

Examining Differences (Comparing Groups) using SPSS Inferential statistics (Part I)

Dwayne Devonish

Statistics

- Statistics are quantitative methods of describing, analysing, and drawing inferences (conclusions) from data.
- Practitioners need to understand statistics:
 - To know how to properly present and describe information,
 - To know how to draw conclusions about large populations based only on information obtained from samples,
 - To know how to solve key industry-related problems and make sensible, valid, and reliable decisions on the basis of the statistical analysis conducted.

Quantitative Data-Analysis: Statistics

- In quantitative research, there are two (2) general categories of statistics:
 - Descriptive Statistics – statistical procedures used for summarising, organising, graphing and describing data.
 - Inferential Statistics – statistical procedures that allow one to draw inferences to the population on the basis of sample data. Represented as tests of significance (test relationships and differences).

Descriptive Statistics (2)

- Descriptive statistics include:
 - Frequencies/percentages
 - Means, standard deviations, medians, modes, ranges
 - Crosstabulations
- Although relevant, descriptive statistics give limited and inconclusive information which can aid policy and practice.
- The focus of this session is on the use of inferential statistical tests to better understand how these procedures can inform and enhance policy and practice in the tourism industry.

Quantitative Data Analysis

Inferential Statistics

- In quantitative data analysis, there are several statistical tests that can be used to examine relationships between two or more variables, or differences between two or more groups.
- Inferential statistics represent a category of statistics that are used to make inferences from sample data to the population. In particular, these statistics test for statistical significance of results – i.e. statistically significant relationships between variables, or statistically significant differences between two or more groups.

Statistical Significance

- Statisticians often choose a cut-off point under which a p-value must fall for a finding to be considered statistically significant.
- If the p-value is less than or equal 0.05 (5%), the result is deemed statistically significant, i.e., there is a significant relationship between the variables. Use the p-value as an indicator of statistical significance.
- Two forms of inferential statistics exist: tests that examine associations, and tests that examine differences.

Two Categories of Inferential Statistics

- *Associational Inferential Statistics*
- *Comparative Inferential Statistics*

REMEMBER

- At the heart, **all inferential statistics examine underlying relationships between variables**: whether they seek to examine differences between groups, or direct relationships between variables.

Variables

- A variable is any characteristic that is measured or captured in a dataset – any factor/issue under investigation: e.g. tourist arrivals per year, expenditure, tourist satisfaction, nationality, gender, number of nights in destination, perceived quality, likelihood to return to the destination, etc.
- The variables can be measured in one of two general ways:
 - As a categorical variable or,
 - As a quantitative/numerical variable

Variables (2)

- Quantitative/numerical variables

A quantitative/numerical variable has numeric values such as 1, 5,-9, 17.43, etc. Values can range between the lowest and highest points on the measurement scale. They are usually referred to as quantitative or numerical variables.

Recall that quantitative/numerical variables can be either discrete (expressed as whole numbers only – e.g. number of arrivals) or continuous (expressed as any value within a continuum – e.g., expenditure).

Examples of quantitative/numerical variables: height, weight, number of absences, income and age. In SPSS, these variables are referred to as scale variables.

Variables (3)

- Categorical Variable

- A categorical variable has a limited number of values. Each value usually represents a distinct label or category:
- Gender is categorical = Male and Female; Marital status is categorical = Married and Not Married; Educational level = Primary, Secondary, Undergraduate, Post Graduate.
- Categorical (or qualitative) variables identify categorical properties – they differ in kind or type, whereas quantitative/numerical variables differ in quantity or distance; they highlight that participants or objects differ in amount or degree.

Independent and Dependent Variables

- Variables can be classified as independent or dependent variables.
- Independent variables are also called explanatory variables and are examined to see how they explain, predict, or influence other variables – called dependent variables.
- Dependent variables are the variables that are believed to be influenced by independent variables.
- Example the effect of crime rates on tourist arrivals.
- Crime rates represent the independent variable, and tourist arrivals represent the dependent variable.

