MULTIVARIATE ANALYSIS OF VARIANCE

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MULTIVARIATE ANALYSIS OF VARIANCE

OVERVIEW

Multivariate analysis of variance (MANOVA) was performed on 4 variables on the HBAT.xls file with x_5 (Distribution Systems) as the nonmetric independent variable, and all other variables listed below as the dependent variables. Distribution Systems is comprised of two different types: Indirect through Broker and Direct to Customer. The tables provide visual understanding of the multivariate relationships.

ID	Variable	Measurement	Description	Type
x_5	Distribution Systems	nonmetric	Classification	Independent
x_{19}	Satisfaction	metric	Relationship	Dependent
x_{20}	Likelihood of Recommendation	metric	Relationship	Dependent
x_{21}	Likelihood of Future Purchase	metric	Relationship	Dependent

MANOVA

metric *nonmetric*

$$Y_1 + Y_2 + \ldots Y_N = X_1 + X_2 + \ldots X_N$$

TABLE 7.5

Part of stage 2 is to research the design of multivariate analysis of variance. Three groups of metric dependent variables were selected for analysis: X_{19} customer satisfaction, X_{20} likelihood of recommendation, and X_{21} likelihood of future purchase. The metric dependent variables are measured with X_5 distribution system, which is a nonmetric independent variable. These variates are particularly keen for marketing and purchasing professionals since marketing is responsible for finding ways to increase customer's buying frequencies and identify whether or not new revenue can be generated from recommendations, all while maintaining a high satisfaction level.

Purchasing, on the other hand, would likely use the analysis to determine the if the current contract negotiations with their vendors is suitable. That is, high satisfaction that leads to more sales will require more raw material, and consequently a better leverage with economies of scale with its suppliers (the more you buy, the cheaper the per unit cost); while low satisfaction can indicate lower future sales and thus potential breach of contacts with suppliers if a minimum quantity must be met.

The descriptive statistics give a general insight into how the metric dependent variables are grouped with the nonmetric independent variable, distribution systems.

TAB E 5 Descriptive Statistics of Purchase Outcome Measures (X_{19}, X_{20}, and X_{21}) for Groups of X_5 (Distribution System)

	X_5 Distribution System	Mean	Std. Deviation	N
X_{19} Satisfaction	Indirect through broker	6.325	1.033	108
	Direct to customer	7.688	1.049	92
	Total	6.952	1.241	200
X_{20} Likely to Recommend	Indirect through broker	6.488	.986	108
	Direct to customer	7.498	.930	92
	Total	6.953	1.083	200
X_{21} Likely to Purchase	Indirect through broker	7.336	.880	108
	Direct to customer	8.051	.745	92
	Total	7.665	.893	200

TABLE 7.6

Box's M test is a parametric test that assesses if two or more covariance matrices are homogeneous. Bartlett's Test, on the other hand, tests for homogeneity of variances for normally distributed samples, which is especially important given MANOVA's normality assumptions.

Box's M: high p-value (.607) indicates that the three variables are nonsignificant and suggests rejecting the null hypothesis (no difference among groups).

TABLE 6 Multivariate and Univariate Measures for Testing Homoscedasticity of X_5

Multivariate Test of Homoscedasticity				
Box's Test of Equality of Covariance Matrices				
Box's M	4.597			
F	.753			
*df*1	6			
*df*2	265275.824			
Sig.	.607			
Univariate Tests of Homoscedasticity				
Levene's Test of Equality of Error Variances				
Dependent Variable	***F***	***df*1**	***df*2**	**Sig.**
X_{19} Satisfaction	.001	1	198	.978
X_{20} Likely to Recommend	.643	1	198	.424
X_{21} Likely to Purchase	2.832	1	198	.094
Test for Correlation Among the Dependent Variables				
Bartlett's Test of Sphericity				
Likelihood Ratio	.000			
Approx. Chi-Square	260.055			
df	5			
Sig.	.000			

TABLE 7.7

The next stage in multivariate analysis of variance is to estimate the MANOVA mode and assess overall fit. Table 7.7 assesses the variables' significance collectively and individually. The four tests performed were Pillai's Criterion, Wilks' Lambda, Hotelling's T^2, and Roy's greatest characteristic root. All four tests show a highly significant difference between the two types of distribution system (variate: x_5) with all significance levels being less than 0.05. In return, table 7.7 confirms the group differences seen in TABLE 7.5 and TABLE 7.6.

The power (right-hand column) indicates that that the sample size and effect size were sufficient to ensure that the significance levels would be detected given the sampling error.

TABLE 7 Multivariate and Univariate Tests for Group Differences in Purchase Outcome Measures (X_{19}, X_{20}, and X_{21}) Across Groups of X_5 (Distribution System)

Multivariate Tests

Statistical Test	Value	F	Hypothesis df	Error df	Sig.	η^2	Observed Power[a]
Pillai's Criterion	.307	28.923	3	196	.000	.307	1.00
Wilks' Lambda	.693	28.923	3	196	.000	.307	1.00
Hotelling's T^2	.443	28.923	3	196	.000	.307	1 00
Roy's greatest characteristic root	.443	28.923	3	196	.000	.307	1.00

[a]Computed using alpha = .05

Univariate Tests (Between-Subjects Effects)

Dependent Variable	Sum of Squares	df	Mean Square	F	Sig.	η^2	Observed Power[a]
X_{19} Satisfaction	92.300[b]	1	92.300	85.304	.000	.301	1.00
X_{20} Likely to Recommend	50.665[c]	1	50.665	54 910	.000	.217	1.00
X_{21} Likely to Purchase	25.396[d]	1	25.396	37.700	.000	.160	1.00

[a]Computed using alpha = .05
[b]R^2 = .301 (Adjusted R^2 = .298)
[c]R^2 = .217 (Adjusted R^2 = .213)
[d]R^2 = .160 (Adjusted R^2 = .156)