Sampling In Research

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INTRODUCTION

This tutorial is a discussion on sampling in research it is mainly designed to eqiup beginners with knowledge on the general issues on sampling that is the purpose of sampling in research, dangers of sampling and how to minimize them, types of sampling and guides for deciding the sample size. For a clear flow of ideas, a few definitions of the terms used are given.

What is research?

According Webster(1985), to research is to search or investigate exhaustively. It is a careful or diligent search, studious inquiry or examination especially investigation or experimentation aimed at the discovery and interpretation of facts, revision of accepted theories or laws in the light of new facts or practical application of such new or revised theories or laws, it can also be the collection of information about a particular subject.

What is a sample?

A sample is a finite part of a statistical population whose properties are studied to gain information about the whole(Webster, 1985). When dealing with people, it can be defined as a set of respondents(people) selected from a larger population for the purpose of a survey.

A population is a group of individuals persons, objects, or items from which samples are taken for measurement for example a population of presidents or professors, books or students.

What is sampling? Sampling is the act, process, or technique of selecting a suitable sample, or a representative part of a population for the purpose of determining parameters or characteristics of the whole population.

What is the purpose of sampling? To draw conclusions about populations from samples, we must use inferential statistics which enables us to determine a population`s characteristics by directly observing only a portion (or sample) of the population. We obtain a sample rather than a complete enumeration (a census) of the population for many reasons. Obviously, it is cheaper to observe a part rather than the whole, but we should prepare ourselves to cope with the dangers of using samples. In this tutorial, we will investigate various kinds of sampling procedures. Some are better than others but all may yield samples that are inaccurate and unreliable. We will learn how to minimize

these dangers, but some potential error is the price we must pay for the convenience and savings the samples provide.

There would be no need for statistical theory if a census rather than a sample was always used to obtain information about populations. But a census may not be practical and is almost never economical. There are six main reasons for sampling instead of doing a census. These are; -Economy -Timeliness -The large size of many populations -Inaccessibility of some of the population -Destructiveness of the observation -accuracy

The economic advantage of using a sample in research Obviously, taking a sample requires fewer resources than a census. For example, let us assume that you are one of the very curious students around. You have heard so much about the famous Cornell and now that you are there, you want to hear from the insiders. You want to know what all the students at Cornell think about the quality of teaching they receive, you know that all the students are different so they are likely to have different perceptions and you believe you must get all these perceptions so you decide because you want an indepth view of every student, you will conduct personal interviews with each one of them and you want the results in 20 days only, let us assume this particular time you are doing your research Cornell has only 20,000 students and those who are helping are so fast at the interviewing art that together you can interview at least 10 students per person per day in addition to your 18 credit hours of course work. You will require 100 research assistants for 20 days and since you are paying them minimum wage of $5.00 per hour for ten hours ($50.00) per person per day, you will require $100000.00 just to complete the interviews, analysis will just be impossible. You may decide to hire additional assistants to help with the analysis at another $100000.00 and so on assuming you have that amount on your account.

As unrealistic as this example is, it does illustrate the very high cost of census. For the type of information desired, a small wisely selected sample of Cornell students can serve the purpose. You don`t even have to hire a single assistant. You can complete the interviews and analysis on your own. Rarely does a circustance require a census of the population, and even more rarely does one justify the expense.

The time factor.

A sample may provide you with needed information quickly. For example, you are a Doctor and a disease has broken out in a village within your area of jurisdiction, the disease is contagious and it is killing within hours nobody knows what it is. You are required to conduct quick tests to help save the situation. If you try a census of those affected, they may be long dead when you arrive with your results. In such a case just a few of those already infected could be used to provide the required information.

The very large populations

Many populations about which inferences must be made are quite large. For example, Consider the population of high school seniors in United States of America, agroup numbering 4,000,000. The responsible agency in the government has to plan for how they will be absorbed into the differnt departments and even the private sector. The employers would like to have specific knowledge about the student`s plans in order to make compatiple plans to absorb them during the coming year. But the big size of the population makes it physically impossible to conduct a census. In such a case, selecting a representative sample may be the only way to get the information required from high school seniors.

