

---

# **UNIT 1    DEFINITION AND DESCRIPTION RESEARCH DESIGN, QUALITY OF RESEARCH DESIGN**

---

## **Structure**

- 1.0 Introduction
- 1.1 Objectives
- 1.2 Research Design
- 1.3 Purpose of Research Design
  - 1.3.1 Answers to Research Questions
  - 1.3.2 Research Design Acts as Variance Control
  - 1.3.3 Systematic Variance
  - 1.3.4 Extraneous Variance
  - 1.3.5 Error Variance
- 1.4 Design Selection
- 1.5 Criteria of Research Design
  - 1.5.1 Capability to Answer Research Questions Adequately
  - 1.5.2 Control of Variable
  - 1.5.3 Generalisability
- 1.6 Qualities of Research Design
- 1.7 Let Us Sum Up
- 1.8 Unit End Questions
- 1.9 Suggested Readings

---

## **1.0 INTRODUCTION**

---

Having decided what you want to study about, the next question comes up as to how are you going to conduct your study? What procedures will you adopt to obtain answers to research questions? How will you carry out the tasks needed to complete the different components of the research process? What should you do and what should you not do in the process of undertaking the study?

These are some of the questions that need to be answered before we proceed to conduct the study. Basically, answers to these questions constitute the core of a research design. This unit therefore begins with the definition and the description of the research design. Then the purpose of the research design is highlighted in which you will study how a research can maximize the systematic variance, control extraneous variance through the various controlling techniques i.e. randomization, matching, elimination and statistical control. Further you will find how a researcher can minimize the error variance. Moreover, research cannot ignore the criteria of good design. This unit acquaints you with the basic criteria of research through which you can distinguish good design from weak design. Finally, the qualities of research design are indicated and described.

## 1.1 OBJECTIVES

---

After reading this unit, you will be able to:

- Define research design;
- Describe research design in terms of its various components;
- Discuss various objectives/purpose of research design;
- Describe the different procedures to control the extraneous variable and reduce error variance;
- Explain the criteria of research design; and
- State the qualities of research design.

## 1.2 RESEARCH DESIGN

---

Winner (1971) compared the research design to an architect's plan for the structure of a building. The designer of researcher performs a role similar to that of the architect. The owner of the building gives his basic requirements to the architect, who then exercising his expertise, prepares a plan or a blue print outlining the final shape of the structure.

Similarly, researcher has to do planning or prepare a structure before starting data collection and analysis. According to Myers (1980), the research design is the general structure of the experiment, not its specific content. In fact, the research design is the conceptual structure within which research is conducted; it constitutes the blueprint for the collection, measurement and analysis of data.

According to Thyer (1993) a traditional research design is a blueprint or detailed plan for how to conduct a research study and how to complete the same. Planning such a research design involves, (i) operationalising variables so that they can be measured, (ii) selecting a sample of interest to study, (iii) collecting data to be used as a basis for testing hypothesis, and (iv) analysing the results.

According to Matheson (1970) a research design is a basic plan for research, including the assignment of subjects to the levels of the independent variable and the manipulation of the independent variable.

According to Kerlinger (1986) research design is the plan, structure, and strategy of investigation conceived so as to obtain answers to research questions and to control variance.

The definition of Kerlinger reveals three important components, which are (i) research design is a plan (ii) research design is the structure (iii) research design is the strategy. Let us see what these are:

- i) *Research Design is the Plan*: The plan is the overall scheme or program of the research. It includes an outline of what the investigator will do from writing the hypotheses and their operational implications to the final analysis of data.
- ii) *Research Design is the Structure*: The structure of the research is more specific. It is the outline, the scheme, the paradigm, of the operation of the variables. When we draw diagrams that outline the variables and their relation and juxtaposition, we build structural schemes for accomplishing operational research purposes.

- iii) *Research Design is the Strategy*: Strategy as used here is also more specific than plan. It includes the methods to be used to gather and analyse the data. In other words strategy implies how the research objectives will be reached and how the problems encountered in the research will be tackled.

---

## 1.3 PURPOSE OF RESEARCH DESIGN

---

The purpose of research design is to provide a maximum amount of information relevant to the problem under investigation at a minimum cost. The research design has the following purposes:

### 1.3.1 Answers to Research Questions

Research design is formulated to enable the researcher to answer research questions such as validity, objectivity, accuracy, and describe research plans as economically as possible. Any research plan is deliberately and specifically conceived and executed to bring empirical evidence to bear on the research problem. Research design sets up the framework for adequate test of relations among variable. The research design in a way tells us what observations to make, how to make them and how to analyse the quantitative representations of the observations. It also tells us as to what types of statistical analysis to use. Finally, an adequate design outlines possible conclusions to be drawn from statistical analysis. Thus a research design after moving through the sequence of different related steps enables the researcher to draw a valid and objective answer to research questions.

