B.A. 3rd Year
ECONOMICS (CBCS)

Course Code: ECONA309
SEC

RESEARCH METHODOLOGY

Lessons - 1 to 10

By: Prof. Sanju Karol

CENTRE FOR DISTANCE AND ONLINE EDUCATION
HIMACHAL PRADESH UNIVERSITY
SUMMER HILL, SHIMLA - 171005

CONTENTS

Course No. **ECONA309**
Course title: **Research Methodology**
Nature of Course: **SEC – 5**
Number of credits: **4**
Number of Lectures (L): Practical (P): Tutorial (T): 40:00:00

Course Description

This course is designed to rigorously train the students in the concepts, methodology and reasoning involved in analyzing economic behavior of firms and markets, in general, in both static and partial
equilibrium frameworks.

Course Outline

Unit	Title	Credits
		L
I.	**Introduction to Research Methodology** Research: concept, meaning, significance, types, approaches; Criteria of good research; Research problem: selection, need, techniques involved; Reviewing and reporting Literature, Research Design: Meaning, need and Types. Data Collection Techniques: Questionnaire Method: Types, Format and Pre-Testing of Questionnaires. Techniques for Increasing Response of Respondents. Interview Method: Types, Process and Rules of Interviews. Factors affecting interview. Interviewer"s Bias. Selection and Training of Interviewers. Observation Method: Types of Observations.	10
II.	**Measurement and Scaling Techniques** Measurement Scales: Different types of scales - nominal, ordinal, ratio and interval. Accuracy of Measurement and Testing of Reliability. Increasing Reliability. **Sampling Techniques:** Probability Vs Non-probability sampling methods (Merits, Demerits and Applications).	10
III.	**Testing of Hypotheses:** Hypothesis: Meaning, and formulation. Types of hypothesis – Procedure for testing hypothesis -Type-I and Type-II errors. One tail, 2-tail test. Parametric Tests: Applications of t, z, and F-test Statistics. Non-Parametric Tests: Application of Chi- Square.	10
IV.	**Data Preparation, Analysis and Report Writing** Process of data analysis - Editing, coding, tabulation, diagrams. Use of computers: coding, data tabulation and graphic presentation of the data. Report writing: Significance of report writing. Different steps in writing the report - Mechanics of writing a research report. Ethics in research. Presentation of Research Report.	10

Suggested Readings:

1. Goode and Hatt, Research Methodology, Prentice Hall Publications, 1959.
2. Kothari, C.R. Research Methodology, Methods and Techniques, New Age International Publisher.
3. Donald R. Cooper and Pamela S. Schindler, Business Research methods, 9th Edition, Tata McGrawHill, 2006.
4. Ghosh, B.N. Research Methodology, Himalayan Publishing House, New Delhi.
5. Alan Bryman and Emma Bell, Business Research methods, Oxford University Press, New Delhi, 2008.
6. Uma Sekaran, Research methods for Business, Wiley India, New Delhi, 2006.
7. K. N. Krishnaswamy, Appa Iyer Sivakumar and M. Mathirajan, Management Research Methodology,Pearson Education, New Delhi, 2006.
8. Sadhu A.N. and A. Singh, Research Methodology in Social Sciences, Himalaya Publishing House.
9. Gopal, M.H., Research Methodology in Social Sciences, Asia Publishing House, New Delhi.

LESSON 1

RESEARCH METHODOLOGY: AN INTRODUCTION

STRUCTURE

1.0 Objectives

After going through this lesson you will be able to:

- Understand the meaning of research
- List the significance of research
- Elucidate the different types of research
- Explain the different approaches

- Explicate in detail the research problem

1.1 Introduction

The search for knowledge is a never ending process and in its simplest form this process has been called research. The world has evolved as a result of steady efforts to discover new things. In the current times research has become an organized and specialized field. Newer methods to conduct research have come up. However, whatever be the field in which research is being carried out, the research methodology parameters remain the same, even if the objectives and the population to which the problem is being addressed is different. Certain basic rules, often referred to as standard operating procedures, are common to all fields, although they can be easily developed for scientific research and are fuzzy for social science research. Differences exist between one subject and other, but there is also interdependence. It has been seen that there are inputs of theoretical considerations in empirical studies and in a theoretical study we look for empirical evidences to support the theory.

Thus, conducting research to deal with any problem is a scientific, systematic, and interlinked exercise, which requires experience and knowledge. This chapter is an attempt to understand the nature and scope of research.

1.2 Concept and Meaning of Research

In the present composite world every society is faced with serious social, economic & political problems. These problems need systematic, intelligent and Practical solutions. Problem solving is technical process. It requires the accumulation of new knowledge. Research provides the means for accumulating knowledge & wisdom. In other words, research is a systematic effort of gathering analysis & interpretation of problems confronted by humanity. It is a thinking process and scientific method of studying a problem and finding solution. It is an in depth analysis based on reflective thinking.

1.2.1 Definitions

Research in common parlance refers to a search for knowledge. One can also define research as a scientific and systematic search for pertinent information on a specific topic.

Research is an academic activity and the term should be used in a technical sense.

a) –William Emory defines Research as “any organized enquiry designed and carried out to provide information for solving a problem”

b) The new Oxford English Dictionary defines research is “the scientific investigation into and study of material, sources etc in order to establish facts and the reach new new conclusions”.

c) Redman and Mory defines, research as “a systematised effort to gain new knowledge’’.

d) “A careful investigation or inquiry specially through search for new facts in any branch of knowledge” Advanced Leaner’s Dictionary.

1.3 Significance of Research

“All progress is born of enquiry. Doubt is often better than overconfidence, for it leads to enquiry & enquiry leads to invention”. Increased amount of research make progress possible. Research inculcates scientific and inductive thinking and it promotes the development of logical habits of thinking and organization. The significance of research can be summed up as follows.

1. Research leads to discovery and innovation- Research helps us to discover the unknown, be it the physical world or the social world. It enables us to explore new things and provides newer opportunities for growth. Research open doors for new innovations.

2. Research improves decision- making- Research inculcates the habit of logical and inductive thinking, thereby improving our decision-making facilities. All business organizations and governments make their decisions after careful analysis of the prevailing circumstances. Research tools are actively used by them for decisions regarding their policies and day to day work.

3. Research helps in ascertaining trends- The strength to face the future is based on our ability to make certain predictions about future. These predictions are not shots in the dark, but based on an analysis of the past trends. E.g. the growth predictions made by the finance minister are based on a careful trend analysis of selected economic indicators. The business cycles are predicted using technique like barometric forecasting, index number etc.

4. Provides the basis for government policies- Almost all policies of the government find their basis in research. For instance, government’s budgets rest in part on an analysis of the needs and desires of the people and on the availability of revenues to meet these needs. The cost of the needs has to be equated to probable revenues and this is a field where research is most needed. Through research we can devise alternative policies and can as well examine the consequences of each of these alternatives.

5. Research has special significance in solving various operational and planning problems of business and industry- Operations research and market research, along with motivational research, are considered crucial and their results assist, in more than one way, in taking business decisions. Market research is the investigation of the structure and development of a market for the purpose of formulating efficient policies for purchasing, production and sales. Operation research refers to the application of mathematical, logical and analytical techniques to the solution of business problems of cost minimization or of profit maximization or what can be termed as optimization problems. Motivational research of determining why people behave as they do is mainly

concerned with market characteristics. All these are of great help to people in business and industry who are responsible for taking business decisions.

6. Research is equally important for social scientist in studying social relationships and in seeking answers to various social problems- Social scientist use research to understand the dynamics of social relationships. It helps us to understand the working of social groups and social structures. As a result several misconceptions are removed and new insights are gained which makes social progress possible.

In addition to this, the significance of research can be understood with the following points.

a. To the students who are to write a Ph. D; it is careerism.
b. To Professionals in research methodology, research means a source of livelihood.
c. To Philosophers & thinkers research may mean the outlet for new ideas and insights.
d. To literary man research means the development of new styles & creative work.
e. To the intellectuals research mean the generalization of new theories.

1.4 Types of Research

Research can be classified on the basis of purpose, time methodology, setting etc. However one can broadly classify research as Basic or Applied research.

1. Basic research- Research for the sake of enhancing knowledge is termed as basic research. Basic or pure research is done with the intention of over powering the unknown. It is an intellectual exploration and the outcome of such research may or may not have any practical relevance. It is primarily concerned with developing and formulating theories and generalizations.

2. Applied Research – Applied or practical research is termed as “need Based” research having practical relevance. The goal of applied research in terms of adding to scientific knowledge base requires a secondary position. The basic aim of such research is to find solutions to problems being faced by society, government or business. Since it is specific in nature, its results are oriented and are driven by clear aim, the time and cost factors are well planned and budgeted.

3. Qualitative Research - Qualitative Research is especially important in the behavioral sciences were the aim is to discover the underlying motives of human behavior. Such a research tries to measure the attitudes and opinions of the people using the technique of interview and observation. Various projective techniques like thematic appreciation test, word association test, sentence completion test are used. Such a research is also called as motivation research.

4. Quantitative research - Quantitative Research is based on the measurement of quantity or amount. It is applicable to a phenomenon that is phenomenon relating to or involving quality or kind. An example of this kind of research is a study conducted to find out the proportion of school students using self driven vehicles for commuting to school for a given area.

5. Longitudinal Research – This kind of research is generally spread over a long period of time. In this kind of study the problem or the phenomenon is studied over a consecutive stretch of time e.g. in marketing research a panel of potential consumers can be chosen. They are subject to variations in the advertisement to judge the most effective advertisement campaign and their purchasing behavior is recorded after exposure to each advertisement over a considerable stretch of time.

