Lean Six Sigma Green Belt Certification Course

simplilearn

Business Results for Projects

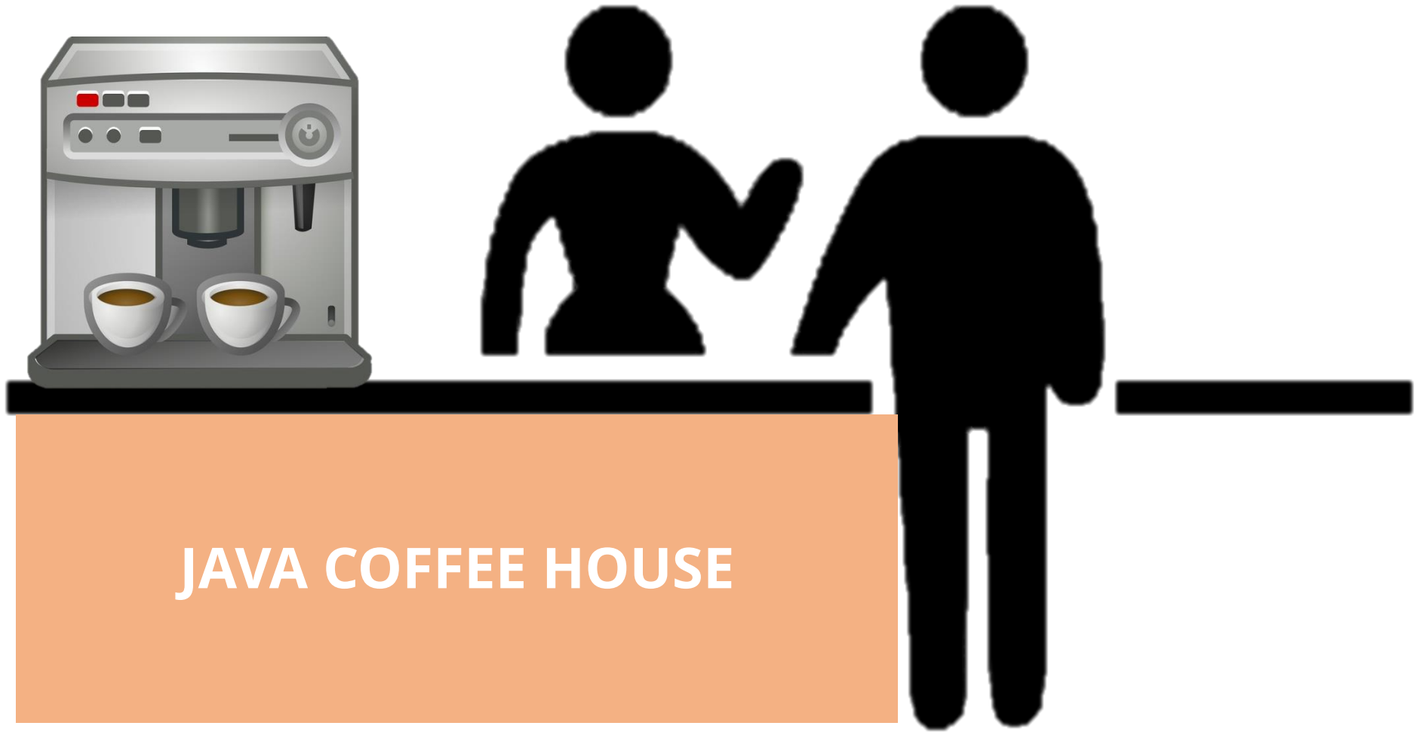
Learning Objectives

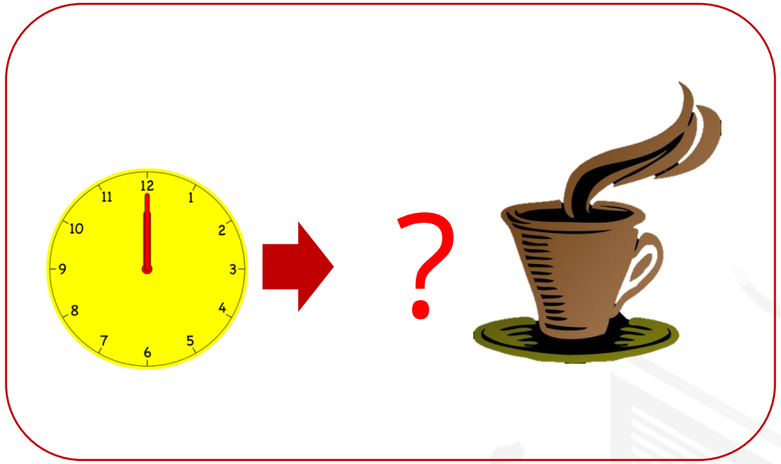
By the end of this lesson, you will be able to:

