**Hypothesis Testing Exercise**

1. F&B manager wants to determine whether there is any significant difference in the diameter of the cutlet between two units. A randomly selected sample of cutlets was collected from both units and measured? Analyze the data and draw inferences at 5% significance level. Please state the assumptions and tests that you carried out to check validity of the assumptions.

Minitab File : **Cutlets.mtw**

**Answer ->**

* H0-> if diameters are not equal then perform repairs/restoration on preparation mechanism

Ha-> No need for any actions

Here X= 2(2 samples) and Y -> diameter of the cutlets (no of observation)

Y is continues

* **Normality Test ->**
* H0 -> If Y1 and Y2 both are normal then no action

Ha-> if H1 or H2 are not normal then take action

For Y1->

> ad.test(cutlet$Unit.A)

Anderson-Darling normality test

data: cutlet$Unit.A

A = 0.43309, **p-value = 0.2866**

P higher than 0.05, thus null fly i.e. Y1 is normal

For Y2->

> ad.test(cutlet$Unit.B)

Anderson-Darling normality test

data: cutlet$Unit.B

A = 0.26123, **p-value = 0.6869**

Thus, Y2 is not normal

P high thus don’t take action i.e. null hypothesis i.e. failed to reject null hypothesis

* **External Conditions same->**

Ho-> if Yes perform paired T test

Ha-> if no , take action

As given in the problem, the samples are taken from 2 different units

Thus, external conditions are not same.

Ha will be performed

* **Are Variance of both equal->**

Ho ->

If Yes i.e. Var (Y1) = Var (Y2), then no action needed

Ha ->

If no, action is required

> var.test(cutlet$Unit.A,cutlet$Unit.B)

F test to compare two variances

data: cutlet$Unit.A and cutlet$Unit.B

F = 0.70536, num df = 34, denom df = 34, **p-value = 0.3136**

alternative hypothesis: true ratio of variances is not equal to 1

95 percent confidence interval:

0.3560436 1.3974120

sample estimates:

ratio of variances

0.7053649

Thus, P high(>0.05) null fly

Failed to reject the null hypothesis

Thus , variances of both are same.

* **2 sample T-test for equal variances - >**

Ho -> Diameters are equal, no need to take action

Ha-> Diameters are not equal perform repairs and restoration

t.test(cutlet$Unit.A,cutlet$Unit.B,alternative = "two.sided",var.equal = TRUE,conf.level = 0.95)

Two Sample t-test

data: cutlet$Unit.A and cutlet$Unit.B

t = 0.72287, df = 68, **p-value = 0.4722**

alternative hypothesis: true difference in means is not equal to 0

95 percent confidence interval:

-0.09646454 0.20605311

sample estimates:

mean of x mean of y

7.019091 6.964297

P High null fly. Mean diameters of both units is equal.

* Thus, **No action needed**

1. A hospital wants to determine whether there is any difference in the average Turn Around Time (TAT) of reports of the laboratories on their preferred list. They collected a random sample and recorded TAT for reports of 4 laboratories. TAT is defined as sample collected to report dispatch.

Analyze the data and determine whether there is any difference in average TAT among the different laboratories at 5% significance level.

 Minitab File: **LabTAT.mtw**

Answer->

X=4 (no of samples) , Y -> continuous i.e. the TAT score

* **Normality Test ->**

Ho -> if Y1 , Y2 ,Y3 & Y4 are normal , no action needed

Ha -> if any of Y’s not normal , take action

> ad.test(stack\_tat$values)

Anderson-Darling normality test

data: stack\_tat$values

A = 0.7495, **p-value = 0.05072**

P(>0.05) high null fly

Failed to reject null hypothesis

All are normal

* **Variance Test ->**

Ho -> all have same variances, no need of action

Ha -> variances are not equal take action

> leveneTest(stack\_tat$values~stack\_tat$ind,data=stack\_tat)

Levene's Test for Homogeneity of Variance (center = median)

Df F value Pr(>F)

group 3 2.5996 **0.05161** .

476

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

P high null fly, thus variances are same

* **One way Anova test ->**

Ho -> the TAT score for different labs is same, no action required

Ha -> TAT scores are different , thus take maintenance actions

> anova\_res <- aov(values~ind, data=stack\_tat)

> summary(anova\_res)

Df Sum Sq Mean Sq F value Pr(>F)

ind 3 79979 26660 118.7 **<2e-16 \*\*\***

Residuals 476 106905 225

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

P low(<0.05) null go

Reject null hypothesis

* Thus, Average TAT for labs are different .

