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Application of Anova on Culinary Experiences of Wowmomo Customers in Bhubaneswar

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ABSTRACT

ANOVA examines the means of various groups and identifies any statistically significant differences in the means. It can be viewed as an extended multi-group application of the t-test for two independent samples. Analysis of the variances is used to assess whether there are any significant differences in class means. This method is quite helpful in providing crucial information, especially when analyzing experimental results and figuring out how certain elements affect other processing parameters (Eva, Oskar[10]). ANOVA is now widely used in theoretical study as well as in practical activity in practically all sectors, together with other statistical approaches. By utilizing ANOVA we have tried in this study to know the culinary experiences of 96 customers had in Bhubaneswar's WOW MOMO restaurants. We wanted to see if customers preferred any of the four popular non-vegetarian dishes more or less than the others. We also would like to test whether that the location in which the type of non-veg dish is being offered may have an impact on the taste of different dishes. After using complete randomized design and randomized block design of ANOVA, the outcome demonstrated that there are significant variations in the mean ratings given to the four different types of dishes and that the location in which these non-vegetarian dishes are served affects the ratings given by the diners.

Keywords: *ANOVA, Consumer behavior, WOWMOMO, Non-veg dishes, Customer preference*

1. Introduction

The English statistician Sir Ronald A. Fisher (1890–1962) created the initial concepts of analysis of variance in his book "Statistical Methods for Research Workers" (1925). A large portion of the early research in this field focused on agricultural experiments (Aczel, A.D. [1]). The most frequently cited advanced research methodology in academic literature on business and economics is ANOVA. A statistical method called analysis of variance (ANOVA) is used to compare the means of several samples. It can be viewed as an extended multi-group application of the t-test for two independent samples. Analysis of the variances is used to assess whether there are any significant differences in class means. This method is quite helpful in providing crucial information, especially when analyzing experimental results and figuring out how certain elements affect other processing parameters (Eva, Oskar[10]).The following presumptions are necessary when using an ANOVA procedure:

- The responses show a normal population distribution at each level of the factor.
- The variance of these distributions is the same.
- The data are independent of one another.

The name "analysis of variance" refers to the process by which multiple types of variance connected with the random samples under study must be analyzed, even if the technique's goal is to find differences among several population means (Aczel, A.D. [1]). During a hypothesis testing technique, a specific claim or hypothesis is made regarding a population parameter, and the likelihood that the claim is true is evaluated using sample statistics. The hypothesis is supported by the data at hand and the researcher's perception of the population's characteristics (Lisa Sullivan [8]).

ANOVA HYPOTHESES

These remain constant.

H0: All groups under study have equal (population) means.

H1: Not all of the (population) means are equal. (Note: This is distinct from asserting that everyone is unequal.)

TESTING NULL HYPOTHESIS IN ONE-WAY ANOVA

One-way ANOVA is the term used to describe the analysis of variance when there is only one predictor variable.

This design is used when there is only one categorical predictor variable and one predicted(metric) variable. Each category of the predictor variable is called a level.

The total variation which is known as Sum of squares total (SST) is equal to the sum of the squared differences between each sample value from the grand mean $\bar{\bar{x}}$.

$$\text{SST} = \sum_{i=1}^{r} \sum_{j=1}^{n_j} \left(x_{ij} - \bar{\bar{x}}\right)^2 \quad (1)$$

Where r= Number of samples (Levels), n_j = size of the jth sample

To calculate variations between sample means, the sum of squared differences between the sample means in each group is calculated and is denoted as SSC.

$$\text{SSC} = \sum_{j=1}^{r} n_j \left(\bar{x_j} - \bar{\bar{x}}\right)^2 \quad (2)$$

The sum of squared differences within samples is denoted as SSE.

$$\text{SSE} = \sum_{i=1}^{k} \sum_{j=1}^{n_j} \left(x_{ij} - \bar{x_j}\right)^2 \quad (3)$$

When these sums of squares are divided by their respective degrees of freedom we get mean square terms.

$$\text{MSC} = \frac{SSC}{r-1} \quad (4)$$

$$\text{MSE} = \frac{SSE}{n-r} \quad (5)$$

$$\text{MST} = \frac{SST}{n-1} \quad (6)$$

Now we can apply F-test statistic with r-1 degrees of freedom for the numerator and n-r degrees of freedom for the denominator.

$$\text{F} = \frac{MSC}{MSE} \quad (7)$$

Reject H0 if the calculated value of F > its critical value of F otherwise accept H0.

TESTING NULL HYPOTHESIS IN TWO-WAY ANOVA

The two way analysis of variance can be used to explore one factor of interest to partition the sample data so as to remove the unaccountable variation and arriving at a true conclusion. Investigate two factors of interest for testing the differences between sample means.

Consider any interaction between two factors.

