IIT ROORKEE

NPTEL ONLINE CERTIFICATION COURSE

Project Management for Managers

Lec – 57

Sources of Variability and Six Sigma

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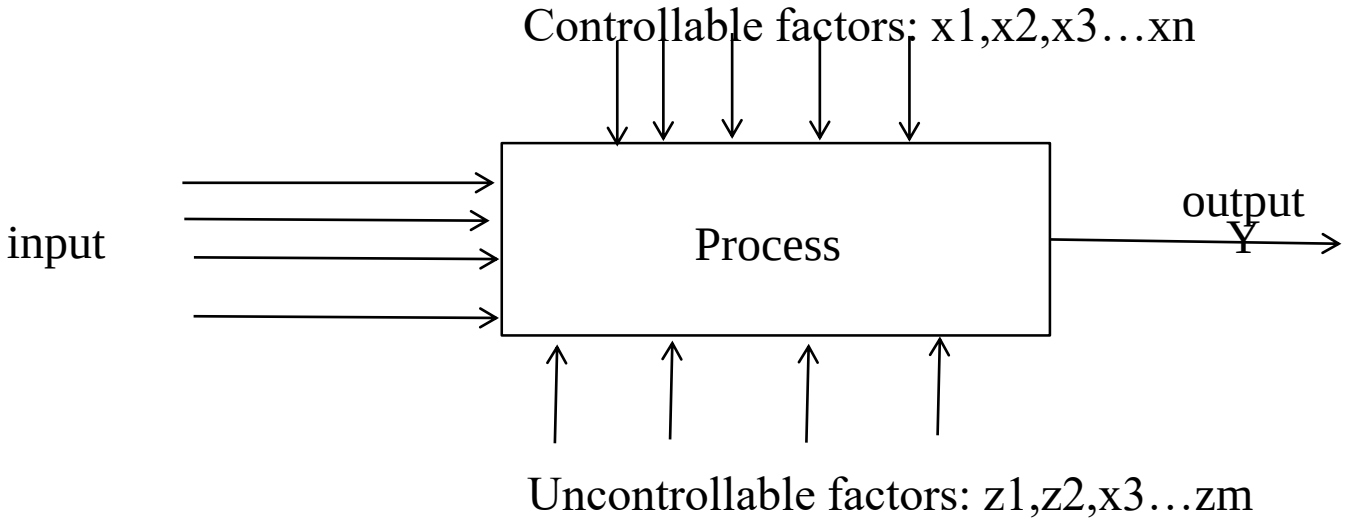
Sources of variability



How to remove variability?

- Determine which **variables** (x's) are most **influential** on the response, y
- Determine where **to set** the influential x's so that y is near the nominal requirement
- Determine where to set the influential x's so that **variability** is **small**
- Determine where to set the influential x's so that the effects of the **uncontrollable variables "z" are minimized**

Number of confirming products at 3 σ : 99.73

Ex. A product consists of 100 parts assembly, the probability that any specific unit of product is confirming.

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Solution: $(0.9973)^{100} = 0.7631 = 76.31\%$

If we go by 3 sigma:

20,000 wrong drug prescription each year.

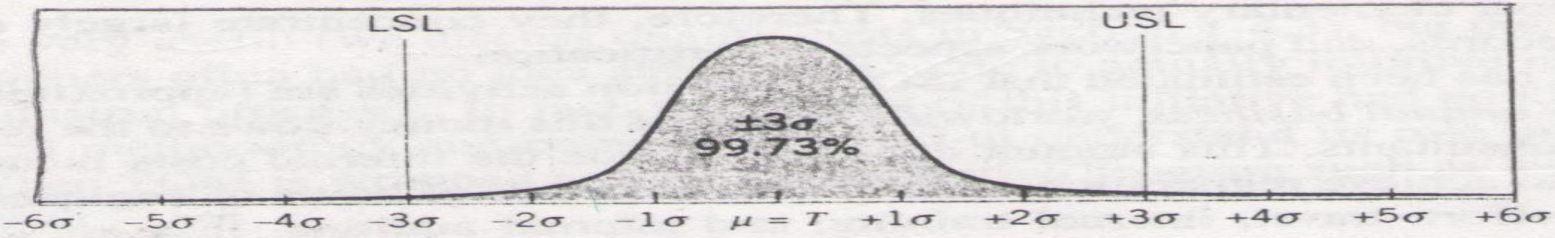
More than 15,000 babies accidently dropped by nurses and doctors each year.

500 incorrect surgical operations per week.

2000 lost pieces of mail each hour.

