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A Case Study: one sample t-test

The Situation

You have been asked to ensure that a recent process change has not impacted a critical dimension of your flagship product. It is absolutely critical that this critical dimension be **equal to or greater than 26 mm**. Due to the level of importance we are only willing to risk being wrong 5% of the time.

Collect Data

During the piloting phase, because we would never make a process change without piloting it first, we collected 20 samples and measured the critical dimension of each unit. A measurement systems analysis had recently been completed and we trust the measurement system is repeatable and reproducible. Here is the data

Critical Dimension
26.0266
25.6270
25.7995
24.7843
23.9433
24.0123
24.0596
24.1617
22.6681
25.8187
25.5415
24.6176
24.0489
25.8860
26.1441
23.8761
24.4975
24.1747
24.7755
23.1442

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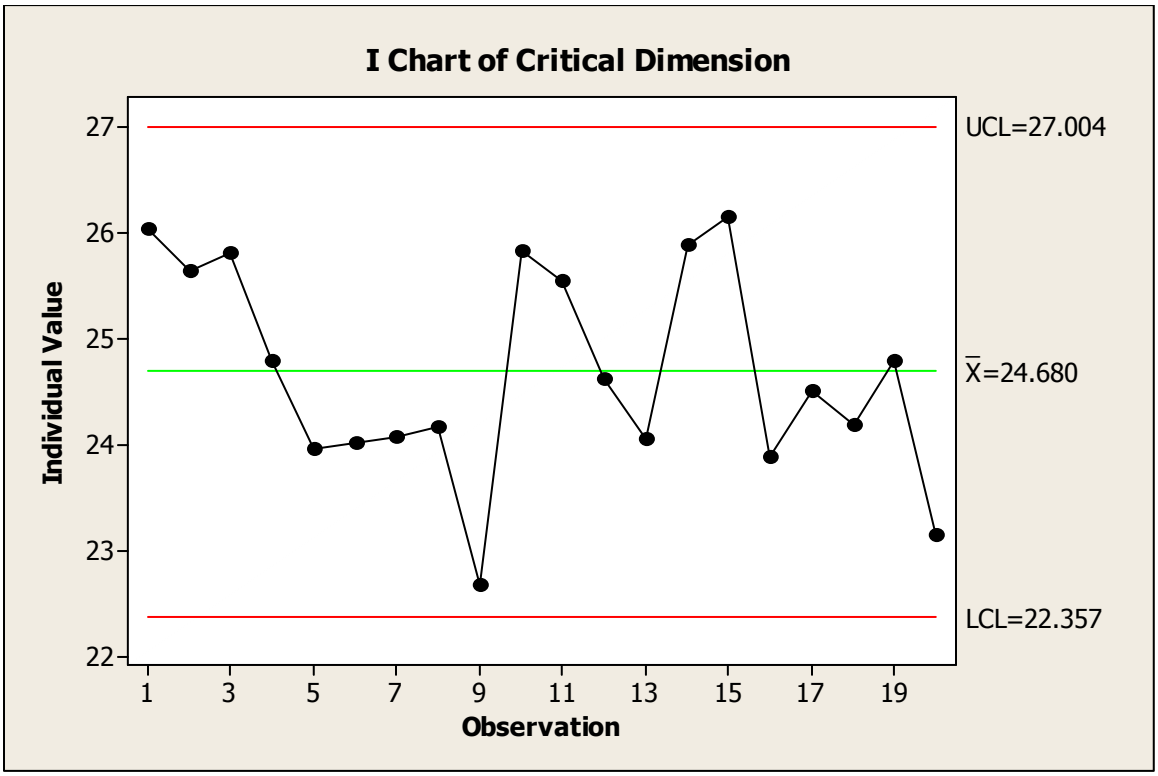
Check for stability

Our next move is to check the stability of the data. We recently read on an excellent lean six sigma blog that this was really important. So, we took our data and entered it into Minitab, which is a standard off the shelf statistical software package, and constructed an Individuals Chart (I Chart) as shown below.



While there seems to be a fair bit of common cause variation in our process it looks as though the data is relatively stable and no trends appear to be developing.

Next up we need to check out this funky thing called normality. Scroll down for more fun sports fans.

