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Analyzing Numerical Data

Learning Objectives

- 1 Explore the difference between measurement scales
- 2 Describe the data analysis process including the pre-analysis review, coding and the entry of data
- 3 Explain descriptive statistical analysis including frequency, central tendency and dispersion
- 4 Explain how statistical tests can be used to prove an hypothesis false

WHAT ARE YOUR VIEWS OF THE BRITISH NATIONAL PARTY? WOULD YOU REALLY SAY?

Research by YouGov, an internet-only research group, has found that responses to sensitive questions will vary based on the media through which they are asked. In the UK they found that people are more likely to give socially 'wrong' answers on an online survey than with other survey formats. They also found the same response pattern in the USA. People in both countries are much more likely to respond to questions with illiberal answers online. Does this mean that researchers are finally getting the 'real' answers? Not necessarily, the fact that online surveys pay and can be completed quickly and easily has resulted in a group of people that participate in many online survey forums and may be skewing results. Online surveys now comprise 20 per cent of UK fieldwork in market research, even though only 63 per cent of households have internet access.

Question: Is the fact that companies are relying heavily on online surveys a matter for concern?

Source: Grande, 2007

15.1 Measuring Differences

Qualitative marketing research methods analyze consumers' psychographic characteristics including attitudes, opinions, values and ideas. These characteristics are difficult to express using numbers. On the other hand, quantitative marketing research methods analyze consumers' current or future behavior which can be expressed using numbers or percentages. When analyzing the data from quantitative research, consumers' physical characteristics such as gender, age, religion, ethnicity, income, education level, or even their height, hair color or weight, can be quantified. In addition, consumers' behavior can be quantified by frequency of purchase, consistency of purchase, place of purchase or size of purchase. Using statistical analysis researchers will explain behavior using numbers rather than words. Furthermore, if the sample for a population is sufficiently large and properly selected, researchers will be able to say with some certainty that the research findings are probably true for the total population (Hellebusch, 2006).

15.1.1 Scales of measurement

A computer will be used to tabulate the results of a survey, but the findings will still need to be analyzed. Before the methods of analysis can be discussed it is important to understand measurement scales, as the type of scale used in designing the answer will affect the type of statistical analysis used.

People use measurement scales on a daily basis. When consumers decide to purchase a rug for their bathroom floor, they may decide to use their own feet and pace out the floor space to be covered. When they go to the store they can again measure off the space using their feet and find a rug that fits. Of course it is simpler to use a measuring tape already marked off with standard units of measurement. In research it is also easier to use standard measurement scales. The four standard measurement scales researchers have available are nominal, ordinal, interval and ratio. There is a very good reason why it is important to understand the differences in measurement scales, as the choice of statistical procedure to analyze the data will depend on the scale being used.

The nominal scale

The nominal scale is used for characteristics that can be defined as different states of being. Male and female, for example, are two characteristics that are measured by the nominal scale. There are only the two states and a research participant must be one or the other. University graduate and non-university graduate are another example. A research participant can be one or the other, but not both. Nominal data are usually analyzed by simply counting the responses. A research study might find that of a study of 100 people on their favorite hobbies, 62 were male and 38 were female. The report might also state that of the 100 participants, 78 did not graduate from university while 22 did graduate. When analyzing central tendency, the mode will be used.

Ordinal measurement scale

The ordinal scale is used when there is not just an absolute difference, such as male or female, but rather a degree of difference, such as preference. A question using the nominal scale would be 'What type of pizza do you prefer?' This question, using an ordinal scale, would ask consumers to rank order their favorite types of pizza. Analyzing these data would provide a ranking such as participants' favorite type of pizza topping is pepperoni, followed by cheese, and then

sausage. While this measure provides information on ranking, what this type of measurement does not show is how much more popular pepperoni pizza is than cheese or sausage. When analyzing central tendency, the median will be used.

The interval scale

Using an interval scale will provide more information than just ranking. An interval scale adds a unit of measure with a start and finish, and the difference between each unit of measurement being the same. Researchers construct the scale by creating the starting and ending point of the scale and the units of measurement. In this type of ranking participants are given a choice of degrees. The question might ask if the pizza was very delicious, delicious, good, all right, or inedible. While the construction of the scale is arbitrary, it is assumed that the amount of difference between 'delicious' and 'very delicious' is the same as the amount of difference between 'good' and 'all right'. With this type of data researchers will be able to provide an average opinion of the pizza by all survey participants.