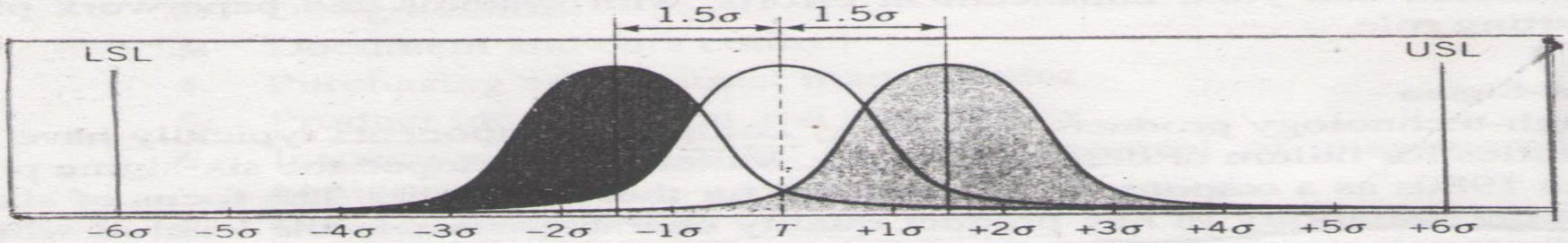
Six Sigma

The Motorola SS concept is to reduce the **variability** in the process so that specific limits are **six standard deviations away from the mean.**



Spec. Limit	Percent Inside Specs	ppm Defective
±1 Sigma	68.27	317300
±2 Sigma	95.45	45500
±3 Sigma	99.73	2700
±4 Sigma	99.9937	63
±5 Sigma	99.999943	0.57
±6 Sigma	99.9999998	0.002

(*a*) Normal distribution centered at the target (*T*)



Spec. Limit	Percent Inside Specs	ppm Defective
±1 Sigma	30.23	697700
±2 Sigma	69.13	608700
±3 Sigma	93.32	66810
±4 Sigma	99.3790	6210
±5 Sigma	99.97670	233
±6 Sigma	99.999660	3.4

(*b*) Normal distribution with the mean shifted by 1.5σ from the target

The Motorola six-sigma concept.

Deming's PDCA cycle

Six Sigma Process

Six Sigma Quality

$\pm 3\sigma$

- A philosophy and set of methods companies use to eliminate defects in their products and processes
- Seeks to reduce variation in the processes that lead to product defects
- The name, “six sigma” refers to the variation that exists within plus or minus three standard deviations of the process outputs

Six Sigma Quality (Continued)

- **Six Sigma allows managers to readily describe process performance using a common metric: Defects Per Million Opportunities (DPMO)**

$$DPMO = \frac{\text{Number of defects}}{\left[\begin{array}{l}\text{Number of}\\ \text{opportunities}\\ \text{for error per}\\ \text{unit}\end{array}\right] \times \text{No. of units}} \times 1{,}000{,}000$$

Six Sigma Quality (Continued)

Example of Defects Per Million Opportunities (DPMO) calculation.

Suppose we observe 200 letters delivered incorrectly to the wrong addresses in a small city during a single day when a total of 200,000 letters were delivered. What is the DPMO in this situation?

Six Sigma Quality (Continued)

Example of Defects Per Million Opportunities (DPMO) calculation. Suppose we observe 200 letters delivered incorrectly to the wrong addresses in a small city during a single day when a total of 200,000 letters were delivered. What is the DPMO in this situation?

