PART 3 Quantitative Marketing Research

11 Determining Probability Samples

Learning Objectives

1 Understand types of sampling and sour ces of sampling er ror
2 Learn to deter mine the cor rect tar get population and develop the sample frame
3 Examine pr obability sampling including simple, stratif ed, systematic and cluster
4 Describe the steps involved in deter mining the size of the sample

WHAT YOUNG EUROPEANS NOW WEAR ON TH EIR FEET WAS FIRST WOR N IN TOKYO

No, young Europeans are not wearing used shoes. But the styles they are wearing might have been first tested on young Japanese. Young residents of Tokyo are known for pushing the envelope on what is fashionable. After all, where do you think the Goth-Loli style came from? (Just in case you aren't in the know – it's a popular style in Tokyo that combines the Sid Vicious look with Little Bo Beep sentimentality.) Marketing researchers looking for new ideas for the designer Gola went to Tokyo to conduct observational research. After watching these fashion savvied consumers, the researchers developed the idea for shin-high boxing boots for women. They were first a hit in Japan and then exported to Europe where they also sold well. Who would have known the opinions of Tokyo teenyboppers would predict what young Londoners would wear?

Questions: If you were going to conduct research on the latest in music trends where would you go? What about entertainment? Education?

Source: Rowley and Tashiro, 2007

11.1 Sampling Issues

One of the questions researchers face when developing a research plan is who will be chosen to be research participants. The word 'population' is commonly used to define everyone of interest

who could be possibly included in a research study. Researchers may define a population by geographic area. In addition, they may also define a population using such demographic data as age, gender, income, or ethnicity. Because marketing promotion is often targeted based on psychographic segmentation, researchers may also define a population based on interests, values or lifestyles. Product usage can also be a means for defining a population, such as nonusers, occasional users and frequent users. Of course these variables can also be used in combination. The resulting population may be very large, such as daily users of toothpaste who live in Germany, or very small, such as people over the age of 70 in the UK who are attending university as full-time students.

One of the ways that a sample frame is often first defined is by the geographic area where people live or work. Once an area is defined individual participants can be contacted using telephone numbers. However, this is becoming even more difficult due to a mobile population, homes without a landline phone and people working from home or living temporarily near a worksite (Wynter, 2006).

11.1.1 Using a census

When conducting quantitative research, researchers are attempting to support a fact or hypothesis. This fact might be how many consumers would buy a product, what type of new promotion would work best, the effect of pricing on purchase behavior, or the best store in which to distribute a product. Of course if a 100 per cent accurate answer is needed, researchers must ask every person who is included in a population.

Asking everyone in a population is called a census. Conducting a census is possible if the number of people from whom information is needed is small and all of the members can be reached. For example, a professor might wonder if students in his class study each evening. A census could be used for surveying all the members of this class about their plans for the evening. However, if even one student is absent due to illness the census would be incomplete. Even if everyone is present, if one student refuses to answer this question, again, the census would be incomplete.

Obviously, there are problems with trying to conduct a census. Some people will not be present and some may refuse to participate. A census might be conducted despite these difficulties in reaching everyone but any errors in the answers obtained from this research would be very expensive. For example, a medical equipment supplier might be developing a piece of equipment that would be used by only a very few doctors treating a rare condition. If the cost of developing such equipment for the marketplace is very expensive, the company may wish to ensure that the design of the equipment is exactly right so that it will be purchased. When only a small number of people are in the population, such as a few doctors, conducting a census is possible.

11.1.2 Using a sample

However, most research will involve the sampling of a population rather than a census. For example, researchers might be developing a new toothpaste flavor that they plan to introduce in France. Asking everyone in the population will simply take too much time and money. In addition, the company commissioning the research does not need to know with 100 per cent accuracy that the new flavor will be acceptable. Less accuracy will still provide the information as to whether the flavor will be acceptable to a significant percentage of adults in France. Thus

asking a sample of the population will still provide an accurate enough estimate of consumer preference and this will allow the company to proceed with product development plans.

In this type of research situation, researchers will save money and time by surveying a sample of the total population. This money will be saved because not as many surveys need to be conducted. Time is an issue here, not just because increased time spent in conducting research means increased staff expenses. It is also important in this case because while the toothpaste company is conducting a census of everyone, a rival company may introduce the same new flavor.