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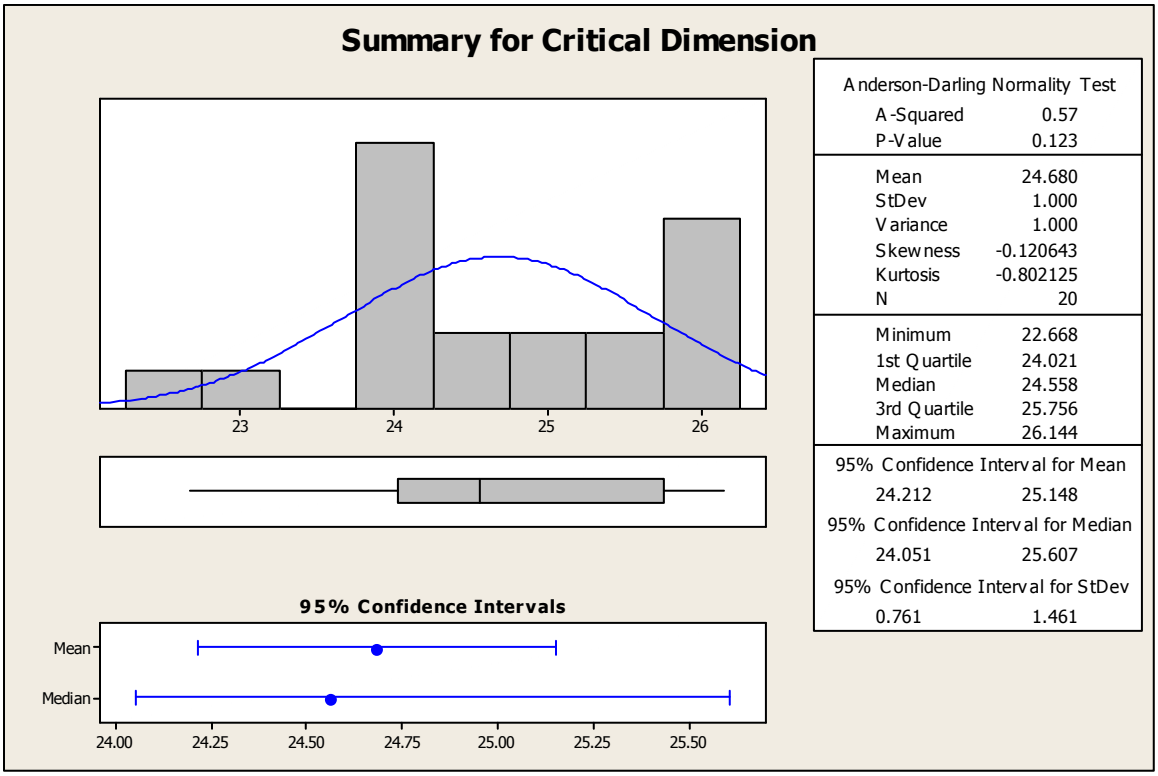
Check for normality

Our next move was to determine whether or not the data were normally distributed. To do this we used Minitab to help us study the "descriptive statistics" in a graphical manner as shown below.



Before looking at the numbers we looked at the shape of the distribution. We noticed that it was not the prettiest bell curve we had ever seen but also realized that with such as small sample size we may not want to beat ourselves up too much.

So, we took a look at the Anderson-Darling Normality Test results in the top right hand corner. Our null hypothesis (Ho) and alternate hypothesis (Ha) for this normality test are as follows:

Ho: Data are normal
Ha: Data are not normal

In this case, assuming an alpha risk of 0.05, we fail to reject our null hypothesis and state our data are normal enough for what we want to accomplish today! Had this P value been less than 0.05 we would have rejected the null and stated the data do not appear normal enough for us. But no worries we are ready to press on with our stable and normal data.

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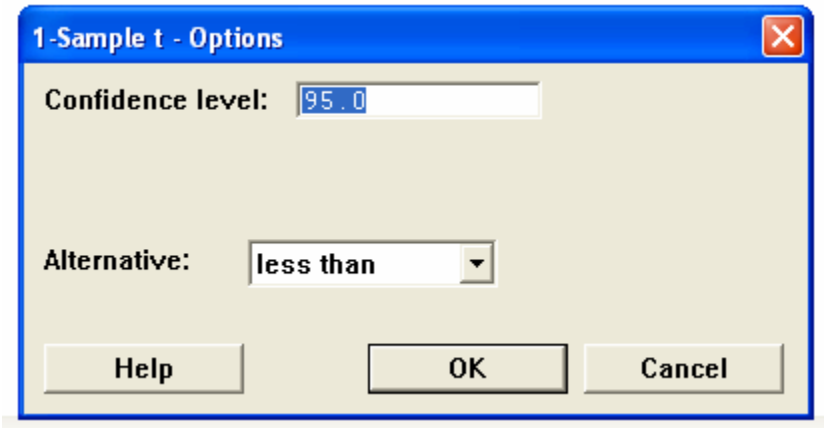
Setup the one sample t-test

We are now ready to run the one sample t-test. In this situation we will be stating our null and alternate hypothesis a bit differently so please stay focused.

If you remember back to our original objective we are only concerned if our critical dimension is less than 26 mm. In other words, **we need our critical dimension to be equal to or greater than 26 mm**. So we set things up as follows.

Ho: mu > or = 26
Ha: mu < 26

To accomplish this in Minitab we have force the alternate hypothesis to be less than by clicking the options button in the one sample t-test window which then brings us to this window where we make the change.



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The Results

Once we have everything setup and ready to go we simply press a few buttons in Minitab (using the excellent help menu anytime we get stuck) and we see the following results.

One-Sample T: Critical Dimension

Test of mu > or = 26 vs < 26

Variable	N	Mean	StDev	SE Mean	95% Upper Bound	T	P
Critical Dimensi	20	24.6804	1.0002	0.2236	25.0671	-5.90	0.000

Immediately we examine the P value and note that it is definitely lower than 0.05! And then we remembered the famous phrase we read on the aforementioned lean six sigma blog:

"If P is low, Ho must go!"

Therefore, since our P value is low we reject the null hypothesis and state with a high level of confidence (100% according to the sample of data, sample being the key word) that the new process will get us into all kinds of hot water as we should expect the critical dimension to be less than 26 mm!

To show someone graphically what we mean we can share the following graphical output from this same Minitab one sample t-test which shows the same story in a histogram with the "target" value of 26 mm noted as Ho. Notice the 95% upper bound is only 25.0671 mm! So we definitely want to hold off on this new process for awhile lest we make our customer very mad!