Binomial Process Capability

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Learn to perform Binomial Process Capability
&
use it to take decisions

Level of Difficulty

High

Attribute Data

An external Audit firm checks the HR records of employees (new joinees) every month. They pick 35 samples/month.

After 2 years, sample data of verification and its results.

a) Calculate the process capability of the process (Defective PPM)

b) What is the probability that in the coming month sample of 35 records, we will have 34 correct?

Data Transformation

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When & how to use Data Transformation for Process Capability?

Box-Cox Transformation & Johnson Transformation

Level of Difficulty

High

Time Process Data

Data is collected for computing the capability from a lead time for process. Customer spec is 90 mins maximum.

Performing Pre-Checks in Minitab

Non-Normal Data

- Box-Cox Transformation
- Johnson Transformation

Box-Cox Data Transformation

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Simple transformation of non-normal data using Lambda to a normal data.

Lambda (λ) value	Transformation
$\lambda = 2$	$Y' = Y^2$
$\lambda = 0.5$	$Y' = \sqrt{Y}$
$\lambda = 0$	$Y' = \ln Y$
$\lambda = -0.5$	$Y' = 1 / (\sqrt{Y})$
$\lambda = -1$	$Y' = 1 / Y$

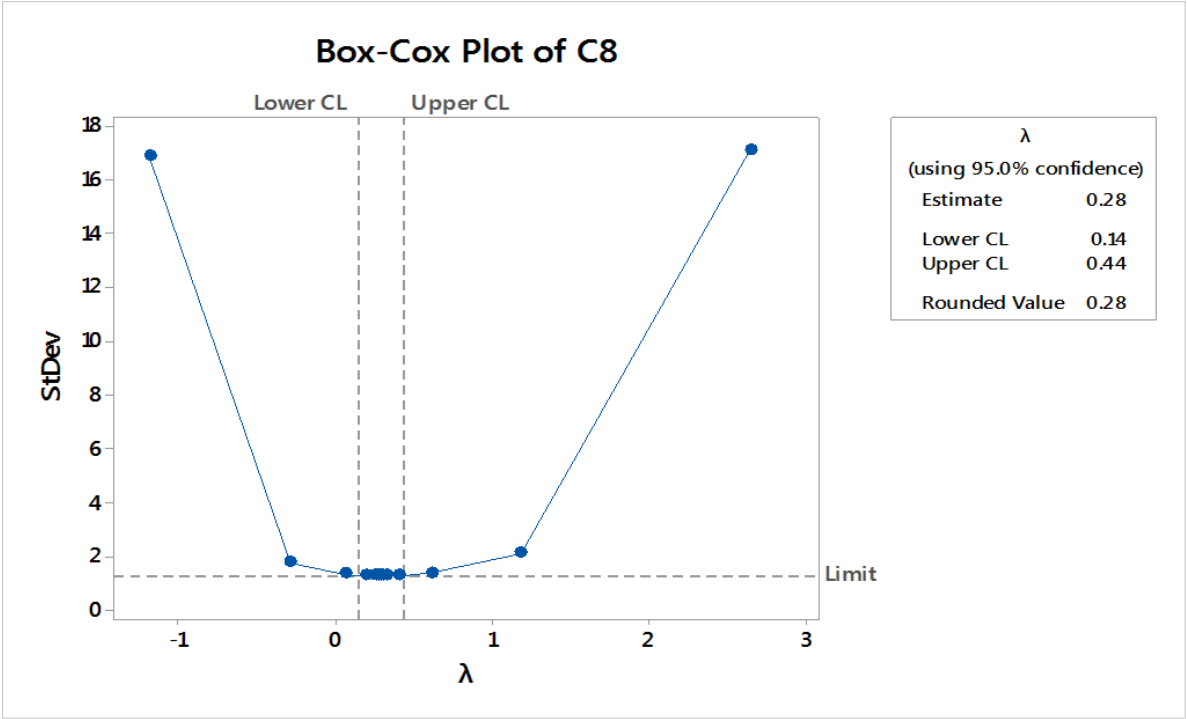
May not work in all scenarios

Depends on selection of Lambda value

Can't take negative values

Box Cox Transformation Process Capability