### 1.3.2 Research Design Acts as Variance Control

The main technical function of research design is to control variance. Research design is a set of instructions to the investigator together analyse data in certain ways. Therefore, research design acts as control mechanism and enables the researcher to control unwanted variances. Variance control is a central theme of research design. Variance control as we shall notice throughout this book, is the central theme of experimental design. Variance is a measure of the dispersion or spread of a set of scores. It describes the extent to which the scores differ from each other. Variance and variation, though used synonymously, are not identical terms. Variation is a more general term which includes variance as one of the statistical methods of representing methods.

### 1.3.3 Systematic Variance

The researcher is directly concerned with three types of variance namely experimental variance, extraneous variance and error variance. Main functions of research design are to maximize the effect of systematic variance, control extraneous variance and minimize error variance. A discussion of these variances is presented below.

**Systematic Variance:** by constructing an efficient research design the investigator attempts to maximize the variance of the variable of substantive research hypotheses. Systematic variance is the variability in the dependent measure due to the manipulation of the experimental variable by the experimenter. An important task of the experimenter is to maximize this variance. This objective is achieved by making the level of the experimental variable as unlike as possible. Suppose an experimenter is interested in studying the effect of intensity of light on visual acuity. The experimenter decides to study the effect by manipulating three levels of light intensity, i.e. 10 ml, 15ml, 20 ml. as the difference between any two levels of the

experimental variable is not substantial, and there is little chance of separating its effect from the total variance. Thus, in order to maximize systematic variances, it is desirable to make the experimental conditions (levels) as different as possible. In this experiment it would be appropriate, then to modify the levels of light intensity to 10 ml, 20 ml, and 30 ml so that the difference between any two levels is substantial.

### 1.3.4 Extraneous Variance

Extraneous variance is produced by the extraneous variables or the relevant variables. An experimenter always tries to control the relevant variables and thus, also wants to eliminate the variances produced by these variables. For elimination of extraneous variance it is essential that the extraneous variables be properly controlled. There are four ways to control the extraneous variances. These procedures are elimination, randomization, matching, and statistical control. A discussion of these procedure is given below:

- 1) **Randomization:** an important method of controlling extraneous variables is randomization. It is considered to be the most effective way to control the variability due to all possible extraneous sources. If through randomization has been achieved then the treatment groups in the experiment could be considered statistically equal in all possible ways. Randomization is a powerful method of controlling variable. In other words it is a procedure for equating groups with respect to secondary variable. Randomization means random selection of the experimental units from the larger population. Random assignment means that every experimental unit has an equal chance of being placed in any of the treatment conditions or groups. In using randomization method some problems may be encountered. It is possible to select a random sample from a population, but then assignment of experimental units to groups may get biased. Random assignment of subjects is critical to internal validity. If subjects are not assigned randomly, confounding may occur.

Randomized group design and randomized block design are the examples of research design in which randomization is used to control the extraneous variable.

- 2) **Elimination:** this procedure is the easiest way to controlling the unwanted extraneous variable through elimination of variable. Suppose, the sex of the subject as unwanted secondary variable, is found to influence the variable in an experiment. Therefore the variable of sex has to be controlled. The researcher may decide to take either all males and all females in an experiment and thus, controlled through elimination the variability due to the sex variable.

By using elimination for controlling the extraneous variables, researcher loses the power of generalisation. If the researcher selects the subject from a restricted range then the researcher can generalise the results within restricted range and not outside it. Elimination procedure is used in non-experimental design.

- 3) **Matching:** is also a non-experimental design procedure, is used to control the extraneous source of variance. In case of controlling organismic and background variable matching is used in this procedure the relevant variable are equated or held constant across all conditions of experiments. Suppose if the researcher finds that the variable of intelligence is highly correlated with the dependent variable, it is better to control the variance through matching on the variable of intelligence. However as a method of control matching

limits the availability of subjects. If the researcher decides to match subjects on two or three variables he may not find enough subjects for the experiment. Besides this the method of matching biases the principles of randomization.

- 4) **Statistical Control:** in this approach, no attempt is made to restrain the influence of secondary variables. In this technique, one or more concomitant secondary variables (covariates) are measured and the dependent variable is statistically adjusted to remove the effects of the uncontrolled sources of variation. Analysis of covariances is one such technique. It is used to remove statistically the possible amount of variation in the concomitant secondary variable.

### 1.3.5 Error Variance

The third function of a research design is to minimize the error variance. The error variance is defined as those variance or viabilities in the measures, which occurs as a function of the factors not controllable by the experimenter. Such factors may be related to the individual differences among the subjects themselves such as to their attitude, motivation, need, ability etc. They may be related to what is commonly called the errors of measurements such as the differences in trials differences in conditions of experiment, temporary emotional state of the subject, fatigability etc.

