**H. Capability after improvements**

Management has implemented many of the recommendations made. To assess impact of the changes, data is again collected for study.

To get the data for this part of the case, generate normal random data (100 observations) with a mean of **.3751** and standard deviation of 0.0012. (Calc>Random Data>Normal Distribution).

Run a control chart on the data. (Use Stat>Control Charts>Variables Charts for subgroups. This time data is in a single column with subgroup size of 4)

Run a capability analysis using the data. (Use Stat>Quality Tools>Capability Analysis)

**H.1. Paste “after” control charts here.**

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**H.2. Analyze the control charts and describe your findings and conclusions.**

The process is in control. There is no point out of control limits, no point more than 3 standard deviations from center line. No more than 9 points in a row on same side of center line. No more than 6 points in a row, all increasing or decreasing. No more than 14 points in a row, alternating up and down.

**H.3. Paste “after” capability analysis here.**

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**H.4. Analyze the Capability Analysis and describe your findings and conclusions.**

According to the above picture of “after” Capability Report, we find that the new process has a Cp greater than 1 which infers that the process is producing a small number of nonconforming parts. The Cpu and Cpl both larger than 1 which means the data is centered in specification limit. So the Cpk is larger than 1, and that means the new process is capable. But we must use a hypothesis test to confirm this assumption.

**I. Statistical Significance of Changes**

While the changes to the process look good, management asks if they are statistically significant or not.

**I.1. At a 95% level of confidence, can you conclude there has been a reduction in the variance before (all operators) and after (improved data). Comment on the strength of the conclusion. Paste in Minitab output and discuss.**

**Descriptive Statistics: after**

Variable N N\* Mean SE Mean StDev Minimum Q1 Median Q3 Maximum

after 100 0 0.37525 0.000119 0.00119 0.37162 0.37439 0.37520 0.37613 0.37799

**Test and CI for One Variance: after**

Method

Null hypothesis σ = 0.001907

Alternative hypothesis σ < 0.001907

The chi-square method is only for the normal distribution.

The Bonett method is for any continuous distribution.

Statistics

Variable N StDev Variance

after 100 0.00119 0.000001

95% One-Sided Confidence Intervals

Upper Bound Upper Bound

Variable Method for StDev for Variance

after Chi-Square 0.00135 0.000002

Bonett 0.00135 0.000002

Tests

Test

Variable Method Statistic DF P-Value

after Chi-Square 38.48 99 0.000

Bonett — — 0.000

The StDev of “before” is 0.001907

The null hypothesis is variance has not changed, the alternative hypothesis is the “after” variance is lower.

P-Value=0.000, so we can reject the null hypothesis and at 95% confident level of confidence, the assumption that there has been a reduction in the variance before and after is plausible.

In practical terms, it means the “after” process is more stable than “before”.

**I.2. At a 95% level of confidence, what conclusion can you draw about the process mean before (all operators) and after (improved data). Paste in Minitab output and discuss.**

**Two-Sample T-Test and CI**

Sample N Mean StDev SE Mean

1 100 0.37525 0.00119 0.00012

2 240 0.37407 0.00191 0.00012

Difference = μ (1) - μ (2)

Estimate for difference: 0.001171

95% CI for difference: (0.000834, 0.001508)

T-Test of difference = 0 (vs ≠): T-Value = 6.84 P-Value = 0.000 DF = 287

The mean of “before” is 0.37407

The null hypothesis is two means have no difference, the alternative hypothesis is the two means have difference.

P-Value-0.000, so we can reject the null hypothesis and at 95% confident level of confidence, the assumption that the process mean before and after are different.

In practical terms, it means the “after” process really changed the capability.