- Define process performance

Scenario

The problem

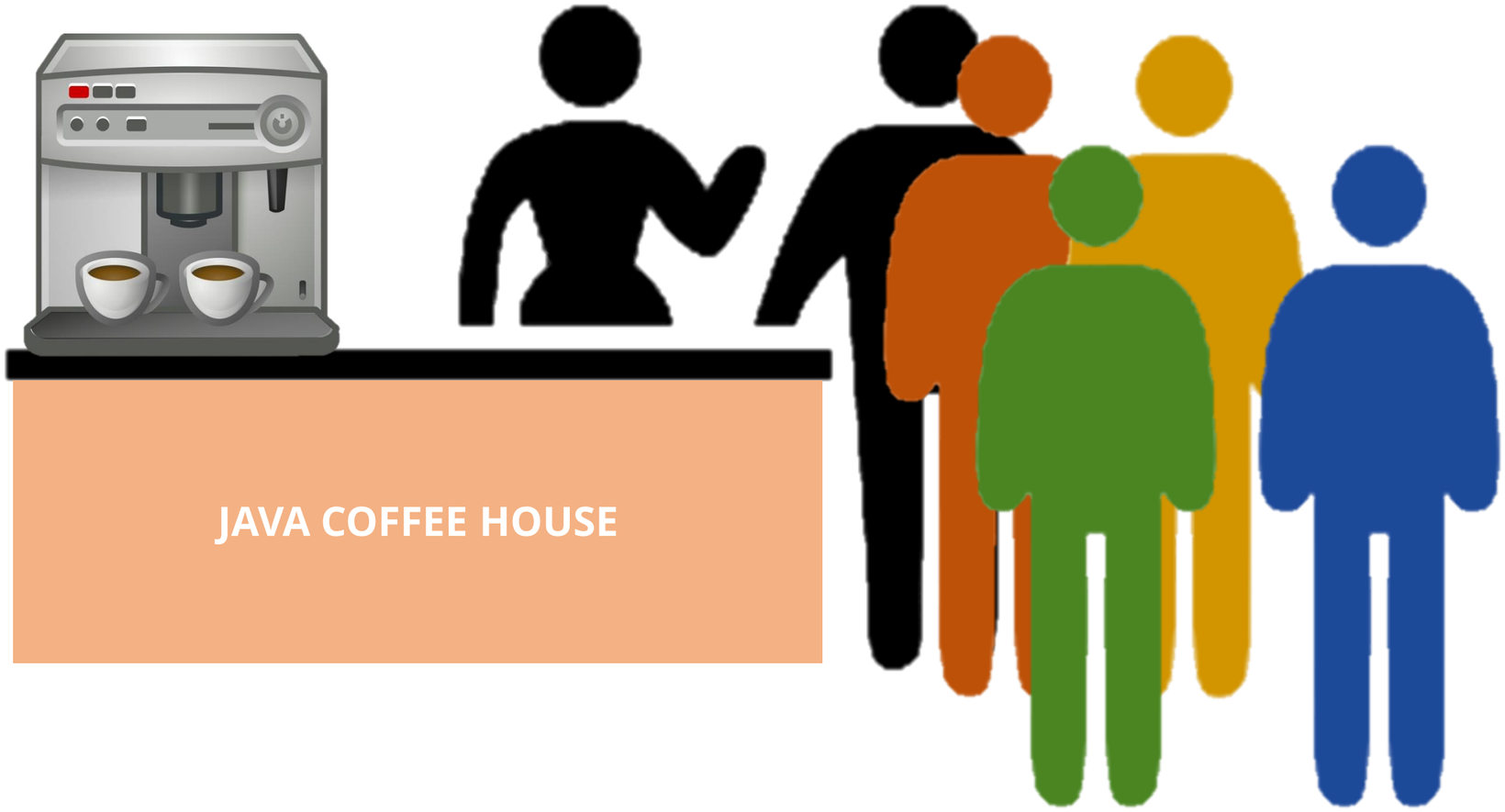




Primary metric:
Number of coffee orders processed per hour

Scenario

The solution



Defects ?

