Certified Maintenance & Reliability Professional (CMRP) BOK Guidance Course – Pillar 2

Presented by

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Pillar 2 – Manufacturing Process Reliability

Concept & strategy

This subject area relates maintenance and reliability activities to the manufacturing process of the organization to ensure that maintenance and reliability activities improve the manufacturing process.

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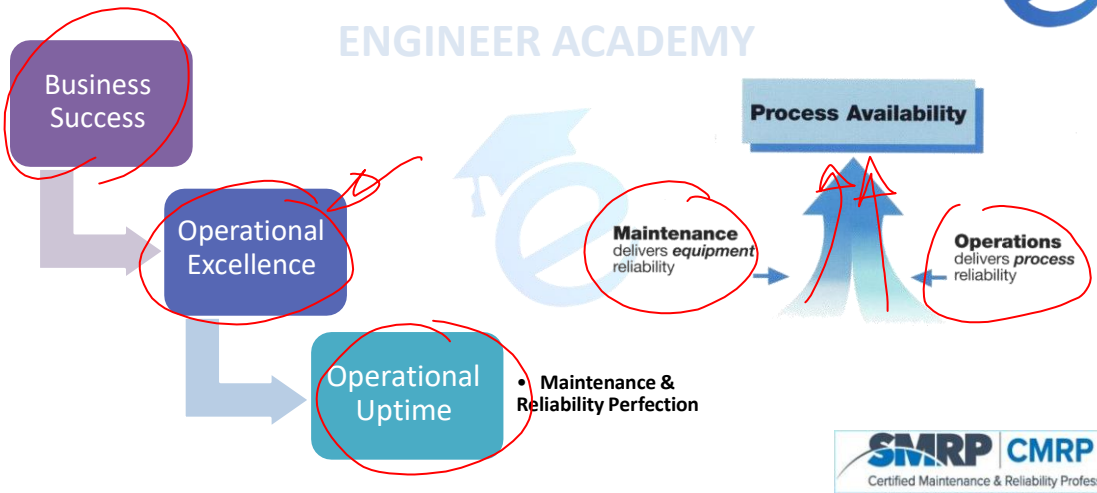
Concept & strategy



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Pillar 2 – Manufacturing Process Reliability

Concept & strategy

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- Understand the applicable processes
- Apply process improvement techniques
- Manage effects of change to processes and equipment
- Maintain processes in accordance with applicable standards and regulations

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2.1 Understand the applicable processes

Document process flow

Understand process parameters

Understand quality specifications

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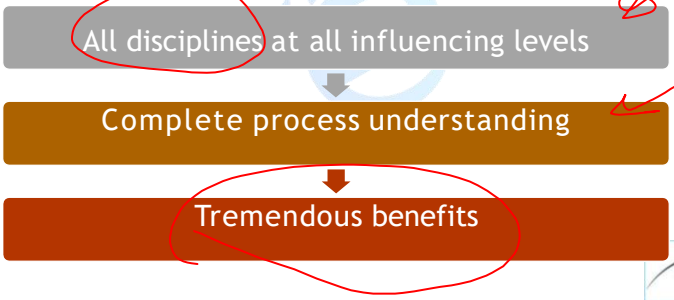
2.1 Understand the applicable processes

A complete process understanding across all disciplines and at all levels of the organization that influence the performance and safety can provide tremendous هائل benefit.



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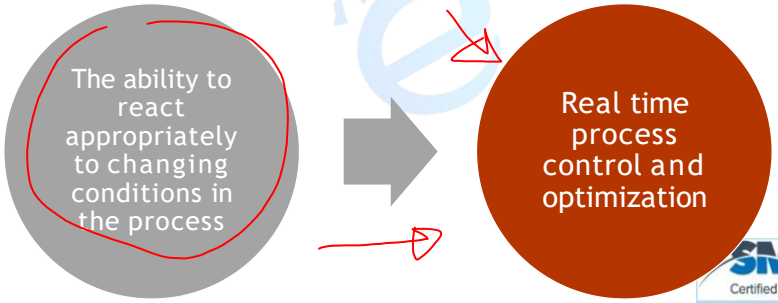
2.1 Understand the applicable processes

The ability to react appropriately to changing conditions in the process, not only related to ones direct function but the impact on the total process provides real time process control and optimization.



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2.1 Understand the applicable processes

Process understanding:

NOT ONLY HOW TO:

- Operate
- Shutdown
- Analyze
- Troubleshoot

But Also

Methods for communicating and documenting continuous improvement activities in:

- Operations
- Maintenance
- Quality
- Safety.

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2.1 Understand the applicable processes

Clearly defined :

- Process operating procedures
- Quality specifications
- Flow diagrams

Are helpful tools in communicating and documenting the desired process performance

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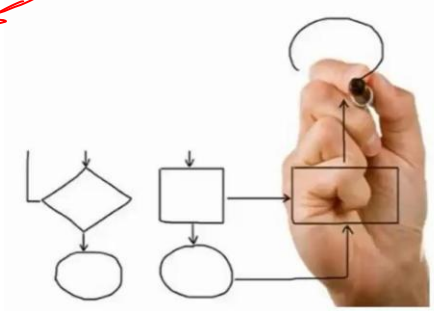
2.1 Understand the applicable processes

Process Mapping :



A Process Map is a graphical representation of the steps involved in a process or portion of a process