The partly accessible populations

There are Some populations that are so difficult to get access to that only a sample can be used. Like people in prison, like crashed aeroplanes in the deep seas, presidents e.t.c. The inaccessibility may be economic or time related. Like a particular study population may be so costly to reach like the population of planets that only a sample can be used. In other cases, a population of some events may be taking too long to occur that only sample information can be relied on. For example natural disasters like a flood that occurs every 100 years or take the example of the flood that occured in Noah`s days. It has never occured again.

The destructive nature of the observation Sometimes the very act of observing the desired charecteristic of a unit of the population destroys it for the intended use. Good examples of this occur in quality control. For example to test the quality of a fuse, to determine whether it is defective, it must be destroyed. To obtain a census of the quality of a lorry load of fuses, you have to destroy all of them. This is contrary to the purpose served by quality-control testing. In this case, only a sample should be used to assess the quality of the fuses

Accuracy and sampling A sample may be more accurate than a census. A sloppily conducted census can provide less reliable information than a carefully obtained sample.

BIAS AND ERROR IN SAMPLING A sample is expected to mirror the population from which it comes, however, there is no guarantee that any sample will be precisely representative of the population from which it comes. Chance may dictate that a disproportionate number of untypical observations will be made like for the case of testing fuses, the sample of fuses may consist of more or less faulty fuses than the real population proportion of faulty cases. In practice, it is rarely known when a sample is unrepresentative and should be discarded.

Sampling error

What can make a sample unrepresentative of its population? One of the most frequent causes is sampling error.

Sampling error comprises the differences between the sample and the population that are due solely to the particular units that happen to have been selected.

For example, suppose that a sample of 100 american women are measured and are all found to be taller than six feet. It is very clear even without any statistical prove that this would be a highly unrepresentative sample leading to invalid conclusions. This is a very unlikely occurance because naturally such rare cases are widely distributed among the population. But it can occur. Luckily, this is a very obvious error and can be etected very easily.

The more dangerous error is the less obvious sampling error against which nature offers very little protection. An example would be like a sample in which the average height is overstated by only one inch or two rather than one foot which is more obvious. It is the unobvious error that is of much concern.

There are two basic causes for sampling error. One is chance: That is the error that occurs just because of bad luck. This may result in untypical choices. Unusual units in a population do exist and there is always a possibility that an abnormally large number of them will be chosen. For example, in a recent study in which I was looking at the number of trees, I selected a sample of households randomly but strange enough, the two households in the whole population, which had the highest number of trees (10,018 and 6345) were both selected making the sample average higher than it should be. The average with these two extremes removed was 828 trees. The main protection agaisnt this kind of error is to use a large enough sample. The second cause of sampling is sampling bias.

Sampling bias is a tendency to favour the selection of units that have paticular characteristics.

Sampling bias is usually the result of a poor sampling plan. The most notable is the bias of non response when for some reason some units have no chance of appearing in the sample. For example, take a hypothetical case where a survey was conducted recently by Cornell Graduate school to find out the level of stress that graduate students were going through. A mail questionnaire was sent to 100 randomly selected graduate students. Only 52 responded and the results were that students were not under strees at that time when the actual case was that it was the highest time of stress for all students except those who were writing their thesis at their own pace. Apparently, this is the group that had the time to respond. The researcher who was conducting the study went back to the questionnaire to find out what the problem was and found that all those who had responded were third and fourth PhD students. Bias can be very costly and has to be gaurded against as much as possible. For this case, $2000.00 had been spent and there were no reliable results in addition, it cost the reseacher his job since his employer thought if he was qualified, he should have known that before hand and planned on how to avoid it. A means of selecting the units of analysis must be designed to avoid the more obvious forms of bias. Another example would be where you would like to know the average income of some community and you decide to use the telephone numbers to select a sample of the total population in a locality where only the rich and middle class households have telephone lines. You will end up with high average income which will lead to the wrong policy decisions.

Non sampling error (measurement error)

The other main cause of unrepresentative samples is non sampling error. This type of error can occur whether a census or a sample is being used. Like sampling error, non sampling error may either be produced by participants in the statistical study or be an innocent by product of the sampling plans and procedures.

A non sampling error is an error that results solely from the manner in which the observations are made.