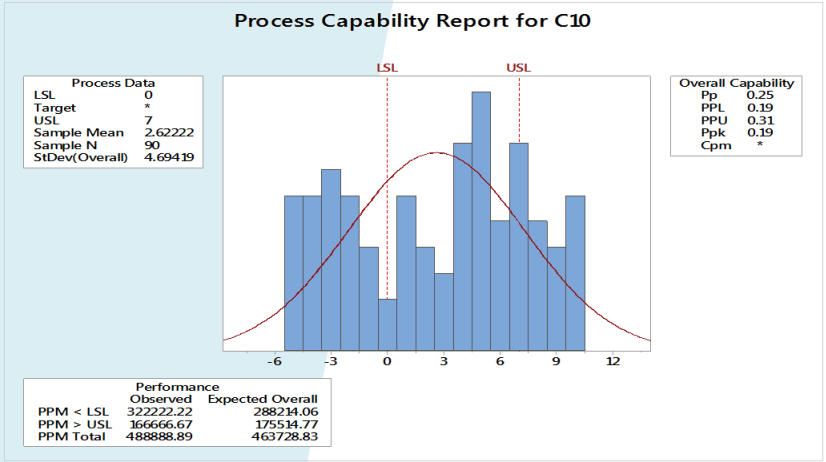
Box-Cox Transformation Plot



Johnson Data Transformation

- More robust than Box-Cox Transformation
- May not work in all scenarios
- Can take negative values
- Uses a family of transformation variables

Johnson Transformation Process Capability



Tips for Data Transformation

- Use Transformation functions cautiously
- Prefer to fix normality issue and run Normal Process Capability (Normal Distribution)
- Use Weibull Process Capability (Non-normal distributions)

Process Capability Analysis

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How to interpret the results of Process Capability Analysis?

Narrowing down on improvement strategies

Level of Difficulty

High

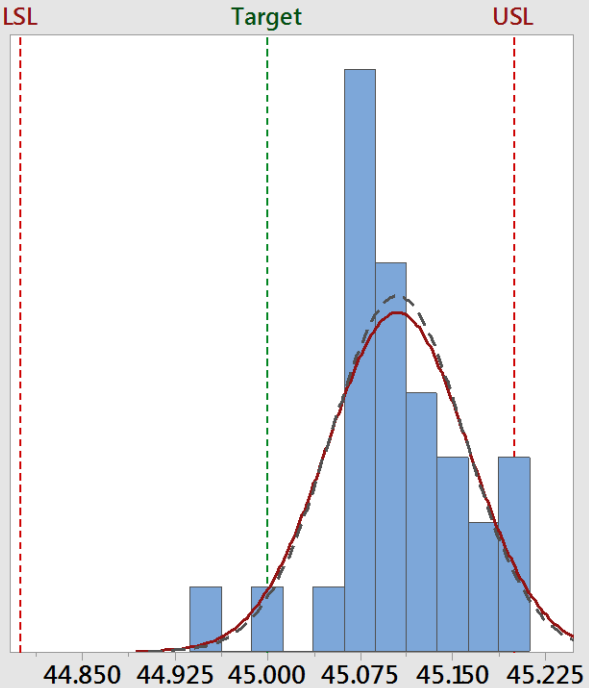
Interpreting the Minitab Results

30 data points have been collected of a process has been collected such that 2 data points are collected consecutively in every hour.

Process Specs are 44.8 & 45.2 target center of 45.0.

Process Capability Report for Dimension_1

Process Data	
LSL	44.8
Target	45
USL	45.2
Sample Mean	45.1056
Sample N	30
StDev(Overall)	0.0571264
StDev(Within)	0.0544406



Overall
Within

Overall Capability	
Pp	1.17
PPL	1.78
PPU	0.55
Ppk	0.55
Cpm	0.55

Potential (Within) Capability	
Cp	1.22
CPL	1.87
CPU	0.58
Cpk	0.58

Performance			
	Observed	Expected Overall	Expected Within
PPM < LSL	0.00	0.04	0.01
PPM > USL	33333.33	49176.29	41420.12
PPM Total	33333.33	49176.33	41420.13

