

# Six Sigma Statistics using Minitab 17

## Green Belt Edition

### 07 Hypothesis Testing Answers to Exercises

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# 7.11 Hypothesis Testing Exercises

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Exercise 7.11.6

Conduct a 2 sample t

Exercise 7.11.7

Conduct a chi-sq test for association.

## Example 7.11.1 PSS

### Measure the PSS of a 1 sample t

Establish the sample size that you would need for a 1 sample t test where you had a Power of 90% under the following conditions

- 1) A one-way test where you are interested only if the alternate is greater than the null hypothesis
- 2) You are interested in being able to detect a difference of 3
- 3) The historical StDev has been 5.

# Set-up

1. Click Stat <<Power & Sample Size<< 1 Sample t

Specify values for any two of the following:

Sample sizes:

Differences:

Power values:

Standard deviation:

Options... Graph...

Help OK Cancel

Alternative Hypothesis

☐ Less than

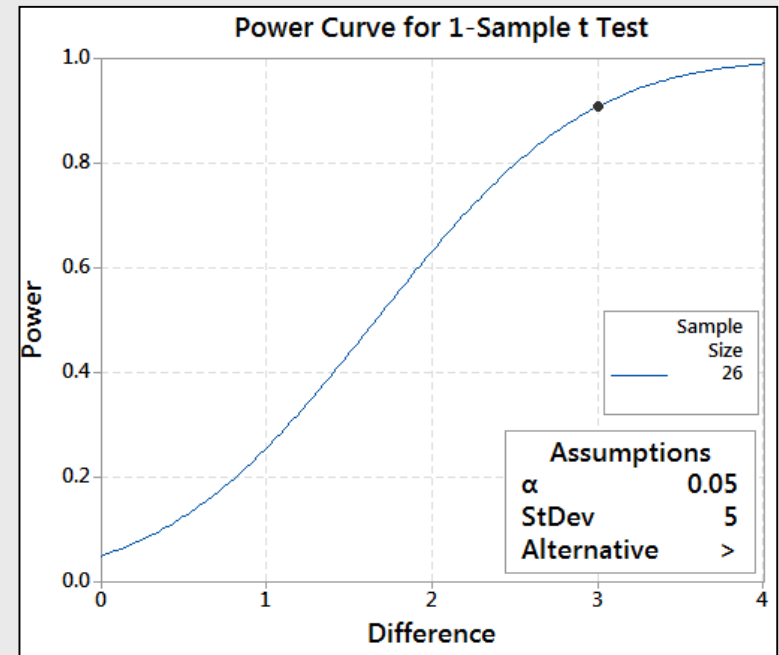
☐ Not equal

☒ Greater than

2. Complete the menu as shown and click OK to execute the procedure.

## Exercise 8.11.1

# Analysis



The power curve shows that 26 samples will be required to meet the test conditions.

## Example 7.11.2

### Measure the PSS of a 2 sample t Test

Establish the Power that you achieve with a 2 sample t test under the following conditions

- 1) A two-way test where you are only considering if the alternate is different to the null hypothesis
- 2) You have a sample size of 60 in each group.
- 3) You are interested in being able to detect a difference of 1
- 4) The historical StDev has been 3.

Before running the procedure try and estimate the power value that would be achieved and then compare your guess to the answer.

# Set-up

1. Click Stat<<Power & Sample Size<< 2 Sample t

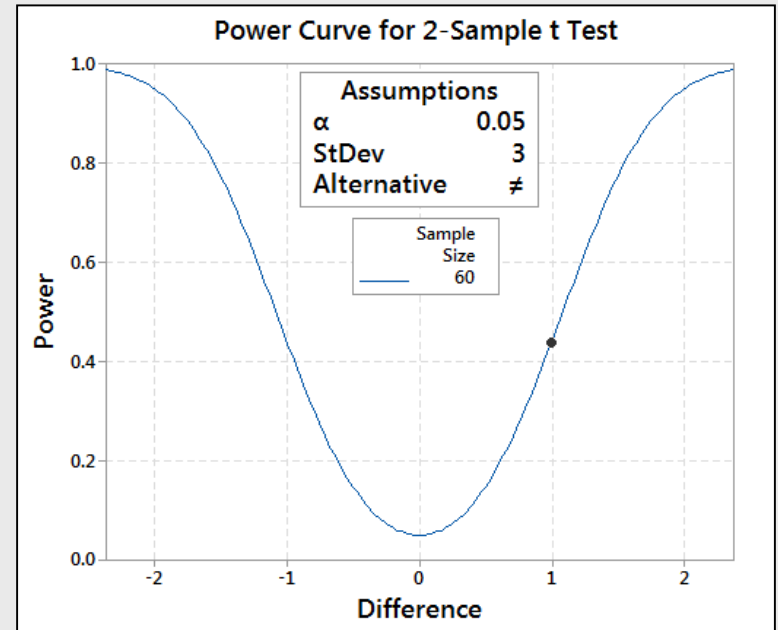
Specify values for any two of the following:

