INSTITUTE OF ACTUARIAL & QUANTITATIVE STUDIES

Class: M.Sc.

Subject : Research Methodology

Chapter: Unit 2 Chapter 1

Chapter Name: Research Design and Data Collection

1 Research Design

Definition
Research Design: A comprehensive framework for collecting, measuring, and analyzing data. It acts as a blueprint for the research process, ensuring the study addresses the research questions effectively.

Key Components of a Research Design:

1. **Research Questions:** What are the main questions the study aims to answer?
2. **Hypotheses:** What are the predicted outcomes or relationships to be tested?
3. **Variables:**
    1. **Independent Variables:** Factors manipulated by the researcher.
    2. **Dependent Variables:** Outcomes measured to see the effect of the independent variables.
4. **Methodology:** Detailed plan of the procedures and techniques to be used for data collection and analysis.
5. **Sampling:** Strategy for selecting participants or data sources.
6. **Data Collection Methods:** Techniques for gathering data (e.g., surveys, interviews, observations).
7. **Data Analysis:** Methods for processing and interpreting the collected data.

2 Types of Research Design

Experimental Design

- A research design that allows the researcher to manipulate one or more independent variables and measure their effect on dependent variables while controlling other variables. Data can be quantitative or qualitative in nature.
- **Example –** Clinical trials testing the efficacy of a new drug

Descriptive Design

- A research design that aims to describe detailed, factual, and systematic characteristics of a population or phenomenon being studied using surveys, case studies, and observational studies It does not involve manipulating variables.
- **Example –** Census surveys

Exploratory Design

- A research design used to investigate a problem that is not clearly defined. It aims to generate new insights, identify potential research questions, and lay the groundwork for future, more in-depth studies. Use of qualitative methods such as interviews and focus groups.
- **Example –** Open-ended surveys to gather insights on a new topic

2.1 Experimental Design

Key Elements:
Hypothesis: A testable prediction about the relationship between variables.
Variables:

- **Independent Variables:** Factors manipulated by the researcher.
- **Dependent Variables:** Outcomes measured to assess the effect of the independent variables.
- **Control Variables:** Variables kept constant to prevent them from influencing the results.

Control Groups and Experimental Groups: Groups used to compare the effects of the independent variable.
Randomization: Random assignment of subjects to control and experimental groups to ensure comparability.

Advantages:
•Ability to determine causal relationships.
•High level of control over variables.
•Replicability of results.

Disadvantages:
•Artificiality of the experimental setting.
•Ethical and practical limitations in manipulating variables.
•Potential for researcher bias.

2.2 Descriptive Design

Key Elements:
Observational Techniques: Systematic recording of observable phenomena or behaviors.
Surveys and Questionnaires: Collecting data from a large sample using standardized questions.
Case Studies: In-depth examination of a single subject or a small group.
Cross-sectional Studies: Analyzing data from a population at a specific point in time.
Longitudinal Studies: Collecting data from the same subjects over an extended period.

Advantages:
- Ability to describe characteristics of a population or phenomenon.
- Provides a comprehensive overview of the subject matter.
- Useful for identifying trends and patterns.