6. Simulation Research – As the word 'simulation' suggest, this research involves the creation of an artificial environment which is similar to the real environment. Thereafter, within this artificial environment the variables are manipulated and studied. Simulation research permits us to observe the dynamic behavior of the consumer under controlled conditions.

7. Empirical Research - This is a data based research in which primary data is collected and the data is analyzed and subject to hypothesis testing, often referred to as experimental research. Empirical Researches rely on experiments or observation alone, often without due regard for system of theory. It is data based research coming up with conclusions which are capable of been variable of observation and experiment.

8. Historical Research- Historical Research is that which utilize historical sources like documents remains etc to study events ideas of the past including the philosophy of persons and groups at any remote point of time.

1.5 Research Approaches

The above description of types of research brings to light the fact that there are two basic approaches to research, viz., Quantitative approach and the qualitative approach. The former involves the generations of data in quantitative form which can be subjected to rigorous quantitative analysis in a formal and rigid fashion. This approach can be further sub-classified into inferential, experimental and simulation approaches to research. The purpose of inferential approach to research is to form a data base from which to infer characteristics or relationships of population. This usually means survey research where a sample of population is studied (questioned or observed) to determine its characteristics, and it is then inferred that the population has the same characteristics. Experimental approach is characterized by much greater control over the research environment and in this case some variables are manipulated to observe their effect on other variables. Simulation approach involves the construction of an artificial environment within which relevant information and data can be generated. This permits an observation of the dynamic behavior of the system (or its sub-system) under controlled conditions. The term simulations refer to "the operation of a numerical model that represents the structure of a dynamic process. Given the values of initial conditions, parameters and exogenous variables, a simulation is run to represent the behavior of the process over time." Simulation approach can also be useful in building models for understanding future conditions.

Qualitative approach to research is concerned with subjective assessment of attitudes, opinions and behavior. Research in such a situation is a function of researcher's insights and impressions. Such an approach to research generates results

either in non-quantitative form or in the form which are not subjected to rigorous quantitative analysis. Generally, the techniques of focus group interviews, projective techniques and depth interviews are used.

1.6 Criteria of good research

Whatever may be the type of research works and studies, one thing that is important that they all meet on a common ground of scientific method employed by them. One expects scientific research to satisfy the following criteria:

(a) A good research has a well defined goal. It should have a clear statement of objectives.

(b)It should have a systematic plan of work. A specific programme helps in monitoring and carrying out the research within a budgeted time and cost framework and at the same time yields conclusive results.

(c)A good research contributes towards the existing knowledge bank. It aims at increasing the understanding of existing and new facts and ideas.

(d)Good research is logical. A clear logical argument is required to communicate an ordered sequence of ideas and activities and hence support research conclusions.

(e)The results of the good research should be verifiable. The research if replicated should yield same conclusions. A research thus relies on concrete data collected from real life situation would have good chances of yielding valid results.

(f) A good research is frank. In other words it lists the flaws in the research and also explains the impact of such flaws on research results.

1.7 Research problem

The first and the foremost stage in the research process is to select and properly define a research problem. “A researcher must find the problem and formulate it so that it becomes susceptible to research.

In general research problem refers to some kind of difficulty the researcher encounters or experience in context of either a practical or theoretical situation, which he/she would like to resolve and find a solution to. A research problem is generally said to exist if the following conditions emerge.

1.There must be an individual(or a group or an organization), let us call it “I’, to whom the problem can be attributed. The individual or the organization, as the case may be, occupies an environment, say ‘N’, which is defined by values of the uncontrolled variables, $Y_{j.}$

2.There must be at least two courses of action, say C1 and C2, to be pursued. A course of action is defined by one or more values of the controlled variables. For example, the number of items purchased at a specified time is said to be one course of action.

3. There must be at least two possible outcomes, say O1 and O2, of the course of action, of which one should be preferable to the other. In other words, this means that there must be at least one outcome that the researcher wants, i.e. an objective.

4. The courses of action available must provide some of obtaining the objective, but they cannot provide the same chance, otherwise the choice would not matter. Thus, if P (O_j/I,C_j,N) represents the probability that an outcome O_j will occur, if I select C_j in N, then P (O_1/I,C_1,N)≠ P(O_1/I,C_2,N). In simple words, we can say that the choices must have unequal efficiencies for the desired outcomes.

Over the above conditions, the individual or the organization can be said to have the problem only if 'I' does not know what course of action is best, i.e., 'I' does not know what course of action is best, i.e., 'I', must be in doubt about the solution. Thus, an individual or a group of persons can be said to have a problem which can be technically described as a research problem, if they (individual or the group), having one or more desired outcomes, are confronted with two or more courses of action that have some but not equal efficiency for the desired objective(s) and are in doubt which course of action is best.

We can, thus, state the components of a research problem as under:

(i) There must be an individual or a group which has some difficulty or the problem.

(ii) There must be some objective(s) to be attained at. If one wants nothing, one cannot have a problem.

(iii) There must be alternative means (or the courses of action) for obtaining the objective(s) one wishes to attain. This means that there must be at least two means available to a researcher for if he has no choice of means, he cannot have a problem

(iv) There must remain some doubt in the mind of a researcher with regard to the selection of alternatives. This means that research must answer the question concerning the relative efficiency of the possible alternatives.

(v) There must be some environment(s) to which the difficulty pertains.

Thus, a research problem is one which requires a researcher to find out the best solution for the given problem, i.e., to find out by which course of action the objective can be attained optimally in the context of a given environment. There are several factors which may result in making the problem complicated. For instance, the environment may change affecting the efficiencies of the courses of action or the values of the outcomes; the number of alternatives courses of action may be very large; persons nit involved in making the decisions may be affected by it and react to it favourably or unfavourably, and similar other factors. All such elements (or at least the important ones) may be thought of in context of a research problem**.**

1.7.1 Selection of research problem

The research problem undertaken for the study must be carefully selected. The task is difficult one, although it may not appear to be so. Help may be taken from a research guide in this connection. Nevertheless, every researcher must find out his own salvation for research problems cannot be borrowed. A problem must spring from the researcher's mind like a plant springing from its own seed. If our eyes need glasses, it is

not the optician alone who decides about the number of the lens we require. We have to see ourselves and enable him to prescribe for us the right number by cooperating with him. Thus, a research guide can at the most only help a researcher choose a subject. However, the following points may be observed by a researcher in selecting a research problem or a subject for research:

(i) Subject which is overdone should not ne normally chosen, for it will be a difficult task to throw any new light in such a case.

(ii) Controversial subject should not become the choice of an average researcher.

(iii) Too narrow or too vague problems should be avoided.

(iv) The subject selected for research should be familiar and feasible so that the related research material or sources of research are within one's reach. Even then it is quite difficult to supply definitive ideas concerning how a researcher should obtain ideas for his research. For this purpose, a researcher should contact an expert or a professor in the University who is already engaged in research. He may as well read articles published and current literature available on the subject and may think how the techniques and ideas discussed therein might be applied to the solution of other problems. He may discuss with others what he has in his mind concerning a problem. In this way he should make all possible efforts in selecting a problem.

(v) The importance of the subject, the qualifications and the training of a researcher, the costs involved, and the time factor are few other criteria that must also be considered in selecting a problem. In other words, before the final selection of a problem is done, a researcher must ask himself the following questions:

(a) Whether he is well equipped in terms of his background to carry out the research?

(b) Whether the study falls within the budget he can afford?

(c)Whether the necessary cooperation can be obtained from those who must participate in research as subjects?

If the answers to all these questions are in the affirmative, one may become sure so far as the practicability of the study is concerned.

(vi) The selection of a problem must be preceded by a preliminary study. This may not be necessary when the problem requires the conduct of a research closely similar to one that has already been done. But when the field of inquiry is relatively new and does have available set of well developed techniques, a brief feasibility study must always be undertaken.

If the subject for research is selected properly by observing the above mentioned points, the research will not be a boring drudgery, rather it will be love's labour. In fact, zest for work is a must. The subject or the problem selected must involve the researcher and must have an upper most place in his mind so that he may undertake all pains needed for the study.

1.7.2 Need of research problem

A problem clearly stated is a problem half solved. This statement signifies the need for defining a research problem. The problem to be investigated must be defined unambiguously for that will help to discriminate relevant data from the irrelevant ones. A proper definition of research problem will enable the researcher to be on the track whereas an ill-defined problem may create hurdles. Questions like: What data are to be collected? What characteristics of data are relevant and need to be studied? What relations are to be explored? What techniques are to be used for the purpose? And similar other questions crop up in the mind of the researcher who can well plan his strategy and find answers to all such questions only when the research problem has been well defined. Thus, defining a research problem properly is a prerequisite for any study and is a step of the highest importance. Infact, formulation of a problem is often more essential than its solution. It is only careful detailing the research problem that we can work out the research design and can smoothly carry on all the consequent steps involved while doing research.

1.7.3 Techniques involved

Let us start with the question: What does one mean when he/she wants to define a research problem? The answer may be that one wants to state the problem along with the bounds within which it is to be studied. In other words, defining a problem involves the task of laying down boundaries within which a researcher shall study the problem with a pre-determined objective in view.

Defining a research problem properly and clearly is a crucial part of a research study and must in no case be accompanied hurriedly. However, in practice this is frequently overlooked which causes a lot of problem later on. Hence, the research problem should be defined in a systematic manner, giving due weightage to all relating points. The technique for the purpose involves the undertaking of the following steps generally one after the other: (i) statement of the problem in the general way; (ii) understanding the nature of the problem; (iii) surveying the available literature; (iv) developing the ideas through discussions; and (v) rephrasing the research problem into a working proposition.

