation-no control- no improvement

Quality Control

- Purpose of Control Processes
  - To maintain control of processes as a result of proper planning
  - To provide ongoing corrective action of any sporadic or extraordinary cause change in a performance matrix

"The bitterness of poor quality is remembered long after the sweetness of low price has faded from memory"
GUCCI

Questions and Answers

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