Total Quality Management-basics

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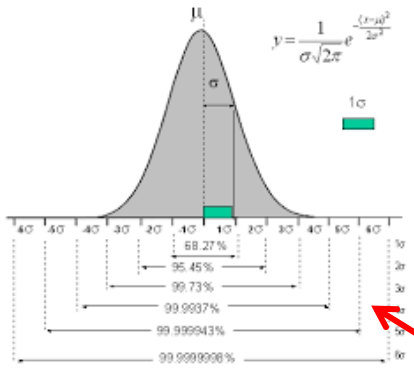
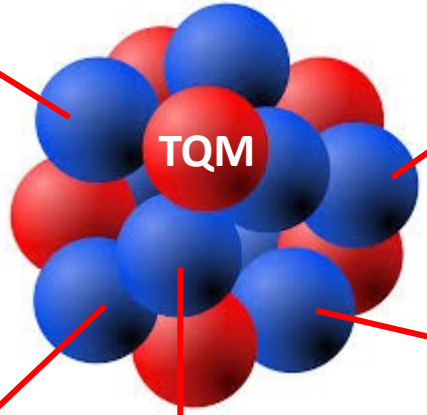
Basic methods

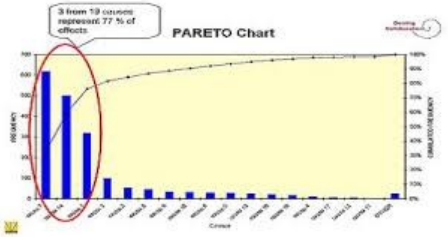


Six sigma

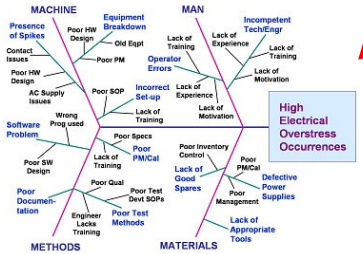
Inspiration of 6σ method

One of the 6σ method



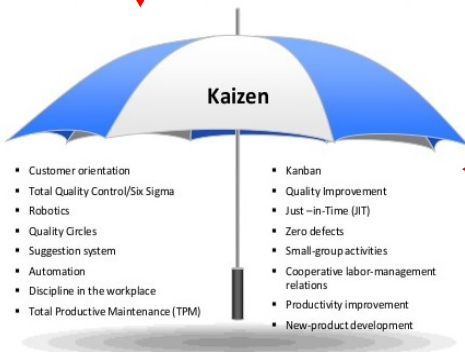


Pareto
(extra session)



Ishikawa FBD
(extra session)

6σ



Kanban & JIT
(extra session)

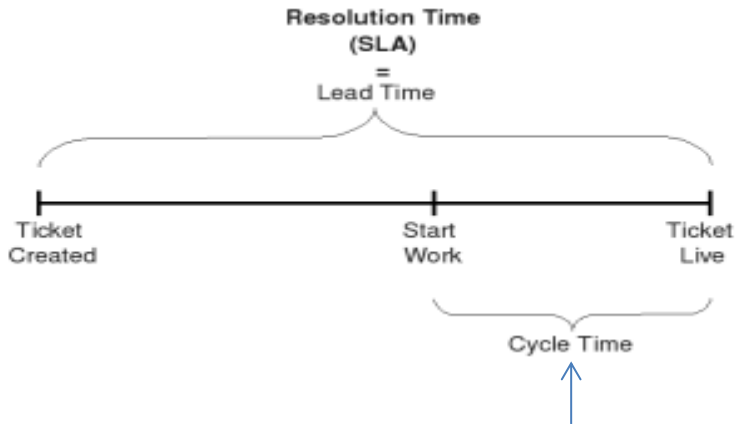
Dimensions of Quality

- **Performance -** How well a car handles, gas mileage and so on
- **Features -** Extra item added (stereo CD, GPS, tire checking,..)
- **Reliability -** It should operates without error (DPMO) within expected time frame (done by customer voice)
- **Conformance** - The degree to witch a product meets pre-established standards
- **Durability -** How long the product last(life span or see PLC see later in Boston show)
- **Serviceability -** The ease of getting repairs, the speed of repairs
- **Esthetics -** How a product looks, feels, sounds ,smells or tastes
- **Safety -** Assurance that customer will not suffer injury or harm from the product (automobiles, brakes, accelerators strings,…)