A brief description of all these points will be helpful.

(i) Statement of the problem in a general way- The entire problem should be stated in a broad general way, keeping in view either some practical concern or some scientific or intellectual interest. For, this purpose, the researcher must immerse himself thoroughly in the subject matter concerning which he wishes to pose a problem .In case of social research, it is considered advisable to do some field observation and as such the researcher may undertake some sort of preliminary survey or what is often called pilot survey. When the researcher can himself state the problem or he can seek the guidance of the guide or the subject expert in accomplishing the task. Often, the guide puts forth the problem in general terms, and it is then up to the researcher to narrow it down and phrase the problem in operational terms. In case there is some directive form an organizational authority, the problem then can be stated accordingly. The problem stated in a broad general way

may contain various ambiguities which must be resolved by cool thinking and rethinking over the problem. At the same time the feasibility of a particular solution has to be considered and the same should be kept in view while stating the problem.

(ii) Understanding the nature of the problem- The next step in defining the problem is to understand its origin and nature clearly. The best way of understanding the problem is to discuss it with those who first raised it in order to find out how the problem originally came about and with what objectives in view. If the researcher has stated the problem himself, he should consider once again all those that induced him to make a general statement concerning the problem. For a better understanding of the nature of the problem involved, he can enter into discussion with those who have a good knowledge of the problem concerned or similar other problems. The researcher should also keep in view the environment within which the problem is to be studied and understood.

(iii) Surveying the available literature- All available literature concerning the problem at hand must necessarily be surveyed and examined before a definition of the research problem is given. This means that the researcher must be well-conversant with relevant theories in the field, reports and records as also all other relevant literature. He must devote sufficient time in reviewing of research already undertaken on related problems. This is done to find out what data and other materials, if any, are available for operational purposes. "Knowing what data are available often serves to narrow the problem itself as well as the technique that might be used". This would also help the researcher to know if there are certain gaps in the theories, or whether the existing theories applicable to the problem under study are inconsistent with each other, or whether the findings of the different studies do not follow a pattern consistent with the theoretical expectation and so on. All this will enable the researcher to take new strides in the field for furtherance of knowledge i.e., he can move up starting from the existing premise. Studies on related problems are useful for indicating the type of difficulties that may be encountered in the present study and also the possible analytical shortcomings. At times such studies may also suggest useful and even new lines of approach to the present problem.

(iv) Developing the ideas through discussions- Discussion concerning a problem often produces useful information. Various new ideas can be developed through such an exercise. Hence, a researcher must discuss his problem with his colleagues and others who have enough experience in the same area or in working on similar problems. This is quite often known as an experience survey. People with rich experience are in a position to enlighten the researcher on different aspects of his proposed study and their advice and comments are usually invaluable to the researcher. They help him sharpen his focus of attention on specific aspects within the field. Discussion with such persons should not only be confined to the formulation of the specific problem at hand, but should also be concerned with the general

approach to the given problem, techniques that might be used, possible solutions, etc.

(v) Rephrasing the research problem- Finally, the researcher must sit to rephrase the research problem into a working proposition. Once the nature of the problem has been clearly understood, the environment (within which the problem has got to be studied) has been defined, discussions over the problem have taken place and the available literature has been surveyed and examined, rephrasing the problem into analytical or operational terms is not a difficult task. Through rephrasing , the researcher puts the research problem in as specific terms as possible so that it may become operationally viable and may help in the development of the working hypotheses.

In addition to what has been stated above, the following points must also be observed while defining a research problem;

(a) Technical terms and words or phrases, with special meanings used in the statement of the problem, should be clearly defined.
(b) Basic assumptions or postulates (if any) relating to the research problem should be clearly stated.
(c) A straight forward statement of the value of the investigation (i.e., the criteria for the selection of the problem) should be provided.
(d) The suitability of the time-period and the sources of the data available must also be considered by the researcher in defining the problem.
(e) The scope of the investigation or the limits within which the problem is to be studied must be mentioned explicitly in defining a research problem.

Exercise 1.1

Q.1 Define research?

Q2 What are significance of research?

1.8 Summary& Conclusion

In this chapter we have discussed the meaning the research, its significance and criteria of good research, we also dealt with research problem. Research in common parlance refers to a search for knowledge. One can also define research as a scientific and systematic search for pertinent information on a specific topic.

1.9 Glossary

- **Research-** Research in common parlance refers to a search for knowledge. One can also define research as a scientific and systematic search for pertinent information on a specific topic

- **Basic research-** Research for the sake of enhancing knowledge is termed as basic research. Basic or pure research is done with the intention of over powering the unknown. It is an intellectual exploration and the outcome of such research may or may not have any practical relevance. It is primarily concerned with developing and formulating theories and generalizations.

- **Applied Research –** Applied or practical research is termed as “need Based” research having practical relevance. The goal of applied research in terms of adding to scientific knowledge base requires a secondary position. The basic aim of such research is ti find solutions to problems being faced by society, government or business. Since it is specific in nature, is result oriented and is driven by a clear aim, the time and cost factors are well planned and budgeted.

- **Qualitative Research -** Qualitative Research is especially important in the behavioral sciences were the aim is to discover the underlying motives of human behavior. Such a research tries to measure the attitudes and opinions of the people using the technique of interview and observation. Various projective techniques like thematic appreciation test, word association test, sentence completion test are used. Such a research is also called as motivation research.

- **Quantitative research -** Quantitative Research is based on the measurement of quantity or amount. It is applicable to a phenomenon that is phenomenon relating to or involving quality or kind. An example of this kind of research is a study conducted to find out the proportion of school students using self driven vehicles for commuting to school for a given area.

1.10 Self Assessment Test

Exercise 1.1

Answer 1: Refer to section 1.2.1
Answer 2: Refer to section 1.3

1.11 Terminal Questions

Question 1 Define research? What is its significance?

Question 2 Describe the technique of defining a research problem.

1.12 Suggested Readings

1. Goode and Hatt, Research Methodology, Prentice Hall Publications, 1959.

2. Kothari, C.R. Research Methodology, Methods and Techniques, New Age International Publisher.

3. Donald R. Cooper and Pamela S. Schindler, Business Research methods, 9th Edition, Tata McGraw Hill, 2006.

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7. K. N. Krishnaswamy, Appa Iyer Sivakumar and M. Mathirajan, Management Research Methodology, Pearson Education, New Delhi, 2006.

8. Sadhu A.N. and A. Singh, Research Methodology in Social Sciences, Himalaya Publishing House.

9. Gopal, M.H., Research Methodology in Social Sciences, Asia Publishing House, New Delhi.

10. Gupta K. Shashi & Rangi Praneet, Research Methodology in Commerce, Kalyani Publishers

LESSON 2

RESEARCH DESIGN

STRUCTURE

2.0 Objectives

After going through this lesson you will be able to:

- Understand the meaning of research Design
- List out the characteristics of a research design
- Elucidate the need for research design
- Enlist different types of research design

2.1 Introduction

Once the research proposal is acknowledged by the sponsors, the researcher faces the vital task of working out the details. He has to explain on the method of drawing a sample, the method of collecting and

arranging the data and build up an instrument for collecting and arranging the data. All these tasks which are concerned with working out the condition of conducting a research are detailed in research design. Through this design, a researcher is able to test the authenticity of the hypothesis on the basis of resulting data. It is the basis on which the problem is studied further. Hence it is very important that a researcher devotes sufficient time and energy in developing a research design. The current chapter will discuss the need for developing a research design and will elaborate on different types of research design.

2.2 Meaning of Research Design

A Research Design is the logical and systematic planning in directing the research. It is a part of the planning stage of research, a blueprint for the collection, measurement and analysis of data. But in practices in most of the basis it is just a plan of study. The research design can either be formal or informal. Research design is also known by different names such as research outline, plan, and blue print. In the words of Fred N. Kerlinger, it is the plan, structure and strategy of investigation conceived so as to obtain answers to research questions and control variance. The plan includes everything the investigator will do from writing the hypothesis and their operational implications to the final analysis of data. The structure is the outline, the scheme, the paradigms of the operation of the variables. The strategy includes the methods to be used to collect and analyze the data. At the beginning this plan (design) is generally vague and tentative. It undergoes many modifications and changes as the study progresses and insights into it deepen's. The working out of the plan consists of making a series of decisions with respect to what, why, where, when, who and how of the research.

2.2.1Definitions of Research Design

1. "It constitutes the blue print for the collection, measurement and analysis of data" - Philips Bernard S
2. It "provides a systematic plan of procedure for the researcher to follow" -Best John N
3. "The design research from controlling general scientific model into varied research procedure"- P.V. Young
4. "A research design is "the programme that guides the investigator in the process of collecting, analysis and interpreting observations". – David and Shava

A research design addressers itself to the following questions:
a) Why the study is being conducted?
b) What is the study all about?
c) When will the study be carried out?
d) Where will the study be conducted?
e) What is the kind of data required?
f) Where is the required data available?

g)What is the technique of collecting data?

h) What is the method of data analysis adopted?

i) What will be the method of sampling used?

j) What will be the format of reporting the results?

2.3Characteristics of Good Research Design

A good research design has following characteristics:

1. Objectivity – The design shows no proclivity towards any side and the resultant data collected under this design would be free from bias.

2. Reliability- A good design would deliver consistent results each time the research is repeated under the design. The response given by the respondent is genuine and would remain the same.

3. Validity- The design would deliver accurate and correct results. It collects and measures what it is supposed to do and nothing else.

4. Generalization- It means that the results collected under this design, which hold true for a sample must hold true for the entire population.