11.1.3 Sampling errors

The data obtained from asking a sample of a population can never provide as accurate an answer as a census of everyone. A professor who wants to learn how many students study at night could ask all of his students. However, if the same professor only asks ten out of the 30 students enrolled in his class, there is the possibility that the answers provided are not representative of everyone. This is called sampling error. This error might result if the professor asked those ten students who always attend class. They would respond positively that they study nightly. The professor would then believe that all his students worked hard. On the other hand, he could also include too many of those students who didn't attend class regularly, get the response that they didn't study and, as a result, will believe that all his students are lazy. No sample can perfectly represent a total population.

11.1.4 Nonsampling errors

Other types of errors that result from using a sample are called nonsampling errors. These errors do not result from the fact that a sample was used instead of a census. Instead those designing and conducting the research cause these errors. Because they are caused by human error, nonsampling errors can be controlled. Types of nonsampling errors include specification errors, design errors, and selection errors.

Specification errors

Specification errors result when the wrong population is specified in a research design. A university admissions office may wish to study students' views on what type of art classes should be offered. For convenience, the admissions office might choose to survey students on the campus where the admission office is located. However, if most of the students who attend classes on the campus are business students, the survey results will be flawed. Business students may have little interest in art classes. They may not even know what type of art classes could potentially be offered. Their opinions will have no comparability to what students interested in art might want. Therefore the wrong choice of population will result in data that are not useable.

Design errors

Design errors occur because of human failure and include data recording, data entry, data analysis and nonresponse error. When the same researcher conducts many surveys, it is possible that some responses may be recorded incorrectly. With self-administered surveys, respondents may also make mistakes in recording data. To minimize data recording errors, it is important that survey takers be properly trained and also motivated to do their job correctly. Survey forms should also be designed so that respondents will be able to easily find the response they wish to indicate. The answer space should be designed so that once an answer is indicated, it will not be

confused with other possible responses. For example, if the question requires a yes or no answer whether a respondent is to make a tick, cross out, circle or underline should be clearly stated. In addition, the blanks for completion of open-ended questions should be far enough apart to ensure there is no confusion when an answer is indicated.

Even if participants and respondents are very careful when administering surveys, there are still occasions for error. Once surveys are collected all the information must be input into a computer software program. Even if the number of surveys is so low that computer software is not used, the responses must still be counted and tabulated. Because this work requires a low level of skill, clerical assistants often perform the data entry task. And because of the repetitious nature of this task, errors can result when the responses are input incorrectly. This is a difficult type of error to eliminate, but careful hiring can help reduce errors. Because of the possibility of data entry error the data should be doubled checked once they are entered.

Data recording errors and solutions

- A researcher makes a wrong entry: training and motivation
- A respondent makes a wrong entry: clear design and instructions
- Data entry personnel make a wrong entry: careful hiring

Selection errors

Selection errors occur when the correct population has been chosen, but the sample taken from the population is not representative of the entire population. For example, a university may decide to ask students who are enrolled in art classes what additional classes they should offer. A selection error occurs when the students who are asked are still not representative of the whole student population. For example, a young male student employed to conduct the survey might view the task as a good opportunity to chat up lots of young women. As a result, a much larger population of women then men will be included in the sample. If women want different types of classes than men, this could result in the survey returning inaccurate information due to selection error.

11.2 Determining the Target Population and the Sample Frame

One of the most critical steps in the quantitative research process is determining the target population to be researched. It is not unusual early in the research process for both marketing researchers and management to speak in generalities. They may discuss the need to research the attitudes of current customers. They may also discuss wanting to research potential customers who are older, retired couples. At first these might appear to be reasonable research requests. However, marketing researchers will understand that both of these definitions of a population are too vague. A target population always needs to be clearly defined so that the correct individuals are included in the sample frame from which the final participants will be chosen. This is especially true of the population and sampling frame for online surveys. Because geography does not need to be considered, when defining a population it is easy to do this too broadly resulting in a higher non-response rate (Dibb and Michaelidou, 2006). Below is an example of how Turkish Airlines decided to use elite status as the sampling frame for their survey study.

WHAT IF YOUR CUSTOMERS LIVE EVERYWHERE? TURKISH AIRLINES CHOSE TO SURVEY THEM ONLINE

Turkish Airlines realized that they didn't know their frequent flyers' opinions about the services and awards offered by the airline's frequent flyer program. But how do you survey when program members live over a wide geographic area? Fortunately, the airline had email addresses and other contact information for all these members. The researchers defined the population as all program members with elite status wherever they lived. Of these 15,000 individuals, 2,000 members were randomly selected. Of these 2,000, 608 usable forms were received, which gave a response rate of 30.4 per cent, which is higher than what normally might be expected.

The result? Among other issues, frequent flyers were unhappy with the availability of free tickets, the behavior of personnel, and the high number of miles needed for trips. Are the flyers of Turkish Airlines unique in their complaints? Only comparison with other airlines' data would answer this question.