When constructing questions that will provide interval data, researchers can use a category rating scale, Likert scale or differential scale. A category rating scale gives a rating such as excellent, very good, good, poor, very poor, awful. In a Likert scale, five to seven choices are given that measure a participant's opinion or agreement with a statement. This could be strongly agree, agree, undecided, disagree, strongly disagree. A number is attached to each category that allows researchers to provide an average. A semantic difference scale is also commonly used in interval measurement question construction. In this type of measure two opposing statements are made with seven points in between. A participant chooses where they stand on the subject by circling a number. An example of a semantic difference scale is an answer to the question 'How would you rank our pizza?' The possible responses would be given as: delicious 1-2-3-4-5-6-7 inedible. When analyzing central tendency, the mean will be used.

The ratio scale

A ratio scale has given start and end points that already exist and are not created by researchers. A consumer's weight is an example of a ratio scale, as no person's weight can be zero pounds. There is also an upper limit on what a human can weigh and still survive. On a ratio scale there is also the ability to measure exactly the difference between units. A person who weighs 200 pounds is exactly twice as heavy as a person who weighs 100 pounds. A person who spends \$900 on food per month spends exactly twice as much as a person who spends \$450 on food. The use of the ratio scale in marketing is not as common as the use of the interval scale because marketing often asks questions about peoples' preferences and opinions using an interval scale. When analyzing central tendency, the geometric mean will be used.

15.2 The Process of Quantitative Data Analysis

After a survey has been conducted, researchers will be faced with either a pile of survey forms or, if the survey was entered directly into a computer, an electronic file. Researchers must now begin the task of analyzing the data. This process of data analysis will begin with a pre-analysis stage where researchers will review the data, including its validity, completeness and accuracy. They will then code any open-ended questions and enter all the data into a computer software program.

Using an electronic form can save time at this stage because the data will already have been entered onto a computer. Another advantage to online surveys is that researchers can monitor the data as they arrive (see the box below). However, the electronic file still needs to be reviewed for completeness and any responses to open-ended questions must be coded. This is also true of online forms that ask for complaints or suggestions (Thomas, 2006).

ONLINE SURVEYS: SOME ISSUES ARE THE SAME – HOWEVER SOME ARE UNIQUE

Conducting a survey online can save a company time and money. However, when conducting a survey online the suggestions that make a survey successful are the same. The need for careful planning, an understanding of the sample population and well written survey questions hold true whatever the delivery mechanism. Yet some extra advice needs to be provided to researchers conducting online surveys.

First of all participants must be notified that the survey form is available online. For existing customers, web links on a company website work well. For potential customers emails can be sent.

Second, participants can be encouraged to finish the survey form by showing them their progress. Since they do not have the ability to page ahead as on a paper survey form, a visual, such as a percentage bar, will let survey takers know how far along they are in the survey.

Third, because survey takers can type in responses, researchers may be tempted to add many open-ended questions. However, such questions take more time and effort for participants to answer. Too many open-ended questions may result in participants abandoning the survey.

Finally, online surveys allow researchers to monitor progress. They can check to see how many participants have completed the survey and how long each survey took to complete. They can also see how many participants did not complete. If the completion rate is too low, the survey may need to be adjusted. In addition, if not enough participants are finding the survey the manner of notification may need to be changed.

Source: Kottler, 2005

After pre-analysis the next step in statistical analysis is determining the frequency of responses. The analysis may be of a single variable or the frequency of more than one variable could be cross-tabulated. Once this has been completed, the data are analyzed for central tendency by calculating the mode, median or mean. Researchers will also want to know how widely the participants' responses varied from each other, so dispersion will be examined by calculating standard deviation, range and variance.