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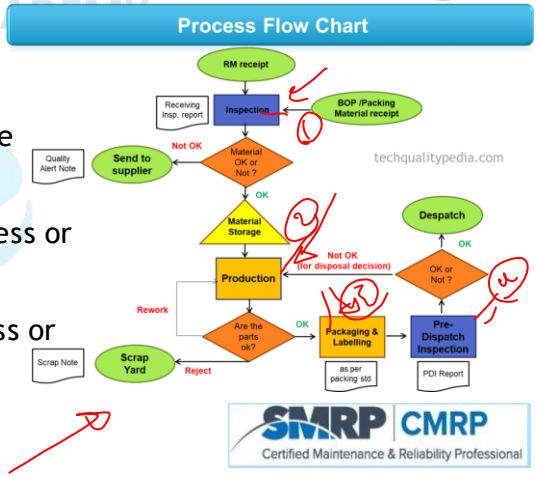
2.1 Understand the applicable processes

Process Flow Charts :

- Visually represents process or stages of project.
- Provide common reference point for those involved in project or procedure.
- Helpful point of reference to find errors in process or project.
- Used to facilitate agreement of steps of process or project
- Leads to better understanding of process.



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2.1 Understand the applicable processes

Statistical Process Control (SPC):

Every output measure has a target value and a level of "acceptable" variation (upper and lower tolerance limits)

SPC uses samples from output measures to estimate the mean and the variation (standard deviation)

EXAMPLE : Accepted clearance is 1 mm +- .05

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2.1 Understand the applicable processes

Average (Mean) :

$$\overline{X} = \frac{1}{N}\sum_{i=1}^{N} x_i$$

Standard Deviation :

$$\sigma = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \overline{X})^2}{N}}$$

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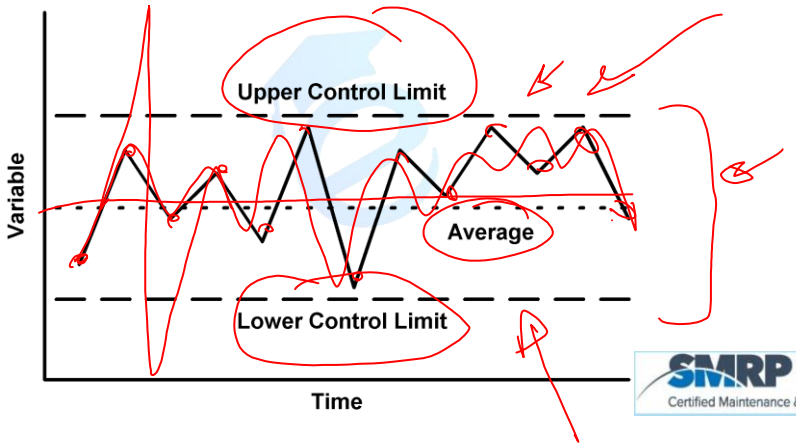
2.1 Understand the applicable processes

Control Charts:



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2.2 Apply process improvement techniques

Identify production losses

Establish continuous improvement process

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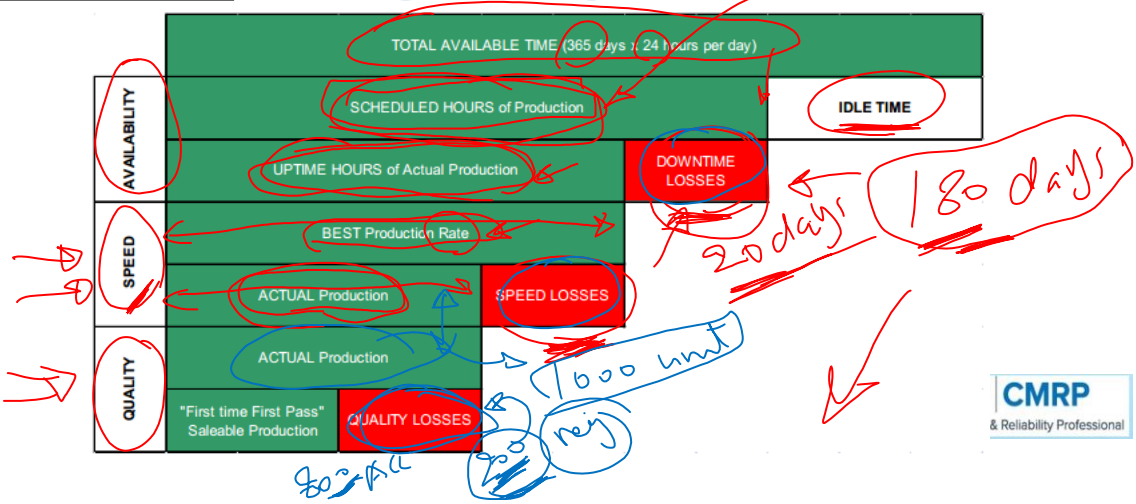
2.2 Apply process improvement techniques

Production losses



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2.2 Apply process improvement techniques

Production losses , Six Big Losses

Overall Equipment Effectiveness	Recommended Six Big Losses	Traditional Six Big Losses
Availability Loss	Unplanned Stops	Equipment Failure
	Planned Stops	Setup and Adjustments
Performance Loss	Small Stops	Idling and Minor Stops
	Slow Cycles	Reduced Speed
Quality Loss	Production Rejects	Process Defects
	Startup Rejects	Reduced Yield

