**MODERN COLLEGE OF ARTS, SCI & COMM.PUNE-05.**

**DEPARTMENT OF STATISTICS.**

**EXPT.NO. 7**

**Title: Random Effects Model For One Way Anova , Estimation of Variation.**

Q.1 A textile mill has a large number of looms. Each loom is supposed to provide the same output of cloth per minute. To investigate this assumption, five looms are chosen at random and their output is noted at different times. The following data are obtained.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Loom | Output (lb/mm) | | | | |
| 1. | 14.0 | 14.1 | 14.2 | 14.0 | 14.1 |
| 2. | 13.9 | 13.8 | 13.9 | 14.0 | 14.0 |
| 3. | 14.1 | 14.2 | 14.1 | 14.0 | 13.9 |
| 4. | 13.6 | 13.8 | 14.0 | 13.9 | 13.7 |
| 5. | 13.8 | 13.6 | 13.9 | 13.8 | 14.0 |

Analyze the above data.

Q.2 A manufacturer suspects that the batches of raw material furnished by his supplier differ significantly in calcium content. There are a large number of batches currently in the warehouse. Five of these are randomly selected for study. A chemist makes five determinations on each batch and obtains the following data.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Batch 1 | Batch 2 | Batch 3 | Batch 4 | Batch 5 |
| 23.46 | 23.59 | 23.51 | 23.28 | 23.29 |
| 23.48 | 23.46 | 23.64 | 23.40 | 23.46 |
| 23.56 | 23.42 | 23.46 | 23.37 | 23.37 |
| 23.39 | 23.49 | 23.52 | 23.46 | 23.32 |
| 23.40 | 23.50 | 23.49 | 23.39 | 23.38 |

Analyze the data.

**Solution**

**Q1.**

**Here we want to test :-**

**H0: -Sigma2T = 0 vs H1:- Sigma2T > 0**

**ANOVA: y versus loom**

Factor Type Levels Values

loom random 5 1, 2, 3, 4, 5

Analysis of Variance for y

Source DF SS MS F P

loom 4 0.34160 0.08540 5.77 0.003

Error 20 0.29600 0.01480

Total 24 0.63760

S = 0.121655 R-Sq = 53.58% R-Sq(adj) = 44.29%

**Result:- P value = 0.003< 0.05**

**Therefore, Reject H0 at 5% l.o.s.**

**Conclusion :There exists Variability between the treatments.**

**Residual Plots for y**



**To test ,**

**H0 : Difference between pair of group means of two looms is insignificant**

**Vs**

**H1: Difference between pair of group means of two looms is is Significant**

**Tukey Pairwise Comparisons**

Grouping Information Using the Tukey Method and 95% Confidence

loom N Mean Grouping

1 5 14.0800 A

3 5 14.0600 A

2 5 13.9200 A B

5 5 13.8200 B

4 5 13.8000 B

Means that do not share a letter are significantly different.