Finally, statistical tests will be performed to determine if differences in the data are due to chance or random error, or if such a difference has a statistical significance (see Table 15.1). Statistical testing can include Chi-square, F-test and t-test. This statistical testing will be used to determine if the hypothesis is supported. For example, the researchers may have hypothesized that more men than

Table 15.1 Data analysis process

Pre-analysis	Review data for validity, completeness and accuracy Code open-ended questions Enter the data into a computer software program
Analysis of responses using descriptive statistics	Calculate: Frequency Central tendency Dispersion
Analysis using inferential statistics	Hypothesis testing for statistical significance Chi-square testing for goodness-of-fit

women attend the cinema. If the data show that men buy fewer theater tickets than women, statistical testing will confirm if this difference is significant enough for the alternative hypothesis to be supported. A study may contain more than one hypothesis as long as questions are written to address each (O'Neil, 2007).

15.2.1 Pre-analysis of survey data

Once survey research has been conducted, the first task confronting a marketing researcher is to review the questionnaire forms. After this review is completed the researcher is ready to code any open-ended questions. The final step in the pre-analysis process is to enter the data into a computer software program.

Review

Researchers may have taken great care in deciding upon the research question. In addition, the questionnaire form may have been painstakingly written and tested. However, unless the survey sample was very small with only a few participants, the actually conducting of the survey will have been out of the control of researchers. For an administered survey form, assistants will have been hired to conduct the survey. Self-administered forms will have been completed without any help from researchers or assistants. Because of these facts, the survey forms must be checked for validity, completeness and accuracy before the data are entered.

The issues that arise when validity is considered are whether the survey was actually conducted by an assistant and whether a participant was eligible for the survey. It is unfortunate but true that sometimes those people hired to conduct surveys may actually have completed the forms themselves. This may be due to frustration, because of an inability to obtain the cooperation of potential participants, or it may be due to dishonesty. Whichever might be the case, all forms should be checked to see if it looks as if an assistant has completed them. Clues would include answers that are extremely random or answers that are constantly duplicated. In addition, the demographic portion of a form should be checked to ensure that any eligibility requirements, such as age and education level, have been respected.

Not all survey forms will have every question answered and so should be checked for completeness. A form may be incomplete because a participant chose not to answer some of the questions or it may not have been completed because of time constraints. In addition, the form may have consisted of more than one page and a participant may not have noticed additional questions on a second page. Researchers must then decide what percentage of completion is required for a form to be included in the study or for it to be discarded.

Lastly, forms must be checked for accuracy. Researchers must review the forms to determine if the answers can be read and understood. They should be able to easily distinguish which answers have been marked. In addition, the answers to open-ended questions should be able to be deciphered.

Coding survey data

After the forms have been checked for validity, completeness and accuracy, they are ready for data entry. Since surveys are a form of quantitative research, the data need to be entered as numbers that can then be statistically analyzed. Close-ended questions should have been precoded on the survey form with the numbers that will be entered into the computer.

However, open-ended questions will require manual processing before they are ready to be entered onto the computer. To accomplish this task, researchers should begin by listing all the answers that were given to an open-ended question, and then consolidate the responses. For example, if a question asked for reasons for shopping at Crossroads Mall, the responses might be consolidated into the groupings of 'convenient location', 'variety of stores', 'parking' and 'special events'. Each grouping is then assigned a numerical code and it is this code that is entered into the computer.

Data entry

If a survey is web-based, the data entry step is not required as the answers are entered automatically. Some paper forms are now designed so that the results can be electronically scanned. Data entry for traditional paper survey forms can be performed by anyone with the skill to use a computer. A software package such as SPSS can be used for statistical analysis. SPSS is commonly used in business and the social sciences. The program is user friendly with built in tutoring features.

15.3 Data Analysis using Descriptive Statistics

Once the data have been entered into the computer software program, marketing researchers are now ready to start the process of analyzing the data. They should never forget that the purpose of the analysis is to provide information that can be used for making strategic decisions (see the box below). There are two types of statistical analysis that can be used and these are descriptive and inferential. Descriptive analysis collects, summarizes and presents a set of data. This type of analysis is simple for researchers to conduct and for management to understand.

