MIT | School of Distance Education

Chapter 3

Research Design

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Learning Objectives

- Explain the concept of research design
- Describe the need and features of research design
- List the different components of research design
- Explain the different types of research designs

The Concept of Research Design

- A **research design** is a systematic approach that a researcher uses to efficiently handle a research problem.
- It provides insights about 'how' to conduct research using a particular methodology.
- It combines various components and data to arrive at a feasible outcome.
- The purpose of a research design is to ensure that the information collected from research enables you to answer the research problem satisfactorily.

A research design is the determination and statement of the general research approach or strategy adopted for the particular project. It is the heart of planning. If the design adheres to the research objective, it will ensure that the client's needs are served.

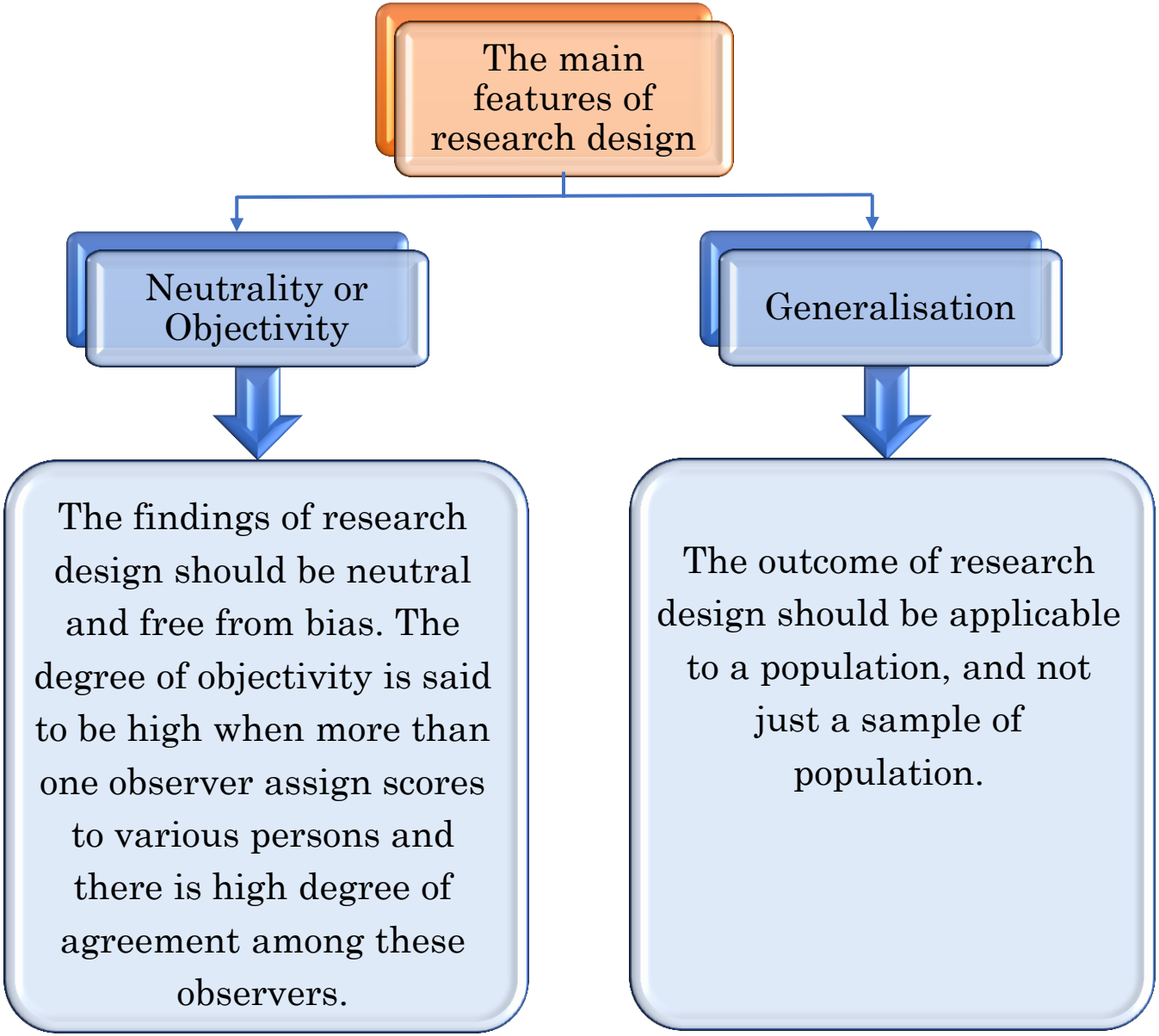
A research design answers the following questions:

- What is the research all about?
- Why is the research required?
- Where will the research be conducted?
- What type of data is required?
- Where can the required data be found?
- What is the time period of research?
- What will be the sample design?
- What techniques of data collection will be used?
- How will the data be analysed?