Secondary metric:
Number of defects

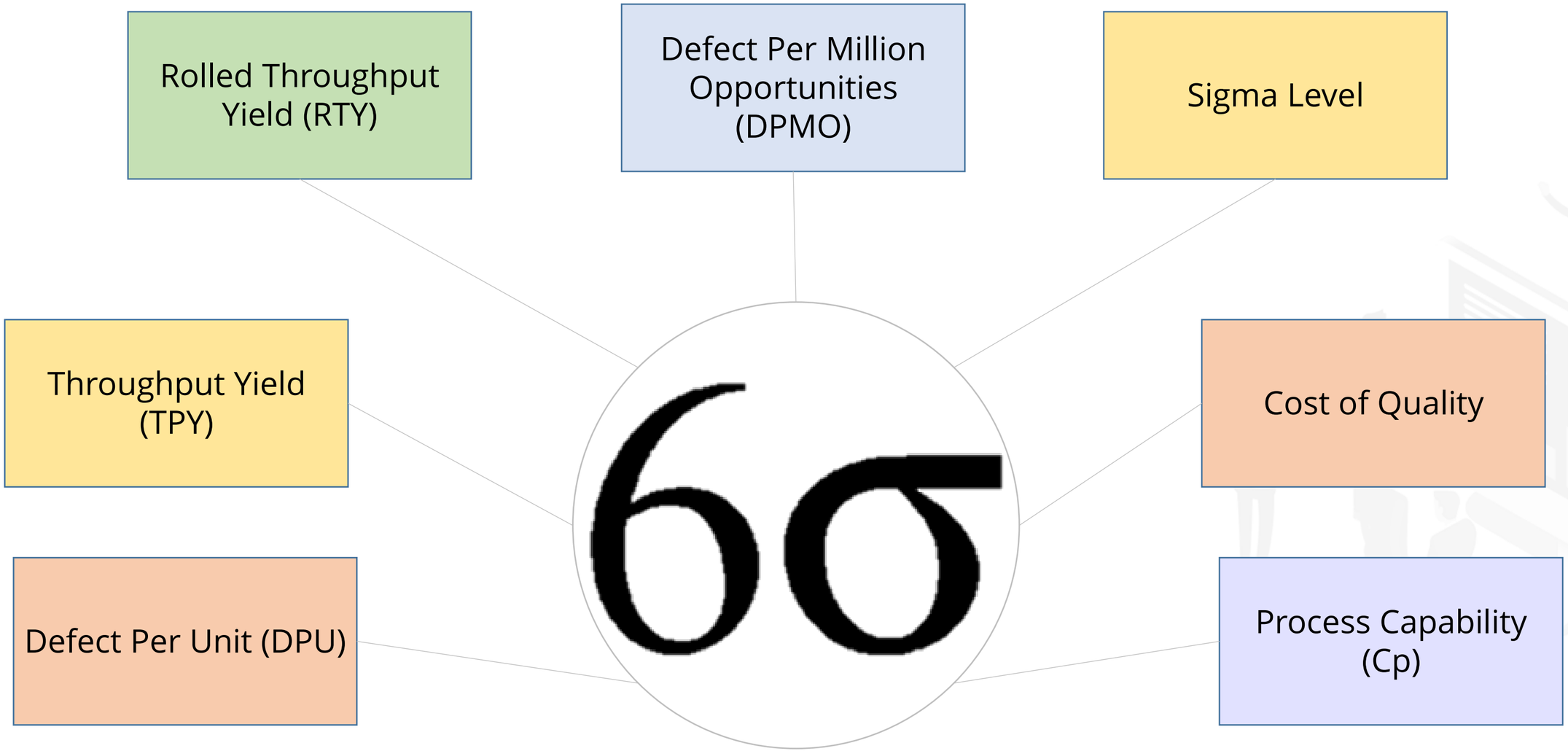
DIGITAL OPERATIONS

Process Performance

Metrics to Assess the Performance of a Business

Metrics to measure business results for projects are critical to evaluate success.

Metrics to Assess the Performance of a Business



Defect Per Unit (DFU): Introduction

Defect per unit (DPU) is the average number of defects per unit of a product.

$$DPU = \frac{\text{Total number of defects}}{\text{Total number of units}}$$