IS GREEN PURCHASING HERE TO STAY? GLOBAL S STATISTICS HELP MARKETERS WITH S STRATEGY

How do companies know if a trend is real? They watch the statistics that are compiled by research firms and stories in the media. Concern for the environment is not new. Green themed advertising campaigns started in the 90s but there wasn't much interest on the part of consumers. Therefore 'green' products didn't sell. But they do now, with companies from Airbus to Proctor & Gamble bringing products to market that are aimed at the environmentally aware consumer.

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How did they know that the time was right to sell these products? The polls show that people are increasingly aware of the issue. In fact, a poll of UK and US consumers found that the change in attitude on environmental issues showed the largest shift of any research that the company has conducted. Who is greenest? A survey taken in 2006 by the Pew Research Center found that consumers in Japan, India, France and Spain were most concerned about environmental issues.

Source: Neff and Thompson, 2007 and Grande, 2007

Descriptive statistics help researchers to see patterns in research data. A basic concept used to analyze consumer characteristics and behavior is frequency, including one-way frequency and cross tabulation. Using frequency researchers can identify how many participants' responses were similar. A second concept is central tendency, which includes the mode, median and mean. In addition, dispersion of central tendency must be examined including range, variance and standard deviation.

Data analysis

- Frequency: one way, cross tabulation
- Central Tendency: mode, median, mean
- Dispersion: range, variance, standard deviation

15.3.1 Frequency

Frequency can be understood using the example of a survey question that asked why consumers shopped at Abdul's Sporting Goods store. The survey question may have provided the answers to choose from – good prices, the best selection and helpful service. If 1,000 people were surveyed Abdul would want to know what percentage of consumers selected each response. However, some people will not respond to a survey at all. In fact the response rate will differ based on cultural values (Lyness and Kropf, 2007).

The first issue faced by the researchers helping Abdul is that not all of the 1,000 survey forms may be useable as some of the participants may not have answered the question, while others may have attempted an answer but the mark they made is difficult to interpret. In addition, some respondents may not have completed the questionnaire. As a result, of the 1,000 survey forms completed perhaps only 950 will be useable. When the data are analyzed for one-way distribution (how many people responded to each potential answer to the question) it may be found that helpful service is the most frequent response. A distribution table of the data would look like Table 15.2 below.

This information will quickly inform Abdul of the ranking of the responses, with helpful service being top, followed by best selection and then good prices. However, it is difficult when just reading the numbers to understand how much more important to the participants was service over selection. Adding a percentage to the table makes the relationship between the responses easier to grasp as most people can see the relationships between percentages more quickly than

Table 15.2 Frequency table with percentages

	<i>Number</i>	<i>Percentage</i>
Helpful service	521	55%
Best selection	287	30%
Good prices	<u>142</u>	<u>15%</u>
Total	950	100%

Table 15.3 Frequency table for question allowing multiple responses

	<i>Number</i>	<i>Percentage</i>
Helpful service	588	62%
Best selection	345	36%
Good prices	<u>162</u>	<u>17%</u>
Total	1095	115%

those between raw numbers. The percentage is calculated off of the total number of responses used (950) rather than the total number of respondents (1,000). The percentages show that helpful service is almost twice as important as best selection.

The survey question asking consumers for their motivation for shopping at Abdul's could have been designed to allow for multiple responses. The question would have read 'Which of these reasons are why you shop here?' In this case the numbers would look different as some people might tick more than one response. The responses look like Table 16.3.

Because the question allowed respondents to tick more than one answer, the total response is now 1,095. However, the percentage is still calculated on 950 respondents which is why when added together, the responses total more than 100 per cent.

These different frequency results demonstrate the importance of carefully planning the survey questions and answers. In the tables above, the ranking did not change. However it is possible that allowing multiple responses will change the frequency ranking. If more than one response is allowed, researchers may wish to ask respondents to rank them in preference. In this way respondents who tick both service and price can demonstrate which of the two is most important.

Cross tabulation

The first step in calculating frequency is to determine which responses were chosen most often. What one-way frequency analysis does not describe is how data collected in the survey are related. For example, Abdul may want to know the ages of the shoppers choosing each response. Cross-tabulation is a simple and yet powerful tool that can be used by researchers to understand how variables are related to each other. The term 'cross-tabulation' results from the fact that one variable is crossed with another to see the relationship between the two.