DPMO=Defect per million opportunities

Flow times – lead times (some used units)- will be also used in Little´s law section

- **Flow Time (FT) is know as a Cycle Time (CT)**
- **Lead Time =LT** (length of the process) – time only, supposed to be constant used for planning

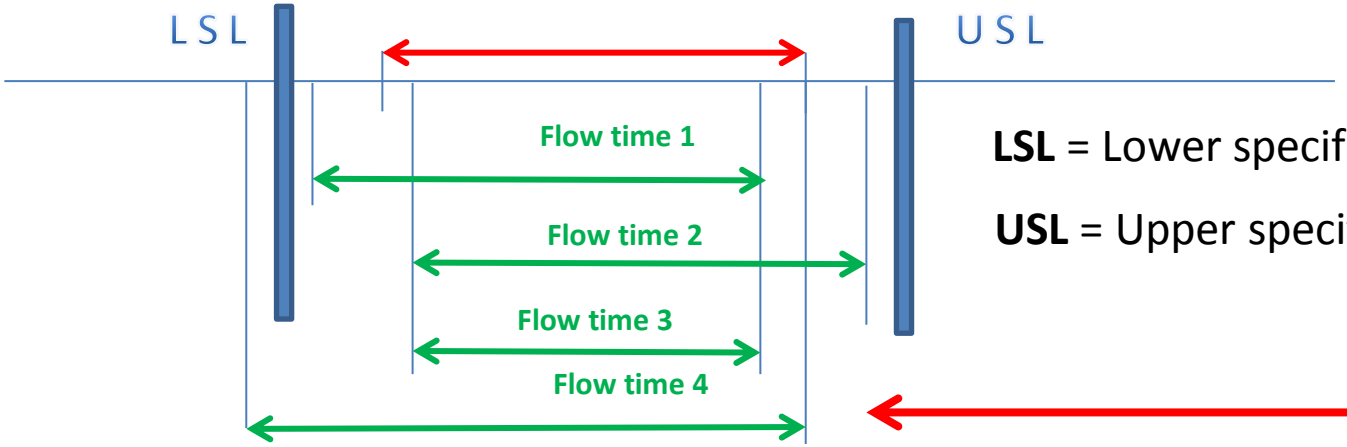


Average time from release of the job of the beginning of the routing until it reaches an inventory point at the end of the routing or time that part spends as a WIP.

Six sigma

Lead time (expected=voice of customer) = Target Quality (expected value)

