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Quantitative Sampling

Chapter Summary

Introduction

Sampling is the process of selecting cases (or participants, or units) from the very broad group *population*, which is difficult to study by itself. Population is the list of *all elements* in the group. For example, it would be too difficult for a researcher to survey the entire population of Canada, because a lot of time and resources are needed. The study will be inefficient. Instead, the researcher may pick a small selection of the population, *a sample*, and study it with available time and resources. Selecting a sample allows researchers to be efficient, economical, and effective in conducting research. Moreover, selecting a small number of cases into a sample still allows researchers to make credible conclusions about the population as a whole, if appropriate selection methods were used.

This chapter considers two methods of drawing samples—*probability* and *non-probability*—and examines the purposes of each type of sampling, its best uses, advantages, and drawbacks. Furthermore, the chapter demonstrates how the qualitative sampling, structured observation, and content analysis sampling are different from the other sampling methods, and speaks on how the sampling issues, such as the sampling error and non-response, affect the quality of research.

The term **sampling** refers to how people or other units of analysis are selected for a study. **Units of analysis** are the actual cases—people, countries, organizations, or newspaper articles—that are going to be analyzed in the process of research. There two main types of sampling in sociology:

- **Probability sampling** goes together with quantitative research, and each case is selected in such a way that it has a known (usually equal) probability of being selected. The goal of probability sampling is to draw samples that are **representative** of the population, or reflect the population in all important respects.
- **Non-probability sampling** does not have the goal to be representative of a population. Rather, it chooses cases that are in some respect typical or reflective of the issue that the researcher studies. The non-probability sample is used in qualitative research.

In quantitative research, the researcher can use a properly representative sample and make inferences about the larger group (population) based on the data gathered from the sample. What makes a sample representative? The representative sample should fairly well represent the population, and be unbiased. There are three sources of bias that make a sample unrepresentative:

1. *Not using a random method* that allows every element of the population to have the same opportunity of being selected for inclusion into the research;
2. *The sampling frame or the list of potential subjects is inadequate:* human judgement that selects one case over another into the sample does not take into account all potential list of subjects; and

3. *Some people in the sample refuse to participate* (resulting in *non-response*), which skews the data.

For these reasons, sampling methodology proposes specific rules for drawing representative samples. The type of sampling used corresponds to the general goal of research: if representativeness if required, we use a probability sample; if not, non-probability qualitative sample is selected.

Basic Terms and Concepts in Sampling

Before we review the main rules of sampling, the list below reminds us of the basic terminology in sampling.

- **Element** or **unit**: a single case in the population.
- **Population**: all cases that the researcher is interested in.
- **Sampling frame**: the list of elements (usually incomplete, but readily available) from which a sample can be selected.
- **Sample**: the elements (subset of a population) selected for investigation.
- **Representative sample**: a sample that has the same essential characteristics as the population.
- **Probability sample**: a sample selected using a random process so that each element in the population has a known likelihood of being selected. The probability sample aims to reduce the sampling error to a minimum.
- **Non-probability sample**: a sample selected using a non-random method.
- **Sampling error***:* the error in predicting the population characteristics that occurs because of differences between the characteristics of the sample and those of the population.
- **Non-response**: when a respondent (or another element selected for the sample) refuses to participate, cannot be contacted, or otherwise does not supply the required data.
- **Census**: data that comes from collecting information on all elements in the population. National census is typically the enumeration of the population of the entire nation-state.

Sampling Error

Sampling error indicates a degree of discrepancy between the population parameters we predict and the indicators received in the sample. For example, if we know that the national level of support for the Liberal Party is at 40 per cent (in the population), receiving the data from the sample showing a 50 per cent support indicates a sampling error. Any sample is not expected to predict the population parameter perfectly. However, if our sample is representative, that is, reflective of the population in important respects, the sampling error should be very small. One way to reduce a sampling error is to use *probability sampling*. Probability samples are collected in such a way that the likelihood of error is low from the start and it can be controlled by selecting a larger number of cases. Knowing the sampling error, we can then predict (or make inference about) the population with a fair degree of accuracy.

Types of Probability Sample

Probability sampling selects sample elements in such a way that they have a known (usually equal) probability of being selected. Using random methods of selection ensures that probability samples are representative of the population from which they are drawn. There are four main types of probability samples: simple random, systematic random, stratified sample, or multi-stage cluster sample.

