Module 2 - Research Design

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Meaning of Research Design

The research design is the conceptual structure within which research is conducted. It constitutes the blueprint for the collection, measurement and analysis of data.

The design includes an outline from writing the hypothesis and its operational implications to the final analysis of data.

More explicitly, the design decisions happen to be in respect of:

(i) What is the study about?

(ii) Why is the study being made?

(iii) Where will the study be carried out?

(iv) What type of data is required?

(v) Where can the required data be found?

(vi) What periods of time will the study include?

(vii) What will be the sample design?

(viii) What techniques of data collection will be used?

(ix) How will the data be analysed?

(x) In what style will the report be prepared?

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The overall research design may be split into the following parts:

(a) the sampling design which deals with the method of selecting items to be observed for the given study

(b) the observational design which relates to the conditions under which the observations are to be made

(c) the statistical design which concerns with the question of how many items are to be observed and how the information and data gathered are to be analysed

(d) the operational design which deals with the techniques by which the procedures specified in the sampling, statistical and observational designs can be carried out.

The important features of a research design are:

(i) It specifies the sources and types of information relevant to the research problem.
(ii) It is a strategy for gathering and analysing the data.
(iii) It also includes the time and cost budgets.

Research design must contain:
(a) a clear statement of the research problem
(b) procedures and techniques to be used for gathering information
(c) the population to be studied
(d) methods to be used in processing and analysing data

Need For Research Design

Research design is needed because it facilitates the smooth sailing of the various research operations, thereby making research as efficient as possible yielding maximal information with minimal expenditure of effort, time and money.

We need a research design before data collection and analysis for our research project.

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The design helps the researcher to organize his ideas such that it will be possible for him to look for flaws and inadequacies.

Such a design can even be given to other experts or peers for their comments and critical evaluation.

Features Of A Good Design

The features of a good design are

1. It minimises bias and maximises the reliability of the data collected and analysed.
2. It gives the smallest experimental error.
3. It is the best design in many investigations.
4. It yields maximal information.
5. It provides an opportunity for considering many different aspects of a problem.
6. It is most economical, appropriate and efficient design.

A research design usually considers the following factors:
(i) the means of obtaining information;
(ii) the availability and skills of the researcher and his staff, if any;
(iii) the objective of the problem to be studied;
(iv) the nature of the problem to be studied; and
(v) the availability of time and money for the research work.

Important Concepts Relating To Research Design

1. **Dependent and independent variables:**

A concept which can take on different quantitative values is called a variable. Example: weight, height, income, etc

A continuous variable is that which can assume any numerical value within a specific range.

A variable for which the individual values fall on the scale only with distinct gaps is called a non-continuous or discrete variable.

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Age is an example of continuous variable, but the number of children is an example of non-continuous variable.

If one variable depends upon or is a consequence of the other variable, it is termed as a dependent variable.

The variable which is independent of other variables but on which other variables depend is termed as an independent variable.
Example: if we say that height depends upon age, then height is a dependent variable and age is an independent variable.

2. **Extraneous variable:**

Independent variables that are not related to the purpose of the study, but may affect the dependent variable are termed as extraneous variables.

Suppose the researcher wants to test the hypothesis that there is a relationship between children's gains in social studies achievement and their self-concepts.

In this case self-concept is an independent variable and social studies achievement is a dependent variable.

Intelligence may as well affect the social studies achievement, but since it is not related to the purpose of the study undertaken by the researcher, it will be termed as an extraneous variable.

Whatever effect is noticed on dependent variable as a result of extraneous variable(s) is technically described as an 'experimental error'.

A study must always be so designed that the effect upon the dependent variable is attributed entirely to the independent variable(s), and not to some extraneous variable or variables.

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3. Control:

One important characteristic of a good research design is to minimise the effect of extraneous variable(s).

The technical term 'control' is used when we design the study minimising the effects of extraneous independent variables.

In experimental researches, the term 'control' is used to refer to restrain experimental conditions.

4. Confounded relationship:

When the dependent variable is not free from the influence of extraneous variable(s), the relationship between the dependent and independent variables is said to be confounded by an extraneous variable(s).

5. Research hypothesis:

When a prediction or a hypothesised relationship is to be tested by scientific methods, it is termed as research hypothesis.

The research hypothesis is a predictive statement that relates an independent variable to a dependent variable.

Usually a research hypothesis must contain, at least, one independent and one dependent variable.

Predictive statements which are not to be objectively verified or the relationships that are assumed but not to be tested, are not termed research hypotheses.

6. Experimental and non-experimental hypothesis-testing research:

When the purpose of research is to test a research hypothesis, it is termed as hypothesis-testing research.