Source: Atalik, 2007

An example of this process would be the management of a football team researching how a rise in ticket prices would affect attendance at games. The first decision that must be made here in defining the population is whether to research the effect on fans who currently attend games or potential fans. If the decision is to research fans who are currently buying tickets, the next step in defining the population is to discuss whether the population includes everyone in this category or a smaller group. Management, with the assistance of market researchers, will need to define what they mean by 'current', 'fans' and 'buy tickets'. This process is summarized in Figure 11.1.

Defining current ticket buyers at first seems self-explanatory. However, it is important to define the time period meant by 'current'. Does this refer to just the most recent game, or to the past month, the current season or the last one or two years? The answer to the question will depend on whether attendance is consistent or varies over time. If management is aware that the same group of fans attends each game, then a short time frame is acceptable. However, if attendance varies a longer time period will be needed.

The next question that needs to be addressed is if a 'fan' includes those people who attend occasionally or those who attend frequently. Management may decide it is more important to learn the attitudes of those people who attend frequently. Finally, does it make a difference if those who attend frequently buy season passes or purchase tickets for each game individually? A final definition of the population could be those people who attended at least 75 per cent of the games during the last season and bought season tickets.

11.2.1 Sampling frame

Once a population has been defined marketing researchers will be able to decide whether they can do a census of the population or whether they will need to choose a sample. If the population is small and the research question demands 100 per cent accuracy, a census could be conducted. However, in most situations researchers will decide to use a sample of a population to

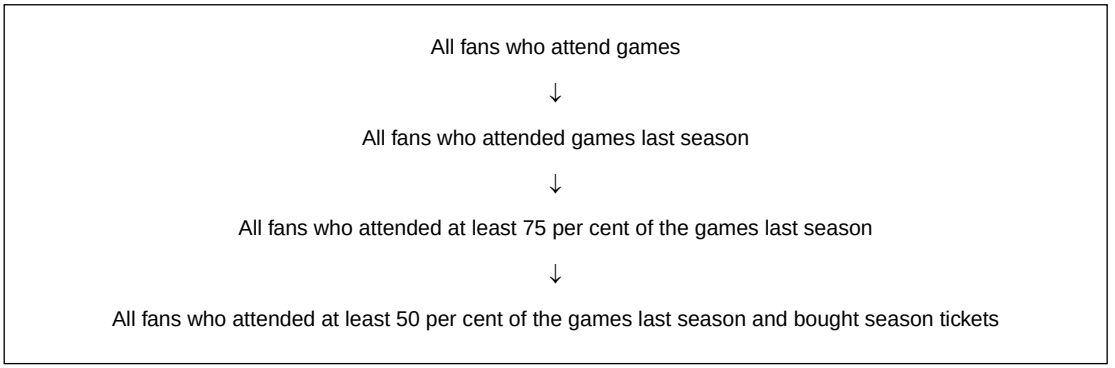

Figure 11.1 Narrowing the population

participate in the survey. In order for a sample of participants to be chosen, researchers must first have potential access to everyone in that population. For the football team mentioned previously this list of potential participants in the population, or sample frame, might be developed using data from the football team's ticket office database.

Using this database, researchers will be able to construct a list of ticket buyers and the frequency of ticket purchases for the past season. With this list researchers can then look for fans who have purchased season tickets for 75 per cent or more of the previous year's games. This method is still not foolproof. There may be ticket buyers who paid cash, or who refused to provide their names when they bought tickets. However, the frame should include a high percentage of people, if not everyone, who makes up a population.

When developing sample frames of customers, there are other sources of information besides ticket office data that could be used to construct sampling frames. Sampling frames can be developed from magazine subscription lists or lists of people who have signed up to receive company information via email. When constructing a sample frame for non-customers voting registration lists and telephone directories can be used.

11.2.2 Probability versus nonprobability sampling

Probability sampling uses techniques that result in an ability to calculate exactly the probability of a single person in a sampling frame being chosen to participate. This probability is based on the number of total people in that sample divided by the number of total people in the population. If the population is a known number this is quite easy to calculate. A survey that includes 250 people, out of a population of 1,000, means that every individual in the population has a 25 per cent probability of being included. The methods of conducting probability sampling include simple, stratified, systematic, and cluster.

Of course for most research studies the total number of people who are in a population at any given moment is unknown. For example, even at a university it is impossible to know exactly how many students are attending classes based on the last registration list. Since that list was compiled, students may have withdrawn or new students may have transferred in. There may also be students who have stopped attending classes but have not yet notified the university. Probability sampling can still be conducted with the probability calculated based on a reasonable estimate of the entire population. The process is summarized below in Figure 11.2.