The Need and Features of Research Design

Some benefits of research design are:

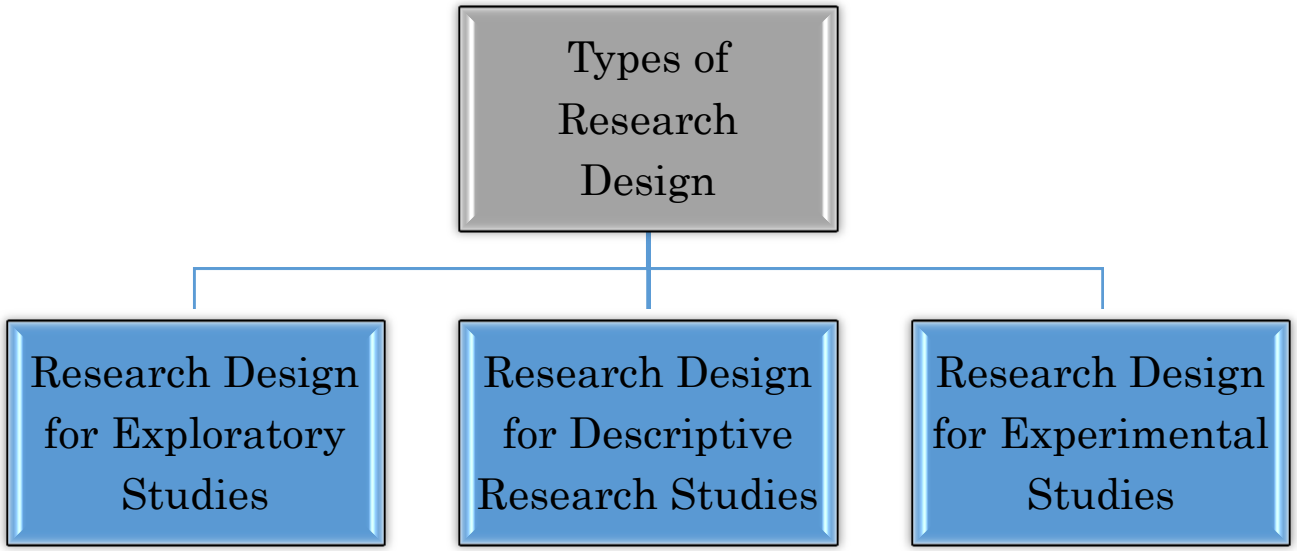
- Reduces Inaccuracy in the Research Project
- Provides Maximum Efficiency and Reliability to the Project
- Removes Bias and Optimise Errors
- Minimises Time Wastage
- Helps in Collecting Research Materials and Testing of Hypothesis
- Indicates the Type of Resources Required for Research
- Provides an Overview to Other Experts
- Guides the Research in the Right Direction


The main features of research design
Neutrality or Objectivity
Generalisation
The findings of research design should be neutral and free from bias. The degree of objectivity is said to be high when more than one observer assign scores to various persons and there is high degree of agreement among these observers.
The outcome of research design should be applicable to a population, and not just a sample of population.

Types of Research Design

Questions should be asked before determining the research design are:

- What is the nature of research problem?
- Which method of data collection and analysis would be used in the research?



Research Design for Exploratory (Formulative) Research Studies

Exploratory studies aim to formulate a problem for more precise investigation.

Methods considered regarding research design for exploratory studies are:

Review of literature:

- If the problem has been formulated earlier, you can review the available literature to test it for its significance and usefulness.
- If the problem has not been formulated earlier, then you can review the literature for formulating it.
- Reviewing available literature also helps you in applying the already developed theories and concepts to your subject of research

Experience survey:

It is a survey of people who have practical experience in the topic of the proposed research or in related topics.

Experienced people can contribute significant and innovative ideas in the research.