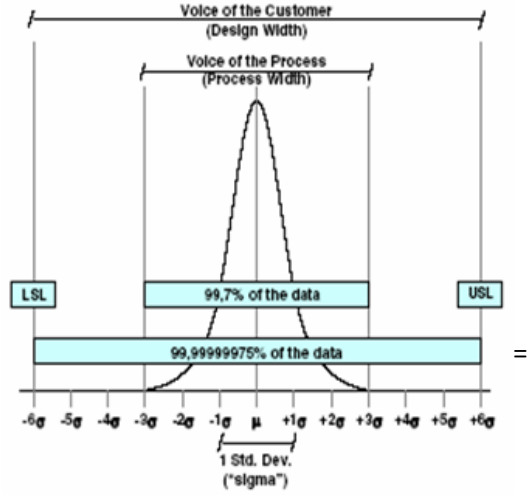
production or replenishment constant



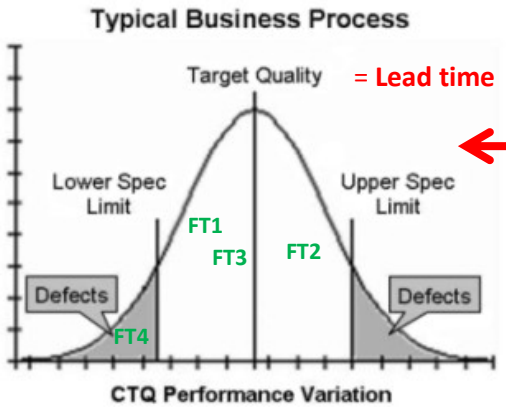
LSL = Lower specification limit

USL = Upper specification limit

The lenght of **flow time** represents a variability (voice of process)



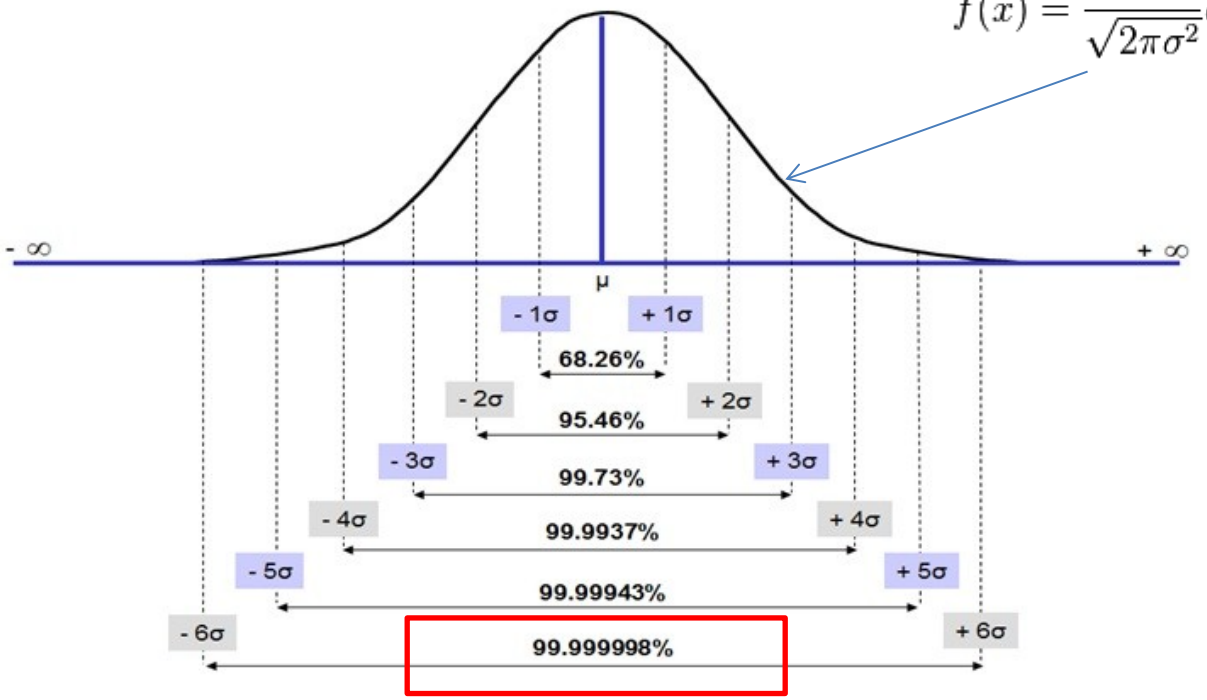
= DPMO=3,4



DPMO=Defect per million opportunities**, CTQ**=Critical to Quality

Six sigma

$$f(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}.$$



$$\mu = \frac{1}{N}\sum_{i=1}^{N} x_i \qquad \sigma^2 = \frac{1}{N}\sum_{i=1}^{N} (x_i - \mu)^2$$

$\sigma = \sqrt{\sigma^2}$ ← root

Mean of the xi ->(1,3,8,6,2)->20/5=4

Process Capabilty Ratio (Cp)

