Requirements

1. For each cell, the sample values come from a population with a distribution that is approximately normal. (This procedure is robust against reasonable departures from normal distributions.)
2. The populations have the same variance σ^2 (or standard deviation σ). (This procedure is robust against reasonable departures from the requirement of equal variances.)
3. The samples are simple random samples of quantitative data.
4. The samples are independent of each other. (This procedure does not apply to samples lacking independence.)
5. The sample values are categorized two ways. (This is the basis for the name of the method: *two-way* analysis of variance.)
6. All of the cells have the same number of sample values. (This is called a *balanced* design. This section does not include methods for a design that is not balanced.)

Procedure for Two-Way ANOVA (See Figure 12-4)

Step 1: *Interaction Effect:* In two-way analysis of variance, begin by testing the null hypothesis that there is no interaction between the two factors. Use technology to find the P-value corresponding to the following test statistic:

$$F = \frac{\text{MS(interaction)}}{\text{MS(error)}}$$

Conclusion:

- **Reject:** If the P-value corresponding to the above test statistic is small (such as less than or equal to 0.05), reject the null hypothesis of no interaction. Conclude that there is an interaction effect.
- **Fail to Reject:** If the P-value is large (such as greater than 0.05), fail to reject the null hypothesis of no interaction between the two factors. Conclude that there is no interaction effect.

Step 2: *Row/Column Effects:* If we conclude that there is an interaction effect, then we should stop now; we should not proceed with the two additional tests. (If there is an interaction between factors, we shouldn't consider the effects of either factor without considering those of the other.)

If we conclude that there is no interaction effect, then we should proceed with the following two hypothesis tests.

Row Factor

For the row factor, test the null hypothesis H_0: There are no effects from the row factor (that is, the row values are from populations with the same mean). Find the P-value corresponding to the test statistic $F = \text{MS(row)}/\text{MS(error)}$.

Conclusion:

- **Reject:** If the P-value corresponding to the test statistic is small (such as less than or equal to 0.05), reject the null hypothesis of no effect from the row factor. Conclude that there is an effect from the row factor.
- **Fail to Reject:** If the P-value is large (such as greater than 0.05), fail to reject the null hypothesis of no effect from the row factor. Conclude that there is no effect from the row factor.

Column Factor

For the column factor, test the null hypothesis H_0: There are no effects from the column factor (that is, the column values are from populations with the same mean). Find the P-value corresponding to the test statistic $F = \text{MS(column)}/\text{MS(error)}$.

Conclusion:

- **Reject:** If the P-value corresponding to the test statistic is small (such as less than or equal to 0.05), reject the null hypothesis of no effect from the column factor. Conclude that there is an effect from the column factor.
- **Fail to Reject:** If the P-value is large (such as greater than 0.05), fail to reject the null hypothesis of no effect from the column factor. Conclude that there is no effect from the column factor.