The Six Big Losses are a very effective way to categorize equipment-based losses

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2.2 Apply process improvement techniques

Production losses example from production workshop

1. Breakdown
2. Set up & adjustment
3. Cutting blade replacement
4. Start up
5. Minor stoppage & idling
6. Speed reduction
7. Defect & rework
8. Shutdown

9. Management loss
10. Motion loss
11. Line organisation loss
12. Distribution loss
13. Measuring & adjustment loss

14. Yield loss
15. Energy loss
16. Die, jig & tool loss

reduction in expected quantity or quality of output compared to potential, caused by inefficiencies, defects, environmental stress, pests, or damage

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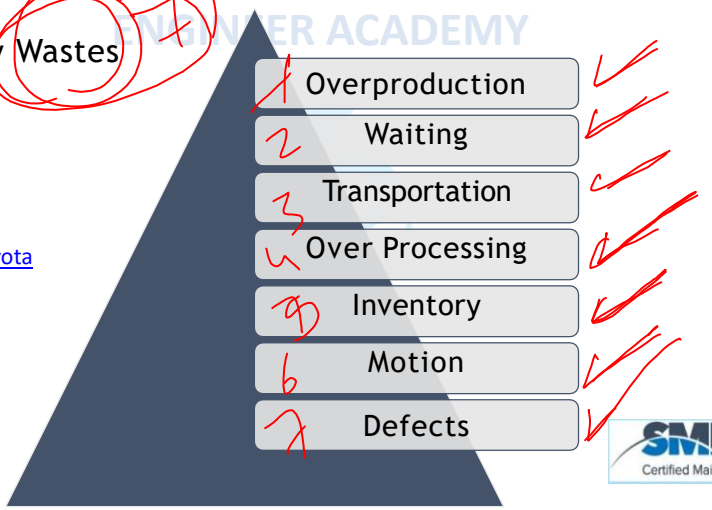
2.2 Apply process improvement techniques

Seven Deadly Wastes

eliminating these helps maximize value while minimizing resource loss.

Developed as part of the Toyota Production System (TPS) to identify non-value-adding activities



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2.2 Apply process improvement techniques

Steps to Manufacturing Excellence:

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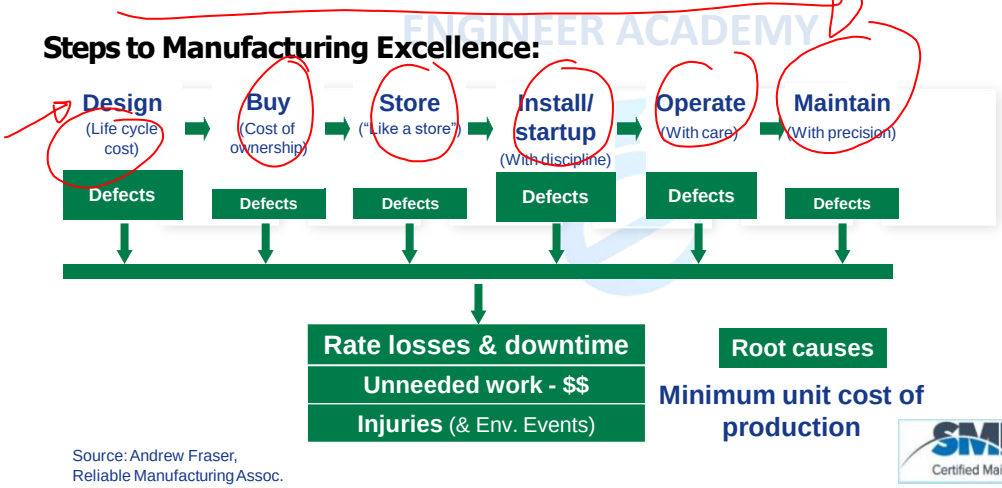
2.2 Apply process improvement techniques



Source: Andrew Fraser, Reliable Manufacturing Assoc.

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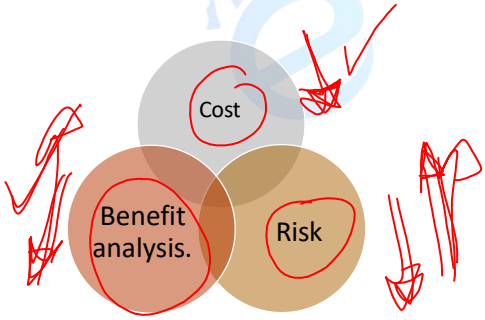
2.2 Apply process improvement techniques

The implementation of process improvement techniques is an important cornerstone for all reliability efforts.

They should incorporate best practices at all levels of business performance and include:



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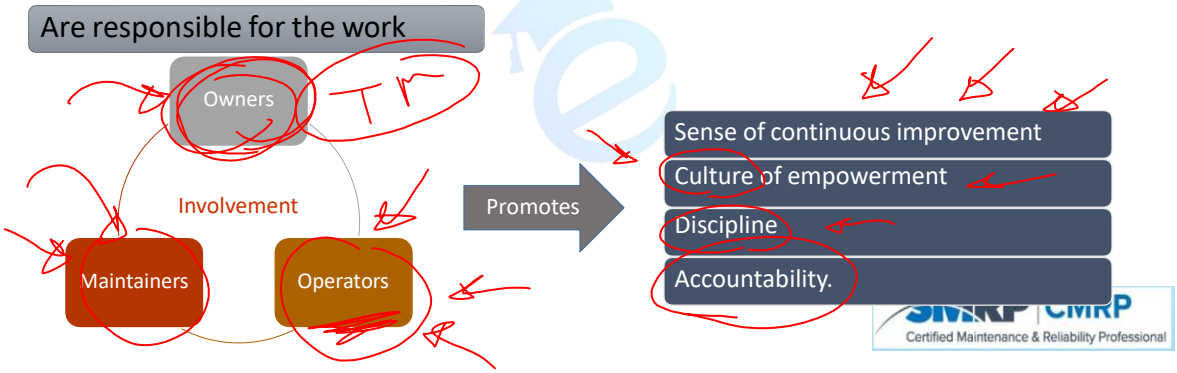
2.2 Apply process improvement techniques