1. Simple Random Sample

In this sample, every element has the same chance of being selected for the research project. To draw this sample, we need to have a sampling frame, or a list that identifies a large majority of cases in the population. The sampling frame is hard to find for the entire population of the country, but it could exist for members of a particular organization, for example, a list of students in a university. The sampling frame is usually not including all members of the population, but is the best approximation of the population we have.

- Having the sampling frame, we first decide on the desired sample size *(n)* and determine the sampling ratio. *Sampling ratio* is the proportion of the sampling frame that will be included into the sample. It is the number of elements that will be selected for inclusion (*n*) divided by the total NUMBER of elements in the population or sampling frame (*N*). For example, if we decided to select 400 cases for the sample and our sampling frame is 4000, our sampling ratio is .1, or 10 per cent.
- To select the simple random sample, we number all elements in the sampling frame (or the population) consecutively from one until the end. Then we use a random-number generation program to generate a list of elements from the frame which should be selected into the sample. By generating the random numbers repeatedly, we select the desired sample size.
- In the process, if we get the same number twice, we simply generate the next number. This kind of method is called *random sample without replacement*. Although a true random sample would actually require us to have all elements in the population at the moment of each case selection, that is, every element would have to be in pool of possible selections each time, in practice this rule can be overlooked. In the standard method used by researchers, each element is selected from a slightly lower population number, and the pool of possible selections is reduced by the elements that have already been selected. This variation has become standard because the error from this procedure has much less impact on the data than the one that would emerge from having several elements show up more than once in the data.

2. Systematic Sample

This is a sample in which the cases are selected directly from the frame, without using the table of random numbers. First, we establish a *sampling interval*. The sampling interval decides the periodicity of including elements from the sampling frame into a sample. It is calculated as N/n, where N is the number of elements in the sampling frame, and n is the decided sample size. In our example, if N=4000 and n=400, the sampling interval is 10. This means that every 10th participant is selected.

- To select the systematic random sample, the first element is selected using the random sample generating program. After that, every new element is selected according to the *sampling interval*, for example, every tenth case in the sampling frame is selected. This process continues until the desired sample size is chosen. The key to choosing a good systematic sample is to ensure there is no pattern to the way the elements are listed in the sampling frame, or *no periodicity*. If there is some pattern in the frame, it will skew the data (e.g., when odd numbers starting at one are male and even numbers starting at two are female. In this case, choosing every 10th element would produce a sample with all females, or all males).

3. Stratified Random Sample

This method of selecting elements ensures that groups in the population are represented adequately in a sample. It requires the population to be sorted into sub-categories (called *strata*), and the percentages for strata representation in the population are noted. Then the desired sample size is chosen, and the number of cases in each stratum is decided. For example, a university has 9000 students and 3000 of them are in the humanities or social sciences, 2000 are in pure sciences and 4000 are in other disciplines. The percentage representation of humanities and social sciences is 33.3 per cent, of pure sciences 22.2 per cent, other disciplines 44.5 per cent. If we want to select a proportional stratified sample of 1000 students, 333 of them should come from humanities or social sciences, 222 from pure sciences and 445 from other disciplines. These numbers will ensure proportional representation in the sample of the population distribution between disciplines.

- *To select the stratified random sample,* the size of strata in the sample is first determined as above. After that, cases within each stratum are chosen using a simple random sample or a systemic random sample. The received sample will reflect the population according to most important strata. However, stratified sampling presupposes that the proportional distribution of the strata in the population is known, which is not always the case.

4. Multi-Stage Cluster Sample

This is a sampling method where cases are selected into the sample based on the multi-stage selection of clusters (usually geographical units). This method is used to overcome problems of large populations and problems of selection where a sampling frame is not available.

- The population is categorized into large "clusters" of elements and then subunits of the cluster, from which samples are chosen. A probability sample is used at each stage to determine selection of the next stage. This reduces the potential costs associated with researching large, geo-graphically dispersed populations, and the problem of no adequate sampling frame.
- For example, to choose a multi-stage cluster sample of 800 Canadian university students, we will first list all the provinces and randomly choose two out of ten provinces (geographical clusters). Within each selected province, list all the universities, and randomly choose two of them. For each of the four selected universities, choose 200 students using a random sampling or a systematic random sampling. This way we will receive a good random sample of Canadian university students without having to travel to all provinces and without having the sampling frame of all Canadian students.