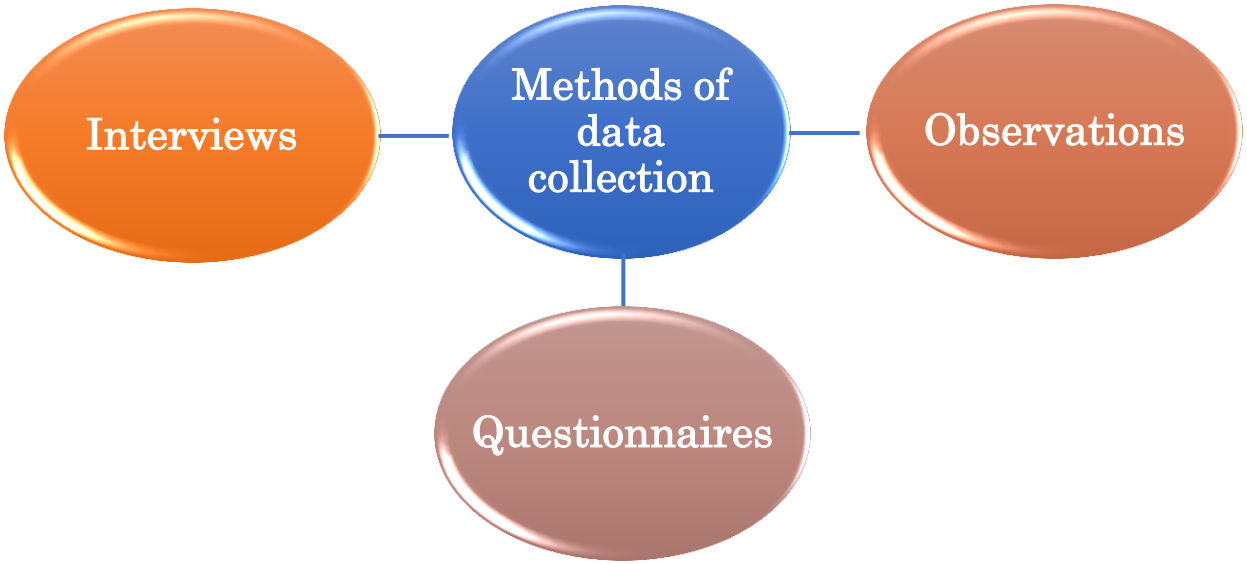
You can conduct an experience survey by scheduling interviews with the experienced people.

Research Design for Descriptive Research Studies

- Descriptive studies aim to describe the facts and situations as they are.
- They are concerned with 'what' & not with 'how' & 'why' of a research problem.
- Example: Studies concerning specific predictions, narration of facts etc.
- In descriptive studies, the researcher should be very careful about data and methods to be used.
- For descriptive studies, research design should not be flexible as was the case with exploratory studies. It should be rigid and free from any bias.

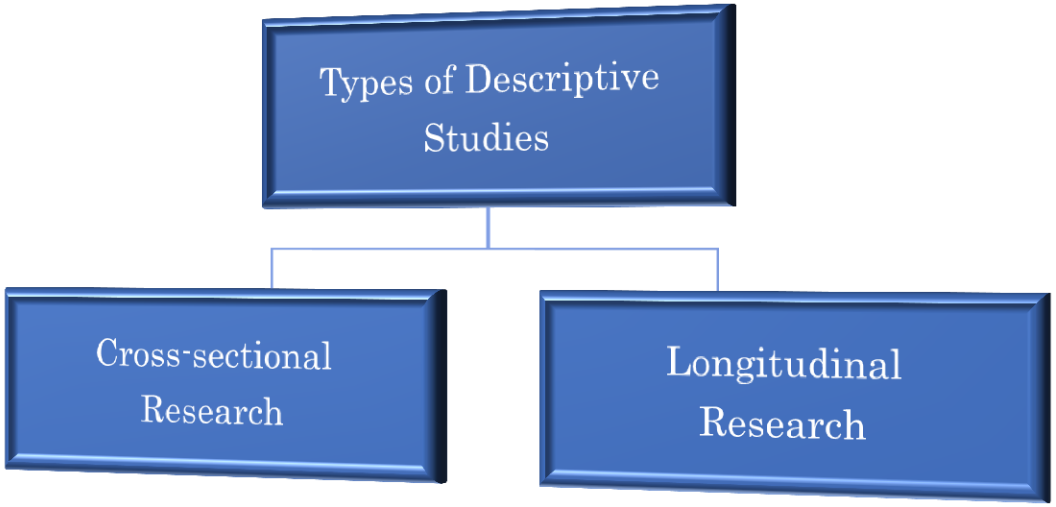
Points should be noted While finalising the research design for the descriptive and the diagnostic studies

- Objectives of the study
- Clearly defining the hypothesis
- Techniques of data collection
- Type of data required
- Place and time period of data
- Data analysis
- Report presentation



Remember

- The time and place of data collection should be taken care.
- The collected data must be properly analysed by using proper statistical and software tools.
- Finally, the report of the study is presented in detail.



Cross-Sectional Research

This type of research is used to observe variables that differ on one key characteristic at the same time.

This is mainly performed for the descriptive studies.