2.4 Need for Research Design

Research design is needed because it eases 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. Just as for better, economical and attractive construction of a house, we need a blueprint, well thought out and prepared by an expert architect; similarly we need a research design or plan in advance of data collection and analysis for our research design or plan in advance of data collection and analysis for our research project. Research design stands for advance planning of the methods to be adopted for collecting the relevant data and the techniques to be used in their analysis, keeping in view the objective of the research and the availability of staff, time and money. Preparation of the research design should be done with great care as any error in it may upset the entire project. Research design, in fact, has great bearing on the reliability of the results arrived at and as such constitutes the firm foundation of the entire edifice of the research work.

Even then the need for a well thought out research design is at times not realized by many. The importance which this problem deserves is not given to it. As result many researchers do not serve the purpose for which they are undertaken. In fact, they may even give misleading conclusions. Thoughtlessness in designing the research project may result in rendering the research exercise futile. It is, therefore, imperative that an efficient and appropriate design must be prepared before starting

research operations. The design helps the researcher to organize his ideas in a form whereby it will be possible for him to look for flaws and inadequacies. Such a design can even be given to others for their comments and critical evaluation. In the absence of such a course of action, it will be difficult for the critic to provide a comprehensive review of the proposed study.

2.5Functions of a Research Design

The function of a research design is to make certain that necessary data in accord with the problem at hand is collected precisely and economically. A research design tells the researcher as to what steps to follow, what things to be observed, what is the study all about, why is the study being carried out, what things are to be observed, how many observations are to be made, where will the study be carried out, what will be the size of the sample and how the sample units should be collected, what techniques of data collection will be used. It helps to locate the variables and tells us how to control variables. It outlines the possible conclusion to be drawn from the analysis. Finally; it tells us in what style will the report be prepared. The research design aims to provide answers to research questions as validly, objectively, accurately and economically as possible and to bring empirical evidence to bear on the research problem by controlling variance.

2.6 Types of Research Design

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. We take up each category separately.

1. **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 infact 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 talked about: (a) the survey of concern in literature; (b) the experience survey and (c) the analysis of ‘insight-stimulating’ examples.

a) *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 be 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.

b) *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.

c) *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 sorts 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.

2. 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 is 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 maximize 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:

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

(b) Designing the method 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 analyzing the data.

(f) 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 use 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 "*structural 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. More often than not, sample has to be designed. Different sample designs have been discussed in detail in a separate chapter in this book. Here we may only mention that the problem of designing samples should be tackled in such a fashion that the samples may yield accurate information with a minimum amount of research effort. Usually one or more forms of probability sampling, or what is often described as random sampling, are used.

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 analysed. 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 labour 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.

Last of all comes the question of reporting the findings. 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 designs in respect of the above two types of research studies can be conveniently summarized 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 maximize reliability)

(i) Sampling Design	Non-probability sampling design (purposive or judgment 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 casual relationships between variables. Such studies require procedures that will not only reduce bias and increase reliability, but will permit drawing inferences about casualty. 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 Field 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 the (3) 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 effects 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.

Important Experimental Designs

Experimental design refers to the framework or structure of an experiment and as such there are several experimental designs. We can classify experimental designs into two broad categories, viz. informal experimental designs and formal experimental designs. Informal experimental designs are those designs that normally use a less sophisticated form of analysis based on differences in magnitudes, whereas formal experimental designs offer relatively more control and use precise statistical procedures for analysis. Important experimental designs are as follows :

(a) Informal experimental designs:

  (i) Before-and-after without control design.

  (ii) After-only with control design.

  (iii) Before-and after with control design.

(b) Formal experimental designs :

  (i) Completely randomized design (C.R. design)

  (ii) Randomized block design (R, B, design)

  (iii) Latin square design (L.S. design)

  (iv) Factorial designs.

We may briefly deal with each of the above stated informal as well as formal experimental designs.

(i)Before-and-after without control design- In such a design a single test group or area is selected and the dependent variable is measured before the introduction of the treatment. The treatment is then introduced and the dependent variable is measured again after the treatment has been introduced. The effect of the treatment minus the level of the phenomenon before the treatment. The design can be represented thus :

Test area:	Level of phenomenon before treatment (X)	Treatment introduced →	Level of Phenomenon after treatment (Y)
	Treatment Effect = (Y) – (X)		

The main difficulty of such a design is that with the passage of time considerable extraneous variations may be there in its treatment effect.

(2) After-only with control design- In this design two groups or areas (test area and control area) are selected and the treatment is introduced into the test area only. The dependent variable is then measured in both the areas at the same time. Treatment impact is assessed by subtracting the value of the dependent variable in the control area from its value in the test area. This can be exhibited in the following form :

Test area :	Treatment introduced	Level of phenomenon after treatment (Y)
Control area :	→	Level of phenomenon without treatment (Z)

Treatment Effect = (Y) – (Z)

The basic assumption in such a design is that the two areas are identical with respect to their behavior towards the phenomenon considered. If this assumption is not true, there is the possibility of extraneous variation entering into the treatment effect. However, data can be collected in such a design without the introduction of problems with the passage of time. In this respect this design is superior to before-and-after without control design.

(3) Before-and-after with control design- In this design two areas are selected and the dependent variable is measured in both the areas for an identical time-period before the treatment. The treatment is then introduced into the test are only, and the dependent variable is measured in both for an identical time-period after the introduction of the treatment. The treatment effect is determined by subtracting the change in the

dependent variable in the control area from the change in the dependent variable in test area. This design can be shown in this way :

	Time Period I		Time Period II
Test area :	Level of Phenomenon before treatment (X)	Treatment introduced	Level of phenomenon after treatment (Y)
		⟶	
Control area :	Level of phenomenon without treatment		Level of phenomenon without treatment
	(A)		(Z)

Treatment Effect = (Y-X) m- (Z-A)

This design is superior to the above two designs for the simple reason that it avoids extraneous variation resulting both from the passage of time and from non-comparability of the test and control areas. But at times, due to lack of historical data, time or a comparable control area, we should prefer to select one of the first two informal designs stated above.

(4) Completely randomized design (C.R. design) involves only two principles viz., the principle of replication and the principle of randomization of experimental designs. It is the simplest possible design and its procedure of analysis is also easier. The essential characteristic of this design is that subjects are randomly assigned to experimental treatments (or vice-versa). For instance, if we have 10 subjects and if we wish to test 5 under treatment A and 5 under treatment B, the randomization process gives every possible group of 5 subjects selected from a set of 10 an equal opportunity of being assigned to treatment A and treatment B. One-way analysis of variance (or one-way ANOVA) is used to analyze such a design. Even unequal replications can also work in this design. It provides maximum number of degrees of freedom to the error. Such a design is generally used when experimental areas happen to be homogenous. Technically, when all the variations due to uncontrolled extraneous factors are included under the heading of chance variation, we refer to the design of experiment as C.R. design.

(5) Randomized block design (R.B. design) is an improvement over the C.R. design. In the R.B. design the principle of local control can be applied along with the other two principles of experimental designs. In the R.B. design, subjects are first divided into groups, known as blocks, such that within each group the subjects are relatively homogenous in respect to some selected variable. The variable selected for grouping the subjects is one that is believed to be related to the measures to be obtained in respect of the dependent variable. The number of subjects in a given block would be

equal to the number of treatments and one subject in each block would be randomly assigned to each treatment. In general, blocks are the levels at which we hold the extraneous factor fixed, so that its contribution to the total variability of data can be measured. The main feature of the R.B. design is that in this each treatment appears the same number of times in each block. The R.B. design is analyzed by the two-way analysis of variance (two-way ANOVA) technique.

Let us illustrate the R.B. design with the help of an example. Suppose four different forms of a standardized test in statistics were given to each of five students (selected one from each of the I.Q. blocks) and following are the scores which they obtained.

	Very low I.Q.	Low I.Q.	Average I.Q.	High I.Q.	Very high I.Q.
	Student A	Student B	Student C	Student D	Student E
Form 1	82	67	57	71	73
Form 2	90	68	54	70	81
Form 3	86	73	51	69	84
Form 4	93	77	60	65	71

If each student separately randomized the order in which he or she took the four tests (by using random numbers or some similar device), we refer to the design of this experiment as a R.B. design. The purpose of this randomization is to take care of such possible extraneous factors (say as fatigue) or perhaps the experience gained from repeatedly taking the test.

(6) Latin squares design (L.S. design) is an experimental design very frequently used in agricultural research. The conditions under which agricultural investigations are carried out are different from those in other studies for nature plays an important role in agriculture. For instance, an experiment has to be made through which the effects of five different varieties of fertilizers on the yield of a certain crop, say wheat, is to be judged. In such a case the varying fertility of the soil in different blocks in which the experiment has to be performed must be taken into consideration; otherwise the results obtained may not be very dependable because the output happens to be the effect not only of fertilizers, but it may also be the effect of fertility of soil. Similarly, there may be

the impact of varying seeds on the yield. To overcome such difficulties, the L.S. design is used when there are two major extraneous factors such as the varying soil fertility and varying seeds.

The Latin-square design is one wherein each fertilizer, in our example, appears five times but is used only once in each row and in each column of the design. In other words, the treatments in a L.S. design are so allocated any one column. The two blocking factors may be represented through rows and columns (one through rows and the other through columns). The following is a diagrammatic form of such a design in respect of, say, five types of fertilizers, viz. A, B, C, D and E and the two blocking factors viz., the varying soil fertility and the varying seeds :

FERTILITY LEVEL						
Seeds Differences		I	II	III	IV	V
	X1	A	B	C	D	E
	X2	B	C	D	E	A
	X3	C	D	E	A	B
	X4	D	E	A	B	C
	X5	E	A	B	C	D

The above diagram clearly show that in a L.s. design the field is divided into as many blocks as there are varieties of fertilizers and then each block is again divided into as many parts as there are varieties of fertilizers in such a way that each of the fertilizer variety is used in each of the block (whether column-wise or row wise)only once. The analysis of the L.S. design is very similar to the two-way ANOVA technique.