In the example of Abdul's Sporting Goods store, the researcher knows that the reasons people shop at the store are service, selection and price. The researcher will have also asked various

Table 15.4 Cross tabulation table

<i>Age:</i>	<i>18–29</i>		<i>30–49</i>		<i>50+</i>		<i>Total</i>	
Service	122	34	187	65	104	34	445	46%
Selection	51	14	50	17	24	41	205	21%
Price	<u>185</u>	52	<u>51</u>	18	<u>76</u>	25	<u>312</u>	32%
Totals	358		288		204		962	
	38%		25%		32%			

demographic questions, including the age of each shopper. If Abdul wants to target young shoppers aged 18–29 to shop at his store, he will be most interested in the opinions of young people. By using cross-tabulation he can determine what the main motivating variable is for this age group. (see Table 15.4 above).

With a small sample, tabulation can be handled with simple math and the table could be constructed manually. More often a software program such as SPSS will be used. The advantage of using this kind of software is that the data can be cross-tabulated using multiple variables simultaneously. The cross-tabulation in Table 15.4 shows that, for all shoppers, service is most important at 46 per cent. However, the group aged 18–29 considers price as being most important at 52 per cent, while for shoppers aged 30–49 service is most important. For shoppers aged 50 plus, selection was most important at 41 per cent.

15.3.2 Central tendency

People often use the term ‘average’ when they are referring to a middle ranking. However there are a number of ways to measure average or central tendency that include mode, median, and mean.

Mode

Mode refers to the response that is the most common for all participants. Mode is used when describing nominal data, which can have one of either two states of being, but not both. In the research for Abdul’s store discussed above, the respondents may have also been asked their gender. The question might have found that of the 950 survey participants who responded to the question on gender, 505 were male and 445 female. Obviously gender cannot be averaged, as the answer would always be exactly half or 500. Instead the concept of mode (most frequent response) is used, with the mode being male instead of female.

Median

Median is the response that measures the halfway point of the responses. Median is used in ordinal data, where there is a degree of difference. In the question on motivation for shopping at Abdul’s, best selection is the median response as one answer received more responses and one answer received less responses. Median cannot be used when analyzing nominal data as there are only two possible responses so there cannot be a midpoint.

Mean

Mean is the average of all of the responses. The mean is calculated by adding all the responses and then dividing by the number of participants. If the survey participants were asked their age,

it would be simple to determine mean age. The ages of all the participants would be added together and then divided by the number of responses, or 950.

Central tendency measures

- Mode: the most frequent response
- Median: the response that divides a series of responses in half
- Mean: the average of the responses

15.3.3 Dispersion measures

One of the issues that researchers must analyze is how varied the responses are from the calculated mean. To do so researchers use the concepts of range, variance and standard deviation. These statistical concepts allow researchers to compare the dispersions of two sets of data. While two sets of data may at first seem similar because they have the same mean, researchers know that the individual responses that comprised the mean may be dispersed very differently. The ways to examine this issue of dispersion of responses include range, variance and standard deviation. The amount of dispersion may depend on the way the rating or ranking question was structured (Coelho and Esteves, 2007).

Range

Range is the easiest dispersion measure to understand and tells researchers how widely answers are dispersed. To calculate range, the smallest value expressed in the survey is subtracted from the highest value. This gives the range of responses. The data below in Table 15.5 give the amount of money spent on lunch by male and female students. Both have the same mean of 11 whether the currency is in dollars or pounds or Euros, and yet just by looking at the figures there is obviously a difference between the spending patterns of male and female students. To calculate range, the lowest figure is subtracted from the highest figure. The range for the females is 6, while the range for the males is 16.

Table 15.5 Calculation for range

	<i>Females</i>	<i>Males</i>
	7	3
	9	5
	9	8
	10	9
	11	10
	12	11
	12	13
	13	14
	16	15
	<u>13</u>	<u>22</u>
Mean	11	11
Range	9	19

Variance

The variance of the set of numbers around the mean helps researchers to understand how dispersed each individual response is from the mean. One way to calculate this number would be to subtract each individual data number from the mean and then add the differences. However, this will not work because the negative numbers and the positive numbers will always cancel each other out and the answer will be zero. To solve this dilemma, the difference between each individual data number and the mean is first squared and the answers are then summed. The final step is to divide the sum by the number that is one less than the number of responses. This step allows researchers to compare the variance between data sets that have different numbers of responses. The final number calculated is the variance.