Interpretation of Results

Visual analysis

- Fit to normal
- Within & Overall Curves

Numericals

- Cp & Cpk
- Pp & Ppk
- Cpk & Ppk

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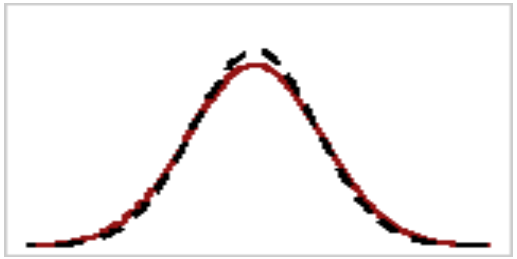
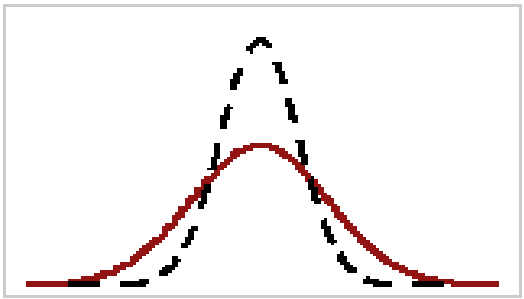
Within & Overall Curves





Not very important when subgroup size =1

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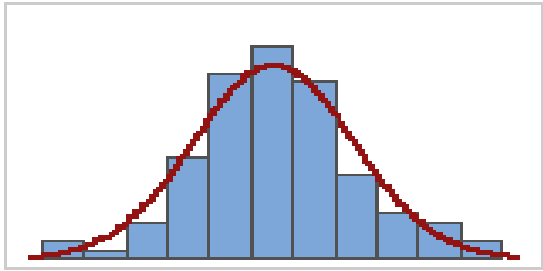
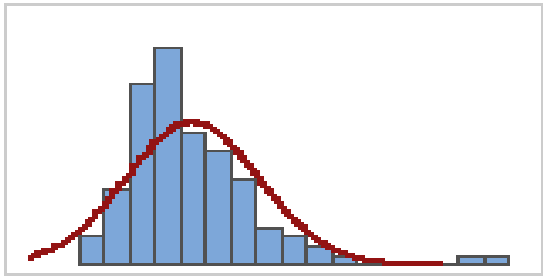
Fit to normal





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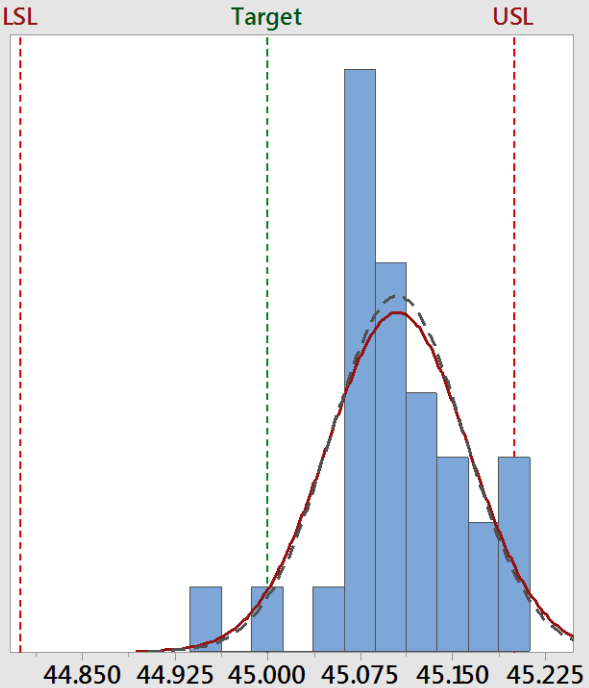

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Process Capability Results

Observed Performance: Actual Performance as per measured data

Expected Overall Performance: Expected Performance over a period of time.

Expected Within Performance: Potential for Improvement on long term if variation & centre issues are corrected.

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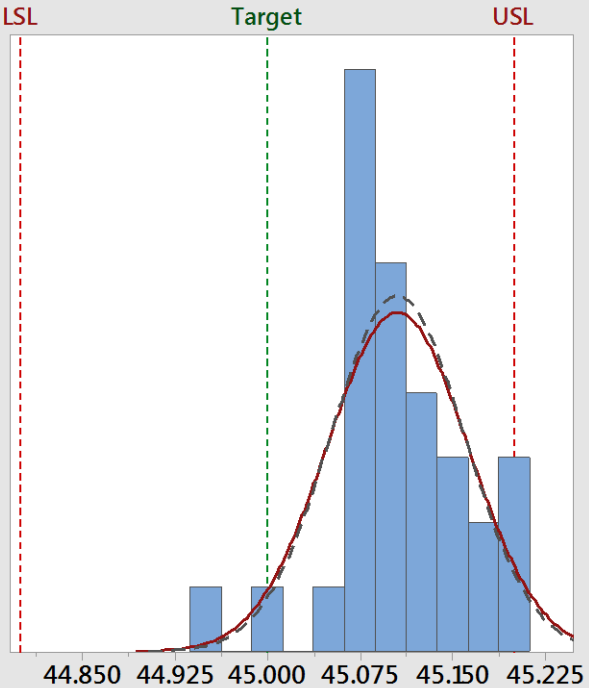