The merit of this experimental design is that it enables differences in fertility gradients in the field to be eliminated in comparison to the effects of different varieties of fertilizer on the yield of cop. But this design suffers from one limitation, and it is that although each row and each column represents equally all fertilizers varieties, there may be considerable difference in the row and column means both up and across the field. This, in other words, means that in L.S. design we must assume that there is no interaction between treatments and blocking factors. This defect can, however, be removed by taking the means of rows and columns equal to the field mean by adjusting the results. Another limitation of this design is that it requires number of rows, columns and treatments to be equal. This reduces the utility of this design. In case of (2X2) L.S. design, there are no degrees of freedom available for the mean square error and hence the design cannot be used. If treatments are10 or more, than each row and each column will be larger in size so that rows and columns may not be homogenous. This may make the application of the principle of local control ineffective. Therefore, L.S. design of orders (5X5) to (9X9) are generally used.

(7) Factorial Designs- Factorial designs are used in experiments where the effects of varying more than one factor are to be determined. They are specially important in

several economic and social phenomenon where usually a large number of factors affect a particular problem. Factorial designs can be of two types (i) simple factorial designs and (ii) complex factorial designs. We take them separately

(i) Simple Factorial Designs- In case of simple factorial designs, we consider the effects of varying two factors on the dependent variable, but when an experiment is done with more than two factors, we use complex factorial designs. Simple factorial design is also termed as a 'two-factor-factorial design' whereas complex factorial design is known as 'multi-factor-factorial design'. Simple factorial design may either be a 2x2 simple factorial design, or it may be, say, 3x4 or 5x3 or the like type of simple factorial design.

(ii) Complex factorial designs- Experiments with more than two factors at a time involve the use of complex factorial designs. A design which considers three or more independent variables simultaneously is called a complex factorial design. In case of three factors with one experimental variable having two treatments and two control variables, each one of which having two levels, the design used will be termed as 2x2x2 complex factorial design which will contain a total of eight cells as shown below.

		Experimental Variable			
		Treatment A		Treatment B	
		Control Variable2 Level I	Control Variable2 Level II	Control Variable Level III	Control Variable Level IV
Control Variable1	Level 1	Cell 1	Cell 3	Cell 5	Cell 7
	Level 2	Cell 2	Cell 4	Cell 6	Cell 8

Factorial designs are used mainly because of the two advantages (i) they provide equivalent accuracy (as happens in the case of experiments with only one factor) with less labour and as such are a source of economy. Using factorial designs, we can determine the main effects of two (in simple factorial design) or more (in case of complex factorial design) factors (or variables) in one single experiment. (ii) They permit various other comparisons of interest. For example, they give information about such effects which cannot be obtained by treating one single facto at a time. The determination of interaction effects is possible in case of factorial designs.

2.6 Techniques for Preparing Research Design

Research design is an important step in the research process which cannot be bypassed. The nature, type, length and complexity of research designs vary considerably for different studies. However, following are the essential steps involved in preparing a good research design;

1. **Formulate the research problem clearly and setup the objectives-** It is true that the choice of a research problem depends on researcher's interest, resources and values. Research design will

differ according to the purpose of research. For example, the study whose purpose is exploration would require a flexible design but the design will have to be rigid in descriptive or diagnostic study. So first of all formulate the research problem and setup the objectives.

2. **Review previous published literature dealing with the problem-** In the next step go through all the existing literature related to the problem. It helps to know if the problem has been investigated earlier. If so how and to what extent? Moreover, it will sensitize you to the methods and procedures which have been used by others investigating the same area.
3. **Clearly and explicitly specify hypotheses-** The third major step in a research design is to clearly state the hypotheses to be tested. Hypotheses are tentative solutions of a problem. Clear and careful statement of the hypotheses entails clear conceptual definition of the major variables involved and helps the researcher in delimiting the scope of the study.
4. **Clearly describe the data which will be necessary for an adequate test of the hypotheses and explain how such data will be obtained-** After you have stated your hypotheses clearly describe the data you will need to test the hypotheses, the sources primary or secondary from which you will collect data and the tools and techniques which will be used for collecting data.
5. **Describe the methods for processing and analysis the data-** Now identify the methods of analysis appropriate for treating the data. This involves selection of appropriate statistical techniques. Be as specific as possible in describing the approach you will use, but do not propose to employ a technique that you do not really understand because every techniques serves a special purpose and has a special set of assumptions which must be met before it can be used for analysis and interpretation.
6. **Prepare a working guide with time and budget estimates-** lastly prepare a working guide which gives details about the funding, costing and timing of various steps of research study.

Exercise 2.1

Question 1 Define research design?

Question 2 What are the different names of research design?

Question 3 Why do we need a research design?

2.6 Summary& Conclusion

In this chapter we have studied about research design, its various characteristics, need for a research design and different types of research design. In simple words research design includes a number of components which are interdependent and which

demand a series of decisions regarding definitions, scope, methods, techniques, procedures, instruments, time, place, expenditure and administration aspects. There are different types of research design and the researcher has to decide in advance before collection of the data as to which design will prove to be appropriate for his research.

2.7 Glossary

- **Research Design-** A Research Design is the logical and systematic planning in directing the research. It is a part of the planning stage of research, a blueprint for the collection, measurement and analysis of data. But in practices in most of the basis it is just a plan of study
- **Factorial Designs-** Factorial designs are used in experiments where the effects of varying more than one factor are to be determined. They are specially important in several economic and social phenomenon where usually a large number of factors affect a particular problem. Factorial designs can be of two types (i) simple factorial designs and (ii) complex factorial designs. We take them separately
- **Simple Factorial Designs-** In case of simple factorial designs, we consider the effects of varying two factors on the dependent variable, but when an experiment is done with more than two factors, we use complex factorial designs. Simple factorial design is also termed as a 'two-factor-factorial design' whereas complex factorial design is known as 'multi-factor-factorial design'. Simple factorial design may either be a 2x2 simple factorial design, or it may be, say, 3x4 or 5x3 or the like type of simple factorial design.
- **Complex factorial designs-** Experiments with more than two factors at a time involve the use of complex factorial designs. A design which considers three or more independent variables simultaneously is called a complex factorial design.

2.8Self Assessment Test

Exercise 2.1

Answer 1: Refer to section 2.2
Answer 2: Refer to section 2.2
Answer 3: Refer to section 2.4

2.9 Terminal Questions

Question 1 What is a research design? What are the characteristics of a good research design ?

Question 2 Explicate some of the important research designs used in experimental hypothesis testing research study.

2.10 Suggested Readings

1. Goode and Hatt, Research Methodology, Prentice Hall Publications, 1959.

2. Kothari, C.R. Research Methodology, Methods and Techniques, New Age International Publisher.

3. Donald R. Cooper and Pamela S. Schindler, Business Research methods, 9th Edition, Tata McGraw Hill, 2006.

4. Ghosh, B.N. Research Methodology, Himalayan Publishing House, New Delhi.

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6. Uma Sekaran, Research methods for Business, Wiley India, New Delhi, 2006.

7. K. N. Krishnaswamy, Appa Iyer Sivakumar and M. Mathirajan, Management Research Methodology, Pearson Education, New Delhi, 2006.

8. Sadhu A.N. and A. Singh, Research Methodology in Social Sciences, Himalaya Publishing House.

9. Gopal, M.H., Research Methodology in Social Sciences, Asia Publishing House, New Delhi.

10. Gupta K. Shashi & Rangi Praneet, Research Methodology in Commerce, Kalyani Publishers.

11.Sharma Hemlata, Research Methodology in Social sciences, VK Publications.

LESSON 3

HYPOTHESIS

STRUCTURE

3.0 Objectives

After going through this lesson you will be able to:

- Understand the meaning of hypothesis
- Classify different types of Hypothesis
- Explicate the procedure for testing hypothesis
- Understand Type-1 and Type-2 errors
- Give the meaning of one tail and two tail test

3.1 Introduction

When a researcher observes known facts and takes up a problem for analysis, he first has to start somewhere and this point of starting is Hypothesis. In other words, one has to proceed to formulate tentative solution. This purposed solution constitutes the Hypothesis. The collection of facts (data) will be fruitful if they are either for or against this proposed solution. The tentative explanation or solutions are the very basis for research process.

3.2 Meaning of Hypothesis

Hypothesis is an assumption made about a population parameter. This hypothesis is then proved or disproved by using the information from the sample to decide the likelihood of the hypothesized population parameter to be correct. To understand the meaning of a hypothesis, let us see some definitions:

3.2.1 Definitions of Hypothesis:

"A hypothesis is a tentative generalization, the validity of which remains to be tested. In its most elementary stage the hypothesis may be any guess, hunch, imaginative idea, which becomes the basis for action or investigation". (G.A.Lundberg)

"It is a proposition which can be put to test to determine validity". (Goode and Hatt).

"A hypothesis is a question put in such a way that an answer of some kind can be forth coming" - (Rummel and Ballaine).

These definitions lead us to conclude that a hypothesis is a tentative solution or explanation or a guess or assumption or a proposition or a statement to the problem facing the researcher, adopted on a cursory observation of known and available data, as a basis of investigation, whose validity is to be tested or verified.

3.3 Formulation of Hypothesis

From any problem statement, it is generally possible to derive more than one hypothesis. There are three simple hypotheses generated from this problem to determine, "the effect of massive, positive, verbal rewards on the reading achievement of children." (Singh,2006).