Sample sizes:	60
Differences:	1
Power values:	
Standard deviation:	3

2. Complete the menu as shown and click OK to execute the procedure.

## Exercise 8.11.2

# Analysis



The power curve shows that a Power of 44% would be achieved. This falls far short of the minimum 80% requirement.

## Example 7.11.3

### Conduct a 1 sample t Test

Analyse the data in File 07Hypothesis Testing.xlsx worksheet Ex 7.11.3 and answer the questions shown below. The data was collected randomly and is recorded in time order.

- 1) Is the sample data within Column Pressure likely to have come from a population where the mean was different to 77?
- 2) What is the confidence interval for the mean of the population?
- 3) Have the requirements of the test that you have used been met?
- 4) What was the Power of the test when you want to detect a difference of 2?
- 5) Are there any issues associated with this level of Power ?
- 6) Does the Report Card generate any warnings?

# Set-up

1. Click Stat  
<<Assistant<< Hypothesis Tests
2. Click on 1 Sample t

Sample data

Data column:

Test setup

What target do you want to test the mean against?

Target:

What do you want to determine?

☐ Is the mean of Pressure greater than 77?

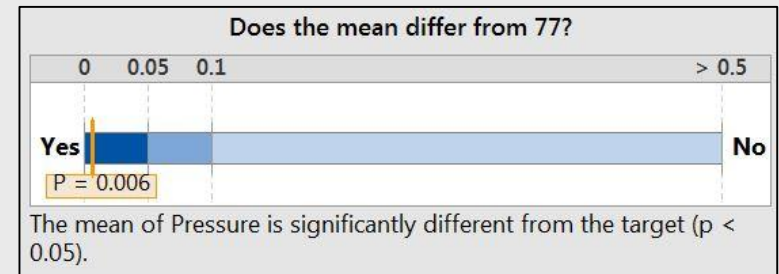
☐ Is the mean of Pressure less than 77?

☒ Is the mean of Pressure different from 77?

Difference:

3. Complete the menu as shown and click OK to execute the procedure.

# Analysis-I



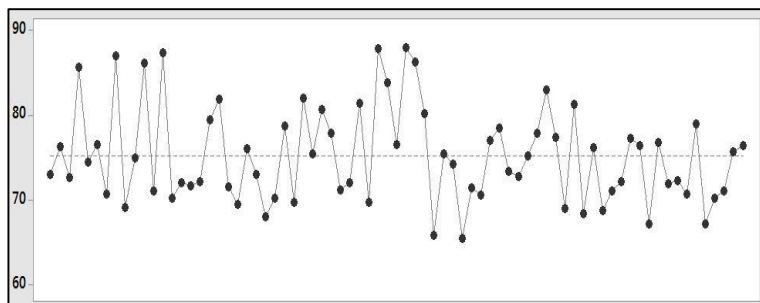
Starting from the top left of the Summary Report, the sample data within Column Pressure is likely to have come from a population where the mean was different to 77.

Statistics	
Sample size	75
Mean	75.152
95% CI	(73.852, 76.453)
Standard deviation	5.6535
Target	77

The confidence interval for the mean of the population was 73.85 to 76.45, which is obviously lower than the target we were checking against. Also, note that the sample size was 75 which shows that we met the minimum sample size requirement for normality not to be an issue.