Example: A cross-sectional study of people who are similar in other characteristics but different in a key factor such as age, income levels or geographical location

Key characteristics of a cross-sectional research are:

- The research takes place at a single point in time
- It does not involve manipulating variables
- It allows researchers to observe several characteristics at once
- It is often used to observe the prevailing conditions in a given population
- It can provide information on what is happening in a current population

Longitudinal Research

Longitudinal research involves observing variables over an extended period of time, such as weeks, months or even years.

This type of research can be used to discover relationships between variables over an extended period.

Key characteristics of longitudinal research are:

- It allows changes to be analysed at a micro level
- It is used to find relationship between two variables
- It involves collecting data over an extended period of time

Research Design for Experimental Studies

In experimental studies, some variables of interest are manipulated to observe their effects on other variables.

Example: An experimental research is conducting a laboratory test

The five steps to prepare an experimental research design are:

1. Define the goals of experiment
2. Identify and classify variables (dependent, independent and extraneous)
3. Develop a relationship between dependent and independent variables
4. Select a suitable experimental design
5. Ensure the validity of design

Principles of Experimental Research Designs

The purpose of an experiment is to decide:

- Whether the observed differences among the treatments included in the experiment are due to chance only
- Whether the extent of these difference is of practical importance

The three principles of experimental design to decide the above two principles are:

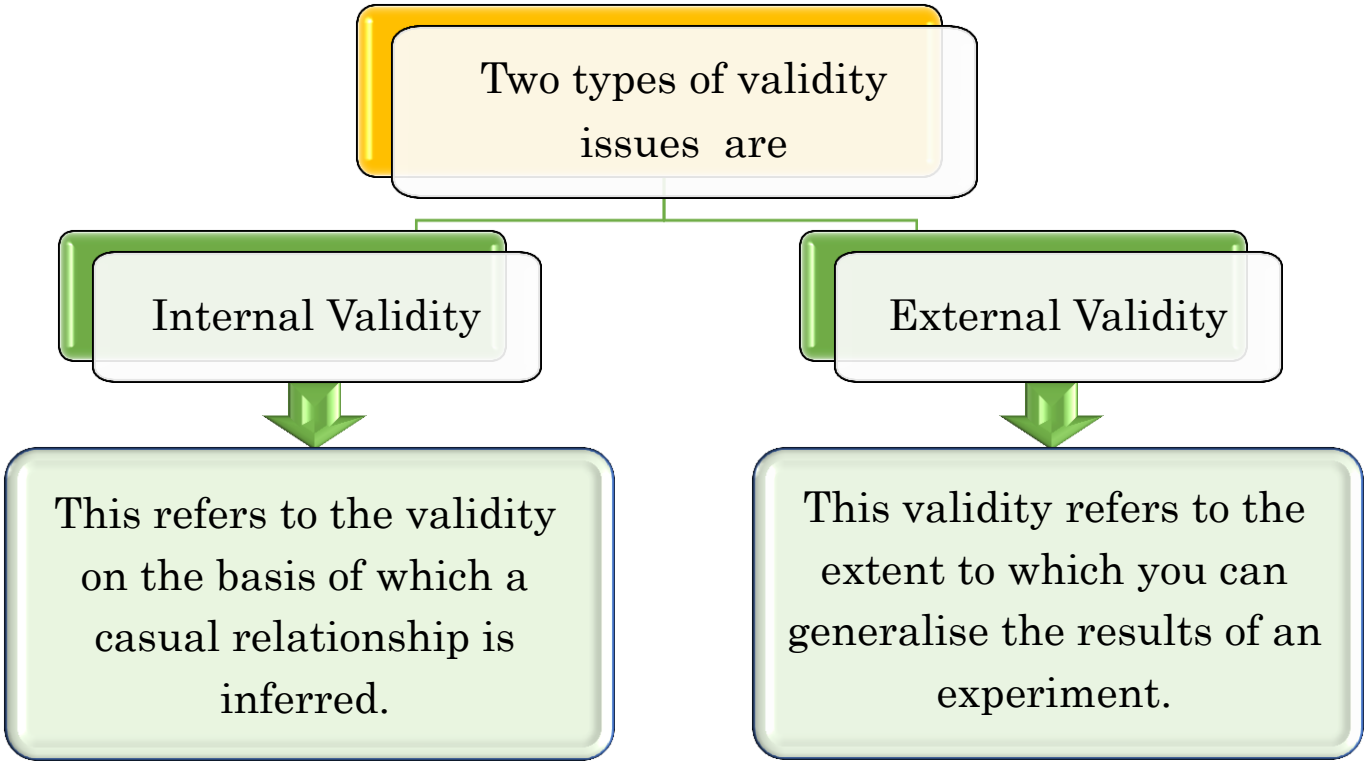
Principle of replication — This principle provides an estimate of experimental error.

Principle of randomisation — This principle ensures that this estimate is statistically valid.