Summary of Variable Types

- Categorical Variables
 - ✓ Gender, Ethnicity, religious affiliation, occupation.
 - ✓ Age measured as categories: What is your age: 18-26 years, 27- 35 years, Over 35 years.
- Quantitative/numerical (numerical) variables
 - ✓ Based on data in the form of numbers
 - ✓ Age in years (What is your age _____?)
 - ✓ Tourism expenditure data (\$)

Choosing Inferential Statistics

- When deciding which inferential statistics to use:
 - ✓ Please consider how many *variables* are being examined.
 - ✓ If possible, the independent and dependent variable(s).
 - ✓ Consider the type of variables (categorical vs quantitative/numerical).

Independent samples t-test and ANOVA

- Two popular tests that can be used to examine differences between various groups of participants are:
 - ✓ *Independent samples t-tests*
 - ✓ *One-way Analyses of Variance (ANOVA)*

Inferential statistics: Examining Differences

- These tests can answer questions that are comparative in nature such as:
 - ✓ Is there a difference between British tourists and U.S tourists in relation to tourist expenditure?
 - ✓ Are there significant differences among tourists from different income levels in relation to their satisfaction levels with various aspects of a destination?

1. Independent samples t-test: Test of Difference between 2 groups

Independent samples t-test

- An independent samples t-test examines whether there is a significant difference on a quantitative/numerical variable between two groups or categories of respondents.
- The independent variable must be categorical with only two categories (dichotomous), the dependent variable must be quantitative/numerical.
- Two group means are compared to determine whether they are significantly different from each other.
- You need to examine several statistics, one of which is the p-value. This value must be .05 or below to determine whether a significant difference between the two groups exist.

NOTE

- One assumption of the t-test is that the variances (variability) of groups are equal.
- Independent samples t-test produce two different results, based on whether the equal variances are assumed between the groups.
- The Levene's test seeks to examine this assumption.
- If the Levene's test is not significant ($p > .05$), assume equal variances and read the top row of the table
- If Levene's test is significant ($p < .05$), equal variances cannot be assumed (it is violated) and read the bottom row of the table (this information makes adjustments to the violation of equal variances).

T-TEST Question

- ASK THESE QUESTIONS:
 - How many variables?
 - Which one is the independent variable, and which one is the dependent variable?
 - What types of variables are they (categorical vs quantitative/numerical)?
 - T-test appropriate?

Let's examine data in SPSS

- **Using data from tourism data1:**
 - Are European tourists more satisfied with the overall destination experience than U.S tourists ?
 - Two variables: nationality and satisfaction
 - Independent variable = Nationality
 - Dependent variable = Satisfaction with overall destination.
 - Nationality is categorical with only 2 groups (European and U.S)
 - Satisfaction is numerical on a five-point scale ranging from 1(very dissatisfied) to 5 (very satisfied).

Group Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Overall satisfaction with the destination				
European	78	3.42	.933	.106
U.S	184	4.04	.892	.066

- This table describes the means and standard deviations of each group: U.S and European visitors. The means represent the average satisfaction with the overall destination scores for the groups on a five-point scale. One can see clearly that the average satisfaction score for European visitors is 3.42, whereas for U.S visitors it is 4.04. We cannot arrive at any conclusions that one category is more significantly more satisfied than another category without examining the statistical significance of the result (t-test information).

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means							
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		
								Lower	Upper	
Overall satisfaction with the destination	5.092	.025	-5.077	260	.000	-.620	.122	-.861	-.380	
Equal variances assumed										
Equal variances not assumed			-4.985	139.433	.000	-.620	.124	-.866	-.374	

- This table describes independent samples t-test information to ascertain whether there is a significant difference between the nationality groups in relation to satisfaction with the destination. Before examining the t-test information, you must decide whether you can assume equal variances or not. Look at the p-value (sig.) for the Levene's test (.025), it is below .05, hence you cannot assume equal variances, read the bottom row of the table.