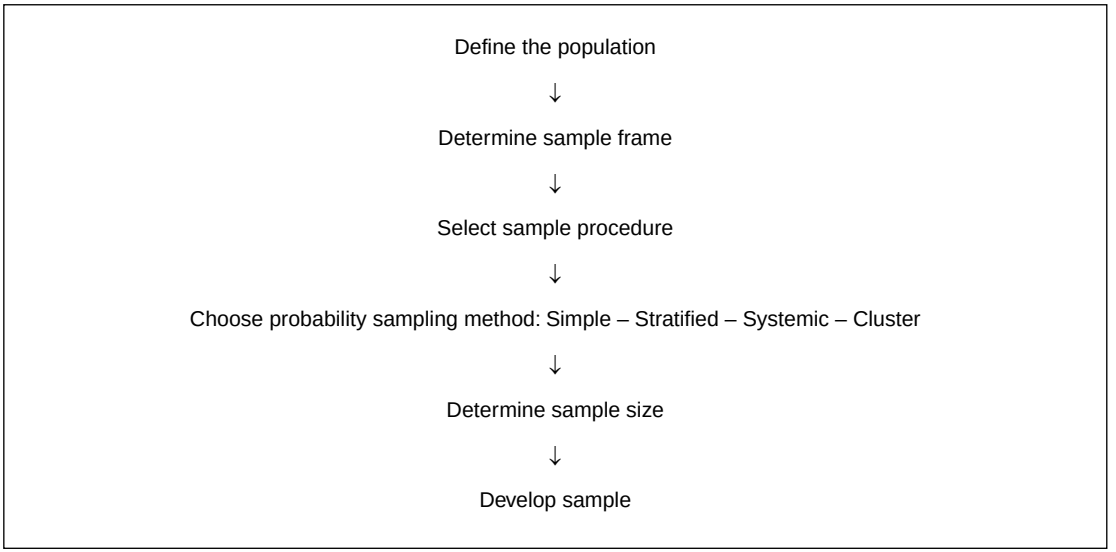

Figure 11.2 Sample definition process

11.3 Probability Sampling

The methods of probability sampling from which researchers can choose include simple, stratified, systemic and cluster. These vary in the randomness of the resulting sample. They also vary in their complexity and the time and effort it will take to construct a sample. Sometimes researchers may decide to use the services of a commercial provider (see the box below).

CAN A SYNDICATE HELP YOU?

The Target Group Index (TGI), started in the UK in 1969, is an example of a company that collects data that are then resold to other companies. Why would a company's management use a commercial data provider? The TGI can provide a broader range of consumer information than one company can collect on its own. The TGI collects information from over 50 countries on consumer product preferences, media consumption and attitudes and beliefs. All of these data can then be compared using demographic characteristics such as age, income, gender, employment and family status.

How many brands and products does the TGI cover? The service can provide information on the preferences and consumption of 500 types of products and over 4000 brands. For example, the information on media covers the press, all type of broadcast television, radio, cinema, outdoor media and the internet. The service can even provide information on how consumers view such issues as money, health, and the environment. So if you need to know what dog food young, single dog owners who care about the environment and attend the cinema buy – you can!

Source: TGI Surveys, 2007

11.3.1 Simple random sampling

The most easily understood method is simple random sampling. In this method each sampling unit has an equal chance of being chosen to participate in the research study. The probability can be calculated by dividing the number of people in that sample by the total number of people in the population. For example, a university's administration may wish to conduct a study of all of its students. They decide to survey 300 students out of a total population of 15,000. Thus the probability of being chosen is 2 per cent, or 300 divided by 15,000.

Probability sampling

$$\text{Probability} = \frac{\text{Sample Size}}{\text{Total number in population}}$$

Whilst it is easy to calculate the probability of being chosen, what is difficult is choosing the 300 participants so that this is done randomly. The university's administration could go to the entrance to the main building and ask the first 300 people to come in the door to participate. However, this would not be random because participation would be determined by who happens to have a class right after that time period. Even just going down the list of student names choosing every fiftieth name will not result in a truly random list because someone has to choose a starting point, so this first name is not random.

The problem is easy to understand if a low-tech solution to the problem is described. One way to achieve a random sample of student names is to write each student's name on a piece of paper and put all of these in a hat. Someone who is not looking then draws out the names. Each name will have the same 2 per cent chance of being drawn. After a name has been drawn a blank piece of paper is put back into the hat to represent that name, so that each time there is still one chance in 15,000 of being drawn.

Of course this would be somewhat cumbersome. Therefore most researchers will use a random number generator or table. A random number table consists of rows and columns of numbers that have no order or sequence. The first step in using the table is to give each unit, or name, in the population a number. Students could be numbered from 1 to 15,000. Then the researcher uses the list to choose the number of the first participant. The researcher will use the next 299 numbers in the random list to determine who is included in the sample. Other methods to ensure that a sample is truly random are using automatic dialing, a software program or a calculator that generates random numbers.

11.3.2 Systematic sampling

Even though it is a much simpler method to use, systematic sampling will result in a sample that is almost random. In systematic sampling, after the population has been determined, all units in the population are listed and counted. A skip interval is then calculated by dividing the total population by the sample size and this interval is used to choose who will be included in the sample. Using the example described above, the skip interval is 50, or 15,000 divided by 300. A random start point is chosen and then the skip interval is used to count off every fiftieth name on the list which is then included in the sample.

Calculating the skip interval

$$\text{Skip Interval} = \frac{\text{Population Size}}{\text{Sample Size}}$$

At first glance this may seem to be as random as simple sampling, but this is not so. The starting letter of family names is not random but often determined by ethnic and national origin. For example, if a university has a large number of students of Korean ethnicity, Korean student names would not be scattered randomly throughout a list of student names. A very common Korean name is Kim and students named Kim would not have an equal chance of being chosen because their names would be grouped together on the list. Using student numbers would also be a problem as these are implemented as students enter a university, resulting in a bias by time period.

One solution to this problem is to randomize the list before using the skip interval. If the list is computerized it can be sorted by a more random factor then name or student number. Another method is restarting the skip interval and counting once or twice when choosing the sample. Each time this happens a new random start would be chosen.

11.3.3 Stratified sampling

Stratified sampling is used when researchers believe that answers will vary depending on the demographic, psychographic, geographic or usage characteristics of each person in a population. There are two main reasons for choosing a stratified sample. First of all the population may be skewed in such a way that it is difficult to obtain a random sample using either a random or systematic method. In this case, stratified sampling is used to increase the randomness of the sample. Second, the research study may call for comparing results between specific groups within a population. The main reason for using stratified sampling is to ensure that any differences are diminished by the sampling procedure. Another reason is when the research study is designed to learn more about differences between groups.

Most populations can be divided into smaller groups based on shared characteristics. These characteristics can be based on demographic factors such as gender, age, income and education level. They can also be grouped by psychographic characteristics such as interests and lifestyles. Geographic grouping may be an important option to consider if the answer to a research question might vary depending on where participants live. Finally, product usage status (such as nonusers, occasional users and frequent users) might be of interest to researchers.

The example of using stratified sampling when conducting a survey of university students can be used to clarify this method. Perhaps a university's administration is interested in learning the views of students from all ethnic backgrounds. The administration therefore wants to ensure that their sample includes at least some students from all the ethnic groups represented on the student body. Using a simple random or systematic sampling procedure might include students from all the ethnic groups or might not, because each student at the university has a random chance of being chosen.

Using a stratified sample allows marketing researchers to examine each of the strata separately. Initially, researchers must decide how many participants will be chosen from the population as a whole. After that researchers must decide on how to distribute the number of total participants among the different strata.

Using proportionate sampling, each stratum will be given same proportion of sample participants as the strata's proportion of the entire population. For example, the strata may have been developed using ethnic groups of students for a university in the USA that would include Americans of European descent, Asian-Americans, African-Americans, and those from an Hispanic ethnic background. The university also possesses census data that give the proportion of each group in the total population. This information is used to calculate how many participants will be chosen for each group if the total population is 15,000 and the sample is 300.

Mean of population

Mean	*% of population*	*# in sample*
Caucasian	40%	120
African-American	25%	75
Hispanic	25%	75
Asian-American	10%	30
Total sample	100%	300

To implement proportionate sampling, a separate list of units or names must be developed for each group and then the names must be chosen using systematic sampling. However, the university in this case may chose to use disproportionate sampling if they decide that they need much more information about groups other than the majority group of Caucasian students. They may therefore decide to decrease the number of people in the Caucasian sample and increase the numbers in the other samples.

11.3.4 Cluster sampling

Cluster sampling also divides populations into groups. However, cluster sampling differs by reason of why a population is divided and the number of resulting groups. In stratified sampling groups are based on a few demographic, psychographic, geographic or usage characteristics (see the box below). The purpose here is to ensure that at least a few individuals from each group will be included. In cluster sampling a population is divided into many groups. Rather than being different, the aim of the resulting groups is that each will include individuals who represent the total population. The purpose of cluster sampling is to economically and efficiently obtain a sample from a large population that provides an accurate representation of an entire population. Such a method could also be combined with other sampling methods to form subgroups. This method can also be used to measure joint group preference in comparison to individual consumer choice (Arora, 2006).

DON'T FORGET TO CONSIDER PRODUCT USAGE STATUS WHEN CONSTRUCTING A SAMPLE

Many sample profiles will describe a population in terms of demographic and geographic characteristics. However, within these similar groups there may be big differences in how people use products. Companies may find it is worth their while to consider product usage when designing a sample. For example, frequent product users can give added insight

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into desired product characteristics that occasional users simply cannot provide. A study of heavy users of cell phones, particularly heavy business users, led to the development of many of the features that are now considered as standard on cell phones. It was these core customers who first requested such product features as the ability to store 100 or more numbers and download name and number information from a computer.

Source: Grapentine and Klupp, 2004

Cluster sampling is often used when it is impossible to determine the exact number of individuals in a population. One example would be if a university's administration wanted to conduct a telephone survey of potential students living in the city. While the university could determine the exact number of current students, they would never know how many potential students existed. Another problem is that a telephone survey of the entire geographic area from which the university draws students would be too expensive. Therefore they may decide to cluster sample.

One common means of clustering the population is to randomly divide a geographic area. If the same university believes that potential students are evenly dispersed throughout the city, they can subdivide it into several geographic areas. The first step would be to choose how the city was to be subdivided, such as by postal code. Assuming that there was an even chance that potential students were living in any of the postal codes, the next step would be to randomly choose which of the postal code areas would be included in the cluster sample.

An additional step can be added here to the cluster sampling technique. Once the postal codes that are to be included in the study have been chosen, another probability technique could be used to sample individuals within each of the chosen areas. For example, the university may know that potential students are scattered evenly throughout the metropolitan area. However, they may also know that not all of the residents are likely to be potential students. They may wish to include in the sample in each cluster only those people within the population who are members of a certain age range.

11.4 Determining a Sample Size

Once a sampling procedure has been chosen, researchers must then decide upon the number of subjects that should be included in the research to ensure that the results are representative of the entire population. It is important for the management of the company commissioning the research to recognize that more is not always better when determining the number of research subjects to be included in the study. Research costs money and the more research subjects that are involved, the more the study will cost. Management must understand that if a research population is carefully chosen, a small sample from this population can be reasonably representative of the whole.

There are a few concepts that must be considered when sample size is determined. First, the more variation there is in a population as a whole, the larger a sample will need to be. For example, when planning the design of a new student center a university will need to know the recreational preferences of its students whether they are sports, arts-related or video gaming. The

university may have a fairly homogeneous student population of the same nationality and age. Therefore, it can be assumed that their interests might be similar and it will take a smaller sample to determine their preferences. However, another university might have the same number of students but that this covers both traditional college age students as well as older adults who come from different countries. In this case, it can be assumed that a larger sample will be needed as it would be expected that the interests of the students will vary widely.

A second factor that must be considered in this example is the precision in the range between the survey answer results and the reality of the population as a whole. A survey question might ask how much of a fee each student would be willing to pay to use the new center. From these responses an average fee can be calculated. The university must then decide on how large a range or interval they are willing to tolerate between the average tabulated from the survey responses and the true answer that would be known only if everyone in the population was asked this same question.

A third factor that must be considered when determining sample size is the need for confidence that the research findings reflect the reality of the total population. Total accuracy requires a census of all participants. Since this is not possible, the university must decide what level of confidence they need that the survey data accurately reflect the whole. The larger a sample is, the higher will be the confidence that this is so.

Factors to consider when determining sample size

- Variation within the population
  - More variation means a larger sample
- Precision needed between range of given answer and true answer
  - A smaller range means a larger sample
- Confidence that research findings represent the population as a whole
  - Higher confidence means a larger sample

11.4.1 Calculating the size of a sample

To calculate the necessary size of a sample, it is not necessary to know the size of the population. What are needed for the formula are the variation in the population, the acceptable range of the estimated answer from the true answer, and the confidence level that the calculated answer is correct. Even a small sample size can save a company a great deal of money, as is shown in the example below.

SHOPPERS MIGHT LOVE CLEARANCE RACKS BUT RETAILERS DON'T

A new research method is being introduced into the fashion wear industry that attempts to help retailers with their purchasing. A consumer database of 500 to 600 shoppers has been developed that retailers can use to choose a sample for online research on product preference. This information can then be used by retailers to determine what products stores should stock.