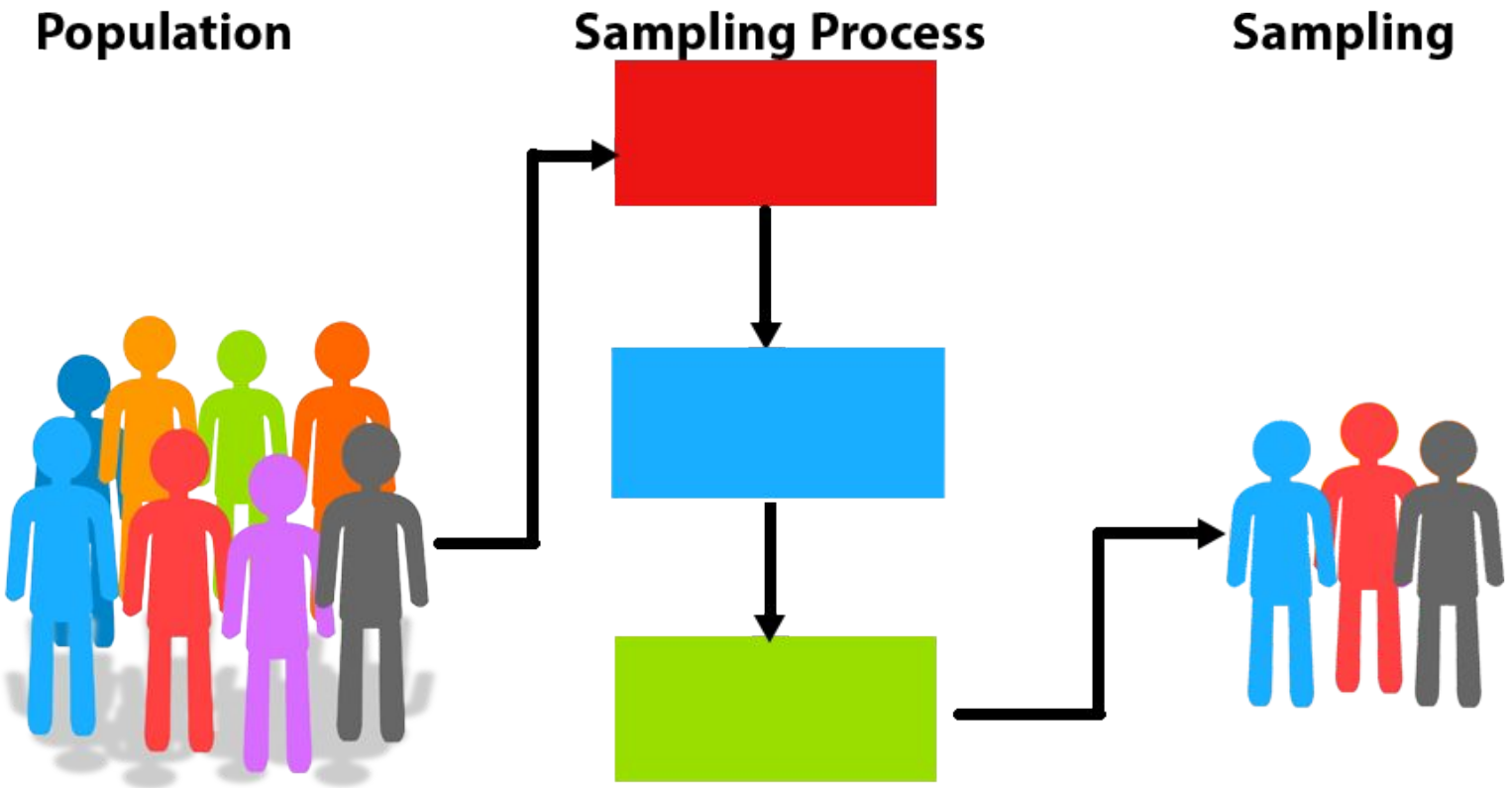
Disadvantages:
- Cannot determine causal relationships.
- Potential for respondent bias in surveys.
- Limited by the accuracy and reliability of observational techniques.

2.3 Exploratory Design

Key Elements:
Flexibility: Adaptable research approach to explore new areas of inquiry.
Qualitative Methods: Use of interviews, focus groups, and open-ended surveys to gather detailed insights.
Pilot Studies: Small-scale preliminary studies conducted to refine research questions and methods.
Literature Reviews: Comprehensive analysis of existing research to identify gaps and formulate hypotheses.

Advantages:
- Useful for exploring new or poorly understood phenomena.
- Helps in generating hypotheses and guiding future research.
- Provides rich, detailed data and insights.

Disadvantages:
- Lack of generalizability due to small, non-random samples.
- Subjectivity in data collection and analysis.
- Limited ability to establish causality.



Sampling

3 Sampling

1 Population

A population is the entire group that you want to draw conclusions about.

In research, a population doesn't always refer to people. It can mean a group containing elements of anything you want to study.

2 Sample

A sample is a subset of the research population that is carefully selected to represent its characteristics. Researchers study this smaller, manageable group to draw inferences that they can generalize to the larger population.

3 Sampling

Sampling refers to a portion of the population selected to represent the entire group, in all its characteristics.