The Qualities of a Probability Sample

Probability sampling allows researchers to generalize the sample finding to the larger population. This generalization will be accompanied by the estimate of its accuracy, and, on the flip side, a mathematically determinable margin of error. Usually the probability samples are chosen in such a way that they have between 95 per cent to 99 per cent accuracy of representing the population, and correspondingly between 1 per cent to 5 per cent of margin of error. The sample size is the number that determines which degree of confidence or margin of error we will have. The higher the sample size, the higher the confidence and the lower the error.

Sample Size

Selecting an appropriate sample size can be quite difficult for both analytic and logistical reasons.

Absolute and Relative Sample Size

The absolute size of a sample is the number of elements chosen. This number is what determines the representativeness of the sample.

As the number of cases included in a sample increases, sampling error tends to decrease. This relates specifically to the standard error of the mean, which in turn relies on the square root of the sample size. The probability rules of sampling distribution (i.e., of distribution of all possible means for the same sample size) tell us that 95 per cent of all sample means will lie within 1.96 standard errors of the overall population mean. This means that if a sample is selected according to the principles of probability sampling we can estimate the interval within which the population mean will lie, with the 95 per cent level of confidence.

Common sample sizes are 100, 400, 900, 1600, and 2500. The table below shows that as the sample size increases, the difference in sampling error gets smaller. The change from 100 elements to 400 elements gives a reduction in sampling error of 50 per cent (1/2) but from 400 to 900 elements the reduction is only another 30 per cent (1/3). So one has to ask: is the value of including another 500 elements (e.g., interviewing another 500 students) worth the cost in time, effort, and money for the minor reduction in sampling error?

Elements	Square root	Reduction in sampling error from prior selection amount
100	10	1
400	20	1/2 20–10=10 (10 of 20=1/2)
900	30	1/3 30–20=10 (10 of 30=1/3)
1600	40	1/4 40–30=10 (10 of 40=1/4)
2500	50	1/5 50–40=10 (10 of 50=1/5)

This table indicates what the appropriate sample size is depending of the desired reduction of sampling error. However, sampling error is just one consideration in determining the appropriate sample size. Often the financial cost of doing the research sets the limits on what the sample size will be.

Non-Response

Often many people identified to be research participants fall out of the research group, some for personal reasons, some because they are unsuitable or their data are unusable. This non-participation rate for any reason is called **non-response**.

Unfortunately, non-response rates in surveys are steadily increasing in recent decades. Therefore, where possible, the reason for non-response should be identified. It may have to be taken into account as a variable in analysis of the research data. Before collecting the sample, the researcher may have to identify the anticipated non-response rate (the percentage of selected participants who will not participate) and increase the projected sample size by about the same number of people. The study will therefore deliberately oversample in order to get the final sample of the decided size. For example, knowing the projected non-response will be at 30 per cent and wanting a sample size of 1,000 respondents, we would sample not the net decided number of 1000 people, but oversample to 1,333 cases in order to receive a final sample of 1,000 people. The strategies of boosting response rate will be discussed later.

Heterogeneity of the Population

When the population, as it relates to the topic of study, is heterogeneous, the samples are also likely to be quite varied. So the more heterogeneous a population is, the larger the sample should be drawn in order for it to be representative of the population.

Kind of Analysis

The type of analysis for which the data will be used must also be considered in determining the sample size. If the analysis is going to be expressed in percentages, a larger sample size should be used. For example, 20 females in the overall sample of 40 represent 50 per cent, a pretty large percentage. A change in supporting the Democratic Party in the sample from 10 females to 20 females represents the change in support from 25 per cent to 50 per cent, a pretty large 25 per cent change. In order to avoid small numbers to unduly influence the percentages, the sample sizes must be made larger.

