**Part 1: WSES Case Questions:**

For all the tests listed below, assume that the significance value α = 0.05, unless otherwise stated.

1. ***The marketing team of WSES believes that the average sales value of the leads that they receive is at least 8 million dollars. The marketing team believes that the standard deviation of sales value is about 2 million. Use an appropriate hypothesis test to check whether the average sales value in the population is at least 8 million dollars.***

Answer:

Ho: Avg Sales Return <= 8M

Ha: Avg Sales Return > 8M

1. ***Change the null and alternative hypothesis used by you in question 1 and conduct the test. What will be your conclusion based on the interchange of null and alternative hypotheses? What do you learn from your answers to questions 1 and 2?***

Ho: Avg Sales Return >= 8M

Ha: Avg Sales Return < 8M

1. ***If the actual average mean sales value of the leads is 8.2 million dollars, calculate the probability of incorrectly concluding that the average sales value is 8 million dollars.***

This essentially is the probability of committing Type 2 error where we concluded that the Ho<=8M

To calculate Type 2 error, we need to calculate the sample mean at Zcrit.

Since this is a right tailed test, = 8.103

Now, if the true distribution has a mean of 8.2M, type 2 error committed by using the first distribution with mean of 8M as mean is the P value at Z with .

The equation is

= 8.103-8.2/0.063 = -1.54.

**P Value of Z = -1.54 is 6.18%, which is the Type 2 Error.**

1. ***Jason McCullagh, senior marketing manager at WSES doubted the value of standard deviation provided by the marketing team. Jason argued that there is no way the marketing team could have known the population standard deviation for the sales value, since the population itself is unknown. Do you agree with Jason McCullagh? If yes, perform the test again using an appropriate hypothesis test.***

Ans: SD of sample (S) with sample size 1000 : 

= 1.983M

Since we have a good sample size of 1000, we can approximate the Sd of sample to be similar to the SD of the population which is 2M

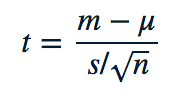
Hence SD of sampling distribution: **S/√n = 1.983/√1000 = 0.063.** This is similar to the SD of sampling distribution calculated from the SD of Population (Sigma/√n). Hence the SD of Population can be assumed to be 2M.

If we do the same hypothesis test using T test (when Population sample is unavailable)

Ho: Avg Sales Return <= 8M

Ha: Avg Sales Return > 8M

This is a right tailed 1 sample T Test

t-Statistic = 

= (8.0442 – 8 )/ 0.063 = 0.70

t-Crit =T.INV(.95,999) = 1.646

**Since T-Stat is less than T-Crit for a right tailed test, we retain the null hypothesis**

1. ***Prudy Perkins, the Chief Marketing Office (CMO) informed the board that they win at least 50% of the sales leads that they receive. Use an appropriate hypothesis testing procedure to check whether the proportion of leads won by WSES is more than 50%.***

This is a Z test for proportion

Ho: p <= 50%

Ha: p > 50%

N = 1000

Won Count = 481

p^ = 481/1000 = 0.481

n \* p^ \* (1-p^) = 1000 \* 0.481 \* (1-0.481) = 249.64 > 10

So, we can use p^ to calculate the population SD

Z Stat = 

= (0.481 – 0.5)/√(0.5\*0.5/1000)

=-1.203

Since this is a right tailed test, Z crit = NORMSINV(.95) = 1.64

**Since Z Stat is less that Z crit. We retain the null hypothesis.**

**There isn’t sufficient evidence to prove that that WSES wins at least 50% of the sales leads that they receive.**

1. ***Hendry Jackson, who works in the product line “learnsys”, claims that the probability of winning a sales lead for the product “learnsys” is more than that of “Finsys”. Is there statistically significant evidence in favor of Hendry’s claim?***

This can be verified using 2 sample Z test for proportions

1. ***John Crocker also claims that the average sales value of “learnsys” projects is higher than that of “Finsys” projects. Check whether John Crocker is correct at 5% significance.***

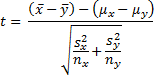
This can be verified using a 2 sample t test with unequal variance

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sample mean sales value of Learnsys: x1 | | | | 8.03047619 |
| Sample sd sales value of Learnsys: S1 | | | | 1.81016501 |
| n1 | | | | 126 |
|  |  |  |  |  |
| Sample mean sales value of Finsys, x2 | | | | 7.80478632 |
| Sample sd sales value of Finsys, S2 | | | | 1.95250396 |
| n2 | | | | 117 |

Ho: mu1 - mu2 <= 0

Ha: mu1 – mu2 > 0

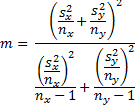
The t-statistic value is



=

|  |  |  |
| --- | --- | --- |
|  | t stat |  |
| 1 | S1^2/n1 | 0.026005535 |
| 2 | S2^2/n2 | 0.032583519 |
| 3 | Add 1 & 2 | 0.058589054 |
| 4 | sqrt (3) : Su | 0.242051758 |
| 5 | x1bar - x2bar | 0.225689866 |
| 6 | t stat = 5/4 | 0.932403331 |

Degrees of Freedom:



|  |  |  |
| --- | --- | --- |
|  | df |  |
| 1 | Su^4 | 0.003432677 |
| 2 | (S1^2/n1)^2 | 0.000676288 |
| 3 | (S1^2/n1)^2/(n1-1) | 5.4103E-06 |
| 4 | (S2^2/n2)^2 | 0.001061686 |
| 5 | (S2^2/n2)^2/(n2-1) | 9.15246E-06 |
| 6 | 3+4 | 1.45628E-05 |
|  | df = 1/6 | 236 |

Critical value of t for Alpha – 0.05 and df = 236 is 1.651363544

|  |  |
| --- | --- |
| t crit | 1.651363544 |

**Since this is a right tailed test and t-stat is below t-crit, Ho cannot be rejected. There isn’t sufficient statistically significant evidence to the claim that the average sales value of “learnsys” projects is higher than that of “Finsys” projects.**

1. Jack Williams, the CEO of the company believed that the sales conversions are different for different products as well as different geographical locations. Check the validity of Jack’s belief using an appropriate hypothesis test.
2. Joe Danby, the chief financial officer believes that the sales conversions depend on the sales value. Use an appropriate hypothesis test to check the validity of this claim by making the following 3 groups:
   1. Sales value less than 6 million
   2. Sales value between 6 and 8 million (both inclusive)
   3. More than 8 million
3. Liz was of the opinion that there is no difference in the average profit and the geographical locations: United Kingdom, India and the Americas. Use an appropriate test to verify the same.
4. Use an appropriate statistical measure to understand the relationship between (1) joint bid percentage and profit; (2) Profit percentage and sales value: and (3) Joint bid and sales conversion.
5. Discuss the business insights based on the data analysis.