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Research in which the independent variable is manipulated is termed 'experimental hypothesis-testing research'.

A research in which an independent variable is not manipulated is called 'non-experimental hypothesis-testing research'.

For instance, suppose a researcher wants to study whether intelligence affects reading ability for a group of students and for this purpose he randomly selects 50 students and tests their intelligence and reading ability by calculating the coefficient of correlation between the two sets of scores.

This is an example of non-experimental hypothesis-testing research because herein the independent variable, intelligence, is not manipulated.

But now suppose that our researcher randomly selects 50 students from a group of students who are to take a course in statistics and then divides them into two groups by randomly assigning 25 to Group A, the usual studies programme, and 25 to Group B, the special studies programme.

At the end of the course, he administers a test to each group in order to judge the effectiveness of the training programme on the student's performance-level.

This is an example of experimental hypothesis-testing research because in this case the independent variable, viz., the type of training programme, is manipulated.

7. Experimental and control groups:

In an experimental hypothesis-testing research when a group is exposed to usual conditions, it is termed a 'control group', but when the group is exposed to some novel or special condition, it is termed an 'experimental group'.

In the above illustration, the Group A can be called a control group and the Group B an experimental group.

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It is possible to design studies which include only experimental groups or studies which include both experimental and control groups.

8. Treatments:

The different conditions under which experimental and control groups are put are usually referred to as 'treatments'.

In the illustration taken above, the two treatments are the usual studies programme and the special studies programme.

Example: if we want to determine through an experiment the comparative impact of three varieties of fertilizers on the yield of wheat, the three varieties of fertilizers will be treated as three treatments.

9. Experiment:

The process of examining the truth of a statistical hypothesis, relating to some research problem, is known as an experiment.

Experiments can be of two types viz., absolute experiment and comparative experiment.

If we want to determine the impact of a fertilizer on the yield of a crop, it is a case of absolute experiment.
If we want to determine the impact of one fertilizer as compared to the impact of some other fertilizer, our experiment then will be termed as a comparative experiment.

10. Experimental unit(s):

The pre-determined plots or the blocks, where different treatments are used, are known as experimental units.
Such experimental units must be selected (defined) very carefully.

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Different Research Designs

Different research designs can be conveniently described if we categorize them as:
(1) research design in case of exploratory research studies
(2) research design in case of descriptive and diagnostic research studies
and (3) research design in case of hypothesis-testing research studies.

1. **Research design in case of exploratory research studies:**

The main purpose of such studies is that of formulating a problem for more precise investigation or of developing the working hypotheses from an operational point of view.

The major emphasis in such studies is on the discovery of ideas and insights.

Three methods in the context of research design are
(a) the survey of concerning literature
(b) the experience survey and
(c) the analysis of 'insight-stimulating' examples.

The survey of concerning literature helps in formulating precisely the research problem or developing hypothesis.

Experience survey means the survey of people who have had practical experience with the problem to be studied.

The object of such a survey is to obtain insight into the relationships between variables and new ideas relating to the research problem.

The respondents should be carefully selected and then be interviewed by the investigator.

The researcher must prepare an interview schedule for the systematic questioning of informants.

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But the interview must ensure flexibility in the sense that the respondents should be allowed to raise issues and questions which the investigator has not previously considered.

It is desirable to send a copy of the questions to be discussed to the respondents well in advance.

This will also give an opportunity to the respondents for doing some advance thinking over the various issues involved so that, at the time of interview, they may be able to contribute effectively.

This survey may as well provide information about the practical possibilities for doing different types of research.

Analysis of 'insight-stimulating' examples is a method for suggesting hypotheses for research.

It is particularly suitable in areas where there is little experience to serve as a guide.

This method consists of the intensive study of selected instances of the phenomenon in which one is interested.

2. **Research design in case of descriptive and diagnostic research studies:**

Descriptive research studies are concerned with describing the characteristics of a particular individual, or of a group.
The studies concerned with specific predictions, with narration of facts and characteristics concerning individual, group or situation are examples of descriptive research studies.

Diagnostic research studies determine the frequency with which something occurs or its association with something else.

The studies concerning whether certain variables are associated are examples of diagnostic research studies.

The design in such studies must be rigid and not flexible and must focus attention on the following:

(a) Formulating the objective of the study (what the study is about and why is it being made?)

(b) Designing the methods of data collection (what techniques of gathering data will be adopted?)

(c) Selecting the sample (how much material will be needed?)

(d) Collecting the data (where can the required data be found and with what time period should

the data be related?)

(e) Processing and analysing the data.

(f) Reporting the findings.