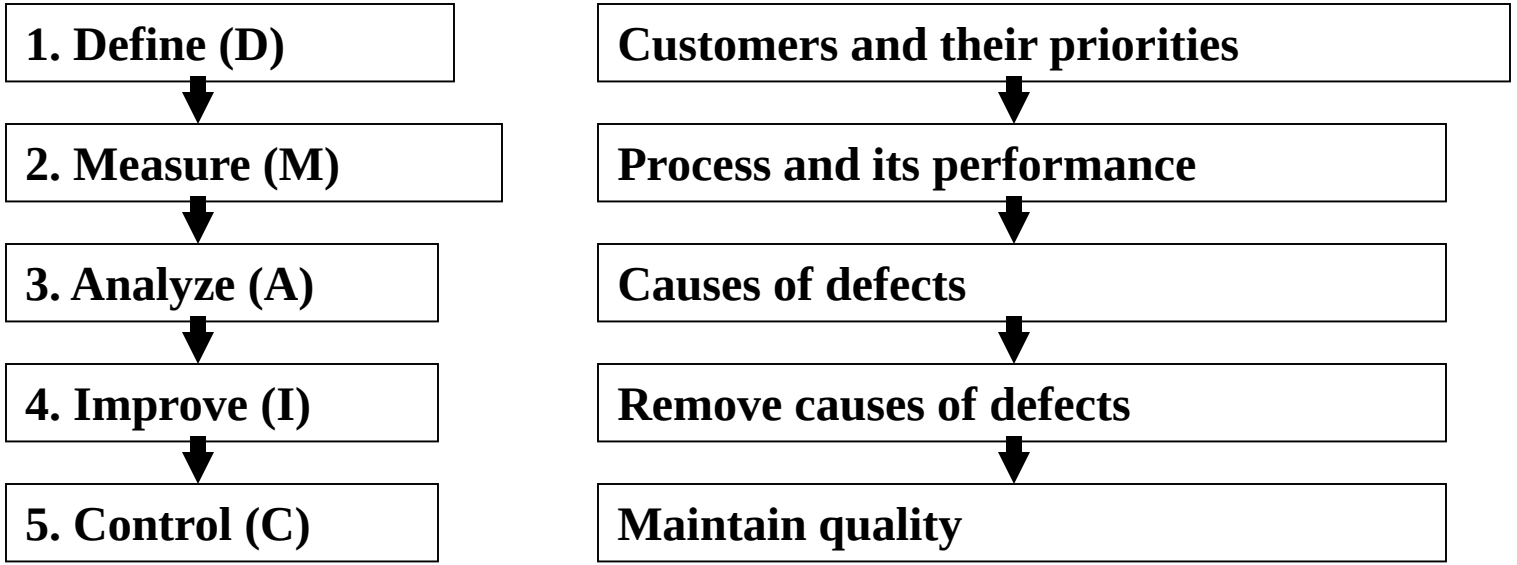
$$DPMO = \frac{200}{[1]\ x200{,}000} x1{,}000{,}000 = 1{,}000$$

So, for every one million letters delivered this city's postal managers can expect to have 1,000 letters incorrectly sent to the wrong address.