(not for MPH_AOPR or MPH_AOMA_2018_2019)

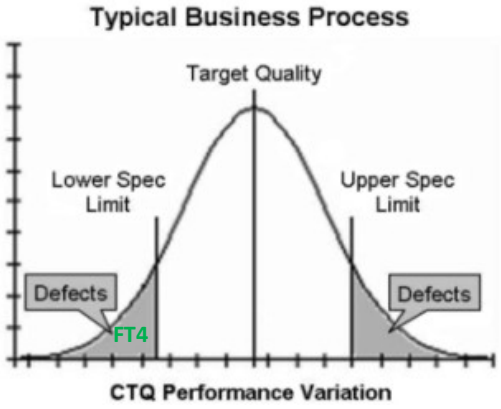
- **Process Capability Ratio** is a statistical measure of **process capability**: the ability of a process to produce output within specification limits.

- The concept of process capability only holds meaning for processes that are in a state of **statistical control**.
- **Process capability** indices measure how much "natural variation" a process experiences relative to its specification limits and allows different processes to be compared with respect to how well an organization controls them.

Process Capability ratio =Cp

(not for MPH_AOPR or MPH_AOMA_2018_2019)

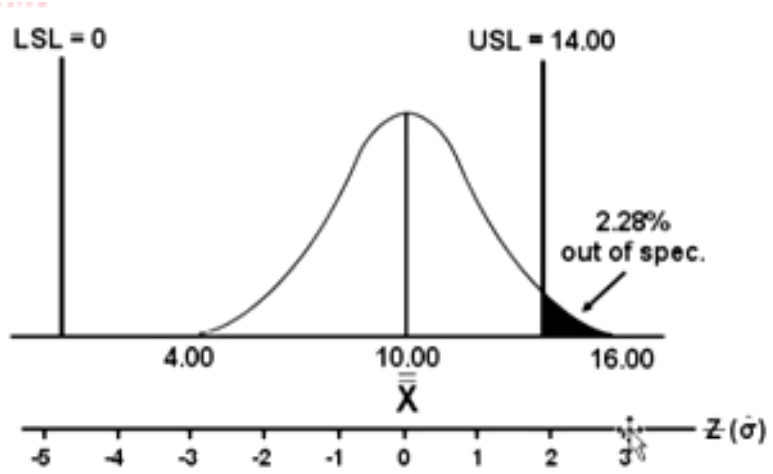
- Cp>=1
- Six sigma requires Cp=2
- It is no focus on whether process is centred in the specific range
- Upper Specification Limit = USL
- Lower Specification Limit = LSL
- Cp= (USL – LSL)/ **6σ**



Cp calculation

Process capability ratio - (example for home study)

(not for MPH_AOPR or MPH_AOMA_2018_2019)



USL = 14

LSL = 0

$\bar{\bar{X}} = 10$

$\hat{\sigma} = 2$

$$C_p = \frac{USL - LSL}{6\hat{\sigma}}$$

$$C_p = \frac{14.00 - 0.00}{6 \times 2.00}$$

$C_p = 1.17$

Standard deviation

It is OK becasue Cp>1

Cpk=Process Capability Index

(not for MPH_AOPR ot MPH_AOMA_2018_2019)

- It is a standard index to state capability of one process
- The higher value of Cpk a better process
- Formula
- Cpk=Zmin/3 where Zmin is smallest of these values:
  - (USL-Mean)/σ and (Mean-LSL)/σ
  - Mean is an average of the part
  - Sigma represents process variation
  - Cpk = 1,0 is equivalent to yield 99,73%
  - Cpk = 1,2 is equivalent to yield 99,97%