Example to Calculate DPU

Defects per unit	0	1	2	3	4	5
Units	50	30	15	4	0	1
Number of defects	0 (0*50)	30 (1*30)	30 (2 * 15)	12 (3 * 4)	0 (4*0)	5 (5 * 1)

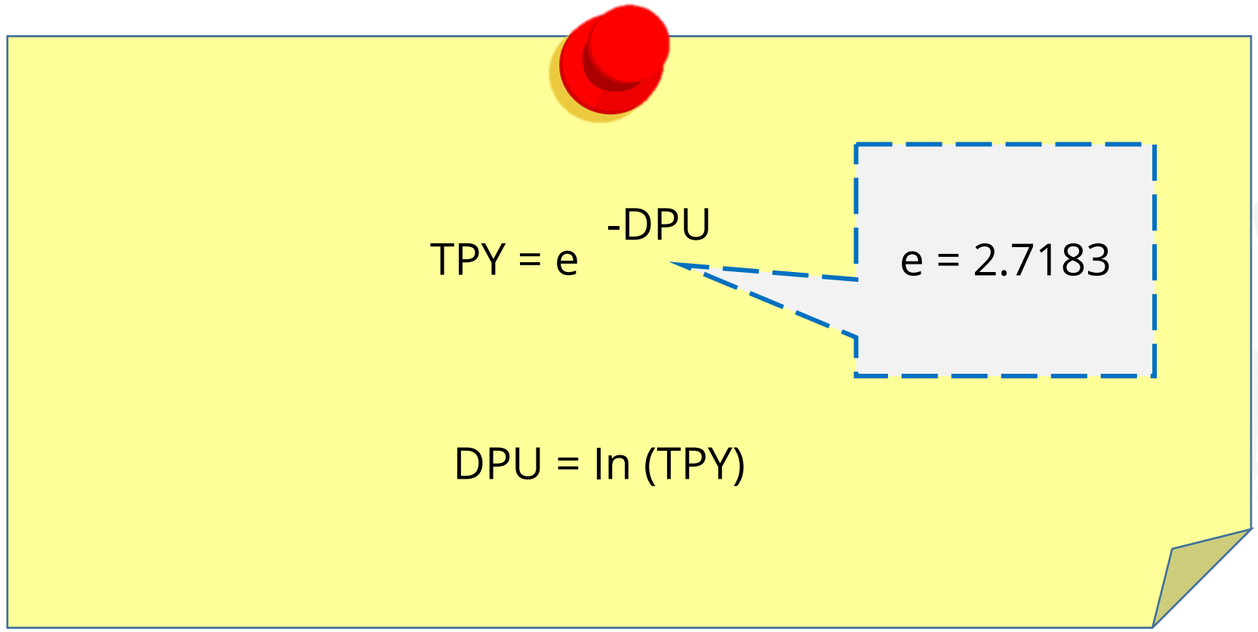
100

77

$$DPU = \frac{0(50) + 1(30) + 2(15) + 3(4) + 5(1)}{50 + 30 + 15 + 4 + 1} = \frac{77}{100} = \mathbf{0.77}$$

Throughput Yield: Introduction

Throughput Yield (TPY) is the number of acceptable pieces, at the end of a process, divided by the number of starting pieces, excluding scrap and rework.