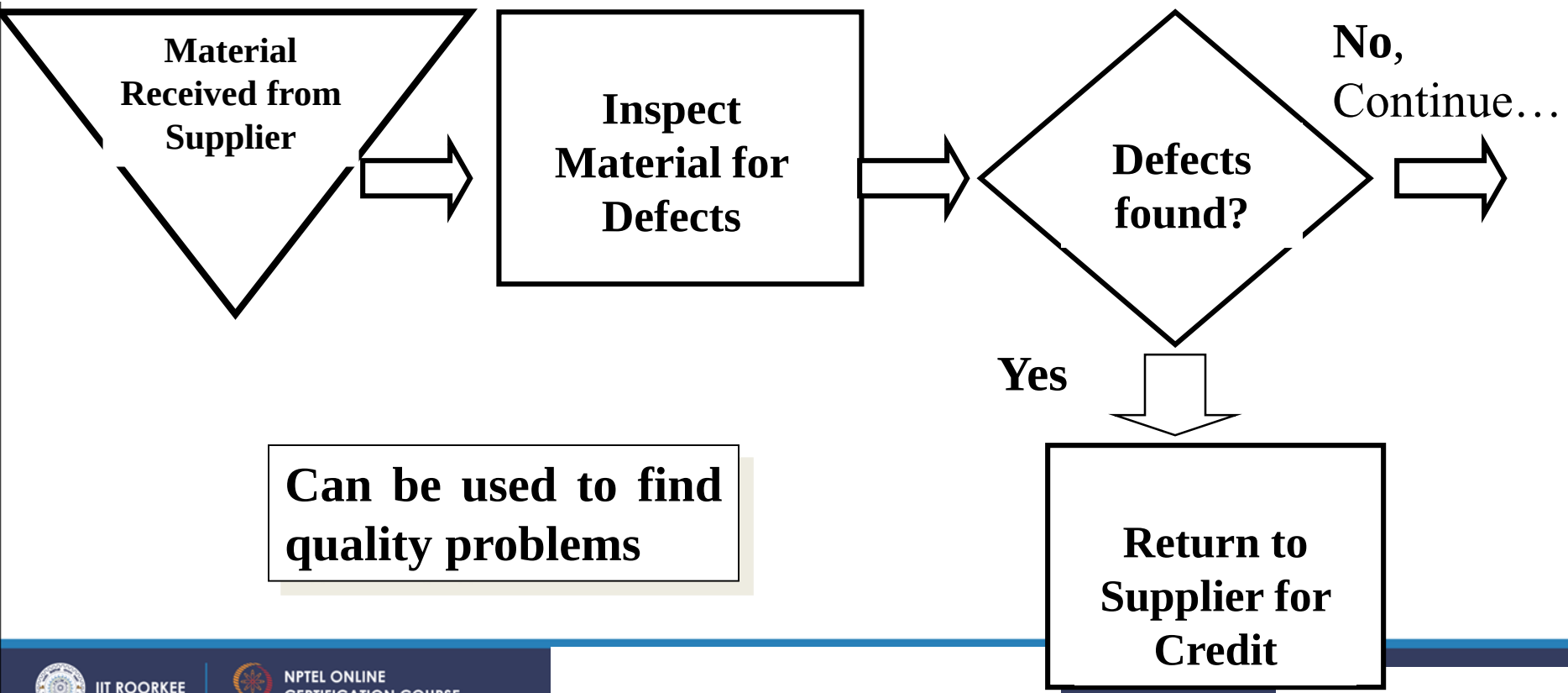
Six Sigma Quality: DMAIC Cycle

- **Define, Measure, Analyze, Improve, and Control (DMAIC)**
- **Developed by General Electric as a means of focusing effort on quality using a methodological approach**
- **Overall focus of the methodology is to understand and achieve what the customer wants**
- **DMAIC consists of five steps….**

Six Sigma Quality: DMAIC Cycle (Continued)

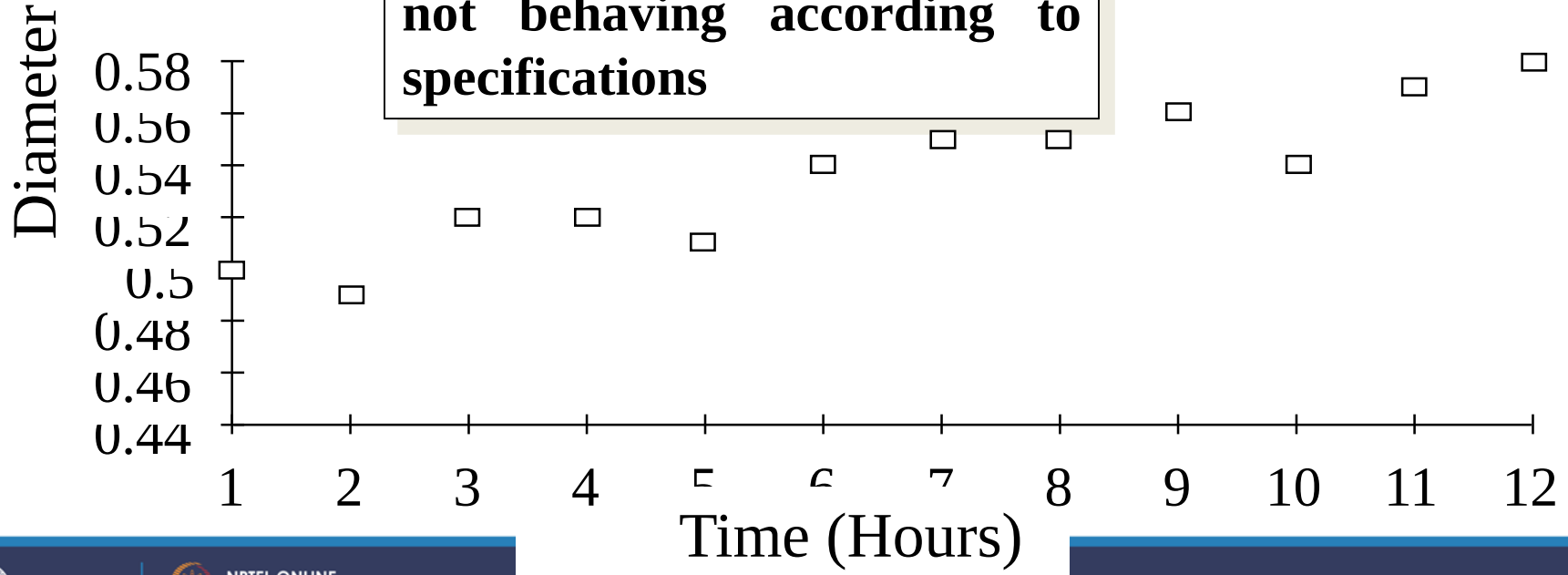


Analytical Tools for Six Sigma and Continuous Improvement: Flow Chart



Analytical Tools for Six Sigma and Continuous Improvement: Run Chart

Can be used to identify when equipment or processes are not behaving according to specifications



Analytical Tools for Six Sigma and Continuous Improvement: Pareto Analysis

Can be used to find when 80% of the problems may be attributed to 20% of the causes