**UNIT III**

**Research design**

**3.0 Definition**

A detailed outline of how an investigation will take place. A research design will typically include how data is to be collected, what instruments will be employed, how the instruments will be used and the intended means for analyzing data collected.

**Research Design**

The strategic plan for a research project or research programme, setting out the broad outline and key features of the work to be undertaken, including the methods of data collection and analysis to be employed, and showing how the research strategy addresses the specific aims and objectives of the study, and whether the research issues are theoretical or policy-oriented. Hence also, the process of developing such a document, choosing between alternative types of study, their relative size, whether triangulation will be employed, and adjusting plans to the available resources and timetable.

**3.1Meaning of Research Design**

Decisions pertaining to what, where, when, how much, and by what means with regards to a study make up a research design. A *research design means* the arrangement of conditions for collection and analysis of data in a fashion which aspires to combine relevance to the research purpose. As such the design consists of an overview of what the researcher will do from writing the hypothesis and its operational significance to the final analysis of data.

More explicitly, the design decisions are actually with respect of:

1. What is the study about?
2. The reason why the study being done?
3. Where will we perform the study?
4. Which kind of data is needed?
5. Where can the necessary data be discovered?
6. What time periods will the study contain?
7. What will be the sample design?
8. What methods of data collection will likely be employed?
9. How will the data be analyzed?
10. In what style will the report be organized?

**We can break up the entire research design into the following sections:**

1. The sampling design that relates to the process of selecting items to be observed for the provided research;
2. The observational design that pertains to the conditions under which the observations are to be made;
3. The statistical design that concerns with the question of how many items are to be observed and the way the information and data collected should be analyzed; and
4. The operational design that is concerned with the techniques through which the procedures given in the sampling, statistical and observational designs can be executed.

***The key features of a research design are:***

(i) It is a plan which describes the sources and kinds of information strongly related to the research problem.

(ii) It is a strategy indicating which method will be employed for collecting and examining the data.  
(iii) It also consists of the time and cost budgets because most studies are done under these two limitations.

In a nutshell, research design must, at least, contain

(a) A clear statement of the research problem;

(b) Processes and methods to be utilized for collecting data;

(c) The population to be researched; and

(d) Techniques to be employed in processing and examining data.

**Research design is what makes the entire research project work – without it, you’ve just got a lot of material but absolutely no way of using it correctly or putting it together.**

# 3.2 Need for Research Design

Research design has a significant impact on the reliability of the results obtained. It thus acts as a firm foundation for the entire research. It is needed because it facilitates the smooth functioning of the various research operations. It makes the research as efficient as possible by giving maximum information with minimal expenditure of effort, time and money. For construction of a house, we need to have a proper blueprint prepared by an expert architect. Similarly, we need a proper research design or plan prior to data collection and analysis of our research project. Preparation of research design should be done carefully as even a minute error might ruin the purpose of the entire project. The design helps the researcher to organize his ideas, which helps to identify and correct his flaws, if any. In a good research design, all the components  with each other or go together with each other in a coherent manner. The theoretical and conceptual framework must  be with the research goals and purposes. Likewise, the data collection strategy must fit with the research purposes, conceptual and theoretical framework and approach to data analysis.

### The need for research design is as follows:

* It reduces inaccuracy;
* Helps to get maximum efficiency and reliability;
* Eliminates bias and marginal errors;
* Minimizes wastage of time;
* Helpful for collecting research materials;
* Helpful for testing of hypothesis;
* Gives an idea regarding the type of resources required in terms of money, manpower,  time, and efforts;
* Provides an overview to other experts;
* Guides the research in the right direction.

# 3.3 Features of good research design?

Generally a good research design minimizes bias and maximizes the reliability of the data collected and analyzed. The design which gives the smallest experimental error is reported to be the best design in scientific investigation. Similarly, a design which yields maximum information and provides a opportunity for considering different aspects of a problem is considered to be the most appropriate efficient design. Thus the question of a good design is related to the purpose or objective of the research problem and also with the nature of the problem to be studied.

A good research design should satisfy the following four conditions namely objectivity, reliability, validity and generalization of the findings.

1. Objectivity: It refers to the findings related to the method of data collection and scoring of the responses. The research design should permit the measuring instruments which are fairly objective in which every observer or judge scoring the performance must precisely give the same report. In other words, the objectivity of the procedure may be judged by the degree of agreement between the final scores assigned to different individuals by more than one independent observer. This ensures the objectivity of the collected data which shall be capable of analysis and drawing generalizations.