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means							
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		
								Lower	Upper	
Overall satisfaction with the destination	Equal variances assumed	5.092	.025	-5.077	260	.000	-.620	.122	-.861	-.380
	Equal variances not assumed			-4.985	139.433	.000	-.620	.124	-.866	-.374

- Below the section of t-test for equality of means, you need to focus on the sig (2-tailed) column – this is the p-value. It is .000 or is reported as $p < .001$. This is below our cut-off point. This p-value is related to independent samples t-test and shows that there is a significant difference between the two nationality groups in terms of their satisfaction with the overall destination. Go back to the first table and interpret the nature of this difference

Group Statistics

Nationality of Tourist		N	Mean	Std. Deviation	Std. Error Mean
Overall satisfaction with the destination	European	78	3.42	.933	.106
	U.S	184	4.04	.892	.066

- Given the significant result found, you can now conclusively argue that U.S tourists reported significantly higher levels of satisfaction with the destination than European tourists.

Writing the Results of T-test

Independent samples t-test Info

- You report the following information when reporting the results of the independent samples t-test:
 - ✓ The means and standard deviations for each group.
 - ✓ The t-value (-4.99), degrees of freedom (df) (139.4), and p-value (.000)
 - ✓ Remember that the Levene's test when significant, you report the bottom row for t-test information; if non-significant, report the top row.

Independent Samples T-test Write-up

- Here is a sample write-up:
- “An independent samples t-test was conducted to examine whether there was a significant difference between European and U.S visitors in relation to their satisfaction with the overall destination. The test revealed a statistically significant difference between males and females ($t = -4.99$, $df = 139.4$, $p < .001$). U.S tourists ($M = 4.04$, $SD = .89$) reported significantly higher levels of satisfaction with the overall destination experience than did UK tourists ($M = 3.42$, $SD = .93$).”

More Analyses using Independent Samples-T-Test

- **Open spss file with tourism data2:**
- Answer the following questions:
 - Is there a difference in the likelihood to return to the destination between male and female visitors?
 - Is there a difference in total expenditure between Repeat and First time visitors?

ANOVA: ANALYSIS OF VARIANCE

Analysis of Variance: ANOVA

- One-way ANOVA is a generalised version of the independent samples t-test: it examines differences among three or more groups on a quantitative/numerical (numerical/interval/ratio) variable.
- ANOVA stands for analysis of variance.
- After ANOVA is conducted, one must determine which groups differ significantly using post-hoc or multiple comparisons tests.

ANOVA: NOTE

- You have to select a test of homogeneity of variance to examine equal variances.
- You have then to choose a post-hoc based on whether equal variances are assumed (Scheffe), and one based on whether equal variances are not assumed (Games-Howell).
- Based on results of test of homogeneity of variance, you will select the more suitable post-hoc test, if a significant ANOVA result is found.

ANOVA Question

- ASK THESE QUESTIONS:
 - How many variables?
 - Which one is the independent variable, and which one is the dependent variable?
 - What types of variables are they?
 - ANOVA appropriate?

Post-hoc Tests

- Post-hoc tests allow you to determine where significant differences lie.
- When the ANOVA is found to be significant, one must examine which two groups differ significantly from the total number of groups: so post-hoc tests look at mean differences between different pairs: e.g. given three groups: Jamaican, Barbadian, Grenadian, you will examine differences such as Jamaican versus Grenadian, Grenadian versus Barbadian, and Barbadian versus Jamaican.

Post hoc tests

- There are many post-hoc tests to choose from when doing an ANOVA.
- Post-hoc tests are done based on whether equal variances are assumed, or not. This assumption is also for ANOVA (like the t-test).
- The Scheffe post-hoc test should be selected when equal variances assumed but the Games-Howell post-hoc test should be selected if not.

Doing ANOVA

- **Using tourism data1:**
 - Does overall satisfaction with the destination experience vary by age of tourist?
 - 2 variables: satisfaction with destination and age.
 - Independent variable = age
 - Dependent variable = overall satisfaction with destination
 - Age is categorical with more than 2 categories, and satisfaction is quantitative/numerical.