The simplest example of non sampling error is inaccurate measurements due to malfuntioning instruments or poor procedures. For example, Consider the observation of human weights. If persons are asked to state their own weights themselves, no two answers will be of equal reliability. The people will have weighed themselves on different scales in various states of poor caliberation. An individual`s weight fluctuates diurnally by several pounds, so that the time of weighing will affect the answer. The scale reading will also vary with the person`s state of undress. Responses therefore will not be of comparable validity unless all persons are weighed under the same circumstances.

Biased observations due to inaccurate measurement can be innocent but very devastating. A story is told of a French astronomer who once proposed a new theory based on spectroscopic measurements of light emitted by a particular star. When his colleques discovered that the measuring instrument had been contaminated by cigarette smoke, they rejected his findings.

In surveys of personal characteristics, unintended errors may result from: -The manner in which the response is elicited -The social desirability of the persons surveyed -The purpose of the study -The personal biases of the interviewer or survey writer

The interwiers effect

No two interviewers are alike and the same person may provide different answers to different interviewers. The manner in which a question is formulated can also result in inaccurate responses. Individuals tend to provide false answers to particular questions. For example, some people want to feel younger or older for some reason known to themselves. If you ask such a person their age in years, it is easier for the idividual just to lie to you by over stating their age by one or more years than it is if you asked which year they were born since it will require a bit of quick arithmetic to give a false date and a date of birth will definitely be more accurate.

The respondent effect

Respondents might also give incorrect answers to impress the interviewer. This type of error is the most difficult to prevent because it results from out right deceit on the part of the respondee. An example of this is what I witnessed in my recent study in which I was asking farmers how much maize they harvested last year (1995). In most cases, the men tended to lie by saying a figure which is the reccomended expected yield that is 25 bags per acre. The responses from men looked so uniform that I became suspicious. I compared with the responses of the wives of the these men and their responses were all different. To decide which one was right, whenever possible I could in a tactful way verify with an older son or daughter. It is important to acknowledge that certain psychological factors induce incorrect responses and great care must be taken to design a study that minimizes their effect.

Knowing the study purpose

Knowing why a study is being conducted may create incorrect responses. A classic example is the question: What is your income? If a government agency is asking, a different figure may be provided than the respondent would give on an application for a home mortgage. One way to guard against such bias is to camouflage the study`s goals; Another remedy is to make the questions very specific, allowing no room for personal interpretation. For example, "Where are you employed?" could be followed by "What is your salary?" and "Do you have any extra jobs?" A sequence of such questions may produce more accurate information.

Induced bias

Finally, it should be noted that the personal prejudices of either the designer of the study or the data collector may tend to induce bias. In designing a questionnaire, questions may be slanted in such a way that a particular response will be obtained even though it is inacurrate. For example, an agronomist may apply fertilizer to certain key plots, knowing that they will provide more favourable yields than others. To protect against induced bias, advice of an individual trained in statistics should be sought in the design and someone else aware of search pitfalls should serve in an auditing capacity.

SELECTING THE SAMPLE

The preceding section has covered the most common problems associated with statistical studies. The desirability of a sampling procedure depends on both its vulnerability to error and its cost. However, economy and reliability are competing ends, because, to reduce error often requires an increased expenditure of resources. Of the two types of statistical errors, only sampling error can be controlled by exercising care in determining the method for choosing the sample. The previous section has shown that sampling error may be due to either bias or chance. The chance component (sometimes called random error) exists no matter how carefully the selection procedures are implemented, and the only way to minimize chance sampling errors is to select a sufficiently large sample (sample size is discussed towards the end of this tutorial). Sampling bias on the other hand may be minimized by the wise choice of a sampling procedure.

TYPES OF SAMPLES

There are three primary kinds of samples: the convenience, the judgement sample, and the random sample. They differ in the manner in which the elementary units are chosen.

The convenient sample

A convenience sample results when the more convenient elementary units are chosen from a population for observation.

The judgement sample

A judgement sample is obtained according to the discretion of someone who is familiar with the relevant characteristics of the population.

The random sample

This may be the most important type of sample. A random sample allows a known probability that each elementary unit will be chosen. For this reason, it is sometimes referred to as a probability sample. This is the type of sampling that is used in lotteries and raffles. For example, if you want to select 10 players randomly from a population of 100, you can write their names, fold them up, mix them thoroughly then pick ten. In this case, every name had any equal chance of being picked. Random numbers can also be used (see Lapin page 81).

