Introduction to Six Sigma

(DMAIC Model)

FREE Professional Development Seminar Series

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Agenda

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- About 3FOLD
- What is Six Sigma?
- The DMAIC Model
- Q&A
- Certificate Collection

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About 3FOLD

3FOLD Education Centre

- Established in 2008
- Branches in Abu Dhabi, Dubai and Doha
- Approved by KHDA, PMI, AACE, ASQ, IMA and AACE
- One of the 3 ASQ approved training center to deliver Six Sigma certification training in UAE
- The most economical institute for the official ASQ trainings in UAE

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The need for Six Sigma

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- Every company or organization (even so-called not-for-profits) must make money in some form or another to stay in business. If an organization **spends more than it takes in**, then it will be out of business.
- Thus, the challenge for every organization is to become profitable at whatever it does so that it can continue to do what it does.
- Managers, employees, suppliers, and customers all have their wants and needs that the business must satisfy in an efficient manner so profit can be achieved.
- Thus the first formula that every Six Sigma Green Belt must learn is the S-bar calculation: **$!**

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What is Six Sigma?

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- Six Sigma is a structured and disciplined process designed to deliver perfect products and services on a consistent basis.
- It aims at improving the bottom line by finding and eliminating the causes of mistakes and defects in business processes.
- *Sigma* is a statistical term that refers to the standard deviation of a process about its mean.

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Different Opinion about Six Sigma

- ***Philosophy.*** The philosophical perspective views all work as processes that can be defined, measured, analyzed, improved, and controlled (DMAIC).
- Processes require inputs and produce outputs. If you control the inputs, you will control the outputs. This is generally expressed as the $y = f(x)$ concept.

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Different Opinion about Six Sigma

- *Set of tools.* Six Sigma as a set of tools includes all the qualitative and Quantitative techniques used by the Six Sigma expert to drive process improvement.
- A few such tools include SPC, control charts, failure mode and effects analysis, and process mapping. There is probably little agreement among Six Sigma professionals as to what constitutes the tool set.

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Different Opinion about Six Sigma

- *Methodology.* This view of Six Sigma recognizes the underlying and rigorous approach known as DMAIC. DMAIC defines the steps a Six Sigma practitioner is expected to follow, starting with identifying the problem and ending with the implementation of long-lasting solutions.
- While DMAIC is not the only Six Sigma methodology in use, it is certainly the most widely adopted and recognized.

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Different Opinion about Six Sigma

- *Metrics.* In simple terms, Six Sigma quality performance means 3.4 defects per million opportunities (accounting for a 1.5-sigma shift in the mean).

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Define

- Management commitment—PDSA
- SIPOC (supplier, input, process, output, customer)
- Define the problem—five whys and how
- Systems thinking
- Process identification
- Flowchart
- Project management

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Measure

- Management commitment—PDSA
- Identify a data collection plan
- Measurement systems analysis (MSA)
- Collect data—check sheets, histograms, Pareto charts, run charts,
- scatter diagrams
- Identify variability—instability, variation, off-target

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Analyze

- Management commitment—PDSA
- Continual improvement
- Preventive maintenance
- Cleanliness
- Benchmark—continue process
- Central limit theorem
- Experiments

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Improve

- Management commitment—PDSA
- Process improvement
- Organizational development
- Variation reduction
- Problem solving
- Brainstorm alternatives
- Create "should be" flowcharts
- Conduct FMEA
- Cost of quality

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Control

- Management commitment—PDCA
- Control plan
- Dynamic control plan (DCP)
- Long-term MSA
- Mistake-proofing
- Process behavior charts
- Update lessons learned

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Define – Example (DPMO)

Calculate the DPMO. The bulleted list below indicates the number of opportunities for a defect during each step in the process:

- Step 1 - Apply paint: two opportunities for defect
- Step 2 - Affix decals: three opportunities for defect
- Step 3 - Apply clear coat/varnish: five opportunities for defect

Apply paint	Affix decals	Apply clear coat
Units = 100	Units = 100	Units = 100
Defects = 2	Defects = 1	Defects = 1
Opportunities/unit = 2	Opportunities/unit = 3	Opportunities/unit = 5

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Example (Cont)

DPMO = $(Total_{defects} / Total_{opportunities})(1{,}000{,}000)$

$\mathbf{Total_{defects}} = 2 + 1 + 1 = 4$

$\mathbf{Total_{opportunities}} = (Total_{opportunities/unit})(Total_{units})$

$\mathbf{Total_{opportunities/unit}} = 2 + 3 + 5 = 10$

$\mathbf{Total_{units}} = 100$

$\mathbf{Total_{opportunities}} = (Total_{opportunities/unit})(Total_{units}) = (10)(100) = 1{,}000$

DPMO = $(4/1{,}000)(1{,}000{,}000) = 4{,}000$

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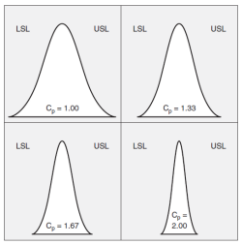
Measure Examples – (Process Capability)

$$C_{pk} = \min\left(\frac{USL - \bar{x}}{3\hat{\sigma}}; \frac{\bar{x} - LSL}{3\hat{\sigma}}\right)$$



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Measure Examples – (Process Capability)

- **To calculate C**pk**, subtract X value from the nearest spec limit, then divide the value by 3 sigma**
- **Given:** X = 7, short-term sigma = 1, and Specifications = 10 +/- 4
- Cpk = (7 - 6) / 3
- Cpk = 0.33

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Cp and Cpk Values

1. Cp = 2 and Cpk = 1.5 are the values given when a process has achieved six sigma quality.
2. Cp, Cpk ≥ 1.33 shows that the process is capable
3. A Cp, Cpk value of 1.0 means that the process barely meets the specification. This will produce 0.27 percent defective units
4. A Cp, Cpk value less than 1.0 means that the process is producing units outside engineering specifications.
5. Abnormally high Cp, Cpk (>3) shows either that the specifications is loose or identifies an opportunity to move to a less expensive process.