Principle of local control — This principle reduces experimental error by making the experiment more efficient.

Concept of Validity

According to the concept of causality, causality refers to the phenomena due to which one thing (called the cause) causes something else (called the effect) under certain conditions.



Threats to Internal Validity of Research Design

History

It refers to the threat wherein external events have an impact on the outcomes of the experiment.

Example:

- If a group of researchers are implementing an educational program in all schools of Delhi in order to increase awareness regarding use of drugs and its ill effects.
- During the study, one of the students dies due to over dosage of drugs. This news was reported extensively in print and electronic media.
- The researchers find out that, at the end of the study, the awareness level of the school students has increased immensely.

Maturation

It refers to the threat wherein the post-test outcomes go up or are improved as a result of the subjects maturing with passage of time.

Example:

- A group of 10 teachers are given a training session every month for two years. The purpose of training is to improve their teaching methodology and quality of instruction.
- After two years, the researchers find out that the quality of instruction and teaching of all the ten teachers has increased drastically

Attrition/ Mortality

It refers to the threat wherein the experiment outcomes may get affected as a result of demise of experimental subjects or due to subjects dropping out of a study.

Example:

- A market research program starts with 1000 respondents which is planned to be carried out over a period of two years.
- However, as the study progresses, some of the respondents may have to leave the research.

Testing response

It refers to the threat that post-test outcomes are better than the pre-test outcomes because the subjects by then (time of post-test) are already experienced with the kind of questions they might expect.

Example:

- A group of 20 students take the mock-test for UPSC IAS examination for the very first time in their lives.
- However, all of them fail to pass in the examination.
- After this, all the 20 students attend a free training session offered by ABC coaching classes.
- Post this session, the same 20 students take another mock-test (having same difficulty level) and it is observed that the scores of all the students have improved drastically.

Instrumentation

The reuse of human instruments such as interviews (questions) and questionnaires leads to them wearing out and becoming less accurate with time. The accuracy level of the instrument has a significant impact on the experiment's outcomes.

Example:

- A research study may use instruments such as questionnaires or survey or interviews.
- The research may show a considerable amount of difference between the pre-test and post-test observations which might be due to reasons such as change in the questions included in the questionnaire or questions asked during the interviews.

Sampling effects/ selection bias

The procedure followed for selection of the experiment's subjects may have a bearing on the outcomes of the experiment.

Example:

- A researcher may carry out a research to study the behaviour of people having anxiety disorder.
- For this, the researcher creates an experimental group and a control group.
- The experimental group has subjects who have anxiety disorders whereas the control group has subjects who have no anxiety disorder.
- It was observed that the people with anxiety disorders (experimental group) immediately focus their attention on sources of threats in their environment as compared with healthy people (control group).

Regression to the mean

This threat may realise as a result of selecting subjects on the basis of extreme scores or characteristics. In such a case when tests are carried out repeatedly, extreme scores tend to regress or cluster around the mean.

Example:

- A researcher selects 20 students who scored extremely low on a Math Test and provides extensive and illustrated Mathematics sessions to these students.