Table 15.6 Calculating variance

	<i>Females</i>		<i>Males</i>	
	7	16	3	64
	9	4	5	36
	9	4	8	9
	10	1	9	4
	11	0	10	1
	11	0	11	0
	12	1	13	4
	12	1	14	9
	13	4	15	16
	16	<u>2.5</u>	22	<u>21</u>
	11.0	56	11.0	264
Variance		6.22		29.33
Standard deviation		2.49		5.42
Most females and males spend between the mean plus or minus the standard deviation. Females: 8.51–13.49, Males: 5.58–16.42.				

Standard deviation

The higher the variance, the more dispersed are the responses in the set of data. As can be seen by looking at the data, the males' spending pattern is more dispersed. The problem with the variance number is that being squared, the number no longer has any meaning. If the square root of the variance is calculated the answer will be the standard deviation, which is in the same units, currency, as the original numbers.

If the standard deviation is added and then subtracted from the variance, this tells researchers that this range is where most responses will fall. The standard deviation for the females is 3.72 and for the males is 4.05. If the standard deviation is greater in one data set than the other, then the responses provided by the participants in that sample will have varied more widely. While this is easy to see in the small sample of ten numbers, it would not be easy to see in a set of 950 numbers.

If these standard deviation numbers are then added and subtracted from the mean, they will show where most of the responses lie. For females, this is between the price of 8.51 and 13.49.

For males, it is 5.58 and 16.42. Two sets of data can have the same mean but still have very different standard deviations.

15.4 Data Analysis using Inferential Statistics

The other type of statistical analysis that researchers can conduct uses inferential statistics. These statistical methods go beyond just describing the data discovered during the research. Of course, no marketing research study that uses a sample can 'prove' anything with absolute certainty. What the analysis of quantitative research data can do however is indicate whether an hypothesis is most likely to be false. Using inferential statistics, researchers can perform statistical tests to determine if responses from a sample can be used to draw conclusions about an entire population. In fact more than one statistical test can be conducted on the same set of data (Park et al., 2007).

15.4.1 Statistical testing process

The first step in using statistical analysis to indicate the truth of a hypothesis is to state the hypothesis, or guess, about some characteristics of consumers or their behavior. The research methodology will then be designed to ensure that these characteristics, whether about people or their behavior, are measured. Once the research study has been completed and the data entered onto a computer, the measured variable for the sample of participants will be compared with the expected outcome stated in the hypothesis.

The type of test that will be used to determine if the difference is significant depends on both the type of measurement that was used and the type of resulting data. These tests can be used on their own or in combination (van Wezel and Potharst, 2007). The z-test is used to determine if the differences in proportions or mean of characteristics are statistically significant or not, while the t-test also looks for statistical significance but between the means of two unrelated groups. The z-test is used in marketing when one segment of consumers is being studied.

15.4.2 Hypothesis

An hypothesis is a guess that is made by the company or individuals commissioning the research. Perhaps an academic publisher has come up with a new textbook product that can be read electronically. The question is whether they should spend the money to develop and introduce the product? Qualitative research has indicated that many students would be interested in this product. However, the finance department of the company has stated that at least 20 per cent of students will need to purchase the product to make it financially viable.

This first hypothesis is the null hypothesis and will be stated as what the company does not wish to be true. (The symbol H_0 is used to designate the null hypothesis.) The null hypothesis is considered true until proven false. For the publisher in this example the null hypothesis is that less than 20 per cent of students will be interested in purchasing the product. The alternative hypothesis would be that 20 per cent or more of students will be interested in purchasing the product. (The alternative hypothesis is designated H_1 .) One hypothesis is the opposite of the other and so both cannot be true.