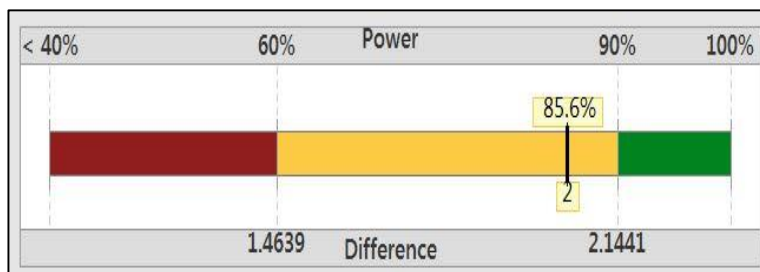


# Analysis-2



On the Diagnostic Report we see that the control chart shows that there were no unusual data points that could affect the validity of the test.

It also shows the distribution was not bi-modal.



On the Power Report we see that a Power of 85.6% was achieved. There are no issues with this level of Power as a difference was detected.

# Analysis-3

Check	Status
Unusual Data	
Normality	
Sample Size	

The Report Card did not show any warnings.

## Example 7.11.4

### Conduct a 1 sample StDev Test

Analyse the data in File 07Hypothesis Testing.xlsx worksheet Ex 7.11.3 and answer the questions shown below. The data was collected randomly and is recorded in time order.

- 1) Is the sample data within Column Pressure likely to have come from a population where the StDev was different to 5?
- 2) What is the confidence interval for the StDev of the population?
- 3) Have the requirements of the test that you have used been met?
- 4) What was the Power of the test when you want to detect a difference of 1?
- 5) Are there any issues associated with this level of Power ?
- 6) Does the Report Card generate any warnings?

# Set-up

1. Click Stat  
<<Assistant<< Hypothesis Test
2. Click on 1 Sample StDev

Sample data

Data column:

Test setup

What target do you want to test the standard deviation against?

Target:

What do you want to determine?

☐ Is the standard deviation of Pressure greater than 5?

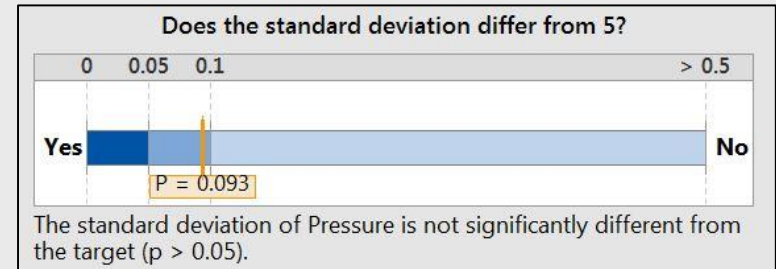
☐ Is the standard deviation of Pressure less than 5?

☒ Is the standard deviation of Pressure different from 5?

Difference:

3. Complete the menu as shown and click OK to execute the procedure..

# Analysis-I

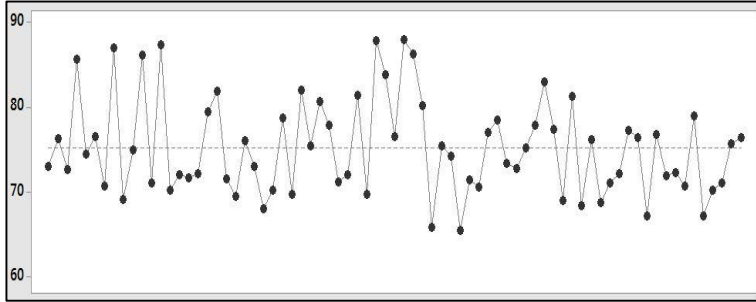


Starting at the top left of the Summary Report we cannot say if the sample data within Column Pressure is likely to have come from a population where the StDev was different to 5. This is because the P-value is within the marginal range.