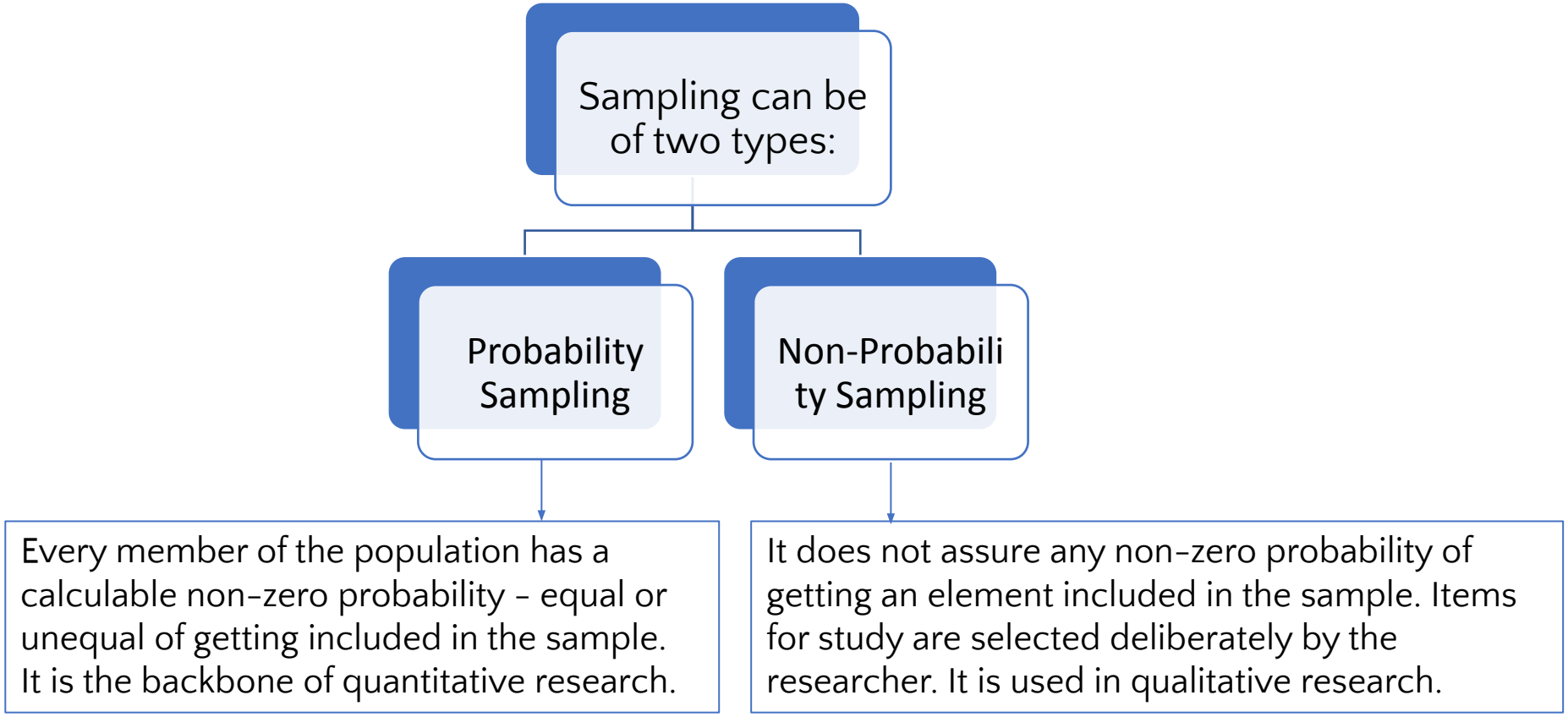
3.1 Sample size

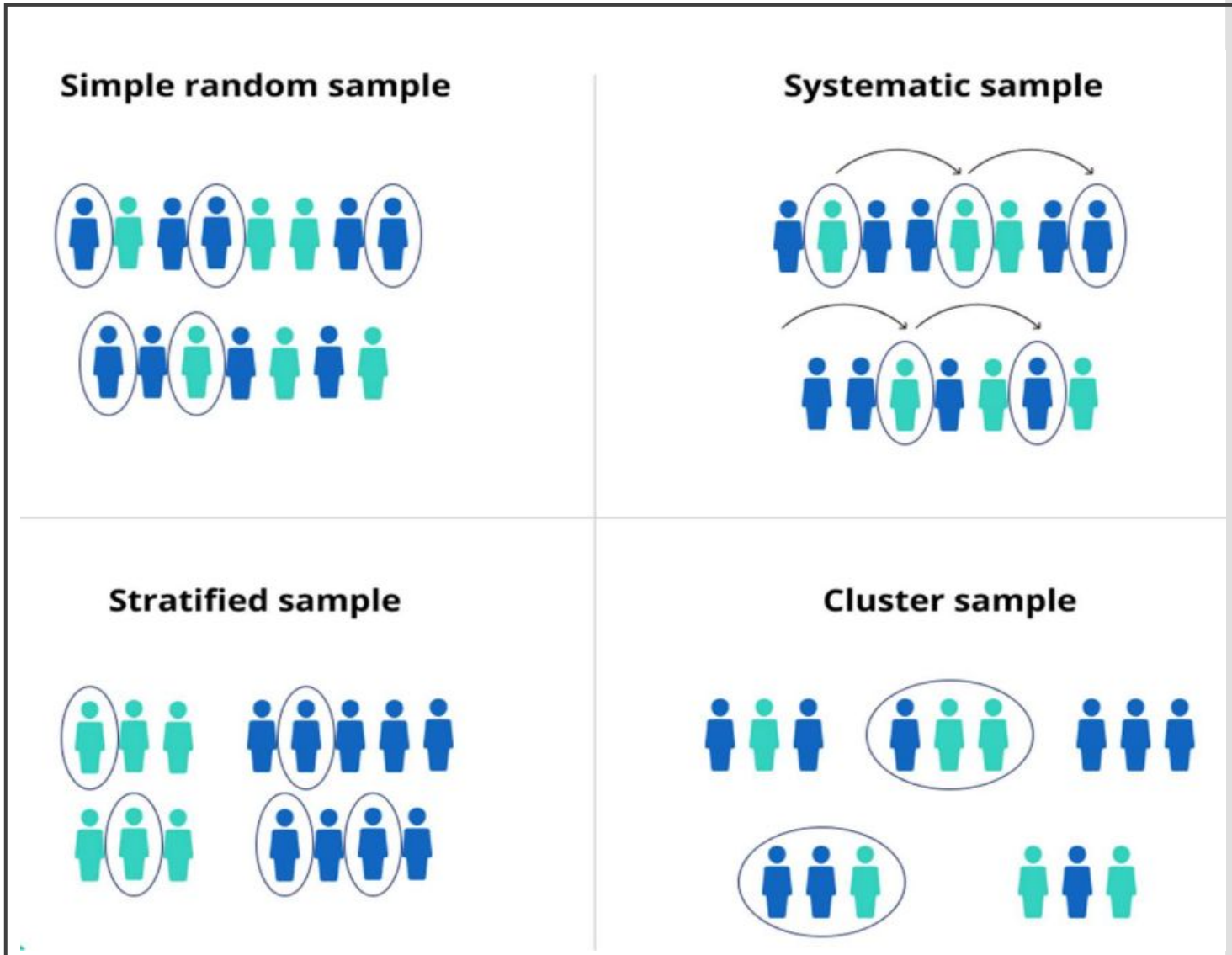
Sample size - number of items to be selected from the population to constitute a sample. It should neither be excessively large nor too small.

Optimum sample size is the one which fulfils the requirements of efficiency, representativeness, reliability and flexibility.

Determining the appropriate sample size for a study will usually involve considering the purpose of the study, population size, risk of committing an error, and available resources. When determining the appropriate sample size, you should consider factors such as the following: Different types of studies might require different sample sizes.