Similarly, where there are unbalanced numbers in some of the identified sub-groups of a population (strata), it may be appropriate to take larger samples (although randomly selected) from the smaller groups in order to make proper comparison between the groups. For example, if we know that the actual proportion of the indigenous population in Canada is at the rate of 1.3 per cent of the total, we might choose the larger sample of the indigenous population than is present in the population, for example 130 per 1000 (rather than 13 per 1000 as the actual proportion is) in order to compare the indigenous groups with non- indigenous groups on the issues of interest. This process is called *over-sampling*.

Types of Non-Probability Sampling

Non-probability sampling is a non-random choice of respondents to the sample. Non-probability sample is used in qualitative research, where representativeness is not a goal of the study. The elements are chosen not on the basis of being representative, but rather because of being a typical or interesting class of cases in itself. Three main forms of non-probability samples are c*onvenience*, *snowball*, and *quota* sampling.

1. Convenience Sample

The sample is chosen because its elements are readily available (e.g., students present in a student cafeteria). This may lead to higher response rates but extrapolation to the broader population is problematic. The group likely represents a specific faction of the overall population, not a representative sample. Still the convenience sample may work well if the subcategories of a population are made purposively, for pilot studies and for testing the usefulness of a research instrument.

2. Snowball Sample

The researcher contacts a small group of people relevant to the research topic and uses that connection to establish contact with other potential research subjects. As such there is either no sampling frame or the frame is so fluid that it becomes meaningless, and therefore is non-representative of the population. The snowball sample is very useful in qualitative research and when the research is focused on relationships between people, or for studying hidden or small populations.

3. Quota Sample

Quota sampling is used heavily in market research and political polling. This sampling method is aimed at a representative sample, but it is not selected randomly. Rather, the sample group is selected specifically by the researcher. Categories of interest are determined (e.g., gender, age, education, political leanings) and then the number of people to be contacted in each category is set. The categories and numbers in each category are meant to be representative of the population. Selection occurs until the prescribed quota (number of contacts in each category) is met. Critics argue that quota sampling is unsuitable for academic research for the following reasons:

- The choice of participants made by the interviewer interferes with the representativeness of the sample.
- The sample demographic is skewed by when and where the researcher is looking for participants.
- The decision about who to approach may reflect a bias in researcher's judgement.
- Statistical estimates of representativeness and confidence are only appropriate when a random sample is used.

On the other hand, there are several advantages to quota sampling:

- Less expensive than obtaining a probability sample, easier to manage, no follow-up contact with participants required. Refusals should be recorded to allow analysis of potential bias in the data.
- It is a quick method of obtaining opinion data.
- It is good for testing new research instruments and ideas.

Structured Observation and Sampling

In structured observation, the research would not only sample people, but also spaces, times, and behaviours:

- *People sampling:* Researchers cannot predict who will show up in a public space. So structured observations in a public space cannot use a sampling frame; however, a table of random numbers can be used to randomize selection of who will be recorded. For example, the researcher may decide the 3rd, 7th, and 17th person occurring in a public area, as per table of random numbers.
- *Time sampling:* A determination of what to observe is based on specific time intervals or particular times of the day. The selection of the time interval or the time of day can be randomized with the table of random numbers.
- *Random sampling of specific places:* Choose specific areas for observation (e.g., different areas in a bar).
- *Behaviour sampling:* watching a group and recording certain types of behaviours.

The concern about the external validity of data from structured observations is raised when the observations are conducted over a short period of time. There may be circumstances peculiar to a particular time and location that will skew the data (e.g., exam time for students). Randomizing the selection of when and where the research is conducted may reduce this concern somewhat. Given that access to certain types of organization is difficult, gaining access in and of itself may raise the issue of skewed data.

Limits to Generalization

One important caution to remember about sampling is that any data collected in a particular locale, although randomly gathered, *is only applicable to that particular locale*. There may also be a limit to how long data may be meaningful.

Sampling Problems

Quota samples are seen as biased. They specifically over-represent some segments of society (housewives) and by nature underrepresent others (people in low/high social strata). Probability samples may also be biased because they too underrepresent certain segments of society (men and employed persons). In addition, **s**ampling errors due to lack of representativeness and sampling-related error such as inaccurate sampling frame or non-response also reduce generalizability and external validity of the samples.

Content Analysis Sampling

Sampling for content analysis involves sampling media pieces for further analysis of their content.