TYPES OF RANDOM SAMPLES

A simple random sample

A simple random sample is obtained by choosing elementary units in search a way that each unit in the population has an equal chance of being selected. A simple random sample is free from sampling bias. However, using a random number table to choose the elementary units can be cumbersome. If the sample is to be collected by a person untrained in statistics, then instructions may be misinterpreted and selections may be made improperly. Instead of using a least of random numbers, data collection can be simplified by selecting say every 10th or 100th unit after the first unit has been chosen randomly as discussed below. such a procedure is called systematic random sampling.

A systematic random sample

A systematic random sample is obtained by selecting one unit on a random basis and choosing additional elementary units at evenly spaced intervals until the desired number of units is obtained. For example, there are 100 students in your class. You want a sample of 20 from these 100 and you have their names listed on a piece of paper may be in an alphabetical order. If you choose to use systematic random sampling, divide 100 by 20, you will get 5. Randomly select any number between 1 and five. Suppose the number you have picked is 4, that will be your starting number. So student number 4 has been selected. From there you will select every 5th name until you reach the last one, number one hundred. You will end up with 20 selected students.

A stratified sample

A stratified sample is obtained by independently selecting a separate simple random sample from each population stratum. A population can be divided into different groups may be based on some characteristic or variable like income of education. Like any body with ten years of education will be in group A, between 10 and 20 group B and between 20 and 30 group C. These groups are referred to as strata. You can then randomly select from each stratum a given number of units which may be based on proportion like if group A has 100 persons while group B has 50, and C has 30 you may decide you will take 10% of each. So you end up with 10 from group A, 5 from group B and 3 from group C.

A cluster sample

A cluster sample is obtained by selecting clusters from the population on the basis of simple random sampling. The sample comprises a census of each random cluster selected. For example, a cluster may be some thing like a village or a school, a state. So you decide all the elementary schools in Newyork State are clusters. You want 20 schools selected. You can use simple or systematic random sampling to select the schools, then every school selected becomes a cluster. If you interest is to interview teachers on thei opinion of some new program which has been introduced, then all the teachers in a cluster must be interviewed. Though very economical cluster sampling is very susceptible to sampling bias. Like for the above case, you are likely to get similar responses from teachers in one school due to the fact that they interact with one another.

PURPOSEFUL SAMPLING

Purposeful sampling selects information rich cases for indepth study. Size and specific cases depend on the study purpose.

There are about 16 different types of purposeful sampling. They are briefly described below for you to be aware of them. The details can be found in Patton(1990)Pg 169-186.

Extreme and deviant case sampling This involves learning from highly unusual manifestations of the phenomenon of interest, suchas outstanding successes, notable failures, top of the class, dropouts, exotic events, crises.

Intensity sampling This is information rich cases that manifest the phenomenon intensely, but not extremely, such as good students,poor students, above average/below average.

Maximum variation sampling This involves purposefully picking a wide range of variation on dimentions of interest. This documents unique or diverse variations that have emerged in adapting to different conditions. It also identifies important common

patterns that cut across variations. Like in the example of interviewing Cornell students, you may want to get students of different nationalities, professional backgrounds, cultures, work experience and the like.

Homogenious sampling This one reduces variation, simplifies analysis, facilitates group interviewing. Like instead of having the maximum number of nationalities as in the above case of maximum variation, it may focus on one nationality say Americans only.

Typical case sampling It involves taking a sample of what one would call typical, normal or average for a particular phenomenon,

Stratified purposeful sampling This illustrates charecteristics of particular subgroups of interest and facilitates comparisons between the different groups.

Critical case sampling> This permits logical generalization and maximum application of information to other cases like "If it is true for this one case, it is likely to be true of all other cases. You must have heard statements like if it happenned to so and so then it can happen to anybody. Or if so and so passed that exam, then anybody can pass.

Snowball or chain sampling This particular one identifies, cases of interest from people who know people who know what cases are information rich, that is good examples for study, good interview subjects. This is commonly used in studies that may be looking at issues like the homeless households. What you do is to get hold of one and he/she will tell you where the others are or can be found. When you find those others they will tell you where you can get more others and the chain continues.