Experimenter bias

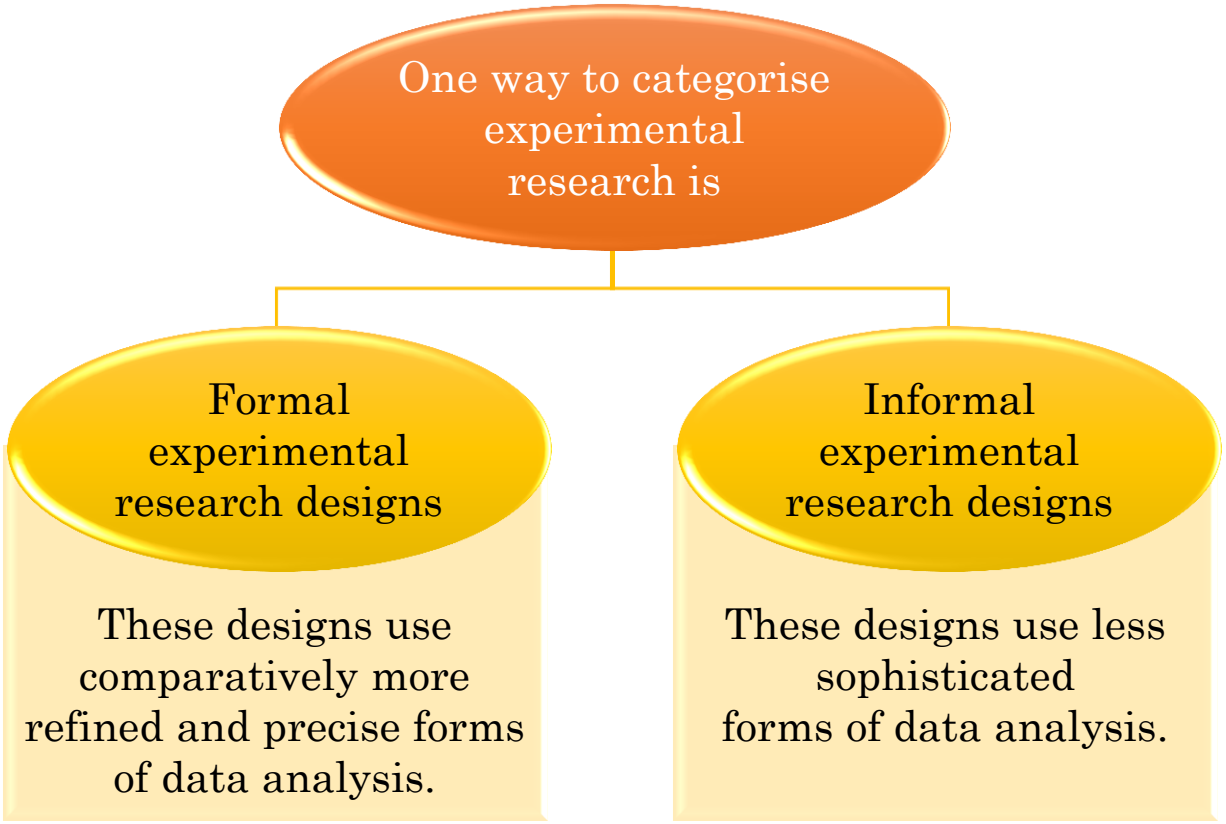
In research studies, it is possible that the researchers are biased towards the results that they desire. Such bias can have an impact on the observations made by the research team which may be used to skew the study in the desired direction.

Example:

- A researcher wants to support his hypothesis that approximately 40% of males living in Bengaluru are chronic smokers who smoke five or more cigarettes daily.

Categories of Experimental Research Designs

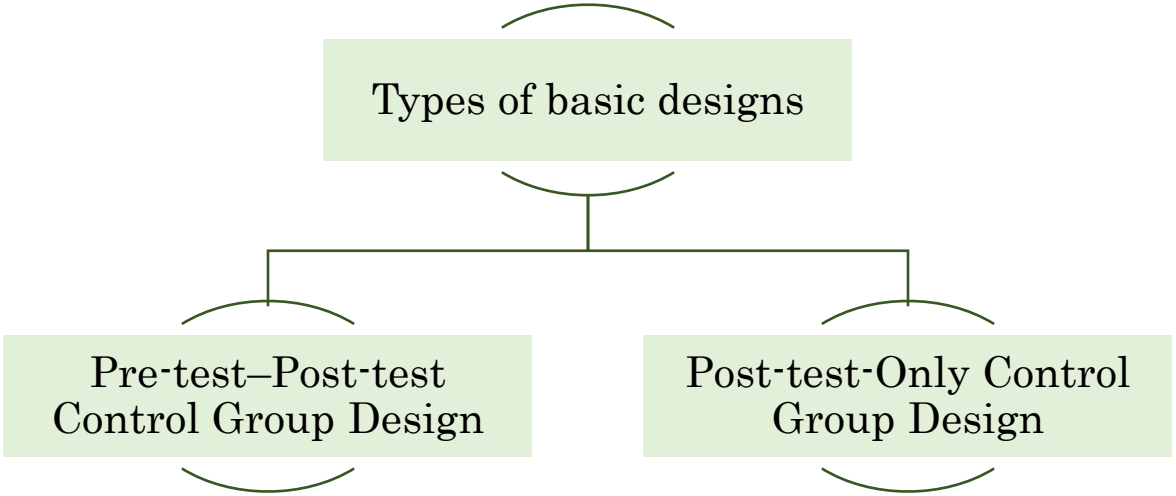
There are multiple ways to categorise experimental research designs.



Another common way in which experimental research are categorised is:
Basic Designs & Statistical designs

Basic designs

Basic designs refer to those designs that include only one independent variable.



Some notations used in these designs are:

- **R:** Random assignment
- **T:** Treatment
- **O:** Observation, outcome or effect

1. **Pre-test–Post-test control group design**
   (randomized pre-test–post-test design/the classical controlled experimental design)

In such experimental designs, the subjects are assigned to the experimental (treatment) and control (no treatment) groups using random numbers.

