Notes:

1 Sample T-Test

Key Learning Points

1. Describe the importance of completing 1 sample t-tests.
2. Explain how to compare a sample to a target.
3. Utilize 1 sample t-tests in improvement projects.

What is a 1 Sample T-Test?

A 1 sample t-test compares an estimate of a population mean to a target value or reference value.

Answers

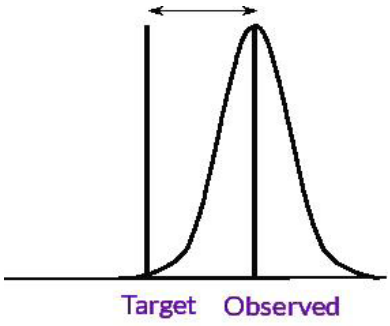
A 1 sample t-test answers the practical question: "How does my population's mean compare to a target value?"

Normal Data

A 1 sample t-test requires normally distributed data. If the data are not Normal, you should not use the t-Test. Other tests have more power.

Population Mean vs. Target Mean

Comparing a population's mean to a target mean requires the t-distribution and continuous data. The t-statistic can be used to test if the population mean is significantly different from the target (nominal) value.



Formulas

The formula for the "1-Sample t-Test" statistic is:
t (calc) = (xbar - μ - μ target) / (s /√n)

or

$$t_{n-1} = \frac{\bar{x} - \mu}{s / \sqrt{n}}$$

- where:
- n = sample size
- s = sample standard deviation
- m target = target mean

The t-Test approaches Normal z-Test as a sample size approaches infinity. It is a better distribution for small sample sizes. When the sample size is > 30 the difference in the z and t values is less than 5%.

Aiming for a Goal

The E.B. Company, a small manufacturing company specializing in producing widgets for use in flux capacitors just completed a cost-benefit analysis and determined that their ideal production output is 240 units per hour. Producing under 240 results in missed orders, and producing over 240 leads to excessive inventory and loss of profit.

Based on this assessment, the company CEO, Emmett Brown asked if the widget process is being run at the optimal output level.

Notes:

Step 1: State the Practical Problem

The Practical Problem:

If the process is not producing 240 widgets an hour, E.B. Company is losing money.
In statistical terms:
$\mu_{target} = 240$

Step 2: Establish the Hypotheses

For μ:

$H_o: \mu_{population} = 240$

$H_a: \mu_{population} \neq 240$

Step 3: Decide on Appropriate Statistical Test

Since you are comparing a mean of a population against a target, you should use a 1 sample t-test. Remember that the 1 sample t-test only works for normal data, so you first have to check the data for normality.

Step 4: Set the Alpha Level

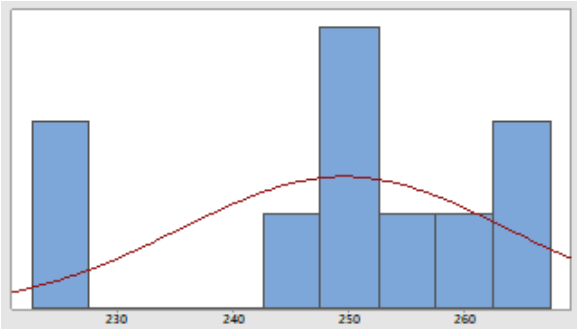
You want to be 95% confident that you are making the correct decision.
$\alpha = 0.05$

Steps 5&6: Set the Power and Sample Size, and Collect the Data

Emmett compiled the data from one day of production. On an average day, machines run for 10 hours, so Emmett collected data on how many widgets were produced every hour for each of the 10 hours.

Step 7: Use the Appropriate Graphical Tool To Explore the Data

Emmett created a histogram to try and interpret what his sample looked like.



Notes:

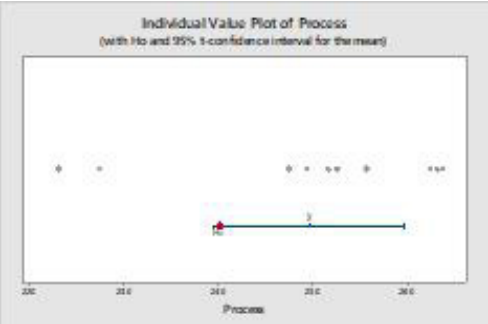
Step 8: Check Data Assumptions

The 1 Sample t-test requires normal data. We verified normality earlier.

Step 9: Run the Statistical Test

- **Minitab: Stat > Basic Statistics > 1-Sample t**
  - Check "Perform Hypothesis Test"
  - Enter "240" as the Hypothesized Mean
  - Select Graphs-Check Individual Value Plot

Results



One-Sample T: Process

Descriptive Statistics

N	Mean	StDev	SE Mean	95% CI for μ
10	249.56	14.15	4.47	(239.44, 259.68)

μ: mean of Process

Test

Null hypothesis	H_0: μ = 240
Alternative hypothesis	H_1: μ ≠ 240

T-Value	P-Value
2.14	0.061

Individual Value Plot of Process

Statistical Conclusion

Since the p value (0.061) > 0.05, Emmett concluded that he must fail to reject the null hypothesis.

H_o: $\mu_{population}$ = 240

Notes:

With these data we cannot conclude a statistically significant difference between H_o: $\mu_{population}$ and μ_{target}.

Step 10: Translate the Statistical Conclusion Into a Practical Conclusion

Emmett could not conclude with this test that the process output is running at a level different than the optimal production speed of 240 widgets an hour. However, the results were borderline, so he will want to check Power calculations to determine if his sample size was adequate.

When Should 1 Sample t-Tests Be Used?

A 1 Sample t-test is appropriate to determine if the population mean of a normally distributed continuous data set is significantly different from a target or reference value.

Pitfalls to Avoid

- Data must be normally distributed for the 1 Sample t-test.
- Be sure to test for power if you fail to reject your null hypothesis.

Notes: