California State University – East Bay

MS in Business Analytics
BAN 602 Case 3 Solution
Group 5

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Introduction: Meticulous Drill & Reamer (MD&R) got a contract to drill 3 cm diameter holes. For this project, they would require to purchase a special drill. They are considering buying from David Drills' T2005 and Worth Industrial tools AZ100. Both the companies have agreed to allow MD&R to use these machines for 1 week in order to decide which one to buy. MD&R used these two tools to drill 31 holes with an objective of drilling a 3cm diameter hole.

The analysis provided in this report is based on data provided by MD&R for 31 drills done separately by models AZ100 and T2005.

Solution 1:

Objective: To provide descriptive statistics for AZ100 and T2005 and to check the accuracy of model (AZ100 and T2005) which produces holes with a mean diameter closer to 3 centimeters.

Method:

Descriptive statistics for T2005 and AZ100 are provided below in Table 1.1

Table 1.1

	Mean	**Median**	**Q1**	**Q3**	**Range**	**Max**	**Min**	**Variance**	**SD**
AZ100	3.023	2.97	2.915	3.2	0.68	3.39	2.71	0.036	0.190
T2005	3.022	3.02	3.005	3.055	0.62	3.31	2.69	0.013	0.113

By looking at table 1.1, we can infer that:

- Mean of T2005 is less and closer to 3 than AZ100.
- Median of T2005 is closer to 3 as compared to AZ100.
- Interquartile range (Q3 – Q1) of T2005 and AZ100 is 0.05 and 0.285 respectively. The higher IQR for AZ100 implies that data points are more spread out as compared to T2005.
- Range of T2005 is lower as compared to AZ100.
- Variance and Standard deviation of T2005 is low as compared to T2005. This implies that T2005 deviates less from the mean as compared to T2005.

To check the accuracy of models (AZ100 and T2005) which produces holes with a mean diameter closer to 3 centimeters, we are calculating mean and deviation from 3 for both the models. In Table 1.2 we can see that Mean diameter of T2005 is less than AZ100 hence the deviation for model T2005 is less as compared to AZ100 i.e., mean of T2005 is closer to 3.

Table 1.2

	Mean	**Deviation from 3**
AZ100	3.023	0.023
T2005	3.022	0.022

Conclusion: From the above analysis, we can say that the holes drilled by T2005 seems to be more accurate than AZ100.

Solution 2:

Objective: To conduct a hypothesis test that T2005 and AZ100 are equally accurate (have equal means).

Method:

Let,

Population Mean of AZ100 = $\mu 1$

Population Mean of T2005 = $\mu 2$

Step1: The first step is to develop the null and alternative hypotheses for the test. The null hypothesis for the test is if the population means are equal. The alternative hypothesis is if population means are not equal. With μ denoting the population mean of holes diameter, the null and alternative hypotheses are as follows:

H_0 (Null Hypothesis): $\mu 1$ - $\mu 2$ = 0

H_a (Alternative Hypothesis): $\mu 1$ - $\mu 2 \neq 0$

Step 2: The level of significance is the probability of making a Type I error when the null hypothesis is true as an equality. Here we are provided with a level of significance = α = 0.05

Step 3: Since population variance is unknown, we will use t statistics to determine whether to reject or fail to reject null hypothesis.

Compute the value of test statistics: t = $\frac{(\overline{x1}-\overline{x2})-D0}{\sqrt{\frac{s1^2}{n1}+\frac{s2^2}{n2}}}$

Where,

$\overline{x1}$ (Sample mean of AZ100) = 3.023

$\overline{x2}$ (Sample mean of T2005) = 3.022

n_1 (Sample size of AZ100) = 31

n_2 (Sample size of T2005) = 31

s_1^2 = (Sample variance of AZ100) = 0.0362

s_2^2 =(Sample variance of T2005) = 0.0127

D_o = 0

Substituting above values in the equation:

$$\frac{3.023 - 3.022}{\sqrt{\frac{0.0362}{31}+\frac{0.0127}{31}}}$$

After substituting we get t value as: **0.025**

Note: If we compute t value using R, we get t = 0.016. Since we are rounding off mean values to 3 decimal places, the manual calculation t value is 0.025.

The degree of freedom for $t\alpha$ are df = $\frac{(\frac{s1^2}{n1}+\frac{s2^2}{n2})^2}{(\frac{1}{n1-1})(\frac{s1^2}{n1})^2(\frac{1}{n2-1})(\frac{s2^2}{n2})^2}$

$$\frac{\left(\frac{0.0362}{31}+\frac{0.0127}{31}\right)^2}{\left(\frac{1}{30}\right)\left(\frac{0.0362}{31}\right)^2+\left(\frac{1}{30}\right)\left(\frac{0.0127}{31}\right)^2}$$

Df = 48

Step 4: Critical Value approach: The critical value approach requires that we first determine a value for the test statistic called the critical value. For two tailed tests, we will reject null hypothesis if t value is greater than t$\alpha_{/2}$.

Determine the critical value and rejection rule:
For α = 0.05, $\alpha_{/2}$ = 0.025 and df = 48, $t_{0.025}$ = 2.011. We will reject H_0 if t >= 2.011

Step5: Because 0.025 < 2.011, we fail to reject H_0.

Conclusion: With 95% confidence we fail to reject null hypothesis.

Solution 3:
Objective: To check holes drilled by which model is more precise.

Method:

Table 3.1

Model	**Variance**	**SD**
AZ100	0.036	0.190
T2005	0.013	0.113

In table 3.1, we have calculated variance and standard deviation of both the models. As we can see, T2005 has less variance as compared to AZ100. Hence T2005 is more precise model.

Conclusion: Holes drilled by T2005 are more precise.

Solution 4:

Objective: To conduct a hypothesis test that T2005 and AZ100 are equally precise (have equal variances).

Method:

Step1: We begin with a test of the equality of two population variances.

Hypothesis:

H_0 : $\sigma_1^2 = \sigma_2^2$ T2005 and AZ100 have same variance
H_a : $\sigma_1^2 \neq \sigma_2^2$ The population variances are not equal

Step 2: We are provided with a level of significance = α = 0.05

Step 3: In F test, we denote the population which has larger sample variance as population 1. Thus, population1 has a sample size of n1 and a sample variance of s_1^2. Population2 has a sample size n2 and a sample variance s_2^2. We are assuming that both populations have a normal distribution. Thus, the ratio of sample variances provides the following F test statistic.

$$\frac{s_1^2}{s_2^2}$$

Where:
s_1^2 = (Sample variance of AZ100) = 0.0362
s_2^2 = (Sample variance of T2005) = 0.0127

$$= \frac{0.0362}{0.0127}$$

F value = **2.85**

Degree of freedom of F_α in F distribution is n_1-1 degree of freedom for numerator and n_2-1 degree of freedom in the denominator i.e., df_1 = 30 and df_2 = 30

Step 4: Critical value approach: We will reject null hypothesis if f value is greater than F$\alpha_{/2}$. Determine the critical value and rejection rule:

For α = 0.05, $\alpha_{/2}$ = 0.025, df_1 = 30, df_2 = 30 and $F_{0.025}$ = 2.07. We will reject H_0 if F >= 2.07

Step 5: Because 2.85 > 2.07, we will reject H_0.

Conclusion: We are atleast 95% confident that the population variance of AZ100 and T2005 are not equal.

Solution 5:
Objective: Proving a recommendation to MD&R about which model to choose.

Method:
From the above analysis, we can infer that the mean T2005 is closer to 3 as compared to model AZ100. Hence, we can say that the holes drilled by T2005 are more accurate than AZ100.

We have also calculated variance and standard deviation of both the models. We can see, T2005 has less variance as compared to AZ100. Thus, T2005 is more precise model.

Table 5.1

Model	Mean	Variance	SD
AZ100	3.023	0.036	0.190
T2005	3.022	0.013	0.113

Conclusion: We can conclude that T2005 seems to be more accurate and precise as compared to AZ100. So, to obtain a better accuracy and precision, we would recommend MD&R to purchase model T2005.