The symbolic representation of the pre-test–post-test control group design

Group	Pre-test (First observation of the dependent variable)	Treatment (T)	Post-test (Second observation of the dependent variable)
Experimental Group (E)	O_1 (Average score of the Experimental Group on the dependent variable)	T	O_2 (Average score of the Experimental Group on the dependent variable)
Control Group (C)	O_3 (Average score of the Control Group on the dependent variable)	No-T	O_4 (Average score of the Control Group on the dependent variable)

2. Post-test-Only Control Group Design

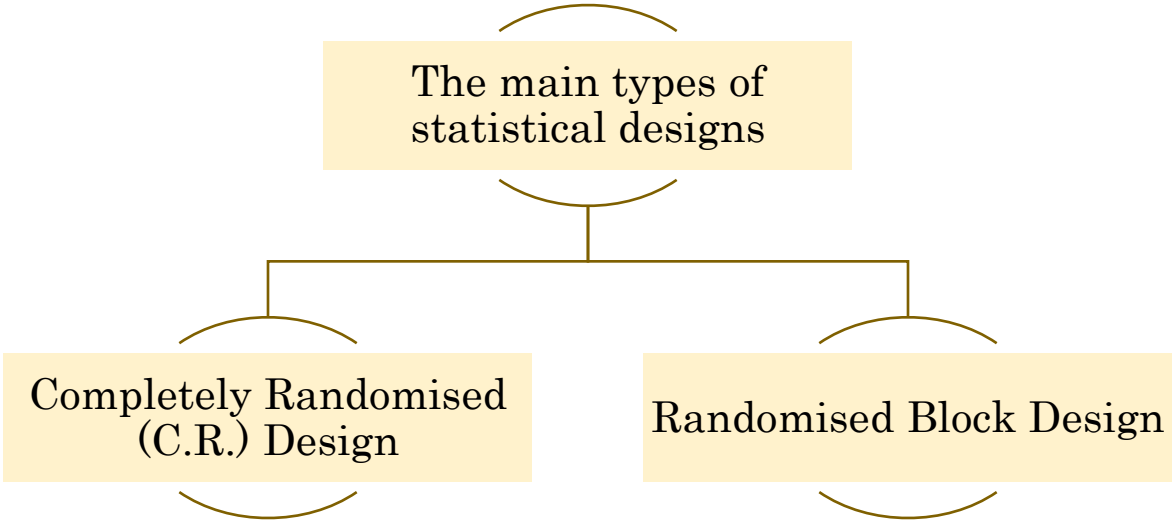
In a post-test-only control group design, the researcher randomly assigns subjects to the experimental and control groups.

The symbolic representation of the pre-test–post-test control group design

Group	Treatment (T)	Post-test (First observation of the dependent variable)
Experimental Group (E)	T	O_1 (Average score of the experimental group on the dependent variable)
Control Group (C)	No-T	O_2 (Average score of the control group on the dependent variable)

Statistical Designs

Statistical designs refer to those experimental designs in which there are two or more independent variables.



Apart from these designs, Latin Square Experimental Design and Factorial Design are two other important statistical experimental designs.

1. Completely Randomised (C.R.) design

The C.R. design refers to the design in which there is random assignment of subjects to treatments.

In this case, every subject carries equal probability to be assigned to any treatment.

Example: To test eight subjects under two treatments (A and B), there is an equal opportunity of every subject to be assigned to any of the treatments.

C.R. designs may be analysed using ANOVA, independent t-test, or non-parametric tests depending upon the number of treatments.

A **two-group randomised design** is the simplest form of C.R. design.