Statistics	
Sample size	75
Mean	75.152
Standard deviation	5.6535
95% CI	(4.8948, 6.7049)
Target	5

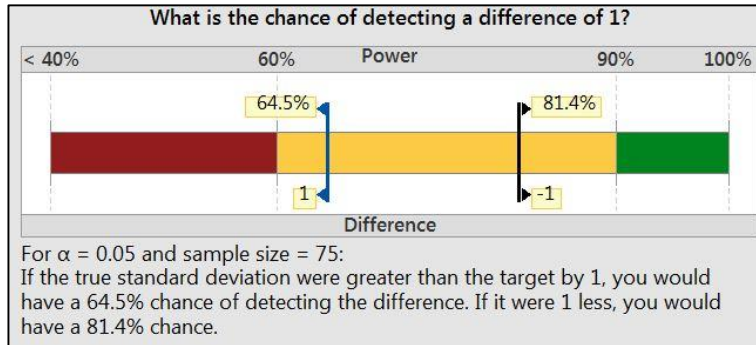
The confidence interval for the StDev of the population was 4.89 to 6.70. Interestingly, the target value of 5 is within the confidence interval. Also, note that the sample size was 75. It had to be above 40 for Minitab to be able to check if the sample data had come from a population with heavy tails.

# Analysis-2



On the Diagnostic Report we see that the control chart shows that there were no usual data points that could affect the validity of the test.

It also shows the distribution was not bi-modal.



We have two different Power values. If we had been checking for a difference of +1 the Power would be 64.5% and if we were checking against -1 it would be 81.4%.

# Analysis-3

Check	Status
Unusual Data	
Validity of Test	
Sample Size	

The Report Card shows a warning for sample size. Our sample size was insufficient to generate an adequate Power for the test conditions. We should obtain more samples in order to improve the Power. The additional data might change the P-value so we do not deem it to be marginal. If it does not we might be willing to accept a different risk level.

## Example 7.11.5

### Conduct a 2 sample StDev Test

Analyse the data in File 07Hypothesis Testing.xlsx worksheet Ex 7.11.5 and answer the questions shown below. The data was collected randomly and is recorded in time order.

- 1) Is the sample data in columns TempA and TempB likely to have come from populations with differing means?
- 2) If the populations are different, which population mean is greater?
- 3) Have the requirements of the test that you have used been met?
- 4) What was the Power of the test when you want to detect a difference of 5?
- 5) Are there any issues associated with this level of Power ?
- 6) Does the Report Card generate any warnings?

# Set-up

1. Click Stat<<Assistant<< Hypothesis Test
2. Click on 2 Sample t Test

Sample data

How are your data arranged in the worksheet?

Each sample is in its own column

Sample 1: TempA

Sample 2: TempB

Test setup

What do you want to determine?

☐ Is the mean of TempA greater than the mean of TempB?

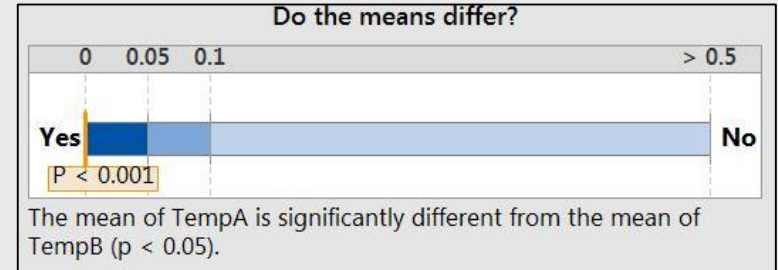
☐ Is the mean of TempA less than the mean of TempB?

☒ Is the mean of TempA different from the mean of TempB?