Cpk=Process Capability Index

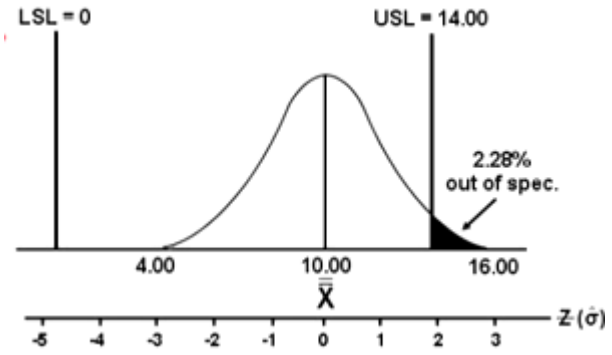
(not for MPH_AOPR or MPH_AOMA_2018_2019)

USL = 14

LSL = 0

$\bar{X}$ = 10

$\hat{\sigma}$ = 2



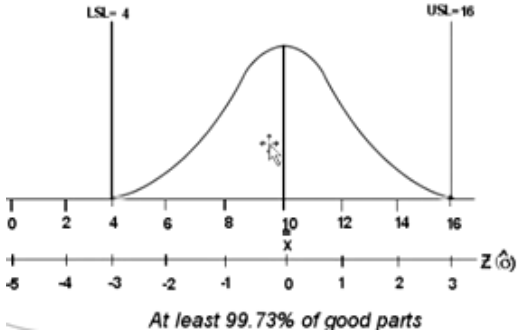
Zusl =(USL-Mean)/ σ = (14-10)/2=2 and Zlsl=(Mean-LSL)=(10-0)/2=5
so Cpk=2/3=**0,67**. Mind you, that Mean = X is our example !!!

USL = 16

LSL = 4

$\bar{X}$ = 10

$\hat{\sigma}$ = 2



This process is better

Zusl =(USL-Mean)/ σ = (16-10)/2=3 and Zlsl=(Mean-LSL)=(10-4)/2=3
so Cpk=3/3=**1,0**. Mind you, that Mean = X is our example !!!

Six sigma

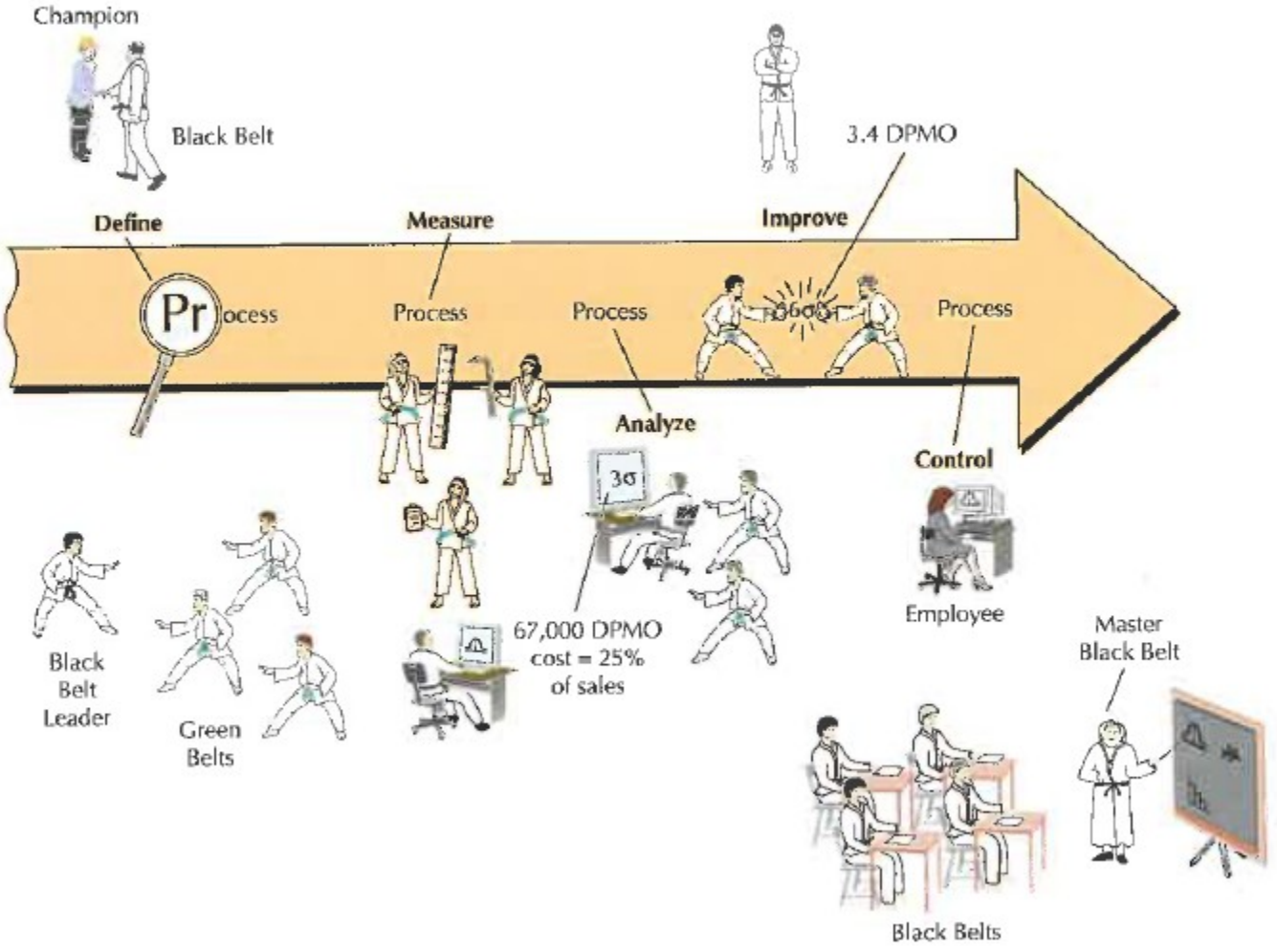
Six Sigma projects follow two project methodologies inspired by Deming's Plan-Do-Check-Act Cycle. These methodologies, composed of five phases each, bear the acronyms DMAIC and DMADV