Criterion sampling Here, you set a criteria and pick all cases that meet that criteria for example, all ladies six feet tall, all white cars, all farmers that have planted onions. This method of sampling is very strong in quality assurance.

Theory based or operational construct sampling. Finding manifestations of a theoretical construct of interest so as to elaborate and examine the construct.

Confirming and disconfirming cases Elaborating and deepening initial analysis like if you had already started some study, you are seeking further information or confirming some emerging issues which are not clear, seeking exceptions and testing variation.

Opportunistic Sampling This involves following new leads during field work, taking advantage of the unexpected flexibility.

Random purposeful sampling This adds credibility when the purposeful sample is larger than one can handle. Reduces judgement within a purposeful category. But it is not for

generalizations or representativeness.

Sampling politically important cases This type of sampling attracts or avoids attracting attention undesired attention by purposisefully eliminating from the sample political cases. These may be individuals, or localities.

Convenience sampling It is useful in getting general ideas about the phenomenon of interest. For example you decide you will interview the first ten people you meet tomorrow morning. It saves time, money and effort. It is the poorest way of getting samples, has the lowest credibility and yields information-poor cases.

Combination or mixed purposeful sampling This combines various sampling strategies to achieve the desired sample. This helps in triangulation, allows for flexibility, and meets multiple interests and needs. When selecting a sampling strategy it is necessary that it fits the purpose of the study, the resources available, the question being asked and the constraints being faced. This holds true for sampling strategy as well as sample size.

SAMPLE SIZE

Before deciding how large a sample should be, you have to define your study population. For example, all children below age three in Tomkin`s County. Then determine your sampling frame which could be a list of all the chidren below three as recorded by Tomkin`s County. You can then struggle with the sample size.

The question of how large a sample should be is a difficult one. Sample size can be determined by various constraints. For example, the available funding may prespecify the sample size. When research costs are fixed, a useful rule of thumb is to spent about one half of the total amount for data collection and the other half for data analysis. This constraint influences the sample size as well as sample design and data collection procedures.

In general, sample size depends on the nature of the analysis to be performed, the desired precision of the estimates one wishes to achieve, the kind and number of comparisons that will be made, the number of variables that have to be examined simultaneously and how heterogenous a universe is sampled. For example, if the key analysis of a randomized experiment consists of computing averages for experimentals and controls in a project and comparing differences, then a sample under 100 might be adequate, assuming that other statistical assumptions hold.

In non-experimental research, most often, relevant variables have to be controlled statistically because groups differ by factors other than chance.

More technical considerations suggest that the required sample size is a function of the precision of the estimates one wishes to achieve, the variability or variance, one expects to find in the population and the statistical level of confidence one wishes to use. The sample size N required to estimate a population mean (average) with a given level of precision is:

The square root of N=(1.96)*(&)/precision Where & is the population standard deviation of the for the variable whose mean one is interested in estimating. Precision refers to width of the interval one is willing to tolerate and 1.96 reflects the confidence level. For details on this please see Salant and Dillman (1994).

For example, to estimate mean earnings in a population with an accuracy of $100 per year, using a 95% confidence interval and assuming that the standard deviation of earnings in the population is $1600.0, the required sample size is 983:[(1.96)(1600/100)] squared.

Deciding on a sample size for qualitative inquiry can be even more difficult than quantitative because there are no definite rules to be followed. It will depend on what you want to know, the purpose of the inquiry, what is at stake, what will be usefull, what will have credibility and what can be done with available time and resources. With fixed resources which is always the case, you can choose to study one specific phenomenon in depth with a smaller sample size or a bigger sample size when seeking breadth. In purposeful sampling, the sample should be judged on the basis of the purpose and rationale for each study and the sampling strategy used to achieve the studies purpose. The validity, meangfulness, and insights generated from qualitative inquiry have more to do with the information-richness of the cases selected and the observational/analytical capabilities of the researcher than with sample size.

CONCLUSION

In conclusion, it can be said that using a sample in research saves mainly on money and time, if a suitable sampling strategy is used, appropriate sample size selected and necessary precautions taken to reduce on sampling and measurement errors, then a sample should yield valid and reliable information. Details on sampling can be obtained from the references included below and many other books on statistics or qualitative research which can be found in libraries.

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