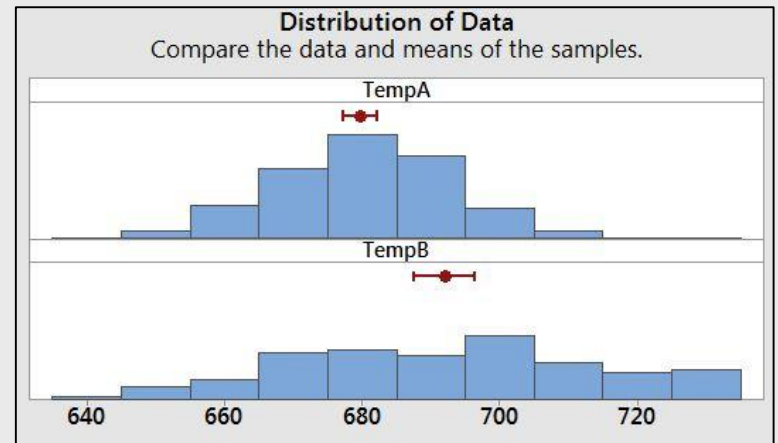
Difference: 5

3. Complete the menu as shown and click OK to execute the procedure.

# Analysis-I

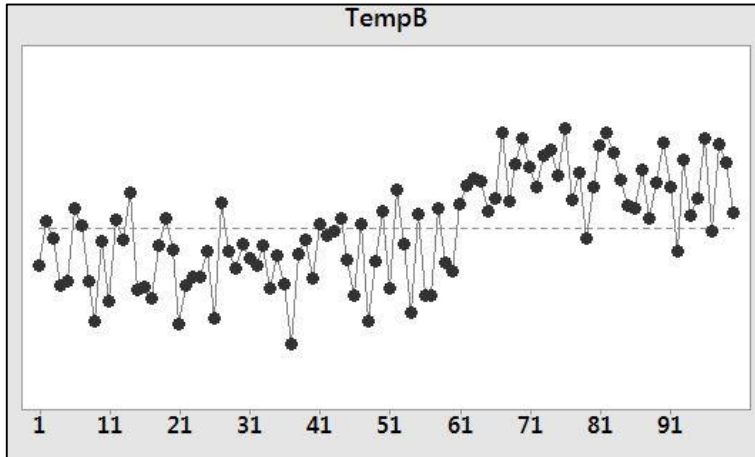


Starting at the top left of the Summary Report we can conclude that the sample data within columns TempA and TempB is likely to have come from different populations.



From the histograms under the Distribution of Data we can see that the 95% CI for the mean of TempB is greater than TempA

# Analysis-2



On the Diagnostic Report we see that the control chart for TempB in the diagnostic report shows that there has been a shift of mean value at some point within the data collection process. The shift in mean is probably due to an external factor that we have not recognised.

This means that the conclusions from our test results are likely to be wrong. We need to identify the unknown factor and control its influence on the results. We can then redo the data collection and analysis.

There is no value looking at the Power level.

# Analysis-3

Check	Status
Unusual Data	
Normality	
Sample Size	

The Report Card does not show any warnings.

## Example 7.11.6

### Conduct a 2 sample t Test

Analyse the data in File 07Hypothesis Testing.xlsx worksheet Ex 7.11.6 and answer the questions shown below. The data was collected randomly and is recorded in time order.

- 1) Is the sample data in columns Freq\_A and Freq\_B likely to have come from populations with differing means?
- 2) If the populations are different, which population mean is greater?
- 3) Have the requirements of the test that you have used been met?
- 4) What was the Power of the test when you want to detect a difference of 3?
- 5) Are there any issues associated with this level of Power ?
- 6) Does the Report Card generate any warnings?



# Set-up

1. Click Stat<<Assistant<< Hypothesis Test
2. Click on 2 Sample t Test

Sample data

How are your data arranged in the worksheet?

Each sample is in its own column

Sample 1: 'Freq\_A'

Sample 2: 'Freq\_B'

Test setup

What do you want to determine?

☐ Is the mean of 'Freq\_A' greater than the mean of 'Freq\_B'?

☐ Is the mean of 'Freq\_A' less than the mean of 'Freq\_B'?

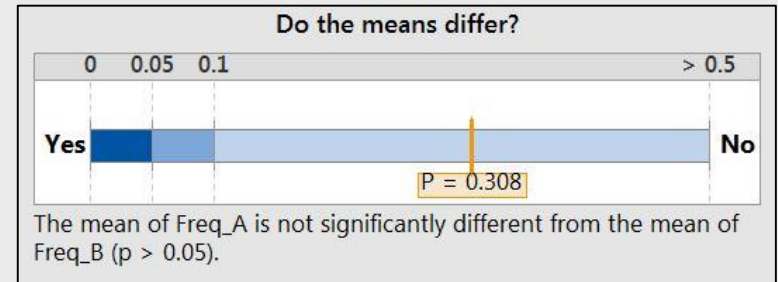
☒ Is the mean of 'Freq\_A' different from the mean of 'Freq\_B'?