Statistical controls can be applied to minimize such error variance. For example, repeated measures design can be used to minimize the experimental error. By this technique the variability due to the individual differences is taken out from the total variability, and thus, the error variance is reduced. Analysis of covariances is also a technique to reduce the error variance. Further, error variance can be controlled by increasing the reliability of measurement by giving clear and unambiguously instructions and by using a reliable measuring instrument etc

---

## 1.4 DESIGN SELECTION

---

The selection of a specific type of design depends primarily on both the nature and extent of the information. Complex designs, usually involving a number of “control groups,” offer more information than a simple group design. However, not all of the relevant information may be needed can be derived from any given design. Some of the information is based on the assumptions and some information are explicit. Other information derives from a network of knowledge surrounding the project in question. Theories, accepted concepts, hypotheses, principles and empirical evidence from related studies ought to be considered in design selection.

- 1) What questions will this design answer? To do this, we must also be able to specify many of the questions the design won’t answer as well ones it will answer. This should lead to a more realistic approach to experimental design than is usually given. Some simple and useful designs have been labeled as “poor” because they are relatively simple and will not answer some questions. Yet, they may provide clear and economical answers to the major questions of interest. Complex designs are not as useful for some purposes.
- 2) What is the relative information gain/cost picture? There is no specific formula or strategy for deriving some cut-off point in this regard. The major point here is that the researcher must take a close look at the probable cost before selecting a design.

Besides this, choice of design depends on different factors, such as;

Feasibility

How reliable should the information be?

Is it ethical to conduct the study?

Cost

Time

### **Self Assessment Questions**

#### **Multiple Choice Questions**

- 1) Who said 'Research design is the plan, structure, and strategy of investigation conceived so as to obtain answers to research questions and to control variance'.
  - a) Myers
  - b) Mcquigan
  - c) Matheson
  - d) Kerlinger
- 2) Which technique is not included to control the effect the extraneous variable?
  - a) Matching
  - b) Elimination
  - c) Extinction
  - d) Randomization
- 3) Which one of the following is not considered as the purpose of research design.
  - a) Error variance
  - b) Extraneous variable
  - c) Statistical variance
  - d) Systematic variance
- 4) Which one of the following is considered as most appropriate technique of control of the extraneous variables?
  - a) Elimination
  - b) Randomization
  - c) Matching
  - d) Statistical Control
- 5) A Good design possess following qualities except one:
  - a) Feasible
  - b) Simple
  - c) Efficient
  - d) Theory base

- 6) Which statement is not correct for research design:
- a) Research design is the blueprint of the detailed procedures of testing the hypotheses and analysing the obtained data.
  - b) Research design is the structure of the investigation that provides a model to study the mutual relationship among the different variable.
  - c) Research design helps in formation of hypotheses and recognise the variables.
  - d) Research design helps in searching the correct solution of the problem.

**Answers:** 1. (d), 2. (c), 3. (c), 4. (b), 5. (b), 6. (d)

#### **True/False**

- 1) Research design is a blue print of collection, measurement and analysis of data. T/F
- 2) The function of research design is to minimize the effect of systematic variance and maximize error variance. T/F
- 3) Generalisability enhances the internal validity of research. T/F
- 4) Variance is the measure of dispersion or spread of a set of scores. T/F
- 5) Random selection of the experimental unit from the larger population is known as random assignment. T/F
- 6) Analysis of covariance is used to reduce the error variance T/F

**Answers:** 1. (T), 2. (F), 3. (F), 4. (T), 5. (F), 6. (T)

## **1.5 CRITERIA OF RESEARCH DESIGN**

As you know that there are various types of research design. Some are weak design and some are good design. Behavioural researchers have been able to formulate certain criteria on the basis of which you can distinguish the good design from weak design. These criteria have proved very useful in guiding the researches in right direction. These criteria are mentioned below.

### **1.5.1 Capability to Answer Research Questions Adequately**

A good research design is the design that answers research questions adequately. Sometimes, the researcher selects a design which is not appropriate for answering the research question in hand. Such designs constitute the example of weak research design. Such a design does not adequately test the hypotheses either. It is a common practice that students while trying to answer a research question by conducting experiment or doing research, often match sex, age intelligence of the subjects on the assumption that such matching would lead to the setting of a better experimental group and control group. The reality is that if there is no relation between say, age and the dependent variable then matching an age will be irrelevant. Therefore, any design based upon matching would be a weak design.