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Study Capability Indices

Cp, Cpk

&

Pp, Ppk Values

Compare Cpk & Ppk

Cpk - Ppk = Long Term Improvement Potential

Focus on eliminating shifts and drifts

Process Capability Report for Dimension_1

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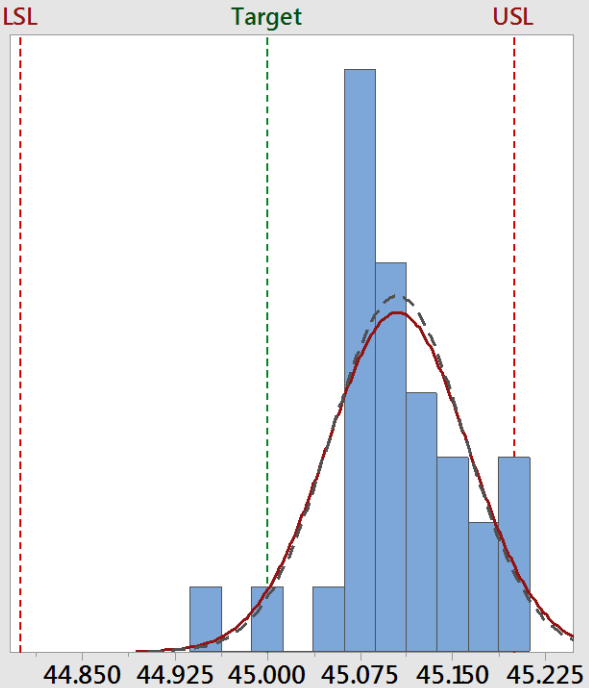

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Compare Indices

Cp ~ Cpk : Process Centred

Cp <> Cpk : Process Not Centred

Pp ~ Ppk : Process Centred

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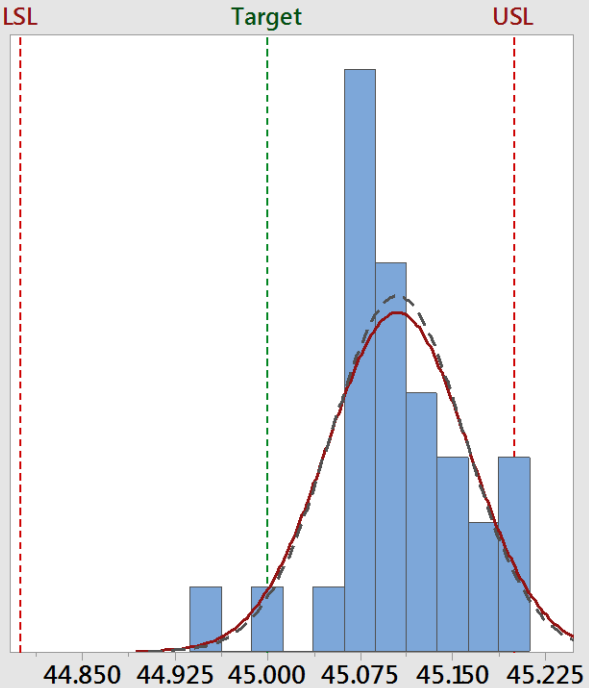

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Improvement Strategies

- Baseline Performance has been established
- Practical Problem has been converted to Statistical Problem
- Improvement Strategies:
  - Shift the process center (Cpk)
  - Reduce Variation (Cp)
  - Reduce gap between Overall & Within

Process Capability Analysis

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You will learn

How to perform Process Capability Analysis using Minitab

Level of Difficulty

High

Computing Process Capability for an accurate process

30 data points have been collected of a process has been collected such that 2 data points are collected consecutively in every hour.

Process Specs are 44.8 & 45.2 target center of 45.0.

Pre-Checks

1. Stability Check
2. Normality Check

Performing Pre-Checks in Minitab

Pre check in Minitab & go for new data set with stability

Performing Process Capability in Minitab

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Process Capability in Minitab

Performing Six Pack Analysis in Minitab

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Process Capability Six Pack in Minitab

Considerations

- Sub-grouping
- Spec & Boundaries
- Target Value
- Data Transformation
- Z-Benchmark

Process Capability Analysis in Minitab

Continued in Next Lecture….