The key to establishing and sustaining improvement techniques is to involve the people who :



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2.2 Apply process improvement techniques

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The establishment of these improvement techniques must be:

- Focused around the business plan and goals for the organization
- Include sustained workforce excellence
- Include quantitative organizational performance assessments
- Ultimate customer satisfaction.

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2.2 Apply process improvement techniques

Many organizations have adopted various tools from ISO (International Standards Organization) standards to a Total Productive Maintenance (TPM) operational approach in order to establish comprehensive process improvement techniques.

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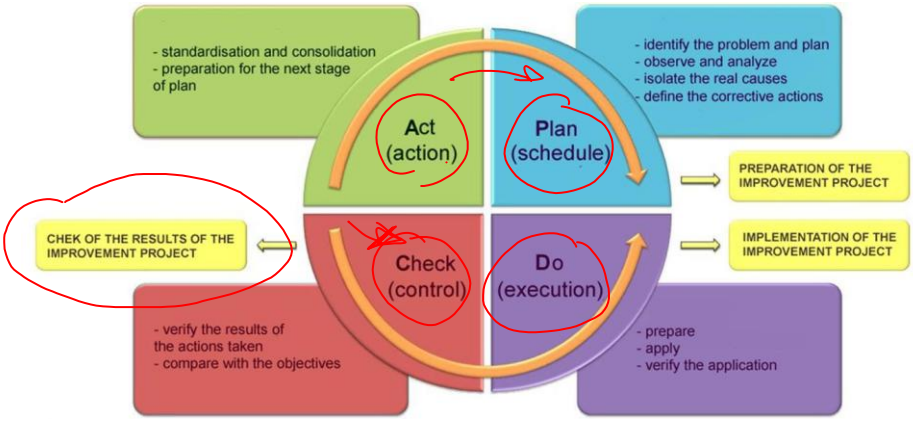
2.2 Apply process improvement techniques

PDCA Improvement Cycle :



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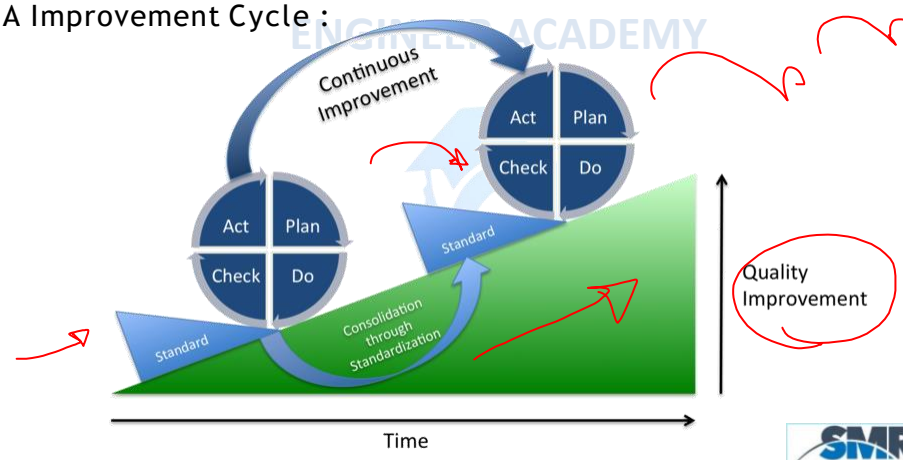
2.2 Apply process improvement techniques

PDCA Improvement Cycle :



Continuous quality improvement with PDCA

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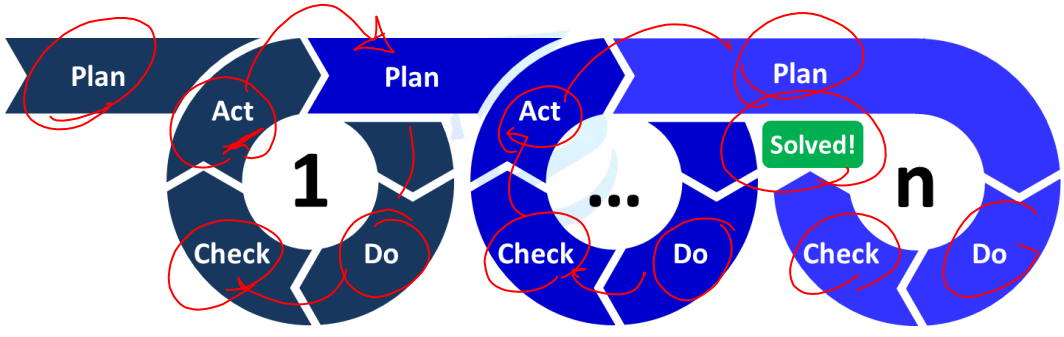
2.2 Apply process improvement techniques

PDCA Improvement Cycle :



Multiple iterations of the PDCA cycle are repeated until the problem is solved.

