

Session 2:

Testing Marketing Hypotheses at WSES

- **The marketing team of WSES believes that the average sales value of the leads that they receive is at least \$8M. The marketing team believes that the standard deviation of the sale value is about \$0.5M. Use an appropriate hypothesis test to check whether the average sales value in the population is at least \$8M.**
- Null hypothesis: H_0 : Population Mean ≤ 8
- Alternate hypothesis: H_A : Population Mean > 8
(Whatever we would like to prove is generally taken as alternative hypothesis)
- $Z = (\text{Sample Mean} - \text{Population Mean}) / (\text{Population Standard Deviation} / \sqrt{\text{sample size}})$
- Sample Mean = 8.04; Standard Deviation = 0.5; sample size = 1000
- $Z = 2.52$
- This is a right-tailed test
- For $\alpha = 0.05$, The Z critical value for right-tailed test = 1.64
- We reject the null hypothesis

- **Jason McCullagh, senior marketing manage 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.**
- Sample standard deviation = 1.98
- $t = (\text{Sample Mean} - \text{Population Mean}) / (\text{Sample Standard Deviation} / \sqrt{\text{sample size}}) = 0.6388$
- This is a right-tailed test. For $\alpha = 0.05$ and degrees of freedom is 999, The t critical value for right-tailed test = 1.64
- We retain the null hypothesis

- **Prudy Perkins, the 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%.**
- Null hypothesis: $H_0: P \leq 0.5$
- Alternate hypothesis: $H_A: P > 0.5$
Where P is the proportion of opportunities won in the population
- The estimated value of P from the sample is 0.481
- Z statistic for proportion = ?
- $Z = -1.2016$
- Appropriate Z critical value = 1.64
- We retain the null hypothesis

- Henry Jackson, who work sin 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 a statistically significant evidence in favour of Hendry’s claim?
- Null hypothesis: $H_0: P_1 \leq P_2$
- Alternate hypothesis: $H_A: P_1 > P_2$
Where P_1 is the proportion of “Learnsys” leads converted and P_2 is the proportion of “Finsys” leads converted.
- $N_1 = 126, p_1 = 71/126 = 0.5635$
- $N_2 = 117, p_2 = 34/117 = 0.2906$
- $Z = 4.2908$
- Reject the null hypothesis
- The conversion rate of learnsys” is better than that of “Finsys

$$z = \frac{(p_A - p_C)}{\sqrt{\bar{p}(1-\bar{p})(1/n_A + 1/n_C)}}$$

$$\bar{p} = \frac{p_A n_A + p_C n_C}{n_A + n_C}$$

- Henry Jackson also claims that the average sales value of “learnsys” projects is higher than of “Finsys” projects. Check whether this assertion is right.
 - Null hypothesis: $H_0: M_1 \leq M_2$
 - Alternate hypothesis: $H_A: M_1 > M_2$
- Where M_1 is the mean sales value of “Learnsys” and M_2 is the mean sales value of “Finsys”.

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - D_0}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

$$df = \left\lfloor \frac{(s_1^2/n_1 + s_2^2/n_2)^2}{(s_1^2/n_1)^2/(n_1-1) + (s_2^2/n_2)^2/(n_2-1)} \right\rfloor$$

- $t = 0.9319$; $DF = 236$
- Critical value = 1.65
- We retain the null hypothesis

t-Test: Two-Sample Assuming Unequal Variances		
	Fin	Learn
Mean	7.804786	8.030476
Variance	3.812272	3.276697
Observations	117	126
Hypothesized Mean Difference	0	
df	236	
t Stat	-0.9324	
P(T<=t) one-tail	0.176041	
t Critical one-tail	1.651336	
P(T<=t) two-tail	0.352081	
t Critical two-tail	1.970067	

- **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 beliefs.**
- Null hypothesis: H_0 : The region and sales outcome are independent
- Alternate hypothesis: H_A : The region and sales outcomes are dependent
- Chi-Square Test
- Create a contingency Table

Region	Won	Lost	Total
Africa	55	38	93
Americas	55	49	104
Canada	4	2	6
India	17	18	35
Japan	10	6	16
Other Europe	66	92	158
Singapore	6	17	23
Spain	1	11	12
UK	267	286	553
Total	481	519	1000

- Chi-square = $\text{SUM} [(\text{Obj}_{ij} - \text{Exp}_{ij})^2 / (\text{Exp}_{ij})]$
- Obj_{ij} = Given; Exp_{ij} = (sum of row i * sum of column j) / Total sum
- Chi-square = 22.26; df = (9-1) * (2-1) = 8; critical value = 15.50
- Reject the null hypothesis – i.e win proportion and geographical location are dependent

- **Joe Danby, the CFO 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:**
 - **Sales value < \$6M**
 - **Sales value [\$6M, \$8M]**
 - **Sales value > \$8M**
- Chi-square test of independence
- Contingency Table

Sales Value	Won	Lost	Total
<\$6M	70	86	156
[\$6M,\$8M]	163	180	343
>\$8M	248	253	501
Total	481	519	1000

- Chi-square test statistic = 1.09; critical value = 5.99
- We retain the null hypothesis

- Liz was of the opinion that there is no difference in the average profit and the geographical locations: UK, India, and Americas. Test it.
- Null hypothesis: $H_0: M1=M2=M3$
- Alternate hypothesis: H_A : Not all are equal
- ANOVA

Anova: Single Factor						
SUMMARY						
Groups	Count	Sum	Average	Variance		
UK	553	559.64	1.012007	0.266504		
India	35	37.87	1.082	0.212428		
USA	104	104.6	1.005769	0.235994		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.170824221	2	0.085412	0.329427	0.719449	3.008795
Within Groups	178.6403704	689	0.259275			
Total	178.8111947	691				

- Current winning probability is $<50\%$.
- Conversion probability of Learnsys is better than Finsys. Thus, if there are two leads; one from Learnsys and another from Finsys, WSES should focus on Learnsys.
- There is dependency between geographical location and sales conversion.
- There is NO dependency between sales value and sales conversion.
- Average profit is not statistically different across geographical locations.