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Practical Example

- In a government department, the target average time to serve a customer is 20 Minutes.
- Variations are too high and the customers started to complain about the quality of service.
- We want to set a specification limit of minimum 10 minutes to maximum 30 minutes to serve a customer with a target of 20 minutes.
- We want the chance of a customer to be served out of this range to be less 0.000000002 Which means the chance of a customer to be served out of this specification is 2 out of a billion!

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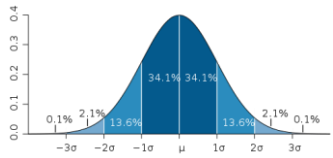
Normal Distribution



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Solution

- The areas under standard normal curve tells us that the chance of things father than 6 SD from the mean happening is less than 2 out of a billion!
- So if we want the chance of an event from 10 Mts and 30 Mts to be 0.99999999901, 10 mts and 30 mts must be 6 SD far away from the mean!

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Solution

- This means 30 minutes must be 6 x SD from mean
- $Z = (30 – \mu)/\sigma$ with a target mean of 20 Mts
- $6 = (30-20)/ \sigma$
- $\sigma = 1.67$
- We have to design a process with such reliability that it is capable of not vary more than a SD of 1.67 (1/12 of spec tol)

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Analyze Example – Hypothesis Testing

EXAMPLE

A vendor claims that the average weight of a shipment of parts is 1.84. The customer randomly chooses 64 parts and finds that the sample has an average of 1.88. Suppose that the standard deviation of the population is known to be 0.03. Should the customer reject the lot? Assume that the customer wants to be 95 percent confident that the supplier's claim is incorrect before he or she rejects.

1. Conditions (a) and (b) are met.
2. H_0: $\mu = 1.84$, H_1: $\mu \neq 1.84$; this is a two-tail test.
3. From the problem statement, $\alpha = .05$.
4. Critical values are the Z-value that has .025 to its right and the negative of this value. These values are 1.96 and –1.96. The reject region consists of the area to the right of 1.96 and the area to the left of –1.96.
5. $Z = (1.88 - 1.84)\sqrt{64}/(.03) = 10.7$
6. Since 10.7 is in the reject region, H_0 is rejected.
7. At the .05 significance level, the data suggest that the vendor's assertion that the average weight is 1.84 is false.

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Analyze Example – Hypothesis Testing

- **TWO-SAMPLE T TEST-** A health management firm has samples of satisfaction ratings from former patients of two hospitals, and wants to know if one is rated more highly than the other. The information will be used to refer patients and to make suggestions for hospital improvement. The variances of the two samples were found to be sufficiently similar, so a pooled standard deviation will be used for the test.

```
Paired T for Before - After

               N     Mean   StDev  SE Mean
Before        15   74.667   3.478    0.898
After         15   72.333   3.200    0.826
Difference    15    2.333   3.352    0.866

95% CI for mean difference: (0.477, 4.190)
T-Test of mean difference = 0 (vs ≠ 0): T-Value = 2.70  P-Value = 0.017
```

Interpretation: Since the hospital satisfaction data were analyzed with an α-level of 0.05, a 95% (or 0.95) confidence interval was constructed. This interval tells you that, based on the sample data, you can be 95% confident that the difference, μA - μB, is greater than or equal to 10.79 and less than or equal to 32.61. Since the reference value of 0 is not within the confidence interval, you can reject H_0 with 95% confidence and conclude that the population means are not the same.

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Improve Example - DOE

Experiment Error for a Three Factor Two-Level Experiment Desgin					
Treatment Combination or Run	Factor			First Measured Response	Second Measured Response
	Temperature	Pressure	Time		
1	400	50	10	Y.1.1	Y.1.2
2	600	50	10	Y.2.1	Y.2.2
3	400	100	10	Y.3.1	Y.3.2
4	600	100	10	Y.4.1	Y.4.2
5	400	50	20	Y.5.1	Y.5.2
6	600	50	20	Y.6.1	Y.6.2
7	400	100	20	Y.7.1	Y.7.2
8	600	100	20	Y.8.1	Y.8.2

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Control Charts - Guide

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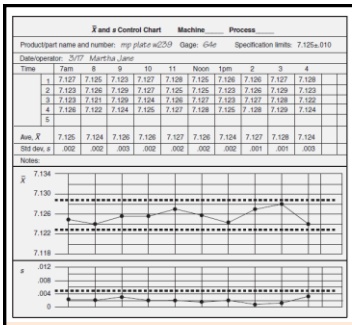

$\bar{X}$ and s Control Charts

The formula calculations:

$UCL_{\bar{x}} = \bar{\bar{X}} + A_3\bar{s} = 7.126 + (1.628)(.0020) = 7.129$

$LCL_{\bar{x}} = \bar{\bar{X}} + A_3\bar{s} = 7.126 - (1.628)(.0020) = 7.123$

Control limits for the standard deviation chart:

$UCL_s = B_4\bar{s} = (2.266)(.0020) = .005$

$LCL_s = B_3\bar{s} = 0(.0020) = 0$

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Q & A

ANY QUESTIONS ?

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Upcoming Training Schedule for Six Sigma

Abu Dhabi

Batch Start Date: November 26, 2016
Batch End Date: December 24, 2016
Frequency: 5 Saturdays
Timing: 5 PM – 9 PM

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END OF SEMINAR

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