- **DMAIC** is used for projects aimed at improving an existing business process
- DMADV is used for projects aimed at creating new product or process designs

Six sigma

- **Define** the system, the voice of the customer and their requirements, and the project goals, specifically.
- **Measure** key aspects of the current process and collect relevant data; calculate the 'as-is' Process Capability.
- **Analyze** the data to investigate and verify cause-and-effect relationships. Determine what the relationships are, and attempt to ensure that all factors have been considered. Seek out root cause of the defect under investigation.
- **Improve** or optimize the current process based upon data analysis using techniques such as poka yoke (see next slide) .
- **Control** the future state process to ensure that any deviations from the target are corrected **before** they result in defects. Implement control systems such as statistical process control, production boards, visual workplaces, and continuously monitor the process.

Six Sigma basics



Poka yoke

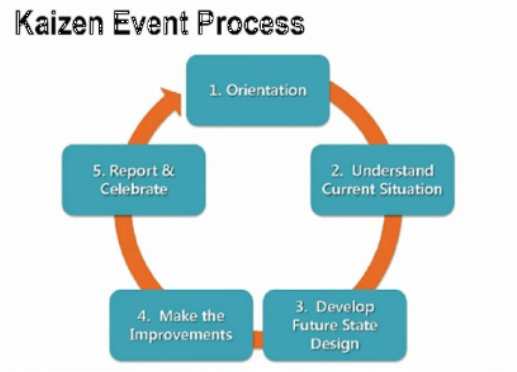
- **Poka yoke** is a Japanese term that means "mistake-proofing„ that helps an equipment operator avoid (yokeru) mistakes (poka). Its purpose is to eliminate product defects by preventing, correcting, or drawing attention to human errors as they occur

Poka-yoke example: Ethernet cable plug is designed to be plugged in only one orientation.