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2.2 Apply process improvement techniques

ISO 9001:2015 Quality Management System

ISO 9001 is a standard that sets out the requirements for a quality management system. It helps businesses and organizations to be more efficient and improve customer satisfaction.

Development of ISO 9001

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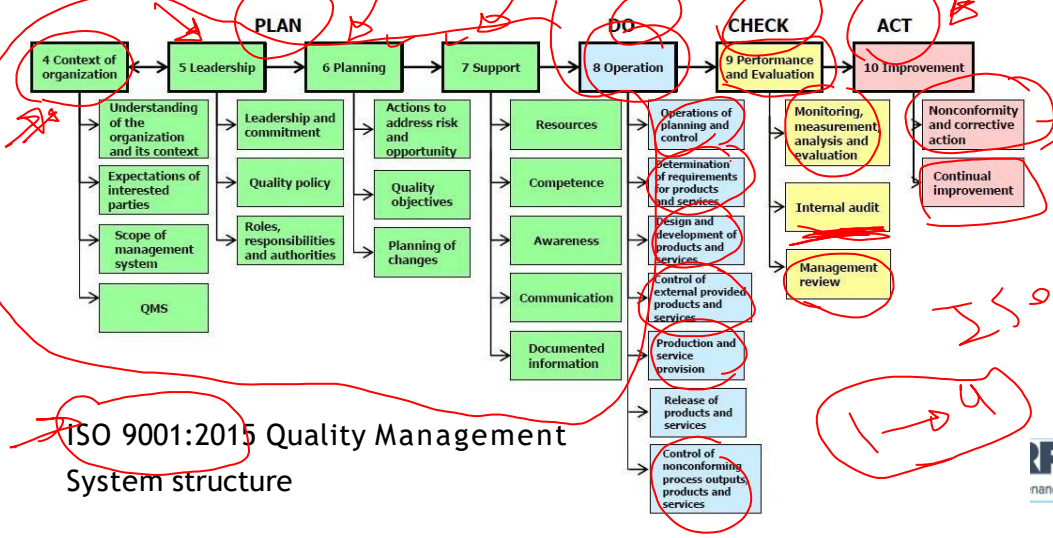
2.2 Apply process improvement techniques



ISO 9001:2015 Quality Management System structure

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2.2 Apply process improvement techniques

Total Productive Maintenance (TPM)

What is TPM ?

Total Productive Maintenance (TPM) is a holistic approach to maximize equipment effectiveness by engaging all employees. It emphasizes proactive and preventive practices, aiming for zero breakdowns, zero defects, and zero accidents.

What TPM Is Not

It is not just a program run by the maintenance department.
It is not a one-time workshop or event.
It is not about eliminating the need for skilled trades.
It is not about turning operators into maintenance technicians.

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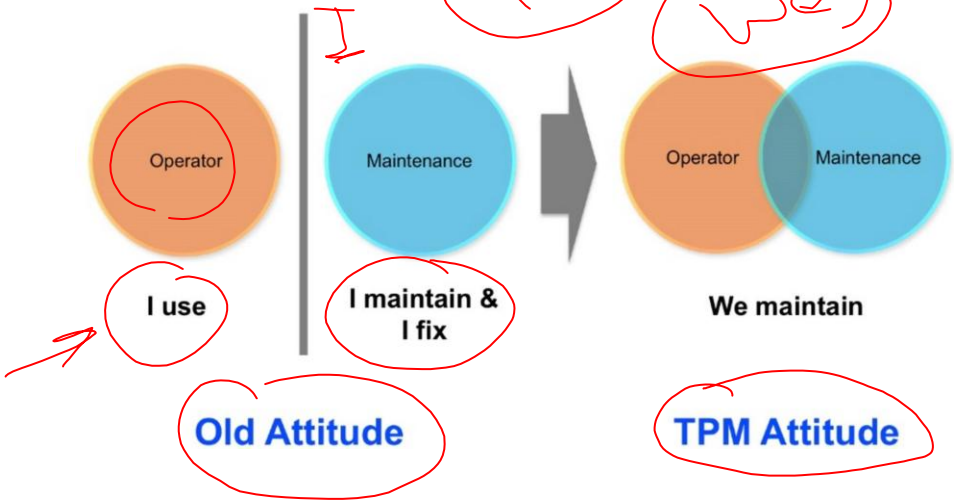
2.2 Apply process improvement techniques

Total Productive Maintenance (TPM)



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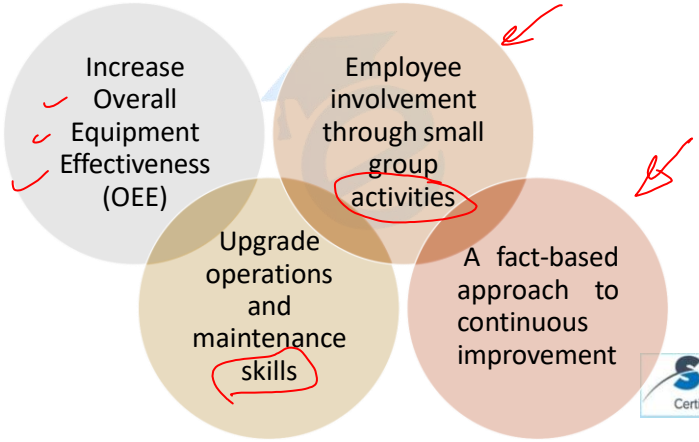
2.2 Apply process improvement techniques