2. Reliability: Reliability refers to consistency throughout a series of measurements. For eg: if a respondent gives out a response to a particular item, he is expected to give the same response to that item even if he is asked repeatedly. If he is changing his response to the same item, the consistency will be lost. So the researcher should frame the items in a questionnaire in such a way that it provides consistency or reliability.

3. Validity: Any measuring device or instrument is said to be valid when it measures what it is expected to measure. For eg: an intelligence test conducted for measuring the I.Q should measure only the intelligence and nothing else, and the questionnaire shall be framed accordingly.

4. Generalizability: It means how best the data collected from the samples can be utilized for drawing certain generalizations applicable to a large group from which sample is drawn. Thus a research design helps an investigator to generalize his findings provided he has taken due care in defining the population, selecting the sample, deriving appropriate statistical analysis etc. while preparing the research design. Thus a good research design is one which is methodologically prepared and should ensure that:

a) The measuring instrument can yield objective, reliable and valid data.   
b) The population is clearly defined.

c) Most appropriate techniques of sample selection is used to form an appropriate sample.   
d) Appropriate statistical analysis has been carried out, and

e) The findings of the study are capable of generalizations.

## Qualities of A Good Research Design

**The following are some of the qualities of a good research design study:-**

1. **A study has a good research design when it is structured systematically:** One of the important characteristic of a good research is that it is structured systematically. This means that the research is planned so that specified steps are taken in a specified sequence in accordance with the defined set of rules. In a systematic research there is no scope of guessing and intuition in arriving at conclusions.
2. **A study has a good research design when it is structured to be logical:** Logical reasoning and the logical process of induction (reasoning from a part to the whole) and deduction (the process of reasoning from some premise to a conclusion which follows from that very premise) are of great value in carrying out a good research. Logical reasoning makes research more meaningful in the context of decision making.
3. **A study has a good research design when it is structured to be empirical:** A good research deals with concrete data that provides a basis for external validity to research results. Moreover, the research is related basically to one or more aspects of a real situation.
4. **A study has a good research design when it is designed such that it is replicable:** A good research should be replicable so that the research results can be verified. If a research study is replicable, it will help in building basis for better decisions.

# 3.4 Research Design: Important Concepts

In order to facilitate a clear and better understanding of the different research designs, it is initially necessary to define all the various important concepts of research design itself.

**1) Dependent and independent variables:** A variable is a concept that can take on different quantitative values. E.g., weight, height, income, etc. A dependent variable can be defined as the variable, which depends upon or is a consequence of the other variable. On the other hand, an independent variable can be defined as the variable that is antecedent to the dependent variable. E.g., if height depends upon age, then height is a dependent variable, while age is an independent variable.

**2) Extraneous variable:** Although, the independent variables are unrelated to the study purpose, they might however affect the dependent variables, known as extraneous variables. E.g., When a researcher investigates the hypothesis of the relationship between children’s gains in moral studies achievement and their self-concepts. The self-concept denotes an independent variable, whereas the moral studies achievement denotes a dependent variable. However, intelligence may also affect the moral studies achievement, but as it is unrelated to the study purpose, it will thus be called an extraneous variable.

**3) Control:** The most significant quality of a good research design is to reduce the influence/effect of extraneous variables. Control is a technical term, which is used while designing the study, by reducing the effects of extraneous independent variables. Besides, in experimental studies, the term control refers to the restraining of experimental conditions.

**4) Confounded relationship:** In case the dependent variable is bound by the influence of extraneous variable, the relationship between the dependent and independent variables is known to be confused by extraneous variables.

**5) Research hypothesis:** This can be defined as the prediction or a hypothesized relationship that needs to be tested by scientific methods. Besides, it is a predictive statement, which connects an independent variable to a dependent variable. Moreover, a research hypothesis needs to contain, at least, one independent and one dependent variable.

**6) Experimental and non-experimental hypothesis-testing research:** When a research aims at investigating a research hypothesis, it is known as the hypothesis-testing research. However, it can be of the experimental or the non-experimental design. On the other hand, a research in which the independent variable is manipulated is known as the experimental hypothesis-testing research, while the research in which an independent variable is not manipulated is known as the non-experimental hypothesis-testing research.

**7) Experimental and control groups:** When any group is exposed to the usual conditions of an experimental hypothesis-testing research, it is known as a control group. Whereas, when the group is exposed to some other special condition, it is known as an experimental group.

**8) Treatments:** This can be defined as the different types of conditions under which the experimental and control groups are put. E.g., In order to determine the comparative impact of three varieties of fertilizers on a crop yield, the three different varieties of fertilizers will be treated as three different treatments.