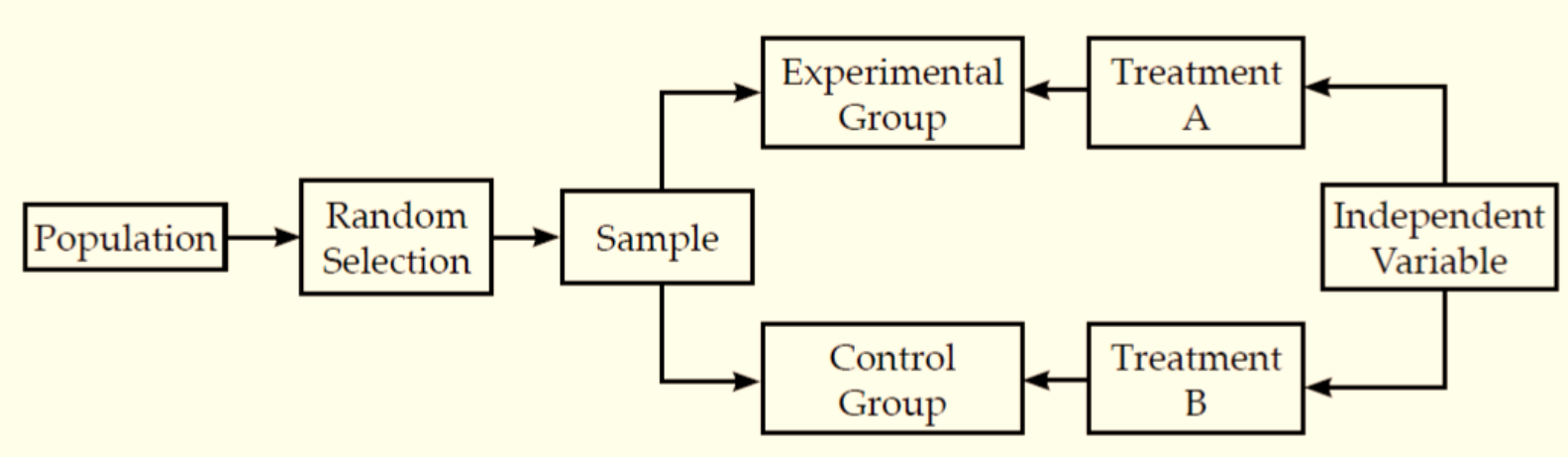
Two-group randomised design

.In this design, two randomisations (selecting the items randomly), namely random sampling and random assignment, take place.

Random sampling refers to selecting a sample from the population

Random assignment refers to assigning subjects selected from the sample to an experimental group and a control group.

The diagrammatic representation of the two-group simple randomised design



2. Randomised block design

The randomised block design refers to the design that is used when you want to eliminate uncontrolled variations.

These variations are caused by a variable called blocking variable or nuisance variable.

Example: A doctor wants to treat a patient with a specifically prepared medicine. In this case, the nuisance factor may be the time of giving medicine to the patient or other issues such as diabetes, hypertension etc.

The Components of Research Design

Sampling Design

This part of research design deals with the method of selecting items for research.

Observational survey design

This part of research design involves deciding how many observations have to be made and under what conditions.

Statistical design

This part of research design involves deciding how the data will be collected and analysed.

Operational design

This part deals with the techniques of carrying out the procedures related to sampling design, observational design and statistical design.

Comparison of the Research Designs for the Exploratory Studies and Descriptive Studies

	Overall Design	Sampling Design	Statistical Design	Observational Design	Operational Design
Exploratory studies	Flexible	Purposive	Not planned	Data can be collected by unstructured methods	Not fixed
Descriptive/ diagnostic studies	Rigid	Probability	Pre-planned	Structured methods	Fixed

The components of the research design can be explained through the following points:

Variable

It refers to a parameter that keeps changing with time and space. Different types of variables are

Dependent variable: It is the variable that can be measured by the researcher. It is affected by the changes in an independent variable.

Independent variable: It is the variable that causes a change in a dependent variable. Independent variables can be controlled.

Extraneous (Confounding) variables: These are independent variables, which are not directly related to the research yet they may affect dependent variables.

Control variable: Control variables are those extraneous variables that can potentially affect the research experiment but the researchers keep them same (or controlled) during experiments.

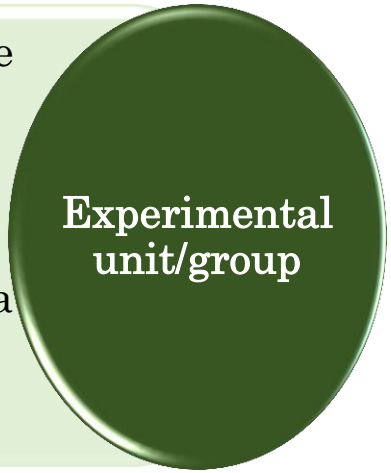
Factors, outcomes, levels and treatments

Factors, outcomes, levels and treatments

- In an experiment, factor refers to that variable that is manipulated or controlled by the researcher. Manipulation of factor is done to study its impact on the research study.
- The observation of the variable of interest yields outcome.
- Each factor can have two or more values called as factor levels.
- These different factor levels are called treatments. It must be remembered that factors may be qualitative or quantitative in nature.
- Example: Factors may include soil quality, type of seeds, type and amount of fertiliser.
- The researcher may use one or more factors. In a single factor study, treatments correspond to the factor levels. In n-factor studies, the treatments correspond to the combination of the factor levels.

Experimental unit/group

- It is the unit/group to which a treatment is applied in a single trial of experiment.
- The experimental unit may be a plot of land, a patient in hospital, a group of operators or a set of machines.
- **Example:** One can compare a patient in a private ward with a patient in a general ward, in terms of the treatment they receive in the same hospital.



Response

- It refers to the results of an experiment on the basis of a treatment.
- The response may be the yield of a process, the purity of a chemical, or any quantitative or qualitative expression.

Thank You