At first glance these three hypotheses might be offered

(A) Reward increases reading achievement

(B) Reward decreases reading achievement

(C) Reward has no effect on reading achievement.

Evidence has already been obtained in the laboratory to support the hypothesis (A) rewards increase performance. However, upon closer examination, the primary purpose this study is to determine whether the enhancing effect of rewards can be incorporated into class-room setting to facilitate children's learning to read. This theory is based on the assumption that the 'law' of learning should apply in classroom. If perhaps more subtly than in a laboratory and on the laboratory findings that support the assumed relationship between reward and performance, the logical conclusion would be that rewards would have a demonstrable enhancing effect on classroom performance. This conclusions based on the first assumption arrived at deductively and the second arrived at inductively.

Both induction and deduction are needed to choose among the possibilities. Many theories, both psychological and educational deal with stabilization (and rigidifying) of behavior patterns as a function of their use.

Researchers formulate hypotheses using induction and deduction, one of the goals of researchers is to produce that piece for generalizable bodies of theory which will provide answers to practical problems. Hypothesis construction and testing enable researchers to generalize their findings beyond the specific conditions which they obtain. Since a hypothesis is a formulation of anticipated findings, students are advised to develop a hypothesis as a means of demonstrating the basis for their study to themselves and their reader. The task of introducing a study and discussing the findings are facilitated by existence of a hypothesis.

3.3.1 Formulation of a Testable Hypothesis

A hypothesis is a tentative assumption drawn from knowledge and theory which is used as a guide in the investigation of other facts and theory that are yet unknown. The hypothesis formulation is one of the most difficult in the entire scientific process. A poorly chosen or poorly worded hypothesis can prevent

(a) The obtaining of enough pertinent data
(b) The drawing of conclusions and generalizations and
(c) The application of certain statistical measures in the analysis of the result.

It is impossible to over-emphasize the role of the hypothesis in research. It is the central core of study that directs the selection of the data to be gathered, the experimental design, the statistical analysis, and the conclusions drawn from the study.

A study may be devoted to the testing of one major hypothesis, a number of subsidiary hypotheses, or both major and subsidiary hypotheses. When several hypotheses are used, each should be stated separately in order to anticipate the type of analysis required and in order to definitely accept or reject each hypothesis on its own merit. Regardless of the number or type of hypotheses used, it is extremely important that each be specific testable, and based upon a logical foundation. Hildreth Hoke Mc Ashan says only one possible exception to the above statements, which is that when fact finding alone is the primary aim of the study, it may not always be necessary to formulate an explicit hypothesis. However, this need not be a concern of the most scientific researchers.

3.4Types of hypothesis

Hypotheses can be classified in a variety of ways into different types or kinds. The following are some of the types of hypotheses:

i) Explanatory Hypothesis: The purpose of this hypothesis is to explain a certain fact. All hypotheses are in a way explanatory for a hypothesis is advanced only when we try to explain the observed fact. A large number of hypotheses are advanced to explain the individual facts in life. A theft, a murder, an accident are examples.

ii) Descriptive Hypothesis: Sometimes a researcher comes across a complex phenomenon. He/ she are unable to understand the relations among the observed facts. But how to account for these facts? The answer is a descriptive hypothesis. A hypothesis is descriptive when it is based upon the points of resemblance of something. It describes the **cause** and **effect** relationship of a phenomenon e.g., the current unemployment rate of a state exceeds 30% of the work force. Similarly, the consumers of local made products constitute a significant market segment.

iii) Analogical Hypothesis: When we formulate a hypothesis on the basis of similarities (analogy), it is called an analogical hypothesis e.g., families with higher earnings invest more surplus income on long term investments.

iv) Working hypothesis: Sometimes certain facts cannot be explained adequately by existing hypotheses, and no new hypothesis comes up. Thus, the investigation is held up. In this situation, a researcher formulates a hypothesis which enables to continue investigation. Such a hypothesis, though inadequate and formulated for the purpose of further investigation only, is called a working hypothesis. It is simply accepted as a starting point in the process of investigation.

v) Null Hypothesis: It is an important concept that is used widely in the sampling theory. It forms the basis of many tests of significance. Under this type, the hypothesis is stated negatively. It is null because it may be nullified, if the evidence of a random sample is unfavourable to the hypothesis. It is denoted as (H_0). If the calculated value of the test is less than the permissible value, Null hypothesis is accepted, otherwise it is rejected. The rejection of a null hypothesis implies that the difference could not have arisen due to chance or sampling fluctuations.

vi) Statistical Hypothesis: Statistical hypotheses are the statements derived from a sample. These are quantitative in nature and are numerically measurable. For example, the market share of product X is 70%, the average life of a tube light is 2000 hours etc.

vii) Common Sense Hypothesis: These represent the commonsense ideas. They state the existence of empirical uniformities received through day to day observations.

viii) False Hypothesis: A hypothesis which is bound to be unsatisfactory when verified is called a false hypothesis.

ix) Barren Hypothesis: A hypothesis from which no consequences can be deducted is called a Barren Hypothesis. It is a hypothesis which cannot be tested. Example the child fell ill because a wicked women's eye fell upon it. This is a baseless hypothesis because it cannot be verified.

3.5 Procedure for testing hypothesis

To test a hypothesis means to tell whether or not the hypothesis seems to be valid. In hypothesis testing the main question is: whether to accept the null hypothesis or not to accept the null hypothesis? Procedure for hypothesis testing refers to all those steps that we undertake for making a choice between the two actions i.e., rejection and acceptance of a null hypothesis. The various steps involved in hypothesis testing are stated below:

(i) **Making a formal statement-** This step consists in making a formal statement of the null hypothesis (H_0) and also of the alternative hypothesis (H_1). This means that hypotheses should be clearly stated, considering the nature of the research problem. For instance, Mr. Mohan of the Civil Engineering Department wants to test the load bearing capacity of an old bridge which must be more than 10 tons, in that case he can state his hypotheses as under:

Null Hypothesis H_0: μ=10 tons

Alternative Hypothesis H_1: μ >10 tons

The formulation of hypotheses is an important step which must be accomplished with due care in accordance with the object and nature of the problem under consideration. It also indicates whether we should use a one-tailed test or a two-tailed test. If H_1 is of the type greater than (or of the type lesser than), we use a one –tailed test, but when H_1 is of the type "whether greater or smaller" then we use a two-tailed test.

(ii)Selecting a significance level- The hypotheses are tested on a pre-determined level of significance and as such the same should be specified. Generally, in practice, either 5 % level or 1% level is adopted for the purpose. The factors that affect the level

of significance are: (a) the magnitude of the difference between sample means; (b) the size of the samples; (c) the variability of measurement within samples; and (d) whether the hypothesis is directional or non-directional. In brief, the level of significance must be adequate in the context of the purpose and nature of enquiry.

(iii)Deciding the distribution to use- After deciding the level of significance the next step in hypothesis testing is to determine the appropriate sampling distribution. The choice generally remains between normal distribution and the t-distribution. The rules for selecting the correct distribution are similar to those which we have stated earlier in the context of estimation.

(iv)Selecting a random sample and computing an appropriate value- Another step is to select a random sample(s) and compute an appropriate value from the sample data concerning the test statistic utilizing the relevant distribution. In other words, draw a sample to furnish empirical data.

(v)Calculating of the probability- One has to calculate the probability that the sample result would diverge as widely as it has from expectations, if the null hypothesis were in fact true.

(vi)Comparing the probability- Yet another step consists in comparing probability thus calculated with the specified value for α, the significance level. If the calculated probability is equal to or smaller than the α value in case of one-tailed test (and α/2 in case of two-tailed test), then reject the null hypothesis (i.e., accept the alternative hypothesis), but if the calculated probability is greater, then accept the null hypothesis. In case we reject H_0, we run a risk of (at most the level of significance) committing an error of Type I, but if we accept H_0, then we run some risk (the size of which cannot be specified as long as the H_0 happens to be vague rather than specific) of committing an error of Type II.

3.6 Type-I and Type-II errors

In the context of testing of hypotheses, there are basically two types of errors we can make. We may reject H_0 when H_0 is true and we can accept H_0 when in fact H_0 is not true. The former is known as Type I error and the latter is known as Type-II error. In other words, Type I error means rejection of hypothesis which should have been accepted and Type II error means accepting the hypothesis which should have been rejected. Type I error is denoted by α(alpha) known as α error, also called the level of significance of test; and Type II error is denoted by β(beta) known as β error. In a tabular form the said two errors can be presented as follows:

	Decision	
	Accept H_0	Reject H_0
H_0(true)	Correct decision	Type I error (α error)
H_0(false)	Type II error (β error)	Correct decision