Table 1: Two way ANOVA test statistic

Sources of variation	Sum of squares	Degrees of freedom	Mean square	Test statistic
Between Columns	SSC	c-1	SSC/c-1	$F_{Treatments}$
Between Rows	SSR	r-1	SSR/r-1	F_{Blocks}
Residual error	SSE	(c-1)(r-1)	SSE/(c-1)(r-1)	
Total	SST	n-1		

As stated above in the Table 1, the total variation consists of three parts (i) Variation between columns, SSC (ii) Variation between rows, SSR and (iii) Variations due to errors, SSE.

In the study of consumer behavior, ANOVA is frequently used. What would happen to sales, for instance, if a marketing mix variable like pricing, a particular promotion or kind of distribution, or even a single feature like shelf space or packaging color, changed? The possible application fields are very diverse.

When there is just one categorical independent variable and one dependent (metric) variable, the completely randomized ANOVA design is utilized. A level is used to describe each category of the independent variable (Mohr, Freund [4]). The taste of the food items supplied to 96 customers in the WOW MOMO restaurants located at 12 distinct locations throughout Bhubaneswar, Odisha, is the subject of this study's experiment. These customers were asked to comment on the flavors of four well-known non-vegetarian foods that were presented to them. Four popular non-vegetarian dishes—chicken steam momo, chicken chillimomo, chicken panfriedmomo, and chicken peri perimomo—have been taken into consideration. 98 customers were asked for their opinion on the scale of 1 to 10 (1 = not liked at all and 10 = most preferred). The null hypothesis for this problem is:

H0: There is no significant difference between the mean ratings given to the four types of non-veg dishes.

The experimental approach for dealing with multivariate classifications uses the randomized block design of the ANOVA (Mohr, Freund [4]). In this study, we suppose that all 12 of Bhubaneswar's non-vegetarian delivery locations received the foods described above. Customers who visited these places and tasted a certain dish have shared their comments. The null hypotheses for this problem are:

H0: The mean rating of the dish type is same for all four dishes.

H1: The block (location of hotel) has no effect on mean ratings for the dish type.

2. Objectives

The research is carried out to know how ANOVA is applied in real life situations. Application of single factor ANOVA (Completely randomized design) and utilization of two factor ANOVA (Randomized block design) is the main focus in this study.

3. Literature Review

When you have data on a categorical independent variable and a quantitative dependent variable, do a one-way ANOVA. There should be at least three levels in the independent variable (i.e. at least three different groups or categories). The dependent variable's relationship to the level of the independent variable is shown by an ANOVA. F test is used by ANOVA to determine statistical significance. Because the error is determined for the entire set of comparisons rather than just for each two-way comparison, this enables comparison of many means at once (which would happen with a t test). The F test contrasts the variation in each group's mean with the variance in the entire group. If the F test will produce a higher F value and, consequently, a higher likelihood that the difference observed is real and not the result of chance if the variation within groups is lower than the variance between groups. (Rebecca Bevans [11]). The randomized complete block (RCB), also known as the randomized block (RB) design, is one of the most straightforward and certainly the most widely used experimental design. This design divides the sample of experimental units into groups or blocks before randomly assigning treatments to the units in each block. There is a natural matching process between observations that originate from the same block. This is the same circumstance that led to the development of the paired test, where two observations from units are chosen to be as similar as feasible, differing only in the treatment of interest(Mohr, Freund [4]). Based on the findings of the marketing research, it is determined through the use of ANOVA that bank customers' total quantities, or populations' unidentified mean scores, are not significantly different from one another. Consumer total quantities, or populations' unidentified mean scores, vary by features in the research study on soft drinks (Todua, Dotchviri [9]).ANOVA is a statistical analysis technique that divides systematic components from random factors to account for the observed aggregate variability within a data set. The presented data set is statistically affected by the systematic factors but not by the random ones. The ANOVA test is used by analysts to evaluate the impact of independent factors on the dependent variable in a regression analysis (Will Kenton [17]).The fact that these tests use the F-values to test the hypotheses is the basis for the term "F-test." The ratio of two variances is known as an F-statistic, and it bears Sir Ronald Fisher's name. Variances quantify how evenly distributed the data points are around the mean. When the individual data points tend to deviate further from the mean, there are more variances (Jim Frost [6]).Post-hoc tests are known to everyone who has used ANOVA. It is derived from the Latin word for "after that" and refers to "the analysis after the fact." The limitations of the inferences that can be drawn from the ANOVA test are the justification for conducting a post-hoc test. To put it another way, if the null hypothesis—according to which the population means of three mutually independent groups are the same—is rejected, the information that can be inferred is not that the three groups are distinct from one another. It just indicates that at least one group may display a difference and that the means of the three groups may vary. This implies that it doesn't detail how each group varies (Tae Kyun Kim [15]). A null hypothesis and an alternate hypothesis are used in an ANOVA. When all of the sample means are the same or don't differ significantly from one another, the null hypothesis in an ANOVA is admissible. They can be viewed as a member of a wider group of the population as a result. On the other hand, when at least one sample mean differs from the other sample means, the alternate hypothesis is true (Analyticsvidya [18]).