The difference between research designs in respect of the above two types of research studies can be conveniently summarised in tabular form as under:

Research Design	*Type of study*	
	Exploratory of Formulative	*Descriptive/Diagnostic*
Overall design	Flexible design (design must provide opportunity for considering different aspects of the problem)	Rigid design (design must make enough provision for protection against bias and must maximise reliability)
(i) Sampling design	Non-probability sampling design (purposive or judgement sampling)	Probability sampling design (random sampling)
(ii) Statistical design	No pre-planned design for analysis	Pre-planned design for analysis
(iii) Observational design	Unstructured instruments for collection of data	Structured or well thought out instruments for collection of data
(iv) Operational design	No fixed decisions about the operational procedures	Advanced decisions about operational procedures.

3. Research design in case of hypothesis-testing research studies:

Hypothesis-testing research studies (generally known as experimental studies) are those where the researcher tests the hypotheses of causal relationships between variables.

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Such studies require procedures that will not only reduce bias and increase reliability, but will permit drawing inferences about causality.

Usually experiments meet this requirement.

Basic Principles Of Experimental Designs

Professor Fisher has enumerated three principles of experimental designs:
(1) the Principle of Replication
(2) the Principle of Randomization
and (3) the Principle of Local Control.

According to **the Principle of Replication**, the experiment should be repeated more than once.

Thus, each treatment is applied in many experimental units instead of one.

By doing so the statistical accuracy of the experiments is increased.

For example, suppose we are to examine the effect of two varieties of rice.

For this purpose we may divide the field into two parts and grow one variety in one part and the other variety in the other part.

We can then compare the yield of the two parts and draw conclusion on that basis.

But if we are to apply the principle of replication to this experiment, then we first divide the field into several parts, grow one variety in half of these parts and the other variety in the remaining parts.

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We can then collect the data of yield of the two varieties and draw conclusion by comparing the same.

The result so obtained will be more reliable in comparison to the conclusion we draw without applying the principle of replication.

The entire experiment can even be repeated several times for better results.

The Principle of Randomization provides protection, when we conduct an experiment, against the effect of extraneous factors by randomization.

We should design or plan the experiment in such a way that the variations caused by extraneous factors can all be combined under the general heading of "chance."

For instance, if we grow one variety of rice, say, in the first half of the parts of a field and the other variety is grown in the other half, then it is just possible that the soil fertility may be different in the first half in comparison to the other half.

If this is so, our results would not be realistic.

In such a situation, we may assign the variety of rice to be grown in different parts of the field on the basis of some random sampling technique i.e., we may apply randomization principle and protect ourselves against the effects of the extraneous factors (soil fertility differences in the given case).

As such, through the application of the principle of randomization, we can have a better estimate of the experimental error.

In The Principle of Local Control the extraneous factor, the known source of variability, is made to vary deliberately over as wide a range as necessary and this needs to be done in such a way that the variability it causes can be measured and hence eliminated from the experimental error.

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This means that we should plan the experiment in a manner that we can perform a two-way analysis of variance, in which the total variability of the data is divided into three components attributed to treatments (varieties of rice in our case), the extraneous factor (soil fertility in our case) and experimental error.

In other words, according to the principle of local control, we first divide the field into several homogeneous parts, known as blocks, and then each such block is divided into parts equal to the number of treatments.

Then the treatments are randomly assigned to these parts of a block.

Dividing the field into several homogenous parts is known as 'blocking'.

In general, blocks are the levels at which we hold an extraneous factor fixed, so that we can measure its contribution to the total variability of the data by means of a two-way analysis of variance.

In brief, through the principle of local control we can eliminate the variability due to extraneous factor(s) from the experimental error.

Developing a Research Plan

After identifying and defining the problem as also accomplishing the relating task, researcher must arrange his ideas in order and write them in the form of an experimental plan or 'Research Plan'.

This is essential specially for new researcher because of the following:
(a) It helps him to organize his ideas

(b) It provides an inventory of what must be done and which materials have to be collected

(c) It is a document that can be given to others for comment.

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Research plan must contain the following items.

1. Research objective should be clearly stated briefly which tells exactly what it is that the researcher expects to do.

2. The problem to be studied stated so that one may know what information is to be obtained for solving the problem.

3. Each major concept should be defined in operational terms.

4. The method to be used in solving the problem along with the assumptions, if any, are to be clearly mentioned.

5. The techniques to be adopted. If tests are to be performed, the conditions should be specified along with the nature of instruments to be used.

6. A clear mention of the population to be studied should be made.

7. The methods to be used in processing the data.

8. Results of pilot test, if any, should be reported. Time and cost budgets for the research project should also be prepared and laid down in the plan itself.

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