Difference: 3

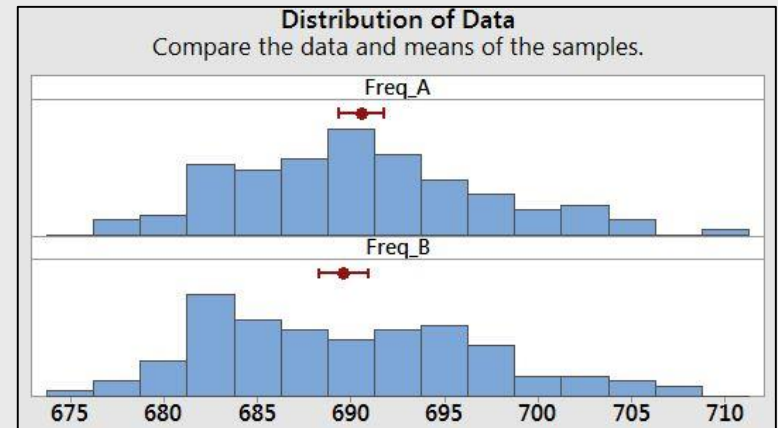
3. Complete the menu as shown and click OK to execute the procedure.

## Exercise 8.11.4

# Analysis-I

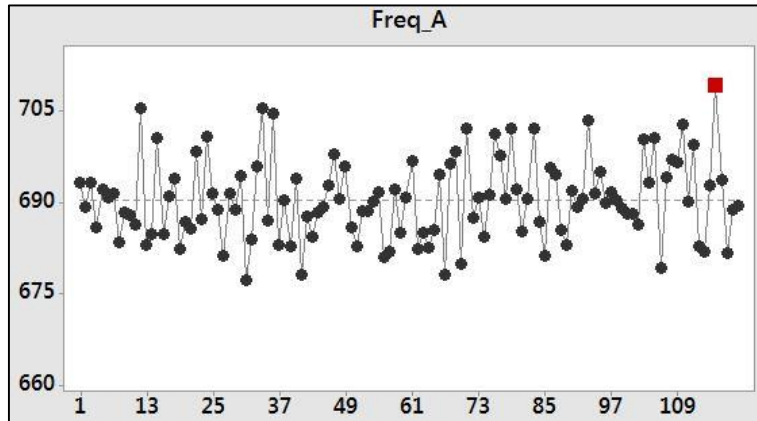


Starting from the top left of the Summary Report we cannot conclude that the sample data within columns Freq\_A and Freq\_B is likely to have come from different populations. There is insufficient evidence to reject the null hypothesis.



From the histograms under the Distribution of Data we can see that the 95% CI for the mean overlap.

# Analysis-2

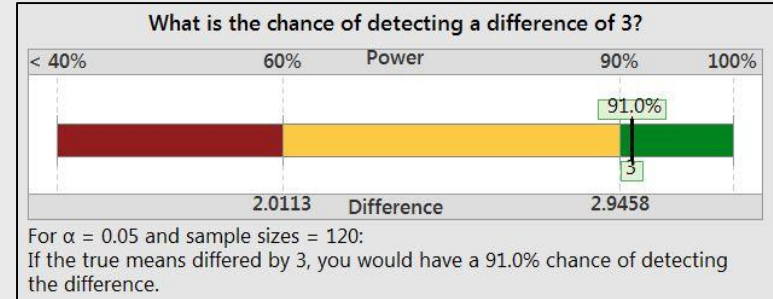


The Diagnostic Report shows us that the control chart for Freq\_A has one unusual data point. As this does not stand out we do not need to be concerned.

There is no evidence of bimodal distributions in either data set.

## Exercise 8.11.5

# Analysis-3



The Power Report shows us that under our test conditions we have a 91% chance of spotting a difference if one had existed. This is a good level of Power.

Check	Status
Unusual Data	
Normality	
Sample Size	

The Report Card does not show any warnings apart from the single data point that was deemed to be Unusual.

## Example 7.11.7

### Conduct a Chi Sq Goodness-of-Fit Test

Analyse the data in File 07Hypothesis Testing.xlsx worksheet Ex 7.11.7 and answer the questions shown below.

A questionnaire is sent to a large number of companies. In one of the questions the companies are asked to select which sector their business would come under. This is then compared with the national average, which is listed in the column called Percentage.