4. Methodology

For this study, 96 respondents were selected as a sample. The respondents were chosen using the convenience sample approach in Bhubaneswar's various WOW MOMO restaurant locations. For each location 2 respondents were chosen for every dish type. ANOVA and descriptive analysis are utilized for analysis using SPSS.

5. Application of ANOVA

In this section we have tried to test the following hypotheses with the help of one way ANOVA (Completely Randomized Design) and two factors ANOVA (Randomized Block Design):

Hypothesis for One way ANOVA (Completely Randomized Design):

H0: There is no significant difference between the mean ratings given to the four types of non-veg dishes.

Hypotheses for Two factor ANOVA (Randomized Block Design):

$H0_a$: The mean rating of the dish type is same for all four dishes.

$H0_b$: The block (location of hotel) has no effect on mean ratings for the dish type.

SINGLE FACTOR ANOVA (COMPLETELY RANDOMIZED DESIGN):

Here, we provide descriptive statistics for the research data used in one-way ANOVA. The average ratings for the 4 different types of food that WOW MOMO restaurant patrons received are shown in Table 2 below. The chicken peri perimomo has the greatest mean rating (7.33), while the chicken chilli momo has the lowest mean rating (4.75).

Table 2: Descriptives for all 4 types of dishes served to the customers in WOW MOMO restaurants

Ratings on 1 to 10

					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Chicken Steam Momo	24	5.2083	2.57039	.52468	4.1230	6.2937	1.00	9.00
Chiken chilli Momo	24	4.7500	2.62513	.53585	3.6415	5.8585	1.00	10.00
Chicken panfried Momo	24	6.6667	1.88049	.38385	5.8726	7.4607	3.00	10.00
Chicken Peri Peri Momo	24	7.3333	2.42571	.49515	6.3090	8.3576	3.00	10.00
Total	96	5.9896	2.58129	.26345	5.4666	6.5126	1.00	10.00

Table 3: One way ANOVA output

Ratings on 1 to 10

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	105.865	3	35.288	6.159	.001
Within Groups	527.125	92	5.730		
Total	632.990	95			

The hypothesis for one way ANOVA (Completely Randomized Design) is that,

H0: There is no significant difference between the mean ratings given to the four types of non-veg dishes.

From the above Table 3, we can see that the p value is 0.001 and hence we reject the null hypothesis here. So we can conclude that there is a significant difference between the mean ratings given to the four types of non-veg dishes.

TWO FACTORS ANOVA (RANDOMIZED BLOCK DESIGN):

The following Table 4 represents the number of respondents interviewed for four types of dishes. It also represents number of respondents interviewed for each 12 locations. We have taken 24 respondents for each type of dishes and 8 respondents from each of the 12 locations. They were asked to give ratings to the taste of the dishes served to them on a scale of 1 to 10 (1 = not liked at all and 10 = most preferred).

Table 4: Between-Subjects Factors

		Value Label	N
Dish Type	1	Chicken Steam Momo	24
	2	Chiken chilli Momo	24
	3	Chicken panfried Momo	24
	4	Chicken Peri Peri Momo	24
Locations of WOW MOMO	1	Bhawani Mall	8
	2	Kharvel Nagar	8
	3	Sahid Nagar	8
	4	ITER Road	8
	5	Nayapalli	8
	6	Esplanade	8
	7	KIIT Road	8
	8	Utkal Mall	8
	9	Master Canteen	8
	10	Infocity	8
	11	DN Regalia	8
	12	Lewis Road	8

The Hypotheses for Two factor ANOVA (Randomized Block Design) are mentioned below:

H0: The mean rating of the dish type is same for all four dishes.

H1: The block (location of hotel) has no effect on mean ratings for the dish type.

From the following Table 5, we can see that the p value for Dish type is 0.000 and for location it is also 0.000 and hence we reject the null hypotheses here. So we can conclude that there is a significant difference between the mean ratings given to the four types of non-veg dishes and the location of restaurants has an impact on the mean ratings given by the customers for the dish type.

Table 5: Tests of Between-Subjects Effects for two factor ANOVA

Dependent Variable: Ratings on 1 to 10

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	291.979[a]	14	20.856	4.957	.000
Intercept	3396.260	1	3396.260	807.304	.000
Dish_Type	112.615	3	37.538	8.923	.000
Location	179.365	11	16.306	3.876	.000
Error	340.760	81	4.207		
Total	4029.000	96			
Corrected Total	632.740	95			

a. R Squared = .461 (Adjusted R Squared = .368)

6. Conclusion

As per the analysis carried out we have seen in this paper that in One factor ANOVA there is a significant difference between the mean ratings given by the customers to all the four types of non-veg dishes. According to the two factors ANOVA it is also found out that there is a significant difference between the tastes for all the four dishes selected and there is an impact of the location on the taste for the 4 types non-veg dishes.

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