Sampling Media

Sampling media involves selecting the type pf media to be studies: TV program, newspaper, radio, chat rooms, social media, etc. Within the media, the units to be studied are first decided (articles, a particular TV show, a particular chat room). Then the period and the frequency of choosing the unit are decided (for example, take each fifth episode of the TV program between 01.01.2000 and 01.01. 2010). The chosen units of the program are then analyzed.

Sampling Dates

The dates to be sampled must also be established with specificity. They are often dictated by when the behaviour of interest is occurring. Where there is an ongoing phenomenon, the sampling dates may be selected using the random sample selection methods described above. The key issue with an ongoing phenomenon is deciding when to stop selecting cases. The decision may be somewhat arbitrary but the researcher must pay attention to variations in materials (e.g., seasonal or geographically based writings).

Reducing Non-Response

Generally, it is thought that telephone interviews have slightly lower response rates. Call screening and the number of cell phones has had a negative impact on telephone survey response rates. Therefore, the following strategies may be undertaken by the interviewer to improve the response rates:

- Interviewers must keep calling until they contact the selected participant, bearing in mind the varying schedules of different people.
- Be optimistic that people will agree to be interviewed.
- State clearly that you are conducting social research and not selling anything.
- For face-to-face interviews, dress to be presentable to many different people.
- Find an interview time that suits the participant.

Improving Response Rates to Mailed Questionnaires

This is a concern because low response rates negatively impact validity. The following strategies may be undertaken here to improve the response rates:

- Prepare a good covering letter stating why the research matters and why this person was selected.
- Personalize the address label and explain on the inside letter how their name was chosen plus how confidentiality will be established.
- Include a stamped return envelope.
- Keep the questionnaire to a reasonable size and start with questions of interest to the selected participant.
- Follow-up on non-response with two or three further reminder mailings.
- Monetary incentives are often seen as unethical, but a small amount inserted with the questionnaire often increases the response rate (increased amounts do not actually increase the response rate).

Learning Objectives

In this chapter, you should learn to do the following:

- Understand the purpose of sampling and the advantages that come from it: effectiveness, speed, and good coverage of the population
- Appropriate and use the main terminology in sampling: sample, population, biased sample, representative sample, margin of error, and non- response
- Differentiate the main goals and types of the *probability sampling*: to select samples representative of the population and distinguish among *simple random*, *systematic random*, *stratified*,

and *multi-stage cluster sampling*. Understand in which situations these samples are better to use.

- Appreciate the main goals and types of the *non-probability sampling*: to select samples of typical cases interesting to research and not accessible otherwise; to distinguish between *convenience sampling*, *quota sampling*, and *snow-ball sampling*. Understand in which situations these samples are better to use.
- Know the steps and be able to construct the basic types of probability and non-probability samples
- Understand how the margin of error, sampling size, and non-response affect the quality of probability samples. Know the basic strategies for establishing the sample size and reducing non-response in various kinds of sampling
- Be aware of specific issues that emerge in qualitative sampling, content analysis sampling and online sampling

Media Resources

Statistics: Power from Data! Statistics Canada.
http://www.statcan.gc.ca/edu/power-pouvoir/toc-tdm/5214718-eng.htm

- How does Statistics Canada collect their data?
- How do they maintain representativeness?
- What is the difference between crime statistics and the General Social Survey collection methods?

Simple Random Sampling
http://www.youtube.com/watch?v=yx5KZi5QArQ

- Could a sample of the sub-category of blue bodies be established?
- Why does the researcher skip over number 5 and 30?
- Does that change the representativeness of the "random" sample?
- What would be the impact of using the same element twice?
- Does the variation impact the data enough that it could be considered statistically significant?

Stratified Sampling
http://www.youtube.com/watch?v=sYRUYJYOpG0

- What is the difference in effort required for the two methods?
- Is this more representative that the simple random sample?
- Would this method still work if the groups aren't balanced equally?

Fowler, J.H., Heaney, M.T., Nickerson, D.W., Padgett, J.F., and Sinclair, B. (2011). Causality in political networks. *American Politics Research, 39*(2): 437–480.
http://apr.sagepub.com/content/39/2/437

- What problems occur with probability samples in political networks?
- How does a researcher determine the appropriate number participants to have in a sample for research that is aimed at providing political guidance?
- What is the impact of sample size on political networks?