**9) Experiment:** This can be defined as the process of examining the truth of a statistical hypothesis, relating to some research problem. E.g., an experiment conducted in order to research the usefulness of a newly developed medicine.

Moreover, experiments can be of two types:

i. Absolute experiment:   The determination of the impact of a fertilizer on a crop yield is an example of absolute experiment.

ii. Comparative experiment: The determination of the impact of one fertilizer, in comparison to another fertilizer, is an example of comparative experiment.

**10) Experimental units:** These represent the pre-determined plots or blocks, where different types of treatments are used. Moreover, such type of experimental units must be selected, as well as defined, very cautiously and thoroughly

## 3.5 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.

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

Exploratory research studies are also termed as formulative 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.

As such the research design appropriate for such studies must be flexible enough to provide opportunity for considering different aspects of a problem under study.

Inbuilt flexibility in research design is needed because the research problem, broadly defined initially, is transformed into one with more precise meaning in exploratory studies, which fact may necessitate changes in the research procedure for gathering relevant data.

Generally, the following three methods in the context of research design for such studies are considered:

(a) The survey of concerning literature;

(b) The experience survey and

(c) The analysis of ‘insight-stimulating’ examples.

***The survey of concerning literature***happens to be the most simple and fruitful method of formulating precisely the research problem or developing hypothesis.

Hypotheses stated by earlier workers may be reviewed and their usefulness be evaluated as a basis for further research.

It may also be considered whether the already stated hypotheses suggest new hypothesis. In this way the researcher should review and build upon the work already done by others, but in cases where hypotheses have not yet been formulated, his task is to review the available material for deriving the relevant hypotheses from it.

Besides, the bibliographical survey of studies, already made in one’s area of interest may as well as made by the researcher for precisely formulating the problem. He should also make an attempt to apply concepts and theories developed in different research contexts to the area in which he is himself working. Sometimes the works of creative writers also provide a fertile ground for hypothesis- formulation and as such may be looked into by the researcher.

***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. For such a survey people who are competent and can contribute new ideas may be carefully selected as respondents to ensure a representation of different types of experience. The respondents so selected may then be interviewed by the investigator.

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

Generally, the experience- collecting interview is likely to be long and may last for few hours. Hence, it is often considered 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.

Thus, an experience survey may enable the researcher to define the problem more concisely and help in the formulation of the research hypothesis. This survey may as well provide information about the practical possibilities for doing different types of research.

***Analysis of ‘insight-stimulating’******examples***is also a fruitful 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. For this purpose the existing records, if any, may be examined, the unstructured interviewing may take place, or some other approach may be adopted.

Attitude of the investigator, the intensity of the study and the ability of the researcher to draw together diverse information into a unified interpretation are the main features which make this method an appropriate procedure for evoking insights.

Now, what sort of examples are to be selected and studied? There is no clear cut answer to it. Experience indicates that for particular problems certain types of instances are more appropriate than others. One can mention few examples of ‘insight-stimulating’ cases such as the reactions of strangers, the reactions of marginal individuals, the study of individuals who are in transition from one stage to another, the reactions of individuals from different social strata and the like. In general, cases that provide sharp contrasts or have striking features are considered relatively more useful while adopting this method of hypotheses formulation.

Thus, in an exploratory or formulative research study which merely leads to insights or hypotheses, whatever method or research design outlined above is adopted, the only thing essential is that it must continue to remain flexible so that many different facets of a problem may be considered as and when they arise and come to the notice of the researcher.

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

Descriptive research studies are those studies which are concerned with describing the characteristics of a particular individual, or of a group. Whereas 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. As against this, studies concerned with specific predictions, with narration of facts and characteristics concerning individual, group or situation are all examples of descriptive research studies. Most of the social research comes under this category.

From the point of view of the research design, the descriptive as well as diagnostic studies share common requirements and as such we may group together these two types of research studies.

In descriptive as well as in diagnostic studies, the researcher must be able to define clearly, what he wants to measure and must find adequate methods for measuring it along with a clear cut definition of ‘population’ he wants to study. Since the aim is to obtain complete and accurate information in the said studies, the procedure to be used must be carefully planned.

The research design must make enough provision for protection against bias and must maximise reliability, with due concern for the economical completion of the research study. The design in such studies must be rigid and not flexible and must focus attention on the following:

* 1. Formulating the objective of the study (what the study is about and why is it being made?)
  2. Designing the methods of data collection (what techniques of gathering data will be adopted?)
  3. Selecting the sample (how much material will be needed?)
  4. Collecting the data (where can the required data be found and with what time period should the data be related?)
  5. Processing and analysing the data.
  6. Reporting the findings.