Throughput Yield: Example to Calculate TPY

Defects per unit	0	1	2	3	5
Number of defects	0	30	30 (2 * 15)	12 (3 * 4)	5 (5 * 1)
Units	50	30	15	4	1

DPU = 0.77

$$TPY = e^{-DPU} = e^{-0.77} = 0.46 = \mathbf{46\%}$$

Rolled Throughput Yield: Introduction

Rolled Throughput Yield (RTY) is the probability of the entire process producing zero defects. It is important as a metric when a process has excessive rework.

Total Defects per Unit (TDPU) is defined for a set of processes.

$$RTY = e^{-TDPU}$$

$$TDPU = -\ln(RTY)$$

First Pass Yield: Introduction

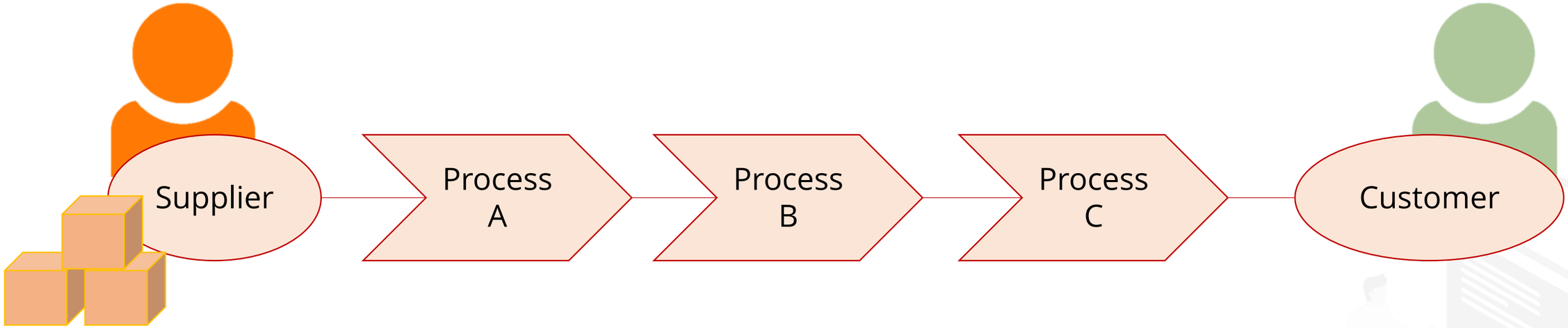
First Pass Yield (FPY) is the number of products which pass without any rework of the total number of units.

$$FPY = \frac{\text{Total number of units} - \text{Number of defective units}}{\text{Total number of units}}$$

$$= \frac{\text{Total number of quality products}}{\text{Total number of units}}$$

$$RTY = FPY_1 * FPY_2 * FPY_3 \ldots FPY_n$$

Calculation of FPY and RTY: Problem



Process	Input parts from the supplier	Input parts that passed inspection	Reworked parts
Process A	100	85	5
Process B	90	80	5
Process C	85	85	0

Calculation of FPY and RTY: Solution

$$\text{FPY for Process A} = \frac{\text{Total number of quality products}}{\text{Total number of units}} = \frac{85}{100} = 0.850 = 85\%$$

$$\text{FPY for Process B} = \frac{\text{Total number of quality products}}{\text{Total number of units}} = \frac{80}{90} = 0.889 = 88.9\%$$

$$\text{FPY for Process C} = \frac{\text{Total number of quality products}}{\text{Total number of units}} = 1 = 100\%$$