Tukey Simultaneous Tests for Differences of Means

Difference Difference SE of Adjusted

of Levels of Means Difference 95% CI T-Value P-Value

2 - 1 -0.1600 0.0769 (-0.3901, 0.0701) -2.08 0.267

3 - 1 -0.0200 0.0769 (-0.2501, 0.2101) -0.26 0.999

4 - 1 -0.2800 0.0769 (-0.5101, -0.0499) -3.64 0.013

5 - 1 -0.2600 0.0769 (-0.4901, -0.0299) -3.38 0.022

3 - 2 0.1400 0.0769 (-0.0901, 0.3701) 1.82 0.390

4 - 2 -0.1200 0.0769 (-0.3501, 0.1101) -1.56 0.538

5 - 2 -0.1000 0.0769 (-0.3301, 0.1301) -1.30 0.694

4 - 3 -0.2600 0.0769 (-0.4901, -0.0299) -3.38 0.022

5 - 3 -0.2400 0.0769 (-0.4701, -0.0099) -3.12 0.038

5 - 4 0.0200 0.0769 (-0.2101, 0.2501) 0.26 0.999

Individual confidence level = 99.28%

**Result:- So from it is clear that Adjusted P value Of Pair of group of (4-1),**

**(5-1),(4-3),(5-3) are less than 0.05 .So We reject null hypothesis.**

**Conclusion:- Difference between pair of group means of two looms is isSignificant**

**Tukey Simultaneous 95% CIs**



**Conclusion:-**

* **The Confidence interval for the difference between the means of loom for (4,1),(5,1),(4,3)&(5,3) not includes zero .Therefore the difference between these means are statistically significant.**
* **The Confidence interval for the difference between the means of loom for (1,2),(3,1),(3,2),(4,2),(5,2)&(5,4) includes zero .Therefore the difference between these means are statistically insignificant.**

**Interval Plot of y vs loom**



**Conclusion:- From above loom 1,loom 3 has highest mean. And loom 4 & loom 5 has lowest mean. You cannot determine from this graph whether any difference is significant.**

**Q2.**

**Here we want to test ;**

**H0:- Sigma2T = 0 vs H1: -Sigma2T > 0**

**ANOVA: y versus loom**

Factor Type Levels Values

loom random 5 1, 2, 3, 4, 5

Analysis of Variance for y

Source DF SS MS F P

loom 4 0.096976 0.024244 5.54 0.004

Error 20 0.087600 0.004380

Total 24 0.184576

S = 0.0661816 R-Sq = 52.54% R-Sq(adj) = 43.05%

**Result:P value = 0.004< 0.05**

**Therefore, Reject H0 at 5% l.o.s.**

**Conclusion :-There exists Variability between the treatments.**

**Residual Plots for y**



**To test ,**

**H0 :- Difference between pair of group means ofthe batches of raw material is insignificant**

**Vs**

**H1:- Difference between pair of group means of the batches of raw material is is Significant**

**Tukey Pairwise Comparisons**

Grouping Information Using the Tukey Method and 95% Confidence

Batch N Mean Grouping

3 5 23.5240 A

2 5 23.4920 A B

1 5 23.4580 A B C

4 5 23.3800 B C

5 5 23.3640 C

Means that do not share a letter are significantly different.

Tukey Simultaneous Tests for Differences of Means

Difference Difference SE of Adjusted

of Levels of Means Difference 95% CI T-Value P-Value

2 - 1 0.0340 0.0419 (-0.0912, 0.1592) 0.81 0.924

3 - 1 0.0660 0.0419 (-0.0592, 0.1912) 1.58 0.528

4 - 1 -0.0780 0.0419 (-0.2032, 0.0472) -1.86 0.368

5 - 1 -0.0940 0.0419 (-0.2192, 0.0312) -2.25 0.204

3 - 2 0.0320 0.0419 (-0.0932, 0.1572) 0.76 0.938

4 - 2 -0.1120 0.0419 (-0.2372, 0.0132) -2.68 0.094

5 - 2 -0.1280 0.0419 (-0.2532, -0.0028) -3.06 0.044

4 - 3 -0.1440 0.0419 (-0.2692, -0.0188) -3.44 0.019

5 - 3 -0.1600 0.0419 (-0.2852, -0.0348) -3.82 0.008

5 - 4 -0.0160 0.0419 (-0.1412, 0.1092) -0.38 0.995

Individual confidence level = 99.28%

**Result:- So from it is clear that Adjusted P value Of Pair of group of (5-2),(4-3),(5-3) are less than 0.05 .So We reject null hypothesis.**

**Conclusion:- Difference between pair of group means of the batches of raw material is Significant**

**Tukey Simultaneous 95% CIs**

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**Conclusion: -**

* **The Confidence interval for the difference between the means of thebatches of raw materialfor (5,2),(4,3)&(5,3) not includes zero .Therefore the difference between these means are statistically significant.**
* **The Confidence interval for the difference between the means of loom for (1,2),(3,1),(1,4),(1,5),(3,2),(4,2)&(5,4) includes zero .Therefore the difference between these means are statistically insignificant.**

**Interval Plot of y vs Batch**

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**Conclusion:- From above the batch of raw material3 has highest mean. And batch of raw material 4 & 5 has lowest mean. You cannot determine from this graph whether any difference is significant.**