Descriptives

Overall satisfaction with the destination

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
18 - 25	14	3.86	1.167	.312	3.18	4.53	2	5
26 - 40	95	4.03	.818	.084	3.86	4.20	1	5
41 - 60	134	3.84	.949	.082	3.68	4.01	1	5
Over 60	19	3.11	1.049	.241	2.60	3.61	1	5
Total	262	3.86	.946	.058	3.74	3.97	1	5

- The first table in the ANOVA output is similar to that of the descriptive stats table from the t-test. It shows the means and standard deviations for each age group. Mean satisfaction scores based on a five-point scale ranging from 1 (very dissatisfied) to 5 (very satisfied).

Test of Homogeneity of Variances

Overall satisfaction with the destination

Levene Statistic	df1	df2	Sig.
1.664	3	258	.175

- This table (Levene's test) tests the assumption of equal variances for the ANOVA – this is the same assumption found in the t-test but in another table. Look at the sig. or p-value - the value is .175 which is above .05. The result indicates that equal variances assumption is met.

Multiple Comparisons

Dependent Variable: Overall satisfaction with the destination

	(I) Age	(J) Age	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Scheffe	18 - 25	26 - 40	-.174	.264	.933	-.92	.57
		41 - 60	.014	.259	1.000	-.72	.74
		Over 60	.752	.325	.151	-.16	1.67
	26 - 40	18 - 25	.174	.264	.933	-.57	.92
		41 - 60	.188	.124	.512	-.16	.54
		Over 60	.926*	.232	.001	.27	1.58
	41 - 60	18 - 25	-.014	.259	1.000	-.74	.72
		26 - 40	-.188	.124	.512	-.54	.16
		Over 60	.738*	.226	.015	.10	1.38
	Over 60	18 - 25	-.752	.325	.151	-1.67	.16
		26 - 40	-.926*	.232	.001	-1.58	-.27
		41 - 60	-.738*	.226	.015	-1.38	-.10
Games-Howell	18 - 25	26 - 40	-.174	.323	.948	-1.11	.76
		41 - 60	.014	.323	1.000	-.92	.94
		Over 60	.752	.394	.249	-.33	1.83
	26 - 40	18 - 25	.174	.323	.948	-.76	1.11
		41 - 60	.188	.117	.378	-.12	.49
		Over 60	.926*	.255	.007	.22	1.63
	41 - 60	18 - 25	-.014	.323	1.000	-.94	.92
		26 - 40	-.188	.117	.378	-.49	.12
		Over 60	.738*	.254	.038	.03	1.44
	Over 60	18 - 25	-.752	.394	.249	-1.83	.33
		26 - 40	-.926*	.255	.007	-1.63	-.22
		41 - 60	-.738*	.254	.038	-1.44	-.03

*. The mean difference is significant at the .05 level.

- This is the post-hoc tests to see where the differences lie. You have to focus on the Scheffe post hoc test as the Levene's test revealed equal variances ($p = .175$). You can see that those over 60 differed significantly from those 26-40, and 41-60 – they (60+) had significantly lower satisfaction scores.

ANOVA: Details

- Include the following information in your write-up:
- Means and standard deviations of both groups (needed when significant difference found)
- F-statistic, Between groups df and Within groups df, and p-value.
- Interpretation from the post-hoc tests used; remember the post-hoc test used is dependent on the Levene's test being significant or not.

ANOVA Write-up

- Sample write-up below:
- “A one-way ANOVA was conducted to examine whether there were statistically significant differences among tourists in different age groups relation to their satisfaction with the destination. The results revealed statistically significant differences among the age groups, $F(3, 258) = 5.34, p = .001$. Post-hoc Scheffe tests revealed statistically significant differences between tourists over 60 years ($M = 3.11, SD = 1.05$), and those 41-60 ($M = 3.84, SD = .95$) and those 26-40 ($M = 4.03, SD = .82$). Tourists 26-40 yrs and 41-60 yrs reported significantly higher satisfaction with the destination compared with tourists over 60 years. There were no other significant differences between the other groups”.

More ANOVA

- Using tourism data1:
 - ✓ Answer the following questions:
 - Does satisfaction with prices at the destination vary across tourists in different income categories.
 - Does total expenditure per person per night vary across tourists in different income categories.