RTY = 0.850 * 0.889 * 1 = 0.75 = **75%**

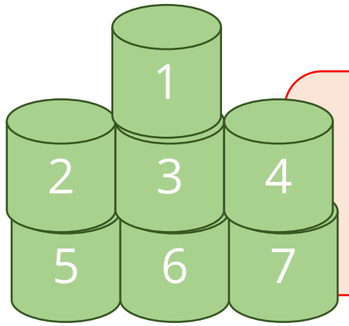
Defects Per Million Opportunities (DPMO): Introduction

Defect per Million Opportunities (DPMO), or Non-Conformities per Million Opportunities (NPMO), is a measure of process performance.

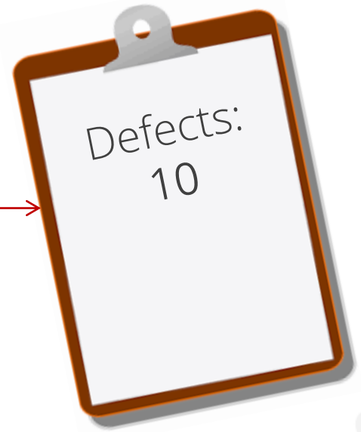
$$DPMO = \frac{\text{Total number of defects}}{\text{Total number of opportunities}} * 10^6$$

Total number of opportunities = Units * Number of opportunities per unit

Defects Per Million Opportunities (DPMO): Example



5 defect opportunities



Total number of opportunities = Units * Number of opportunities per unit

= 7 * 5 = 35 total opportunities

$$\text{DPMO} = \frac{\text{Total number of defects}}{\text{Total number of opportunities}} * 10^6$$

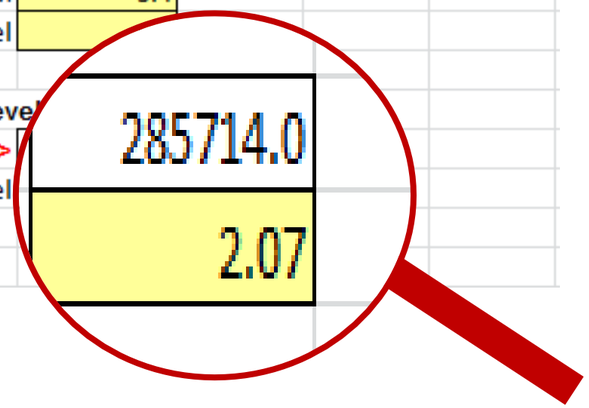
$$= \frac{10}{35} * 10^6 = \textbf{285714 DPMO}$$

Sigma Level: Introduction

Sigma Level is a measure of the error rate of the process.

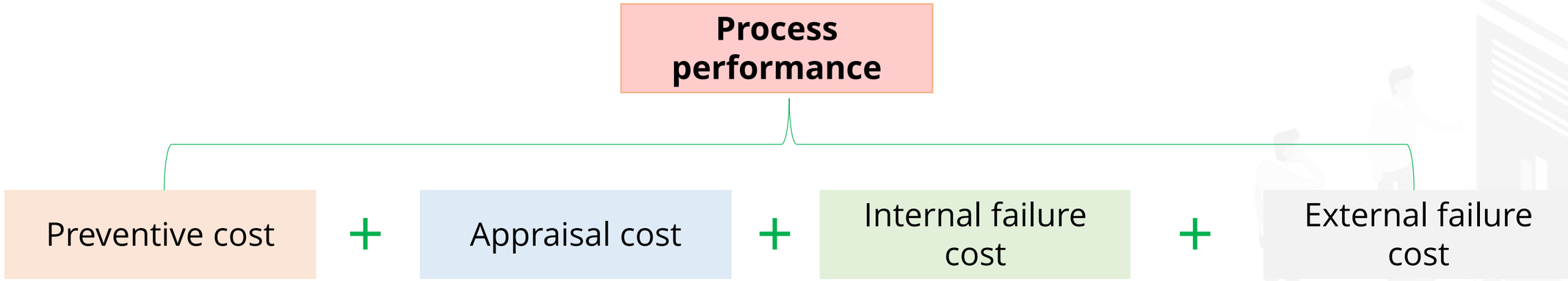
Sigma levels are generally based on DPMO.