3.2 Sampling Techniques



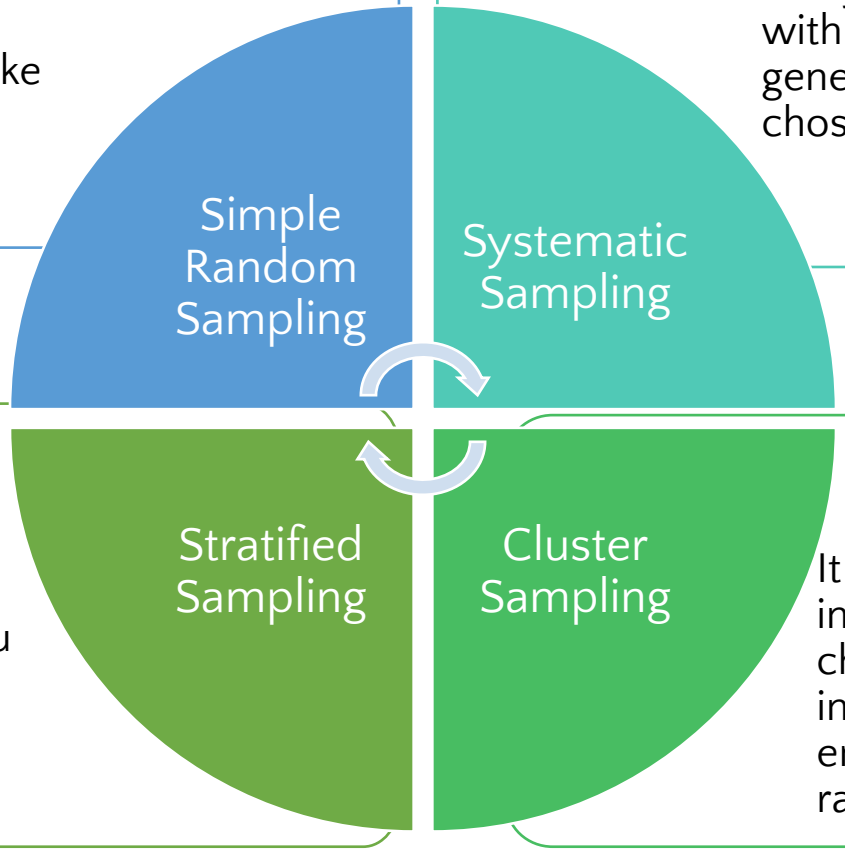


Probabilit
y
Sampling

3.3 Probability Sampling

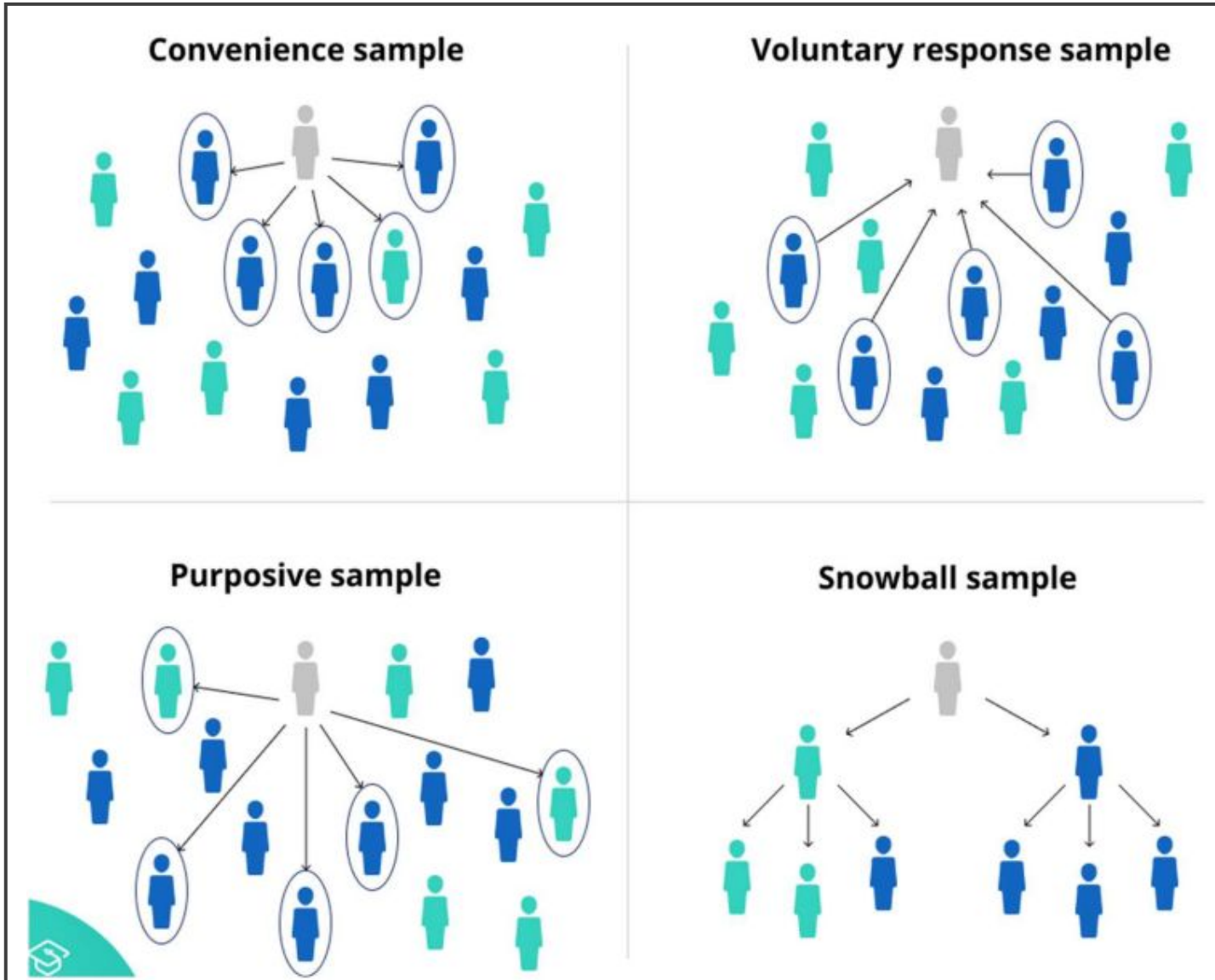
Every member of the population has an equal chance of being selected. To conduct this type of sampling, tools like random number generators are employed.