- 1) Are any of the population sectors different from the target samples?
- 2) Which population sectors are different from their target samples?
- 3) Have the requirements of the test that you have used been met?
- 4) Does the Report Card generate any warnings?

# Set-up

1. Click Stat<<Assistant<< Hypothesis Test
2. Click on Chi Sq Goodness-of-Fit

Sample data

Process name:  (Enter your own name or use the default.)

Complete the table below. Enter your own outcome names or use the defaults. You can type in your data, or click the arrows to get data from the current worksheet.

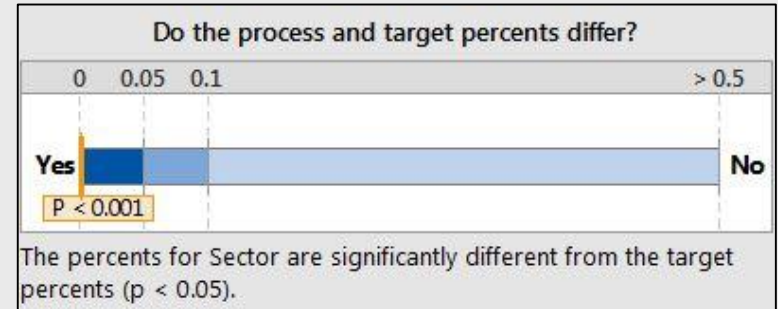
Number of outcomes:

Outcome Name	Sample Count	Target Percent
Service	942	27
Technology	254	8
Health	652	19
Food	589	20
Manufacturing	357	11
Transportation	570	15

3. Complete the menu as shown and click OK to execute the procedure.

## Exercise 8.11.4

# Analysis-I

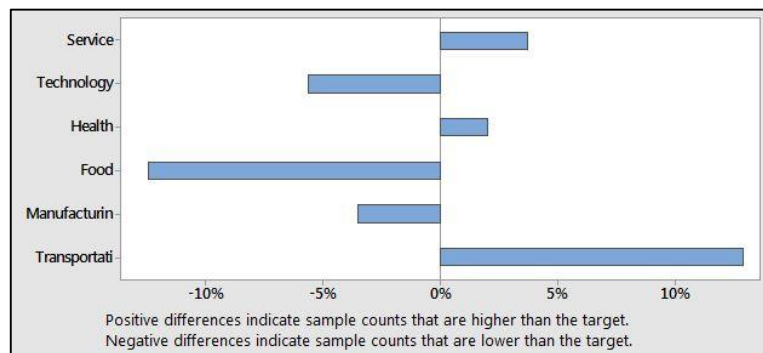


Starting from the Summary Report we see that at least one of the Sector Populations will differ from the target percentage but we don't know which one.

Outcome	Sample Percent	Target Percent	Differ
Service	28.0	27	No
Technology	7.6	8	No
Health	19.4	19	No
Food	17.5	20	Lower
Manufacturin	10.6	11	No
Transportati	16.9	15	Higher
Total count = 3364			

When we check the Outcome Table at on the top right of the Summary Report we find that the Transportation Sector is higher then the target percentage target and that the Food sector is lower.

# Analysis-2



The only graph on the Diagnostic Report shows the percentage difference between samples and targets of each of the sectors.

Outcome	Target Count	target	Sample Count	Sample Percent	Individual 95% CI
		Percent			
Service	908	27	942	28.0	(26.5, 29.5)
Technology	269	8	254	7.6	(6.7, 8.4)
Health	639	19	652	19.4	(18.0, 20.7)
Food	673	20	589	17.5	(16.2, 18.8)
Manufacturin	370	11	357	10.6	(9.6, 11.7)
Transportati	505	15	570	16.9	(15.7, 18.2)

To ensure validity of the test, the target count should be at least 1.25. To ensure validity of the intervals, the sample count should be at least 5.

The table on Diagnostic report provides us with numerical data. Below the table a statement tell us that the target count should be at least 1.25 and the sample count should be at least 5 in each category.

## Exercise 8.11.5

# Analysis-3

Check	Status
Validity of Test	<input checked="" type="checkbox"/>
Validity of Intervals	<input checked="" type="checkbox"/>

The Report Card does not show any warnings the data easily meets the conditions discussed in the Diagnostic Report.