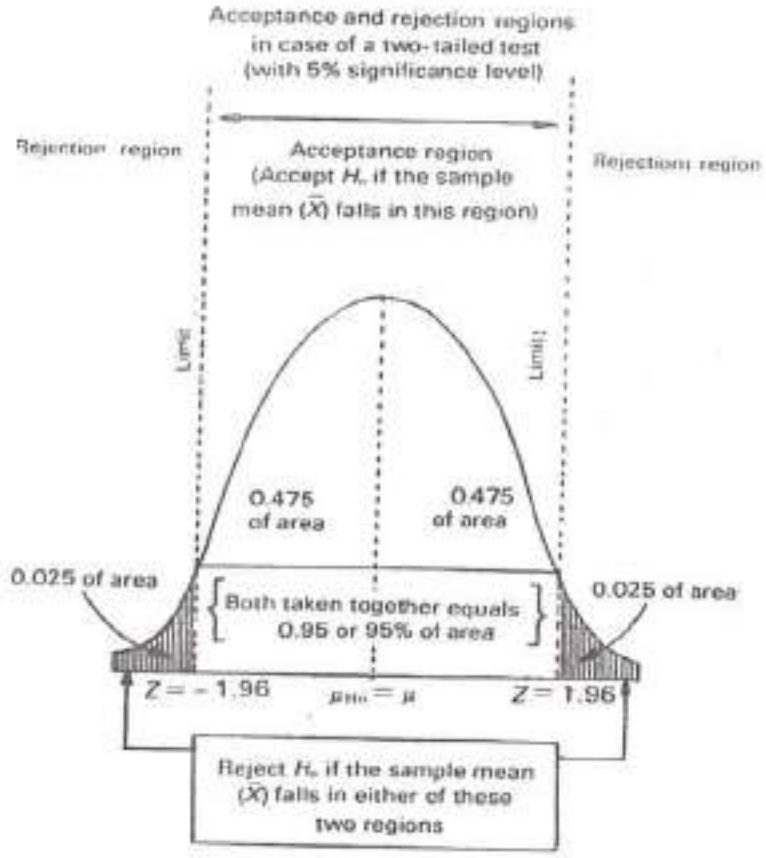
The probability of Type I error is usually determined in advance and it is understood as the level of significance of testing the hypothesis. If type I error is fixed at 5 per cent, it means that there are about 5 chances in 100 that we will reject H_0 when H_0 is true. We can control Type I error just by fixing it at a lower level. For instance, if we fix it at 1 per cent, we will say that the maximum probability of committing Type I error would only be 0.01.

But with a fixed sample size, n, when we try to reduce Type I error, the probability of committing Type II error increases. Both types of errors cannot be reduced simultaneously. There is trade –off between these two types of errors which means that the probability of making one type of error can only be reduced if we are willing to increase the probability of making the other type of error.To deal with this trade-off in business situations, decision-makers decide appropriate level of Type I error by examining the costs of penalties attached to both types of errors.

3.7 One tail, 2-tail test

In the context of hypothesis testing, these two terms are quite important and must be clearly understood. A two-tailed test rejects the null hypothesis if, say, the sample mean is significantly higher or lower than the hypothesized value of the mean of the population. Such a test is appropriate when the null hypothesis is some specified value and the alternative hypothesis is a value not equal to the specified value of the null hypothesis. Symbolically, the two-tailed test is appropriate when we have H_0:$\mu=\mu_{H0}$ and H_1:$\mu\neq\mu_{H0}$ which mean $\mu>\mu_{H0}$. Thus, in a two-tailed test, there are two rejection regions, one on each tail of the curve which can be illustrated as under:

$H_a : \mu \neq \mu_{H_0}$ which may mean $\mu > \mu_{H_0}$ or $\mu < \mu_{H_0}$. Thus, in a two-tailed test, there are two rejection regions*, one on each tail of the curve which can be illustrated as under:



Mathematically we can state:

Acceptance Region A : $|Z| \leq 1.96$

Rejection Region R : $|Z| > 1.96$

*Also known as critical regions.

If the significance level is 5 per cent and the two-tailed test is to be applied, the probability of the rejection area will be 0.05 (equally splitted on both tails of the curve as 0.025) and that of the acceptance region will be 0.95 as shown on the above curve. If we take μ=100 and if our sample mean deviates significantly from 100 in either direction, then we shall reject the null hypothesis; but if the sample mean does not deviate significantly from μ, in that case we shall accept the null hypothesis.

Exercise 3.1

Question 1Define the term Hypothesis?

Question 2 Differentiate between Type-I error and Type II error

Question 3 Define Null Hypothesis?

3.8 Summary& Conclusion

Hypothesis is an expectation about events based on generalization of the assumed relationship between variables. The functions of hypothesis are a temporary solution of a problem concerning with some truth which enables an investigator to start his research works. And it offers a basis in establishing the specifics what to study for and may provide possible solutions to problem. Hypothesis generally can be divided into directional and non-directional. Researchers formulate hypotheses using induction and deduction, one of the goals of researchers is to produce that piece for generalizable bodies of theory which will provide answers to practical problems. Hypothesis construction and testing enables researchers to generalize their findings beyond the specific conditions which were obtained.

3.9 Glossary

- **Hypothesis-**Hypothesis is an assumption made about a population parameter. This hypothesis is then proved or disproved by using the information from the sample to decide the likelihood of the hypothesized population parameter to be correct
- **Null Hypothesis-** Null hypothesis (denoted by H_0) states that there is no difference between the population parameter and the sample statistic being compared.
- **One-tailed test-** A test of any statistical hypothesis where the alternative hypothesis is expressed by the symbol (<) or the symbol (>) is called one tail test since the entire critical region lies in one tail of the distribution of the test statistic. The critical region for all alternative hypothesis containing the symbol (>) lies entirely on the right tail of the distribution while the critical region for an alternative hypothesis containing a less than (<) symbol lies entirely in the left tail. The symbol indicates the direction where the critical region lies.

- **Two-tailed test-** A test of any statistical hypothesis where the alternative is written with a symbol ≠ is called a two tail test.
- **Level of Significance-** This refers to the degree of significance with which we accept or reject a particular hypothesis. Since 100% accuracy is not possible in taking a decision over the acceptance or rejection of a hypothesis, we have to take the decision at a particular level of confidence which would speak of the probability of one being correct or wrong in accepting or rejecting a hypothesis. In most cases of hypothesis testing, such a confidence is fixed at 5% level, which implies that our decision would be correct to the extent of 95%. For a greater precise, however, such a confidence may be fixed at 15 level which would imply that the decision would be correct to the extent of 99%. This level is usually denoted by the symbol, α(alpha) which represents the probability of committing the type I error(i.e. rejecting a null hypothesis which is true). The level of confidence (or significance), is always fixed in advance before applying the test procedures. It is important to note that if no level of significance is given, then we always take α=0.05.
- **Alternative Hypothesis-** Alternative hypothesis (denoted by H_1) states that there is a difference between the population parameter and sample statistic

3.10 Self Assessment Test

Exercise 3.1

Answer 1: Refer to section 3.2
Answer 2: Refer to section 3.6
Answer 3: Refer to section 3.4

3.11 Terminal Questions

Question1 Define the term ‘hypothesis’. Explain in detail the procedure of testing a hypothesis.

Question 2 What is the role of hypothesis in a research? What characteristics define a good hypothesis?

3.12 Suggested Readings

1. Goode and Hatt, Research Methodology, Prentice Hall Publications, 1959.

2. Kothari, C.R. Research Methodology, Methods and Techniques, New Age International Publisher.

3. Donald R. Cooper and Pamela S. Schindler, Business Research methods, 9th Edition, Tata McGraw Hill, 2006.

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10. Gupta K. Shashi & Rangi Praneet, Research Methodology in Commerce, Kalyani Publishers

LESSON 4

MEASUREMENT AND SCALING TECHNIQUES

STRUCTURE

4.0 Objectives

After going through this lesson you will be able to:

- Understand the meaning of variables
- Discuss different types of variables and their importance
- Explain the concepts of measurement and scaling,
- Discuss different types of scales

4.1 Introduction

Very simply, a variable is a measurable characteristic that varies. It may change from group to group, person to person, or even within one person over time. Variables can be defined as any aspect of a theory that can vary or change as part of the interaction within the theory. In other words, variables are anything which can effect or change the results of a study. Every study has variables as these are needed in order to understand differences. Measurement on the other hand is essential in a research process because measurement alone will help us gather some kind of conclusive and quantitative data. Measurement involves assignment of numerals to characteristics pertaining to an object, event, person etc. Analysis and interpretation of data measured help us in presenting the research results. In this chapter we will discuss the issues related to variables, measurement, different levels of measurement scales, various types of scaling techniques.

4.2 Variables in Research

All research projects are based around variables. A variable is the characteristic or attribute of an individual, group, educational system, or the environment that is of interest in a research study. Variables can be straightforward and easy to measure, such as gender, age, or course of study. Other variables are more complex, such as socioeconomic status, academic achievement, or attitude toward school. Variables may also include an aspect of the educational system, such as a specific teaching method or counseling program. Characteristics of the environment may also be variables, such as the amount of school funding or availability of computers. Therefore, once the general research topic has been identified, the researcher should identify the key variables of interest.

For example, a researcher is interested in low levels of literacy. Literacy itself is still a broad topic. In most instances, the broad topic and general variables need to be specifically identified. For example, the researcher needs to identify specific variables that define literacy: reading fluency (the ability to read a text out loud), reading comprehension (understanding what is read), vocabulary, interest in reading, etc. If a researcher is interested in motivation, what specific motivation variables are of interest: external motivation, goals, need for achievement, etc? Reading other research studies about your chosen topic will help you better identify the specific variables of interest.

Identifying the key variables is important for the following reasons:

- The key variables provide focus when writing the Introduction section.
- The key variables are the major terms to use when searching for research articles for the Literature Review.

- The key variables are the terms to be operationally defined if an Operational Definition of Terms section is necessary.
- The key variables provide focus to the Methods section.
- The Instrument will measure the key variables. These key variables must be directly measured or manipulated for the research study to be valid.

4.2.1 Types of Variables

There are six common variable types:

(i) Dependent Variables-. show the effect of manipulating or introducing the independent variables. For example, if the independent variable is the use or non-use of a new language teaching procedure, then the dependent variable might be students' scores on a test of the content taught using that procedure. In other words, the variation in the dependent variable depends on the variation in the independent variable.