Every member of the population is listed with a number, but instead of randomly generating numbers, individuals are chosen at regular intervals.



It involves dividing the population into subgroups or Strata that may differ in important ways. It allows you draw more precise conclusions by ensuring that every subgroup is properly represented in a sample.

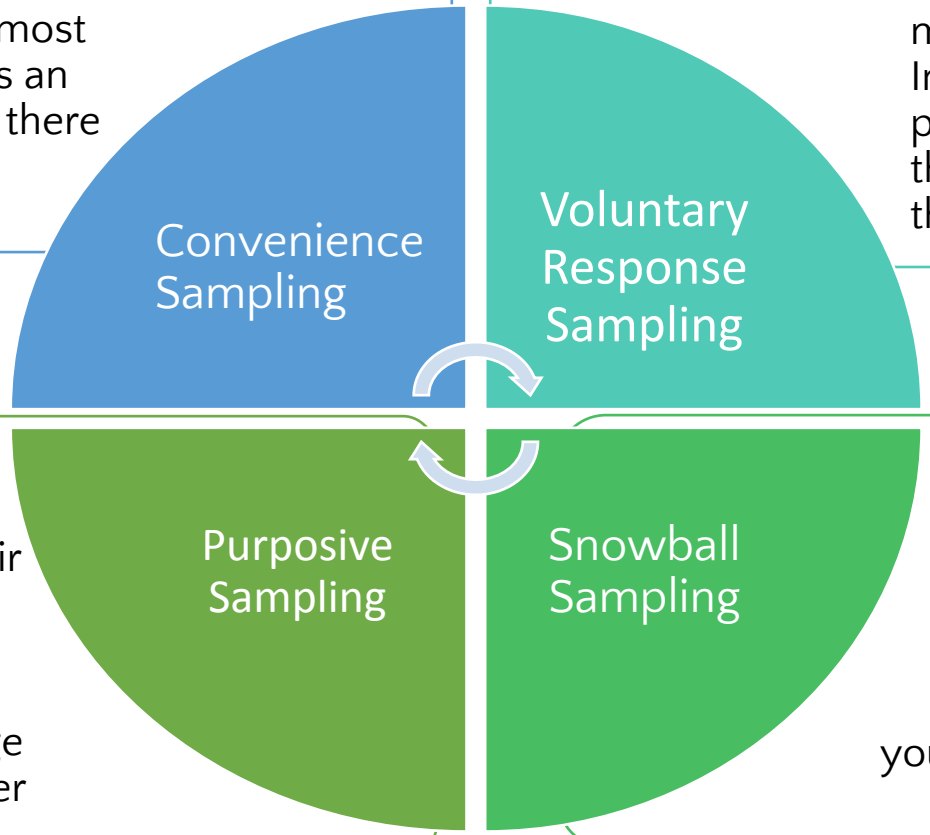
It involves dividing the population into subgroups, having similar characteristics. Instead of sampling individuals from each subgroup, entire subgroups are selected randomly.



Non-Probability Sampling

3.4 Non-Probability Sampling

A convenience sample simply includes the individuals who happen to be most accessible to the researcher. This is an easy way to gather initial data, but there is no way to tell if the sample is representative of the population.