Formulas for stating the hypotheses

$$H_0: \pi = < 0.20$$

$$H_1: \pi = \geq 0.20$$

The statistical tests cannot be used to prove the hypothesis true. This is impossible as the only way to know with 100 per cent accuracy if an hypothesis is true is to survey the entire population. If the null hypothesis is proved false, then the alternative hypothesis (that 20 per cent or more of students will be interested) can be accepted as being true. The null hypothesis needs to be expressed in such a way that its rejection leads to the acceptance of the preferred conclusion – developing the new product. These stated hypotheses are an example of a one-tailed test, the kind most commonly conducted in marketing research.

The publishing company surveyed a sample of 1,100 students (more than the sample size of 1,024 that would have been needed to make the study valid at 95 per cent confidence) and found that 22 per cent stated they were interested. While this is over the required 20 per cent, researchers know that taking a sample will never be as accurate as asking everyone. However, the question remains – if 22 per cent is so close then is it simply error that made it over 20 per cent?

Therefore, the next step is to calculate whether the difference between the hypothesized outcome and the survey outcome is statistically significant. While the word ‘significant’ usually means important, in statistics it means ‘true’. The test to find if it is significant would be automatically calculated by a statistical computer software program such as SPSS. However, the formula is actually easy to understand. To calculate the significance all that is needed is three numbers: the hypothesized percentage, the sample percentage, and the standard error of the percentage. Researchers already have two of these, the hypothesized and sample percentages. To calculate the standard error of the percentage, the researcher would use the following formula.

Formula for calculating standard error

$$\sigma_p = \sqrt{\pi(1 - \pi)/n}$$

$$\sigma_p = \sqrt{.20(1 - .20)/1100} = .010$$

Using this number as the standard error, the z-score can be calculated.

Formula for calculating z-score

$$Z = (p - \pi_h) / \sigma_p$$

$$2.0 = (.20 - .22) / .010$$

This z-score (sometimes referred to as the p-value) can be compared with the numbers found on a table of z-scores to determine if it indicates that the null hypothesis is not true. It is standard procedure to have the computer software do the comparison. However, a rough calculation can be done by remembering the standard numbers for confidence levels. For a 95 per cent confidence level the number was 1.96 and for 97 per cent confidence 2.58. The z-score of 2.0 tells the researchers that they can not say with 95 per cent confidence

that the null hypothesis is not proved false. Therefore the company will not go ahead with production. Interestingly, if the company wanted to be 97 per cent confident – the company would not start production. The same type of calculations can be done for comparing a hypothesized mean and the mean that was found by surveying the sample.

Steps in the analysis process

- State the hypothesis
- Conduct the research
- Compare the measured value with the hypothesized value
- Decide the necessary level of confidence
- Choose a statistical test for significance
- Calculate the test value
- State a conclusion and any recommendations

15.4.3 Level of confidence

The possibility that the null hypothesis will be rejected as false when it is indeed true is called a Type I Error, which is signified by using the lower case Greek alpha (α). The amount of possibility that a Type I error has been committed is called the level of significance of the statistical test. Researchers must decide on the amount of risk they are willing to tolerate of committing a Type I error. There are standard levels of risk that are considered acceptable when conducting statistical analysis. These standard levels, or value of α , are 0.01, 0.05 or 0.010. Another way to express these values is that there is a 1 per cent, 5 per cent or 10 per cent chance of the hypothesis being rejected when it is indeed true. The traditional value used by researchers is 0.05, or there is a 5 per cent risk that the null hypothesis is false, but it isn't rejected.

Another type of error, Type II, happens when the null hypothesis is not rejected when it should be. The Greek letter beta (β) is used for this type of error. A statistical test to check for Type I errors is called a one-tailed test, while a statistical test to check for Type II errors is called a two-tailed test. Most researchers will only use a one-tailed test.

15.4.4 Chi-square tests

The Chi-square test is used for what is called 'goodness-of-fit' when analyzing frequencies of responses in a frequency table using cross-tabulation. Marketers often want to know if there is a relationship between a specific group of consumers and some preference for a product benefit. Marketers also may want to know if men or women prefer the product in a smaller size bottle, or they may want to know if young consumers would prefer the product in a new color. While these statements could be presented as hypotheses this is not necessary. In fact, when using Chi-square all researchers need to do is think – the computer will handle the rest.