In a descriptive/diagnostic study the first step is to specify the objectives with sufficient precision to ensure that the data collected are relevant. If this is not done carefully, the study may not provide the desired information.

Then comes the question of selecting the methods by which the data are to be obtained. In other words, techniques for collecting the information must be devised. Several methods (viz., observation, questionnaires, interviewing, examination of records, etc.), with their merits and limitations, are available for the purpose and the researcher may user one or more of these methods which have been discussed in detail in later chapters. While designing data-collection procedure, adequate safeguards against bias and unreliability must be ensured. Whichever method is selected, questions must be well examined and be made unambiguous; interviewers must be instructed not to express their own opinion; observers must be trained so that they uniformly record a given item of behavior. It is always desirable to pre- test the data collection instruments before they are finally used for the study purposes. In other words, we can say that “*structured instruments*” are used in such studies.

In most of the descriptive/diagnostic studies the researcher takes out sample(s) and then wishes to make statements about the population on the basis of the sample analysis or analyses.

To obtain data free from errors introduced by those responsible for collecting them, it is necessary to supervise closely the staff of field workers as they collect and record information. Checks may be set up to ensure that the data collecting staff perform their duty honestly and without prejudice. “As data are collected, they should be examined for completeness, comprehensibility, consistency and reliability.”

The data collected must be processed and analyzed. This includes steps like coding the interview replies, observations, etc.; tabulating the data; and performing several statistical computations.

To the extent possible, the processing and analyzing procedure should be planned in detail before actual work is started. This will prove economical in the sense that the researcher may avoid unnecessary labor such as preparing tables for which he later finds he has no use or on the other hand, re-doing some tables because he failed to include relevant data.

Coding should be done carefully to avoid error in coding and for this purpose the reliability of coders needs to be checked. Similarly, the accuracy of tabulation may be checked by having a sample of the tables re-done. In case of mechanical tabulation the material (i.e., the collected data or information) must be entered on appropriate cards which is usually done by punching holes corresponding to a given code. The accuracy of punching is to be checked and ensured.

Finally, statistical computations are needed and as such averages, percentages and various coefficients must be worked out. Probability and sampling analysis may as well be used. The appropriate statistical operations, along with the use of appropriate tests of significance should be carried out to safeguard the drawing of conclusions concerning the study.

Finally, the question of reporting the findings comes. This is the task of communicating the findings to others and the researcher must do it in an efficient manner. The layout of the report needs to be well planned so that all things relating to the research study may be well presented in simple and effective style.

Thus, the research design in case of descriptive/diagnostic studies is a comparative design throwing light on all points narrated above and must be prepared keeping in view the objective(s) of the study and the resources available. However, it must ensure the minimization of bias and maximization of reliability of the evidence collected. The said design can be appropriately referred to as a *survey design* since it takes into account all the steps involved in a survey concerning a phenomenon to be studied.

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 or 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) |
| 1. Sampling design 2. Statistical design 3. Observational design 4. Operational design | Non-probability sampling design (purposive or judgement sampling)  No pre-planned design for analysis  Unstructured instruments for collection of data  No fixed decisions about the operational procedures | Probability sampling design (random sampling)  Pre-planned design for analysis  Structured or well thought out instruments for collection of data  Advanced decisions about operational procedures. |

**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. 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. Hence, when we talk of research design in such studies, we often mean the design of experiments.

Professor R.A. Fisher’s name is associated with experimental designs. Beginning of such designs was made by him when he was working at Rothamsted Experimental Station (Centre for Agricultural Research in England). As such the study of experimental designs has its origin in agricultural research. Professor Fisher found that by dividing agricultural fields or plots into different blocks and then by conducting experiments in each of these blocks, whatever information is collected and inferences drawn from them, happens to be more reliable. This fact inspired him to develop certain experimental designs for testing hypotheses concerning scientific investigations. Today, the experimental designs are being used in researches relating to phenomena of several disciplines. Since experimental designs originated in the context of agricultural operations, we still use, though in a technical sense, several terms of agriculture (such as treatment, yield, plot, block etc.) in experimental designs.

## 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. 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. Conceptually replication does not present any difficulty, but computationally it does. For example, if an experiment requiring a two-way analysis of variance is replicated, it will then require a three-way analysis of variance since replication itself may be a source of variation in the data. However, it should be remembered that replication is introduced in order to increase the precision of a study; that is to say, to increase the accuracy with which the main effects and interactions can be estimated.

The ***Principle of Randomization***provides protection, when we conduct an experiment, against the effect of extraneous factors by randomization. In other words, this principle indicates that 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.

The ***Principle of Local Control***is another important principle of experimental designs. Under it 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. 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.