Solution :

***We first do analysis of given data :***

Sample size n = 30

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Mean of Old Scheme = **68.03**

Mean of New Scheme = **72.03**

Mean and Median values are not so different so we can say that data is more reliable.

Checking the normality of the data, if both the data is normally distributed or not.

We do this by **histogram and boxplot method**. We get,

1. **Histogram Method**

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R code for above histogram : **“hist(Old\_Scheme , col = '#FF6D0099')”**

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R code for above histogram : **“hist(New\_Scheme , col = '#FF000099')”**

1. **Boxplot Method**

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R code for above boxplot : **“boxplot(Old\_Scheme , horizontal = TRUE , col = '#F4A460' , main = "Boxplot for Old Scheme" , xlab = "Old Scheme")”**

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R code for above boxplot : **“boxplot(New\_Scheme , horizontal = TRUE , col = '#FFE4B5' , main = "Boxplot for New Scheme" , xlab = "New Scheme")”**

Comparing histograms both sample looks **normally distributed** however new scheme data tends to be **left skewed** from the boxplot.

**Question. Describe the five per cent significance test you would apply to these data to determine whether new scheme has significantly raised outputs?**

**Answer :** Standard Deviation (Sigma) is unknown, so here will use the **Ttest** test, but we have to check if the new scheme has raised more outputs as compared to the old scheme. Thus we will use a Right tailed **Ttest**.

Here, **α** (Alpha) level of significance = 0.05

Sample size **N** = 30

Degrees of Freedom = **N – 1** = 29

Hypothesis Testing :-

Null hypothesis is **Ho : μnew - μold = 0** difference between new scheme and old scheme is 0 which means that new scheme has not raised outputs.

Alternative Hypothesis is **H1 : μnew - μold > 0** if difference between new and old mean is greater than 0 it means new scheme has raised output.

**Ttest** Formula :

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Calculating the values based on above formula we will get the **tstat** value.

**Note : This formula is given in Textbook page no – 346 in eq. 10.3.**

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Above calculation is done in Rstudio to calculate tstat value where

**t.test(x , y , paired = TRUE , alternative = “two.sided”)** following is explanation of this function :

* x,y: numeric vectors
* paired: a logical value specifying that we want to compute a paired t-test
* alternative: the alternative hypothesis. Allowed value is one of “two.sided” (default), “greater” or “less”.

Similarly I have also calculated the value in excel in order to give more clarity and better understanding.

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**Question. What conclusion does this test lead to?**

**Answer :** From above calculations we know that **p-value = 0.0652 > 0.05** hence we do not reject the null hypothesis (accept).

Therefore we can say that the new scheme did not raised any output significantly when compared to the old scheme, there is no proof weather new scheme is more reliable.

**Question. What reservations have you about this result?**

**Answer :** The mean difference between mean **(Xnew – Xold) = 4** and that of standard deviation is **(Snew – Sold) = 14.018**. As mentioned in the question that if “The agreement with the sales force is that if the scheme does not at least break even for the company, it will be abandoned after six months”. So the decision makers have to decide weather to abandon the scheme or continue it for 2 months.

**Question. Suppose it has been calculated that in order for Titan to break even, the average output must increase by £5000. If this figure is alternative hypothesis, what is:**

* **The probability of a type 1 error?**
* **The probability of a type 2 error?**
* **The power of the test?**

**Answer :**

Null Hypothesis states that **μd (difference between) μnew - μold = 0 at 0.05** significance level. We will use a **Right Tailed Test**.

* Probability of **Type 1 Error (α) is 5%** or (significant level = 0.05) which means that rejecting null hypothesis when it is true,
* Probability of Type 2 Error (β) means not rejecting the null hypothesis when it is false. To **find out probability of Type 2 Error**, considering the facts mentioned above we calculate the Tcritical value.

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From above values in R studio and excel we get Tcritical = 1.669127, Since we have to calculate D-bar from the above mentioned tstat equation we get the d value as

Calculate probability of drawing the sample mean < 4.37k is

Now, we will calculate probability of and df = n - 1 = 29.

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Power of Test = 1 - β (probability of Type 2 Error)

**Since β = 0.4037**

**Probability of Type 2 Error is 40.37%**

**Power of Test = 1 - β = 1 - 0.4037 = 0.5963 = 59.63 %**