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To test the system, a study was done for JCPenney. A ten-minute survey was used to ask shoppers about which JCPenney clothing items they preferred. Survey data revealed that the shoppers disliked a certain item of clothing. If this information had been known by the store before it stocked the item, JCPenney could have saved the $267,000 they lost marking down the clothing to clear it off their racks.

Source: Beckett, 2007

The basic formula for calculating the sample when estimating an average or mean is quite simple.

Calculating the sample size

$$n = (z^2/H^{2)} * {}^{(est}\,ó^{2)}$$

In this formula, n represents the number needed in the sample. The symbol z represents the confidence level that is needed that the answer is accurate for the population as a whole. The usual z-scores that are used are 1.65 for 90 per cent confidence, 1.96 for 95 per cent and 2.58 for 99 per cent confidence. H is the half precision or one half of the range that the average from the survey results can be from the answer that is true for the population as a whole. The symbol ó represents the variation in the whole population. Using these three numbers the required sample size can be calculated.

For example, a university might be very interested in determining what annual fee to charge students for admittance to the new student center. Of these three numbers, the z-score is a given and does not need to be calculated by researchers. They only need to know that the university would be happy for the answer to be 95 per cent confident that it represents the whole population. In addition, the range would be supplied by the university. They might state that they want the answer to be within a 25 pound, dollar or Euro plus or minus range. This only leaves the variation in the population for researchers to calculate.

11.4.2 Normal distribution and variation

To understand the variability of data it is not necessary to have an advanced knowledge of a subject. However, when discussing variability the terms 'parameter' and 'statistic' need to be understood. If a market researcher could conduct a census on how much students spent on entertainment last weekend, a true mean or average could be calculated. This number is called the parameter. Of course, conducting a census is too expensive and time consuming so the researcher would survey a sample of students. From these data is calculated a number, or statistic, which is used as an estimate of the entire population.

Perhaps the researcher wants to further make sure that this statistic is an accurate estimate, so the survey is conducted a second time with a new sample. The same sampling procedure is chosen so the same number of subjects are asked the research question. However, the sample

will now consist of different individuals. The researcher will again need to calculate the statistic. If the researcher were able to survey every possible sample in the population, this would result in a series of means. If all the resulting means were examined, it would be found that some answers will occur more frequently than others.

This similarity results from the fact that members of a population will have characteristics in common, which in turn will mean that many will behave in similar ways. However, there will also be some whose behavior will vary. When these similarities and differences are shown visually they result in a graph where the most commonly resulting mean is in the middle with diminishing returns on either side for numbers that are higher and lower. This is the classic 'normal' or bell distribution curve.

Fortunately most data will fit a normal distribution curve and, therefore, the variability within a population can be estimated. Normal variability is considered to be plus or minus three standard deviations away from the true value. Therefore, a researcher can take an estimated range of variability and calculate the variation. For example, the university's administration may estimate that the range in acceptable fees would be from £50 for those students with limited incomes up to a high of £500 for the wealthiest students. This gives a range of £450. Since the standard deviation is plus or minus three on each side, the number 450 is now divided by six to get the variability of the population, which would be £75.

Using the example above, the sample size for the study of how much students are willing to pay annually for the use of a new student center can be calculated.

$$35 = ((1.96)^2 / (25)^2) * (75)^2$$

For the estimate to be 95 per cent, with a range of 25 each way and standard variability, only 35 students would be needed to participate in the survey. However, a total of range of 50 when the variation is only 450 is quite large. Perhaps the university in question would like the answer to be more accurate. They may decide to change the range from 50 to 15. The sample size now changes to 96 students. If the university narrows the acceptable range to only five, the sample size necessary changes to 864! Likewise changing the confidence level will affect the sample size, as will a change in the variability.

11.4.3 Calculating sample size when estimating a population proportion

The university's administration may also be interested in calculating a proportion, such as the proportion or percentage of students who are involved in sports. In this case the z-score of confidence level will be chosen and the range estimated. The confidence level might still be 95 per cent and the acceptable range could be within plus or minus 3 per cent of the true answer. However, the difficulty arises when the researcher needs a number to represent variability in the population as a whole, which for a proportion is represented by the symbol π. In this case, theoretically, the variation can run from zero to 100 per cent of the total population. However, the university will know that is too wide an estimate of variability – after all, they can estimate that at least 20 per cent of students are interested in sports and 20 per cent are not interested in sports. Therefore, the variability should be set at 40 per cent or half of 80 per cent. The resulting sample size needed is 1,024.

$$n = (z^2/H^{2)}) * \pi\ (1-\pi)$$
$$1024 = ((1.96)^2 / (.03)^2) * (.4*(1 - .04)$$

Therefore, to estimate the proportion of a population takes a much larger sample. Why does the proportion take such a larger sample size? The answer lies in the range as compared to the variation. In the calculation involving a mean the range was 50, which is 11 per cent of the total variation of 450 (50/450 = .11). However, with the proportion example the range of 6 per cent (plus or minus 3 per cent) compared with a possible variation of 100 per cent in the population as a whole. Because more precision is needed to estimate within 6 per cent than with 11 per cent, a larger sample is needed.