### **1.5.2 Control of Variables**

Another criterion of a good research design is that it should control the effects of extraneous variables which are more or less similar to independent variables that

have the capacity to influence dependent variables. If left uncontrolled, such variables are called independent extraneous variables or simply extraneous variables. A design which fails to control the effect of extraneous variables is considered a weak one and the research should avoid such designs.

There are various ways to control the effects of extraneous variables. Of these ways randomization is considered by many as one of the best techniques of controlling the extraneous variables. There are three basic phases in randomization-random selection of subjects, random assignment of subjects into control and experimental groups and random assignments of experimental treatments among different groups. Sometimes, it happens that for the researcher it is not possible to make random selection of subjects. In such situations the researcher tries to randomly assign the selected subjects into different experimental groups. When this random assignment is not possible due to any reason, the researcher randomly assigns the different experimental treatments into experimental groups. Randomization has proved very useful in controlling the extraneous variables. This increases the internal validity of the research.

### 1.5.3 Generalisability

The third criterion of research design is generalisability. Generalisability is the external validity of the research. In other words it refers to the extent to which the results of the experiment or research obtained can be generalised to subjects, groups or conditions not included in sample of the research. If the design is such as the obtained results can be generalised to larger groups or subjects, the design is considered to be a good one.

---

## 1.6 QUALITIES OF RESEARCH DESIGN

---

A good design is characterised by flexible; appropriate, efficient, economical and so on. The design which minimizes bias and maximizes the reliability of the data collected and analysed is considered a good design. The design which gives the smallest experimental error is supposed to be the best design in many investigations. Similarly, a design which yields maximal information and provides an opportunity for considering many different aspects of a problem is considered the most appropriate and efficient design. Thus, the question of good design is related to the purpose or objective of the research problem and also with the nature of the problem to be studied. One single design cannot serve the purpose of all types of research problem. Throughout the design construction task, it is important to have in mind some endpoint, some criteria which are to be achieved before accepting a design strategy. The criteria below are only meant to be suggestive of the characteristics found in good research design.

*Theory base:* Good research strategies reflect the theories which are being investigated. Where specific theoretical expectations can be hypothesised these are incorporated into the design. For example, where theory predicts a specific treatment effect on one measure but not on another, the inclusion of both in the design improves discriminant validity and demonstrates the predictive power of the theory.

*Situational:* Good research designs reflect the settings of the investigation. This was illustrated above where a particular need of teachers and administrators was explicitly addressed in the design strategy. Similarly, intergroup rivalry, demoralisation, and competition might be assessed through the use of additional comparison groups who are not in direct contact with the original group.

*Feasible:* Good designs can be implemented. The sequence and timing of events



are carefully thought out. Potential problems in measurement, adherence to assignment, database construction and the like, are anticipated. Where needed, additional groups or measurements are included in the design to explicitly correct for such problems.

**Redundant:** Good research designs have some flexibility built into them. Often, this flexibility results from duplication of essential design features. For example, multiple replication of a treatment helps to insure that failure to implement the treatment in one setting will not invalidate the entire study.

**Efficient:** Good designs strike a balance between redundancy and the tendency to overdesign. Where it is reasonable, other, less costly, strategies for ruling out potential threats to validity are utilised.

This is by no means an exhaustive list of the criteria by which we can judge good research design. Nevertheless, goals of this sort help to guide the researcher toward a final design choice and emphasise important components which should be included.

---

## 1.7 LET US SUM UP

---

We have noticed that research design is a plan, structure and strategies of the collection measurement and analysis of data. Research design purports to obtain answers to research questions and controlling variance. Moreover, research design answers the question as objectively, validly and economically as possible. Main functions of the research design are to maximize the effect of systematic variance, control extraneous variance through randomization, elimination, matching and statistical control and minimize the error variance. A good research design is characterised by feasibility, flexibility, generalisability, theory base, cost and time.

---

## 1.8 UNIT END QUESTIONS

---

- 1) What do you mean by research design? Discuss the basic purposes of research design. How can you minimize the extraneous variance? Discuss the various ways to control the extraneous variable.
- 2) Discuss criteria of a research design with appropriate example.
- 3) Make distinction between random assignment and random selection in terms of their uses in research.
- 4) Discuss the qualities of research design.

---

## 1.9 SUGGESTED READINGS

---

Kerlinger, F N (1986). *Foundations of Behavioural Research*. New York: Holt Rinehart and Winston.

Matheson et.al.(1970) *Experimental Psychology* (Holt),

Myers, A. (1980). *Experimental Psychology*. New York: Van Nostrand.

Thyer, B.A. (1993) ‘ *Single-systems Research Design*’ in R.M. Grinnell (ed), *Social Work, Research and Evaluation* (4<sup>th</sup> ed), Itasca Illionois: Peacock.

Winer, B.J.(1971). *Statistical Principles in Experimental Design*. New York: McGraw Hill.