A voluntary response sample is mainly based on ease of access. Instead of the researcher choosing participants and directly contacting them, people volunteer themselves.

It involves the researcher using their expertise to select a sample that is most useful to the purposes of the research. It is used in where the researcher wants to gain knowledge about a specific phenomenon rather than make statistical inferences.

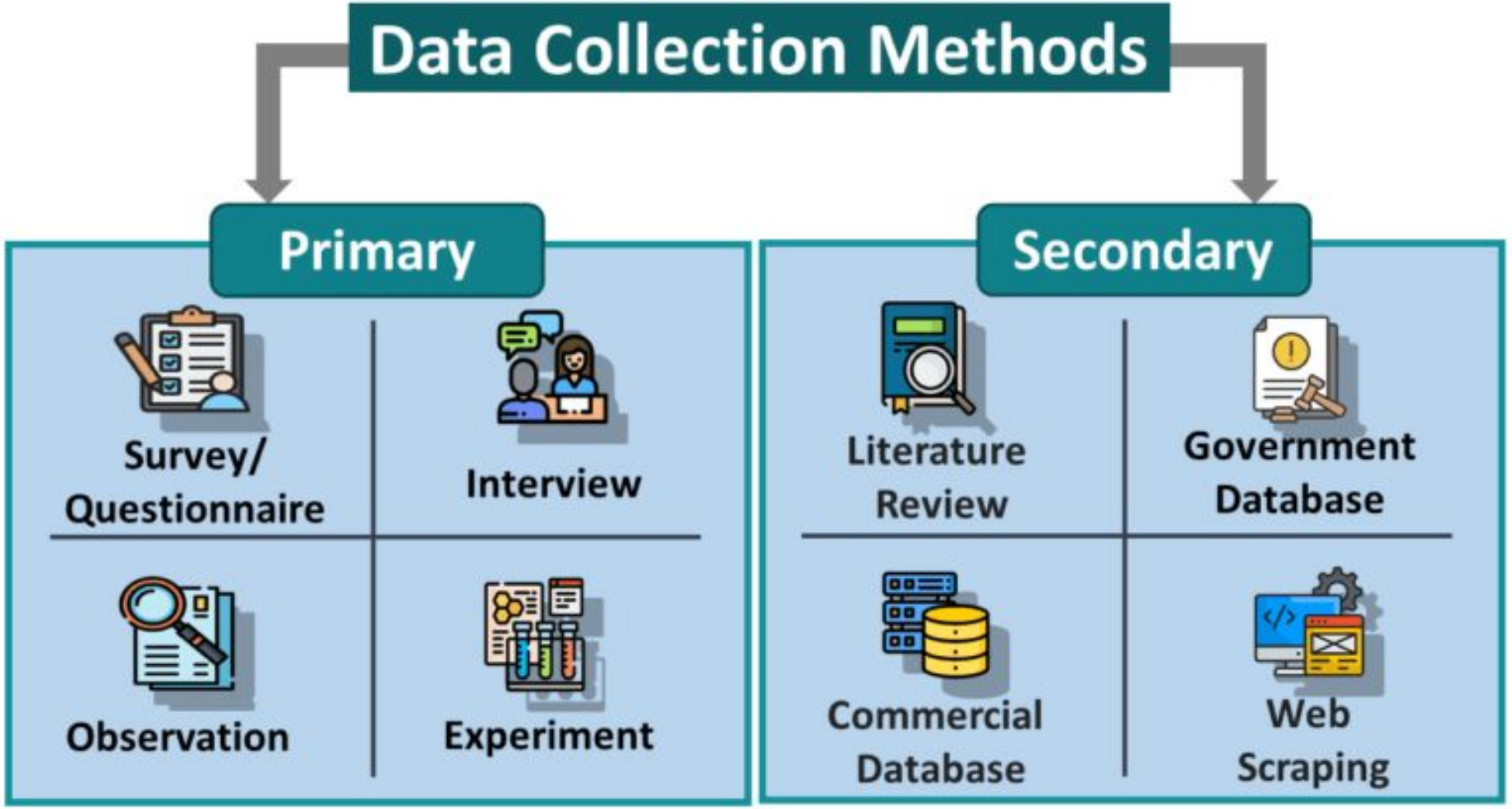
If the population is hard to access, snowball sampling can be used to recruit participants via other participants. The number of people you have access to "snowballs" as you get in contact with more people.