Using the example of the publishing company and the textbook, the company believes that men will be much more interested in the product than women. The researchers will use SPSS to calculate a cross-tabulation of preference (yes or no) with gender (male or female). The computer, based on the proportion of men to women in the sample, will calculate what the expected percentages would be if there was no difference in preference versus if gender makes a difference.

It would be simple to compare these numbers using percentages if the groups were all the same size. However, this is unlikely to be true. For this reason the Chi-square test can be used to determine if there is a statistically valid difference in the relationship between age and reason.

Summary

- 1 Quantitative research produces statistical findings that, if the sample is sufficiently large and has been carefully chosen, can be used to support or reject a null hypothesis. The measurement scales that can be used are nominal, with two states of being, and ordinal, which also shows preference. In addition, interval scales provide a standard unit of measurement, and ratio, which has a given start and end point.
- 2 The process of qualitative data analysis starts with the pre-analysis of data including review, coding and data entry. Descriptive statistical analysis includes frequency, central tendency and dispersion. Inferential analysis includes analysis of statistical significance used to test an hypothesis.
- 3 Frequency analysis provides a count of the frequency of responses. Cross tabulation shows the number of responses along with at least one other variable. Central tendency analysis of the data includes the mode (or most frequent response) the median response, and the mean (or average). Dispersion measurements include range, variance and standard deviation.
- 4 Data analysis can also be used to test the hypothesis, or guess, made before the research begins. The purpose of the analysis is to try to prove the hypothesis false (and the alternative hypothesis true) with a certain level of confidence. A z-test is used to determine if there is significance in the difference in the expected hypothesized result and the result and from the surveyed sample. A Chi-square test finds the goodness-of-fit in a frequency table between two variables.

Key Terms



continuous variables variables whose units of measurement can always be cut into ever smaller units

discrete variables variables that can be measured in distinct units

interval scale measurement scale with standard units of distance between preference choices

nominal scale measurement scale with only two states of being

ordinal scale measurement scale that provides information on preference

ratio scale measurement scale with a natural start and end point

Discussion Questions

- 1 What survey questions would you ask about students' attitudes toward downloading music using all four measurement scales?
- 2 What type of errors can be found when survey forms are reviewed before data entry?
- 3 What kind of problems can result from researchers skipping the pre-analysis stage?
- 4 Which variables would you cross-tabulate with students' opinions on the ethics of downloading music: age, gender, postal code, income, or education level? Why should you test for goodness-of-fit?
- 5 How would you describe the mode, median and mean of the answers to a question on income level?
- 6 If a study finds men and women spend the same mean amount of money on clothes, what additional information would standard deviation supply?
- 7 Why do researchers try to prove the null hypothesis false rather than true?
- 8 Why does a student need to know about statistical testing even if he or she doesn't understand how the math is calculated?

Recommended Reading



Foster, Jeremy, Barkus, Emma and Yavorsky, Christian (2006) *Understanding Advanced Statistics*. London: SAGE. This book provides an explanation of advanced statistical models used for analysis that can be conducted using computer programs.

Good, Phillip I. and Hardin, James W. (2006) *Common Errors in Statistics (And How to Avoid Them)*. Chichester: Wiley. A more advanced treatment of statistics, with an emphasis on the mathematics behind statistical theories.

Kault, David (2003) *Statistics with Common Sense*. Westport, CT: Greenwood. Introduces statistical concepts through their application in real life without overly emphasizing the theory behind the statistics.

Lee, Eun Sul and Forthofer, Ron N. (2006) *Analyzing Complex Survey Data*. London: SAGE. A thorough approach to the many issues involved in analyzing qualitative data, including variance estimation, data requirements and preliminary analysis.

Levine, David M. and Stephan, David F. (2005) *Even You Can Learn Statistics: A Guide For Everyone Who Has Ever Been Afraid of Statistics*. Upper Saddle River, NJ: Pearson Prentice Hall. Starts with an explanation of key statistical terms and then describes the types of statistics, analysis, testing and presentation of statistical findings.

Stevens, Robert E. (2006) *Concise Encyclopedia of Church and Religious Organization Marketing*. Binghamton, NY: Best Business Books. This book is a good reminder that marketing is now used by religious organizations. Chapters on survey research and analysis are included.