**Action is required** which includes inspection of regulation and repairing of devices

1. Sales of products in four different regions is tabulated for males and females. Find if male-female buyer rations are similar across regions.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **East** | **West** | **North** | **South** |
| Males | 50 | 142 | 131 | 70 |
| Females | 550 | 351 | 480 | 350 |

Answer:

Here, X=4 and Y -> Discrete

Thus, We will follow the Hypothesis chart for discrete

As X >4

We need to perform Chi squared test to compare the means.

* **Chi-squared test ->**

Ho -> Means are similar thus no action neede

Ha-> Means are not same thus Buyers ration is not similar across the regions.

> chisq.test(sales$Region,sales$Males,sales$Females)

Pearson's Chi-squared test

data: sales$Region and sales$Males

X-squared = 12, df = 9, **p-value = 0.2133**

* P high null fly

Thus, the buyers’ ratio is similar over different region.

Thus, we don’t need to take action.

1. TeleCall uses 4 centers around the globe to process customer order forms. They audit a certain % of the customer order forms. Any error in order form renders it defective and has to be reworked before processing. The manager wants to check whether the defective % varies by centre. Please analyze the data at *5%* significance level and help the manager draw appropriate inferences

Minitab File: **CustomerOrderForm.mtw**

Answer ->

Ho -> The percentages for male and

Here,

X=4 (different countries) , Y -> Discrete (categorical data)

* **Chi-Squared test ->**

x<-as.vector(orders$Phillippines)

y<-as.vector(orders$Indonesia)

w<-as.vector(orders$Malta)

z<-as.vector(orders$India)

order\_stack <- stack(orders)

combined\_orders<-data.frame(x,y,w,z,stringsAsFactors=FALSE)

stacked\_orders<-stack(combined\_orders)

table(stacked\_orders)

> chisq.test(table(stacked\_orders))

Pearson's Chi-squared test

data: table(stacked\_orders)

X-squared = 3.859, df = 3, **p-value = 0.2771**

* P high null Fly

Thus, there’s no need to take any action.

1. Fantaloons Sales managers commented that *%* of males versus females walking in to the store differ based on day of the week. Analyze the data and determine whether there is evidence at *5 %* significance level to support this hypothesis.

Minitab File: **Fantaloons.mtw**

Ans:

* **Two proportion test ->**

Ho-> if proportion of one gender is same for weekends and week days, no action required

Ha-> if proportion is different , then make offers for other gender .

percen<- read.csv(file.choose())

x<-as.vector(percen$Weekdays)

y<-as.vector(percen$Weekend)

combined\_percen<-data.frame(x,y,stringsAsFactors=FALSE)

stacked\_percen <- stack(combined\_percen)

table(stacked\_percen)

prop.test(x=c(287,233),n=c(400,400),conf.level = 0.95,correct = TRUE,alternative = "two.sided")

> prop.test(x=c(287,233),n=c(400,400),conf.level = 0.95,correct = TRUE,alternative = "two.sided")

2-sample test for equality of proportions with continuity

correction

data: c(287, 233) out of c(400, 400)

X-squared = 15.434, df = 1, **p-value = 8.543e-05**

alternative hypothesis: two.sided

95 percent confidence interval:

0.06706189 0.20293811

sample estimates:

prop 1 prop 2

0.7175 0.5825

P low null go.

Thus we need to take action

H0 -> if proportions of female is low on weekends, prepare more offers on weekends

Ha-> if proportion female is high on weekends, prepare more offers for females on weekdays

> prop.test(x=c(287,233),n=c(400,400),conf.level = 0.95,correct = TRUE,alternative = "greater")

2-sample test for equality of proportions with continuity

correction

data: c(287, 233) out of c(400, 400)

X-squared = 15.434, df = 1, **p-value = 4.272e-05**

alternative hypothesis: greater

95 percent confidence interval:

0.07758261 1.00000000

sample estimates:

prop 1 prop 2

0.7175 0.5825

P low null go

* Thus, we will take action as proportion female is high on weekends, prepare more offers for females on weekdays