Sub-grouping

1. Use correct sub-group size if data collection is in sub-groups
2. For Ex: If 2 samples are collected in each shift, then sub-group size is 2
3. Data has to be arranged in chronological order if sub-grouping is followed
4. If data is not collected in sub-groups, assign sub-group size as 1

Spec & Boundaries

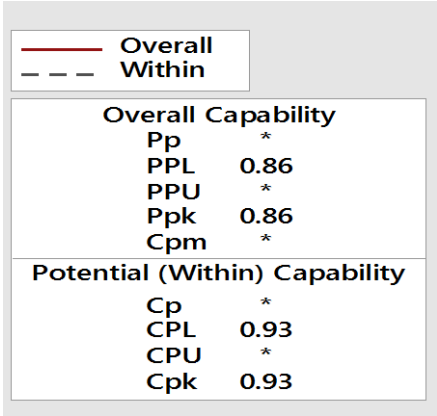
- Use only customer specifications
- If process doesn’t have one side spec, then DON’T assume a value
- Boundary means the spec is hard. There cannot be any value beyond the spec. For Ex: USL Marks in Exam is 100

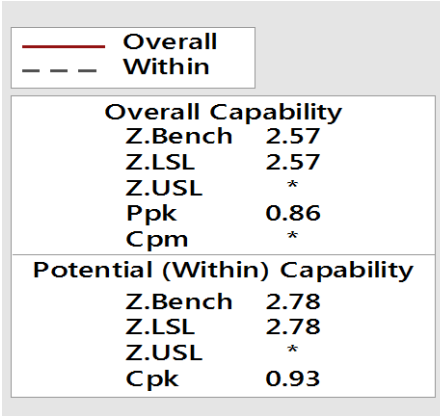
Target Value

- Target Value refers to expected process center
- Only some processes have expected center value mentioned.
- If available, mention the value.
- Only when Target value is provided, Cpm will be calculated.

Z Benchmark

Z Bench is the Sigma Level of the process.





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- Within & Overall Curves

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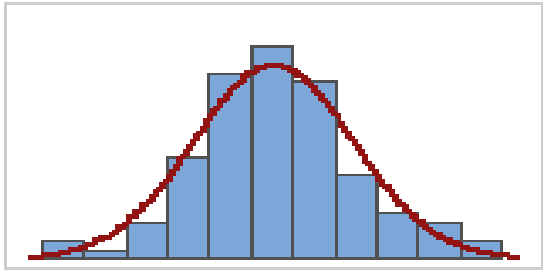
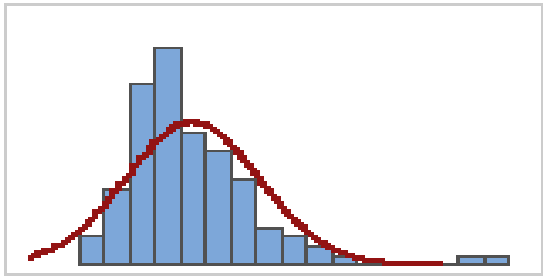
Fit to normal





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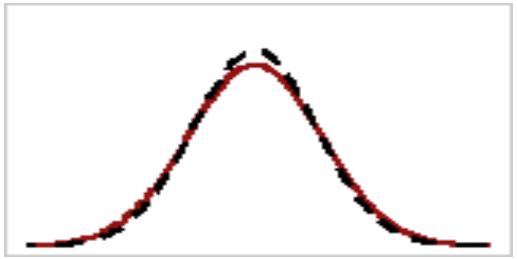
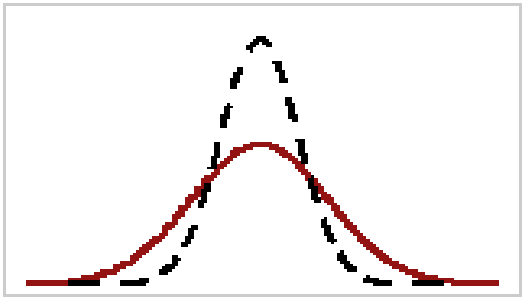
Within & Overall Curves





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Cp <> Cpk : Process Not Centred

Compare Pp & Ppk

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Process Capability Decision Tree