Summary

1 Including everyone in the population in a research study is called a census. A census includes everyone in the population, but is expensive and impractical for research purposes. Sampling is used when only certain people in the population are chosen to be part of a research study. When sampling is conducted it is inevitable that there will be errors. Errors result when the chosen sample is not absolutely representative of the whole population. Mistakes can also result due to human error when recording or entering information.

2 The first step in developing a sample is to determine the targeted population. It is important to narrow the definition of a population so that only those participants who can answer the research question are included. A list of names from this population is called a 'sampling frame'. The next step in the process is to select a sampling method, which can be based on non-probability or probability.

3 Probability sampling includes simple, stratified, systematic and cluster. The methods vary in the randomness of the resulting sample. The probability of someone being chosen during sampling can be calculated by dividing the sample size by the total number of people in the population. Simple random sampling provides the most random sample. Systematic sampling is easier and results in almost as random a sample. Stratified sampling divides a population into smaller groups based on shared characteristics and with a certain number of subjects chosen from each group. In cluster sampling the population is divided into many groups that are similar, rather than dissimilar as in stratified. Cluster sampling is an economical means of sampling a large population.

4 Factors to consider when determining a sample size include the acceptable range of error of the estimated answer from the true answer, the level of confidence needed that the answer is within that range and the variation within the population. The sample size can be calculated using these three numbers. The sample size for estimating a proportion will be higher than the sample size for estimating a mean.

Key Terms

census including everyone in a population as participants in the research study

cluster cost effective way of sampling a large population that is homogeneous

nonprobability sampling methods include convenience, judgment and quota, where each potential subject does not have the same probability of being included

nonsampling errors human errors that occur in the research process

population a group of individuals who share characteristics defined by a researcher

probability sampling methods include simple, stratified, systematic and cluster, where every potential subject has the same probability of being included in the sample

sampling errors errors that occur when a sample is chosen incorrectly

simple random sample sampling system where each unit in a population has an equal probability of being chosen

skip inter val number used when counting off to choose participants from a list of the population

stratified sampling a population is divided by characteristics and each group is sampled separately, after which the mean and percentages are calculated for the entire population based on weighted averages

systematic sample sampling system where each sample unit is chosen using a random start and a skip interval

Discuss ion Question s

1 If you were to conduct a survey of students' favorite sports, would you use a census or sampling?
2 What would be the advantages of using a sample versus conducting a census for a sports study?
3 Can you give an example of a population at your school or college that would be best surveyed using a census?
4 Why is it necessary to understand the standard error of the population when conducting a survey of how much time students spend doing homework?
5 How could a sample frame be determined for members of a church congregation?
6 Which nonprobability sampling method would you recommend should be used for a survey on what classes should be offered in your degree program? Why?
7 Which probability sampling method would you recommend to determine the number of students who plan on going on to obtain an additional degree?
8 How would you determine the sample size for the above study?

Recommended Reading

Chakrapani, Chuck (2000) *Marketing Research: State-of-the-Art Perspectives*. Chicago, IL: American Marketing Association. This book includes articles on many aspects of marketing research including a chapter on sampling technologies.

Fink, Arlene (2003) *How to Sample in Surveys*. London: SAGE. A short book that first explains the various sampling methods and then provides a quick explanation of statistical sampling.

Good, James W. Hardin (2006) *Common Errors in Statistics and How to Avoid Them*. Hoboken, NJ: Wiley. This covers the mathematics of statistical sampling and analysis using many examples and everyday language. A good book for those who believe they can't understand statistics.

Riddick, Carol Cutler and Russell, Ruth V. (1999) *Evaluative Research in Recreation, Park and Sport Settings*. Champagne, IL: Sagamore Publishing. This book is a reminder that marketing research is used in a variety of organizational settings. Includes a chapter on sampling and sample size.

Van Belle, Gerald (2002) *Statistical Rules of Thumb*. New York: Wiley. An excellent reference on everything statistical, the book is organized by topic including sampling.