	A	B	C	D	E
1					
2	**Enter process sigma level, compute PPM**				
3	Process Sigma Level ->	6			
4	PPM	3.4			
5	Percent	0.00034%			
6					
7	**Enter percent, compute PPM and process sigma level**				
8	If the percent is less than 1, you must use the percent sign after the number (e.g., 0.01%)				
9	Percent ->	0.00034%			
10	PPM	3.4			
11	Process Sigma Level				
12					
13	**Enter DPMO, compute process sigma level**				
14	DPMO ->	285714.0			
15	Process Sigma Level	2.07			
16					
17					



Cost Of Quality (COQ): Introduction

Cost of Quality (COQ) is the cost incurred by a process because it cannot consistently make a perfect product.



Cost Of Quality (COQ): Introduction

Cost of Quality (COQ) is the cost incurred by a process because it cannot consistently make a perfect product.

Process performance

Preventive cost + Appraisal cost + Internal failure cost + External failure cost

Cost incurred in preventing a failure

Example: Training and improvement programs

Cost Of Quality (COQ): Introduction

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Process performance

Preventive cost + Appraisal cost + Internal failure cost + External failure cost

Cost incurred to test a product for quality conformance

Example: Testing, audits, and inspection

Cost Of Quality (COQ): Introduction

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Process performance

Preventive cost + Appraisal cost + Internal failure cost + External failure cost

Cost associated with defects identified before a product reaches the customer

Example: Rework and scrap

Cost Of Quality (COQ): Introduction

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Process performance

Preventive cost + Appraisal cost + Internal failure cost + External failure cost

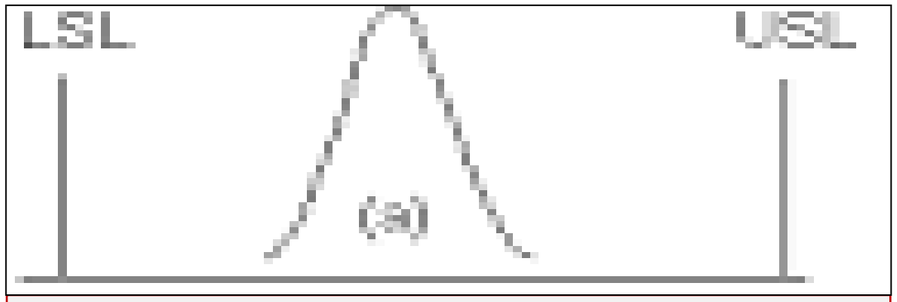
Cost associated with defects after a product reaches the customer

Example: Warranty claims, returned products, and loss in reputation

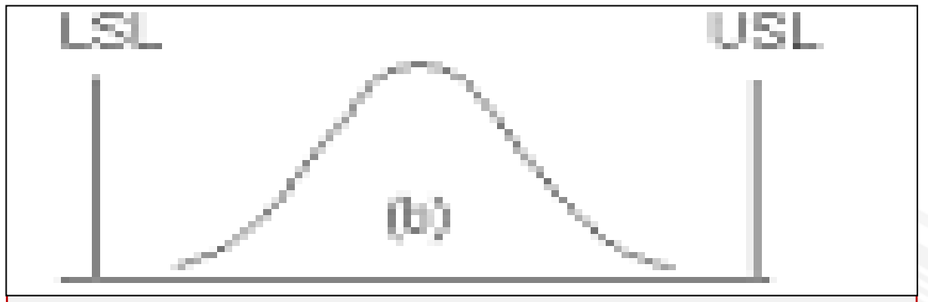
Process Capability (Cp)

Process Capability (Cp) and Process Capability Indices (Cpk) is defined as the inherent variability of a characteristic of a process or a product.