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You will learn

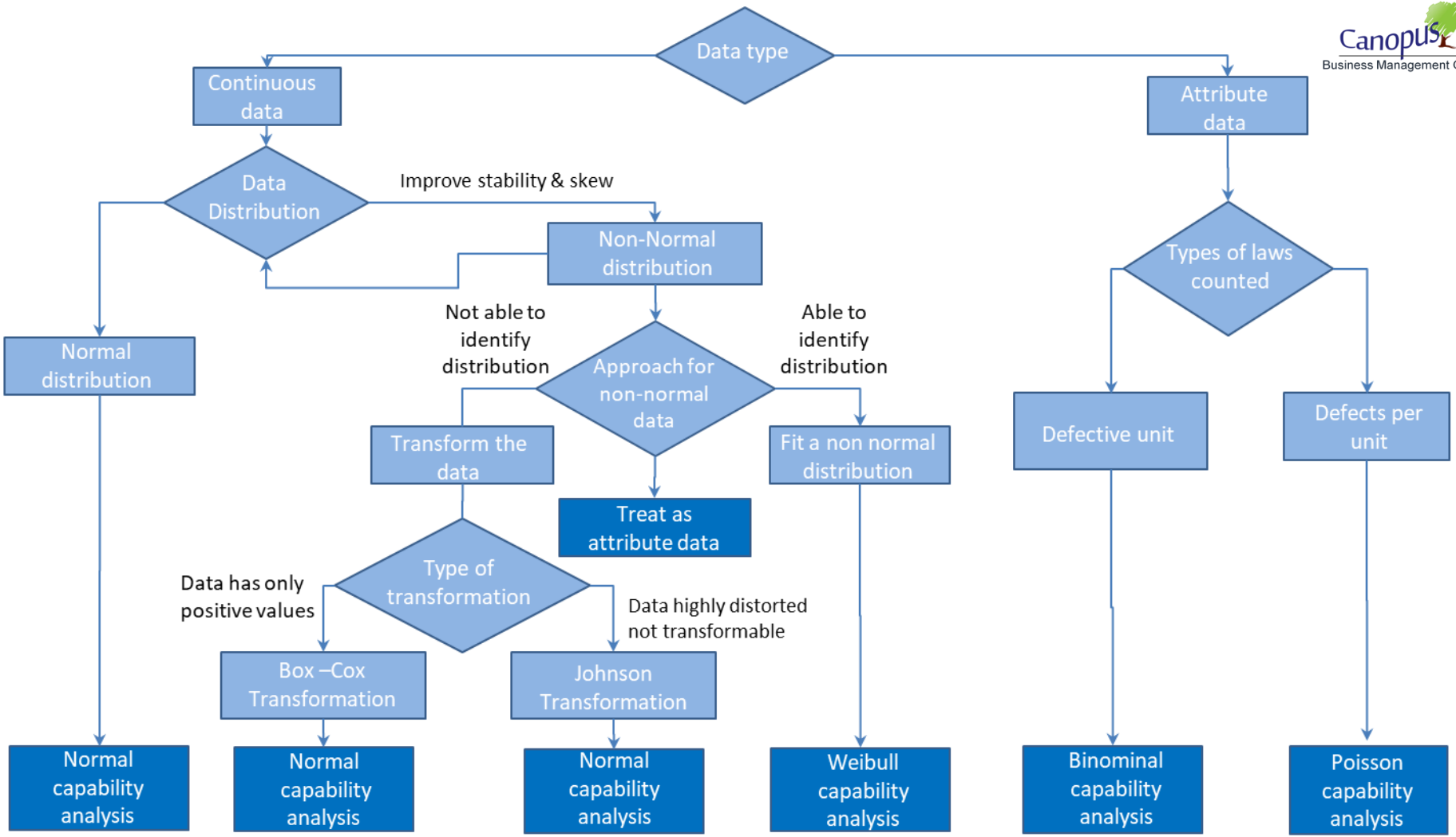
How to select the right type of Process Capability Analysis?

Level of Difficulty

High

Process Capability

Decision Tree



Weibull Process Capability

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Learn to perform Weibull Process Capability &

use it to take decisions

Level of Difficulty

High

Time Process Data

Data is collected for computing the capability from a lead time for process. Customer spec is 90 mins maximum.

Performing Pre-Checks in Minitab

Ignoring Non-normality

What if we ignore non-normality use

Normal Process Capability

Weibull Process Capability

Let’s now use Weibull Process Capability because source data is ‘Lead Time’

Performing Pre-Checks in Minitab