Kaizen

kai 改 change
zen 善 good

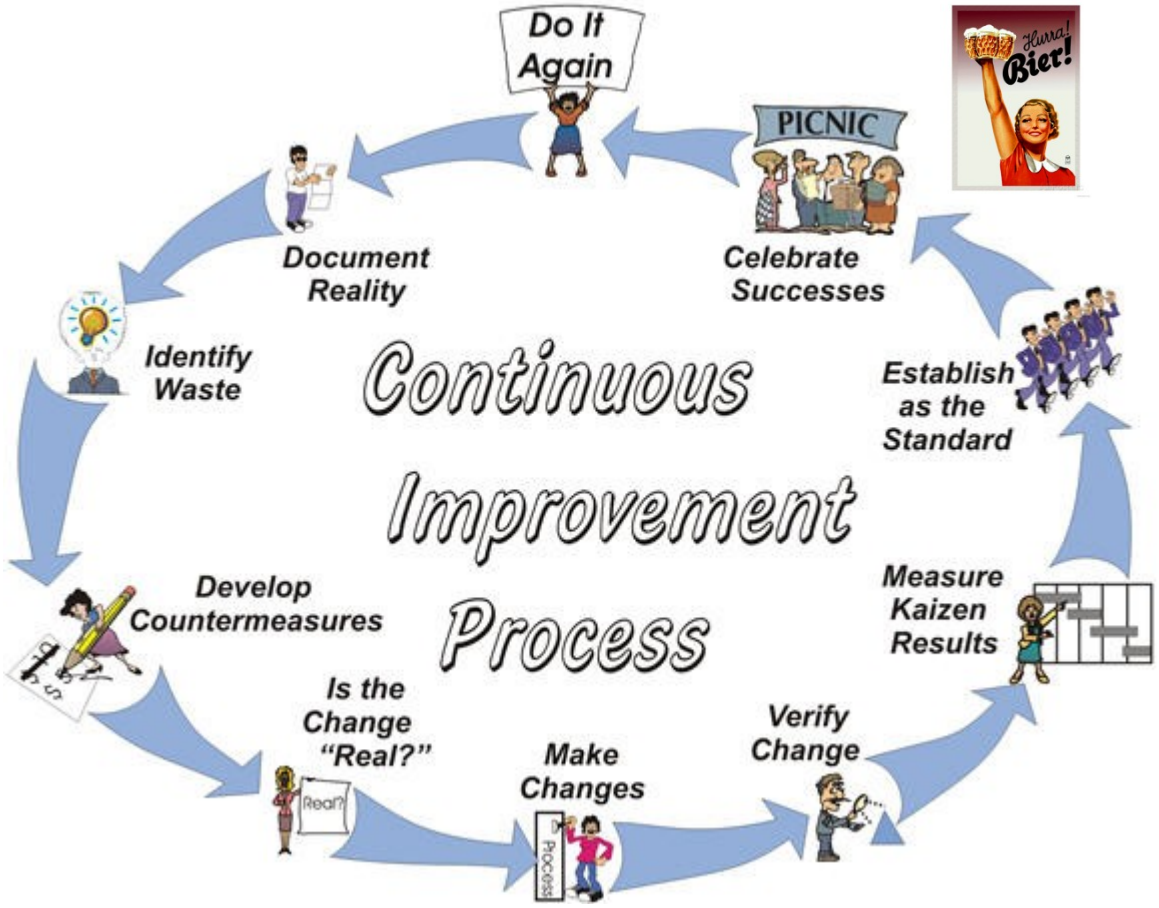
- **Kaizen** (Continuous Improvement) is a strategy where employees at all levels of a company work together proactively to achieve regular, incremental improvements to the manufacturing process. In a sense, it combines the collective talents within a company to create a powerful engine for improvement.



Kaizen events (P-D-C-A)

- Set goals and provide any necessary background.
- Review the current state and develop a plan for improvements.
- Implement improvements.
- Review and fix what doesn’t work.
- Report results and determine any follow-up items.

Kaizen – improvement steps



End of section