Total Productive Maintenance (TPM)

TPM Principles:



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2.2 Apply process improvement techniques

Total Productive Maintenance (TPM)

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TPM Goals:

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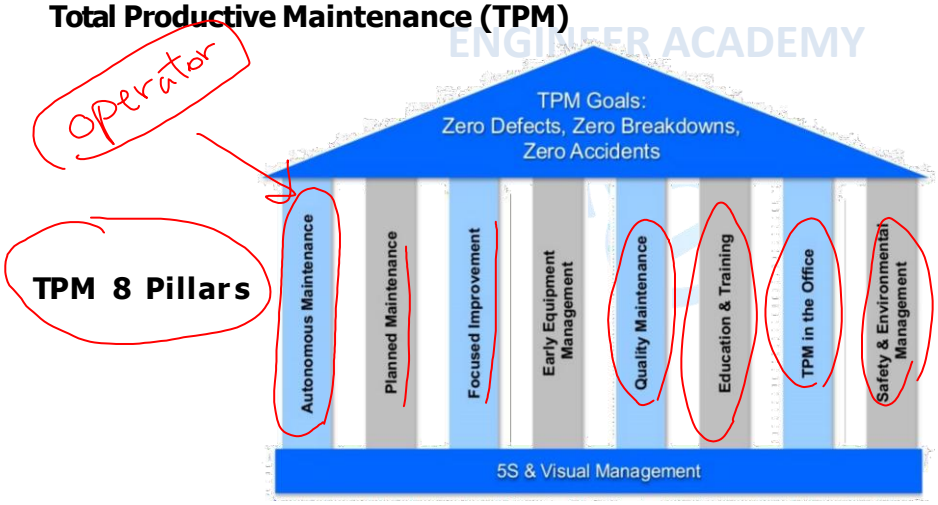
Total Productive Maintenance (TPM)



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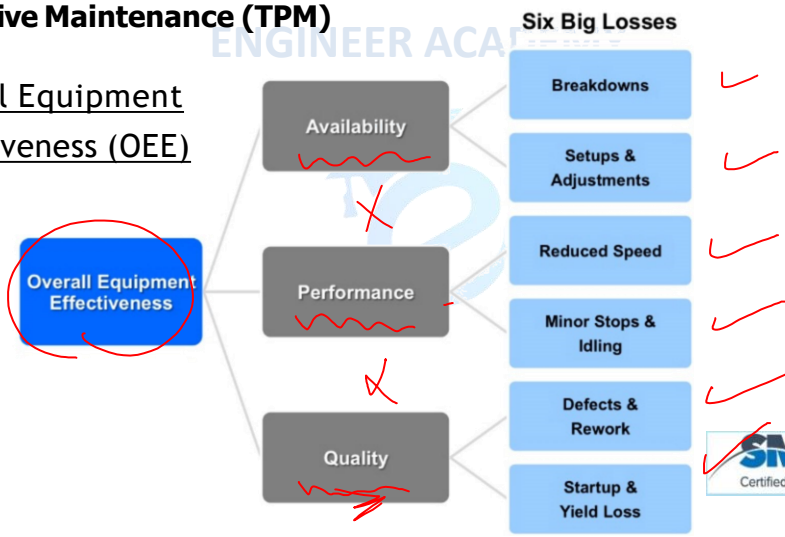
2.2 Apply process improvement techniques

Total Productive Maintenance (TPM)

Overall Equipment Effectiveness (OEE)



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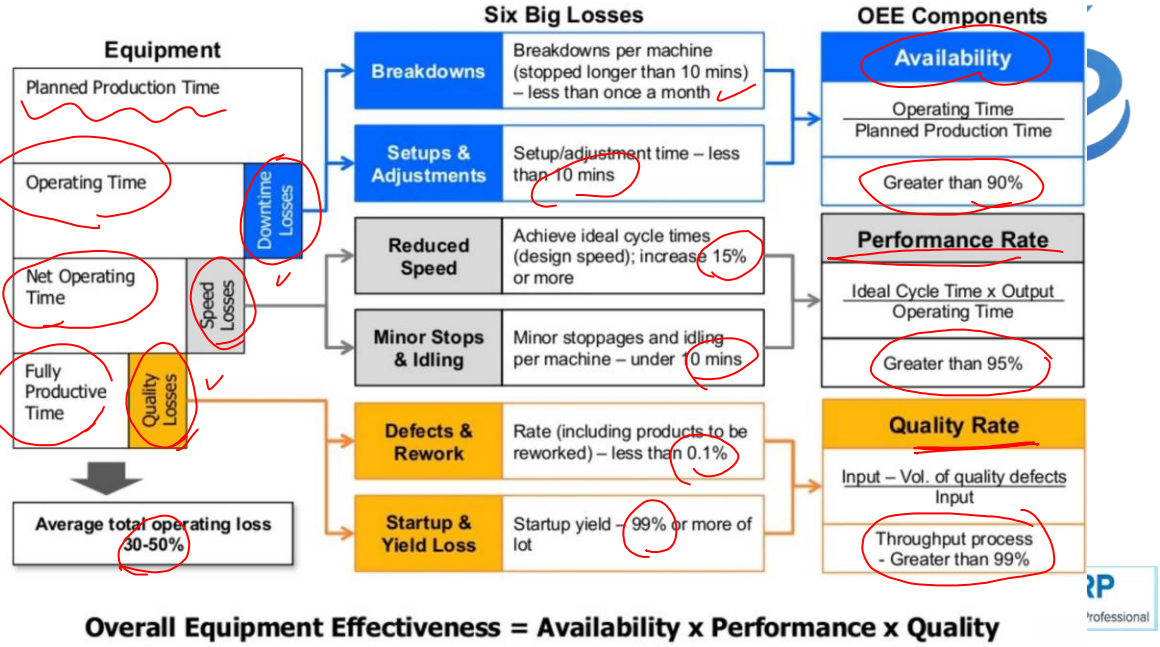