USL

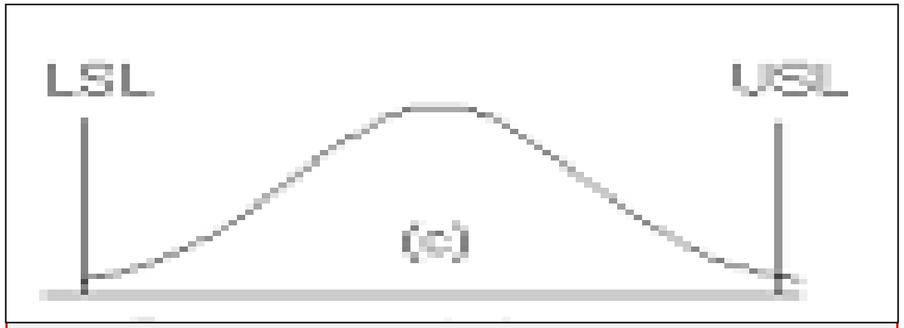


Process meets specification limits

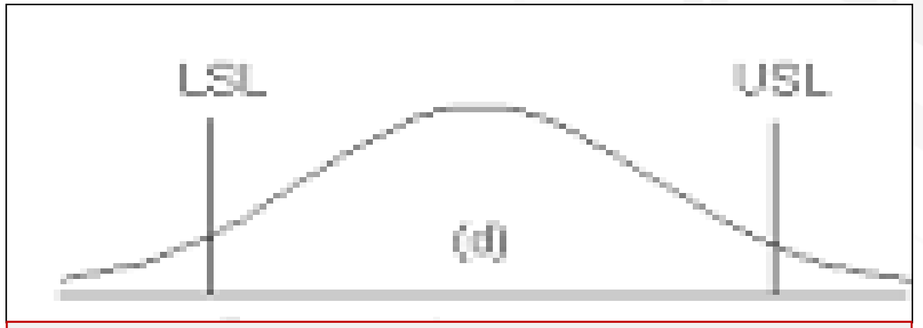


Process comfortably meets specification limits

LSL



Process only meets specification limits. Any shift or spread will result in failures.



Process does not meet specification limits. There are many failures.

Process Capability (Cp): Formula

$$Cp = \frac{\text{Upper specification limit (USL)} - \text{Lower specification limit (LSL)}}{6\sigma}$$

Key Takeaways

- DPU is the average number of defects per unit of a product.
- TPY is the number of acceptable pieces divided by the number of starting pieces.
- RTY is the probability of the entire process producing zero defects.
- FPY is the number of products which pass without any rework of the total number of units.

Key Takeaways

- DPMO or NPMO is a measure of process performance.
- Sigma Level is a measure of the error rate of the process.
- COQ is the cost incurred by a process because it cannot consistently make a perfect product.
- Cp is defined as the inherent variability of a characteristic of a process or a product.

Knowledge Check

Knowledge Check 1

A process has finished running and produced 5 parts. Each part has three opportunities. The inspector found 2 defects. What is the Defect Per Unit (DPU)?

A. 0.13

B. 0.67

C. 0.6

D. 0.5

Knowledge Check 1

A process has finished running and produced 5 parts. Each part has three opportunities. The inspector found 2 defects. What is the Defect Per Unit (DPU)?

A. 0.13

B. 0.67

C. 0.6

D. 0.5

The correct answer is **A**

Total defects/ Total opportunities = 2/(3*5) = 0.13

Knowledge Check 2	If we want to compare the performance of different processes, which metric should we use?

A. RTY

B. DPMO

C. DPU

D. FPY

Knowledge Check 2	If we want to compare the performance of different processes, which metric should we use?

A. RTY

B. DPMO

C. DPU

D. FPY

The correct answer is **B**

Defects per million opportunities, or DPMO, standardizes the number of defects at the opportunity level and allows comparison of the processes with different complexities.