4 Data Collection Methods

Suggest the ways in which data can be collected for research.

A.
B.
C.
D.

4 Data Collection Methods



4 Data Collection Methods

Surveys are a common data collection method that involve asking a sample of respondents a series of questions, either in person, by phone, or through self-administered questionnaires. Surveys can gather quantitative data (e.g., multiple-choice questions) or qualitative data (e.g., open-ended questions).

Interviews involve a one-on-one interaction between a researcher and a participant, where the researcher asks a series of questions to gather in-depth information. Interviews can be structured, semi-structured, or unstructured, depending on the research objectives and the level of flexibility desired.

Observational research involves systematically watching and recording the behavior, actions, or interactions of individuals or groups in their natural environment. Observations can be structured (using predefined categories) or unstructured (open-ended) and can be conducted in-person or through video recordings.

4 Data Collection Methods

A **focus group** is a research method that brings together a small group of people to answer questions in a moderated setting. The group is chosen due to predefined demographic traits, and the questions are designed to shed light on a topic of interest.

The **case study** is a data collection method in which in-depth descriptive information about specific entities, or cases, is collected, organized, interpreted, and presented in a narrative format. The case study report is essentially a story.

The **Delphi technique** is a recognised research technique designed as a futures-oriented methodology that gathers data by engaging a panel of experts to make judgements on a specific real-world issue.

5 Measurement and Scaling in Research

Levels of measurement, also called scales of measurement, tell you how precisely variables are recorded. In scientific research, a variable is anything that can take on different values across your data set (e.g., height or test scores).

There are 4 levels of measurement:

- **Nominal:** the data can only be categorized
- **Ordinal:** the data can be categorized and ranked
- **Interval:** the data can be categorized, ranked, and evenly spaced
- **Ratio:** the data can be categorized, ranked, evenly spaced, and has a natural zero.

Depending on the level of measurement of the variable, what you can do to analyze your data may be limited. There is a hierarchy in the complexity and precision of the level of measurement, from low (nominal) to high (ratio).

5 Measurement and Scaling in Research

Nominal level	Examples of nominal scales
You can categorize your data by labelling them in mutually exclusive groups, but there is no order between the categories.	• City of birth • Gender • Ethnicity • Car brands • Marital status

Ordinal level	Examples of ordinal scales
You can categorize and rank your data in an order, but you cannot say anything about the intervals between the rankings. Although you can rank the top 5 Olympic medallists, this scale does not tell you how close or far apart they are in number of wins.	• Top 5 Olympic medallists • Language ability (e.g., beginner, intermediate, fluent) • Likert-type questions (e.g., very dissatisfied to very satisfied)

5 Measurement and Scaling in Research

Interval level	Examples of interval scales
You can categorize, rank, and infer equal intervals between neighboring data points, but there is no true zero point. The difference between any two adjacent temperatures is the same: one degree. But zero degrees is defined differently depending on the scale – it doesn't mean an absolute absence of temperature. The same is true for test scores and personality inventories. A zero on a test is arbitrary; it does not mean that the test-taker has an absolute lack of the trait being measured.	• Test scores (e.g., IQ or exams) • Personality inventories • Temperature in Fahrenheit or Celsius

5 Measurement and Scaling in Research

Ratio level	Examples of ratio scales
You can categorize, rank, and infer equal intervals between neighboring data points, and there is a true zero point. A true zero means there is an absence of the variable of interest. In ratio scales, zero does mean an absolute lack of the variable. For example, in the Kelvin temperature scale, there are no negative degrees of temperature – zero means an absolute lack of thermal energy.	• Height • Age • Weight • Temperature in Kelvin

6 Reliability & Validity

A researcher must test the collected data before making any conclusion. Every research design needs to be concerned with reliability and validity to measure the quality of the research.

Reliability

- It refers to the consistency of the measurement. Reliability shows how trustworthy is the score of the test.
- If the collected data shows the same results after being tested using various methods and sample groups, the information is reliable.

Validity

- Validity refers to the accuracy of the measurement. Validity shows how a specific test is suitable for a particular situation. If the results are accurate according to the researcher's situation, explanation, and prediction, then the research is valid. If the method of measuring is accurate, then it'll produce accurate results.
- If a method is reliable, then it's valid. In contrast, if a method is not reliable, it's not valid.