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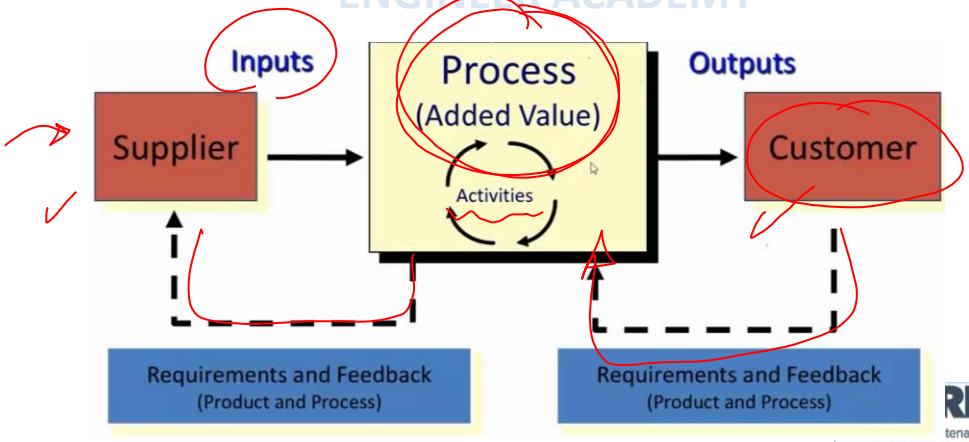
2.2 Apply process improvement techniques

SIPOC improvement model



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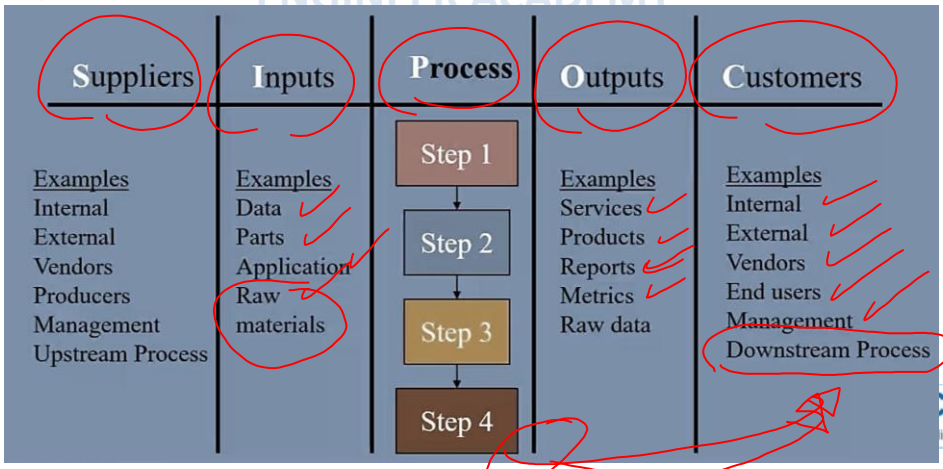
2.2 Apply process improvement techniques

SIPOC improvement model



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2.2 Apply process improvement techniques

SWOT Analysis

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2.2 Apply process improvement techniques

Tools to improve & generate ideas

- Brainstorming
- Affinity diagram
- Fishbone / Cause and Effect Diagram
- Pareto
- Failure Mode & Effects Analysis (FMEA)
- Theory of constraint or Bottleneck analysis
- Barrier analysis
- Flow charts,
- Value Stream Mapping – VSM
- SPC

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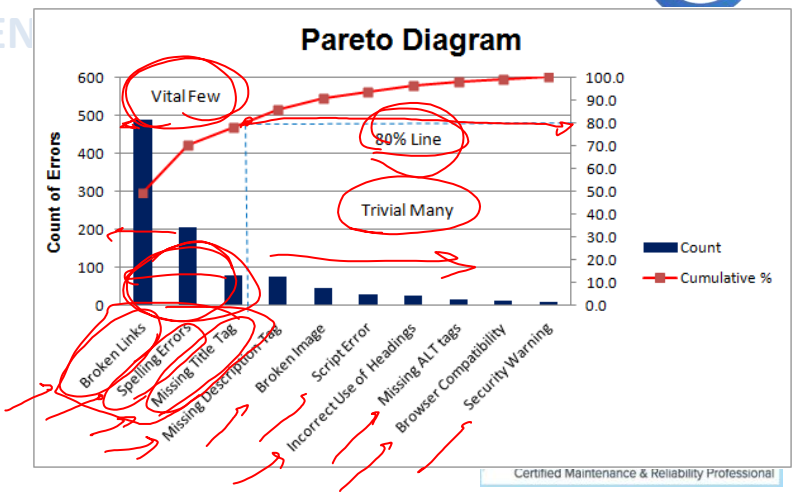
2.2 Apply process improvement techniques

Pareto Analysis

Is a Bar graph its bar lengths represent count and the bars are categories.

The chart visually indicates which situations are more significant



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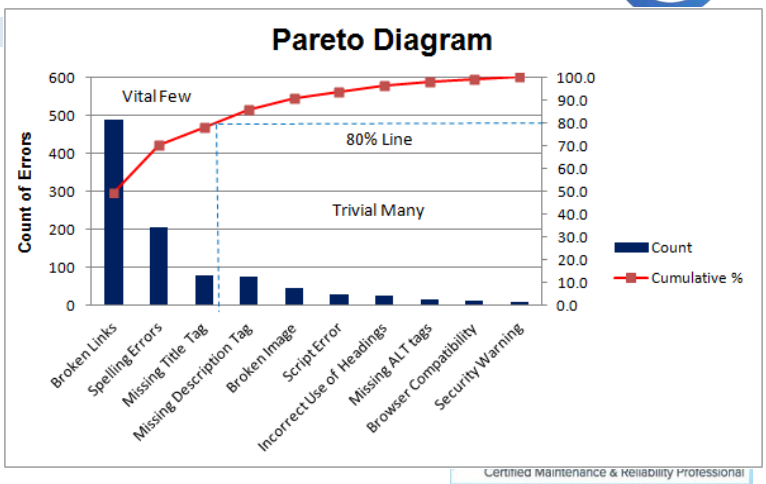
2.2 Apply process improvement techniques

Pareto Analysis

- When to Use a Pareto Chart
  - when analyzing data about frequency of problems or causes in process
  - when there are many problems or causes and you want to focus on the most significant
  - when analyzing broad causes by looking at their specific components
  - when communicating with others about your data



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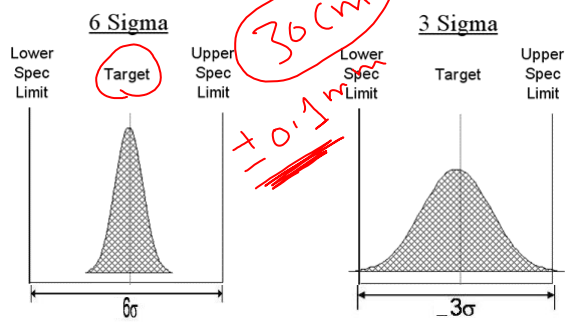
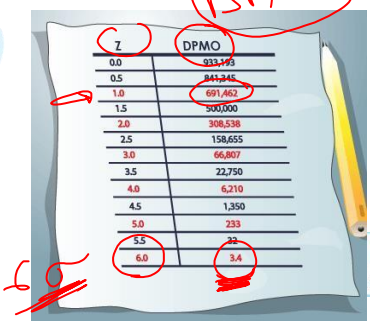
2.2 Apply process improvement techniques

Six Sigma

Business Management and Process Improvement Strategy

- Consistency is the Key, Variation is the enemy
- To optimize the value adding activities by removing variation and defects





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2.2 Apply process improvement techniques

Example:

Imagine two machines producing parts:

Machine A: Produces 100 parts consistently every day.

Machine B: Produces 50 one day, 150 the next, averaging 100.

$\frac{50 + 150}{2} = 100$

Both have the same average (100), but Machine A is stable and predictable, while Machine B is inconsistent. The average hides this difference.

Better Alternatives

Use **median** or **mode** when data is skewed.

Analyze **range, variance, and standard deviation** to understand spread.

Apply **control charts** (SPC) (statistical process control) to visualize stability over time.

Segment data instead of lumping it into one average.

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2.2 Apply process improvement techniques

Six Sigma

(Quality Level Measurement)

	5	50
	-5	-50
Average :	0	0

The *deceiving average* :

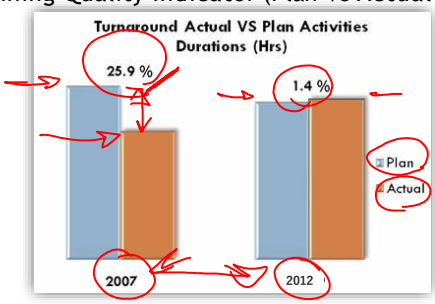
Sigma Level

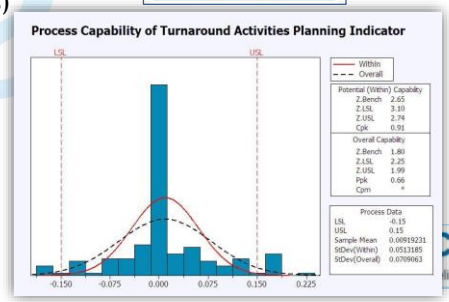
$$Z = \frac{SL - \bar{x}}{\sigma}$$

Z= sigma score
SL= specification limit
$\bar{x}$ = the mean
σ = the standard deviation

Example:

- Planning Quality Indicator (Plan Vs Actual Job times)





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2.2 Apply process improvement techniques

Six Sigma

Improvement Process

Methodology: (DMAIC)

D	M	A	I	C
Define	Measure	Analyze	Improve	Control
What problems & what is important	Is it significant & how we are doing	What's wrong & how we can fix	Fixing what is wrong	Guarantee performance & continuity

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