(ii) Independent Variables- are those that the researcher has control over. This "control" may involve manipulating existing variables (e.g., modifying existing methods of instruction) or introducing new variables (e.g., adopting a totally new method for some sections of a class) in the research setting. Whatever the case may be, the researcher expects that the independent variable(s) will have some effect on (or relationship with) the dependent variables.

(iii)Intervening Variables- refer to abstract processes that are not directly observable but that link the independent and dependent variables. In language learning and teaching, they are usually inside the subjects' heads, including various language learning processes which the researcher cannot observe. For example, if the use of a particular teaching technique is the independent variable and mastery of the objectives is the dependent variable, then the language learning processes used by the subjects are the intervening variables.

(iv)Moderator Variables- affect the relationship between the independent and dependent variables by modifying the effect of the intervening variable(s). Unlike extraneous variables, moderator variables are measured and taken into consideration. Typical moderator variables in TESL and language acquisition research (when they are not the major focus of the study) include the sex, age, culture, or language proficiency of the subjects.

(v)Control Variables- Language learning and teaching are very complex processes. It is not possible to consider every variable in a single study. Therefore, the variables that are not measured in a particular study must be held constant, neutralized/balanced, or eliminated, so they will not have a biasing effect on the other variables. Variables that have been controlled in this way are called control variables.

(vi)Extraneous Variables- are those factors in the research environments which may have an effect on the dependent variable(s) but which are not controlled. Extraneous variables are dangerous. They may damage a study's validity, making it impossible to know whether the effects were caused by the independent and moderator variables or some extraneous factor. If they cannot be controlled, extraneous variables must at least be taken into consideration when interpreting results.

4.3 Measurement

Measurement is the course of observing and recording the observations that are collected as part of research. Warren S. Torgerson has defined measurement as" the assignment of numbers to objects to represent amounts or degrees of a property possessed by all of the objects". The numbers are assigned to the object in such a manner that the numbers are reflective of the relationship that exists between the two objects with respect to the characteristics involved. Thus measurement is done not of the object itself but with regard to some characteristics or property of the object.

The recording of the observations may be in terms of numbers or other symbols to characteristics of objects according to certain prescribed rules. The respondent's, characteristics are feelings, attitudes, opinions etc. The number that is used to measure the characteristics, attitude or property could be just a symbol like 1, 2, 3… or I, II, III which may not have any quantitative purpose. It could only be performing the function of identifying or labeling an object. On the other hand it may have some quantitative meaning associated with it. For example, you may assign '1' for Male and '2' for Female respondents. In response to a question on whether he/she is using the internet banking provided by a particular bank branch, the respondent may say 'yes' or 'no'. You may wish to assign the number '1' for the response yes and '2' for the response no. We assign numbers to these characteristics for two reasons. First, the numbers facilitate further statistical analysis of data obtained. Second, numbers facilitate the communication of measurement rules and results. The most important aspect of measurement is the specification of rules for assigning numbers to characteristics. The rules for assigning numbers should be standardized and applied uniformly. This must not change over time or objects.

4.4 Scaling

Scaling is an extension of the concept of measurement. It can be said that the result of measurement is a scale which comprises of a set of numerals on which an object's score is placed using a certain rule of assignment. The difference between measurement and scaling is that measurement is the assignment of numbers to objects or respondents and scaling is the process of placing them on a continuum with respect to the number scored by them. In words of Alter L Edwards scaling is a "procedure for assignment of numbers (or other symbols) to a property of objects in order to impart some of the characteristics of numbers to the properties in question."

In scaling, the objects are text statements, usually statements of attitude, opinion, or feeling. For example, consider a scale locating customers of a bank according to the characteristic “agreement to the satisfactory quality of service provided by the branch”. Each customer interviewed may respond with a semantic like ‘strongly agree’, or ‘somewhat agree’, or ‘somewhat disagree’, or ‘strongly disagree’. We may even assign each of the responses a number. For example, we may assign strongly agree as ‘1’, agree as ‘2’ disagree as ‘3’, and strongly disagree as ‘4’. Therefore, each of the respondents may assign 1, 2, 3 or 4.

4.5Different types of scales

There are four types of scales or methods of assigning numbers: (a) Nominal scale, (b) Ordinal scale, (c) Interval scale, and (d) Ratio scale. These are simply ways to categorize different types of variables.

4.5.1Nominal

The lowest measurement level you can use, from a statistical point of view, is a nominal scale. A nominal scale, as the name implies, is simply some placing of data into categories, without any order or structure. The nominal scale (also called dummy coding) simply places people, events, perceptions, etc. into categories based on some common trait. Some data are naturally suited to the nominal scale such as males vs. females, redheads vs. blondes vs. brunettes, and African American vs. Asian. The nominal scale forms the basis for such analyses as Analysis of Variance (ANOVA) because those analyses require that some category is compared to at least one other category.

The nominal scale is the lowest form of measurement because it doesn’t capture information about the focal object other than whether the object belongs or doesn’t belong to a category; either you are a smoker or not a smoker, you attended college or you didn’t, a subject has some experience with computers, an average amount of experience with computers, or extensive experience with computers. No data is captured that can place the measured object on any kind of scale say, for example, on a continuum from one to ten. Coding of nominal scale data can be accomplished using numbers, letters, labels, or any symbol that represents a category into which an object can either belong or not belong. For example, labelling men as ‘1’ and women as ‘2’ which is the most common way of labelling gender for data recording purpose does not mean women are ‘twice something or other’ than men. Nor it suggests that men are somehow ‘better’ than women. Another example of nominal scale is to classify the respondent’s income into three groups: the highest income as group 1. The middle income as group 2, and the low-income as group 3. The nominal scale is often referred to as a categorical scale. The assigned numbers have no arithmetic properties and act only as labels. The only statistical operation that can be performed on nominal scales is a frequency count. We cannot determine an average except mode.

4.5.2 Ordinal Scale

An ordinal scale is next up the list in terms of power of measurement. The ordinal scale has at least one major advantage over the nominal scale. The ordinal scale contains all of the information captured in the nominal scale but it also ranks data from lowest to highest. Rather than simply categorize data by placing an object either into or not into a category, ordinal data give you some idea of where data lie in relation to each other.

For example, suppose you are conducting a study on cigarette smoking and you capture how many packs of cigarettes three smokers consume in a day. It turns out that the first subject smokes one pack a day, the second smokes two packs a day, and the third smokes ten packs a day. Using an ordinal scale, your data would look like this.

Ten packs a day smoker

Two packs a day smoker

One pack a day smoker

Another example is that a fast food home delivery shop may wish to ask its customers:

How would you rate the service of our staff?

(1) Excellent • (2) Very Good • (3) Good • (4) Poor • (5) Worst •

Suppose respondent X gave the response 'Excellent' and respondent Y gave the response 'Good', we may say that respondent X thought that the service provided better than respondent Y to be thought. But we don't know how much better and even we can't say that both respondents have the same understanding of what constitutes 'good service'. In marketing research, ordinal scales are used to measure relative attitudes, opinions, and preferences. Here we rank the attitudes, opinions and preferences from best to worst or from worst to best. However, the amount of difference between the ranks cannot be found out. Using ordinal scale data, we can perform statistical analysis like Median and Mode, but not the Mean.

The ordinal scale rank orders the subjects by how many packs of cigarettes they smoke in one day. Notice, however, that although you can use the ordinal scale to rank the subjects, there is some important data missing; the first smoker occupies a rank the same distance from the second smoker as the second smoker occupies a rank the same distance from the third smoker. Consequently, no information exists in the ordinal scale to indicate the distance one smoker is from the others except for the ranking. Richer than nominal scaling, ordinal scaling still suffers from some information loss in the data.

The main characteristic of the ordinal scale is that the categories have a logical or ordered relationship. This type of scale permits the measurement of degrees of

difference, (that is, ‘more’ or ‘less’) but not the specific amount of differences (that is, how much ‘more’ or ‘less’). This scale is very common in marketing, satisfaction and attitudinal research.

4.5.3 Interval

Unlike the nominal scale that simply places objects into or out of a category or the ordinal scale that rank orders objects, the interval scale indicates the distance one object is from another. In this scale the numbers are used to rank attributes such that numerically equal distances on the scale represent equal distance in the characteristic being measured. An interval scale contains all the information of an ordinal scale, but it also one allows to compare the difference/distance between attributes. In the social sciences, there is a famous example often taught to students on this distinction.

Suppose you are near the shore of a lake and you see three tree stumps sticking out of the water. Using the water as a reference point, it would be easy to measure which stump rises highest out of the water. In this way, you can create a relative measure of the height of the stumps from the surface of the water. For example, the first stump may breach the water by twenty-four centimeters, the second by twenty-six centimeters, and the third by twenty-eight centimeters. Unlike the nominal and ordinal scales, you can make relative distance measurements among objects using the interval scale.

However, the distance the stumps extend out of the water gives you no indication of how long the stumps actually are. It’s possible that the bottom of the lake is irregular making the tallest stump look tallest only in relation to the water. Using interval scaling, you have no indication of the absolute length of the stumps. Still, the interval scale contains richer information that the two lower levels of scaling.

Interval scales may be either in numeric or semantic formats. The following are two more examples of interval scales one in numeric format and another in semantic format.

(i)Example of Interval Scale in Numeric Format

Please indicate your views on Balkan Olives by scoring them on a scale of 5 down to 1 (i.e. 5 = Excellent; = Poor) on each of the criteria listed						
Balkan Olives are:						Circle the appropriate score on each line
Succulence	5	5	5	5	5	
Fresh tasting	4	4	4	4	4	
Free of skin blemish	3	3	3	3	3	
Good value	2	2	2	2	2	
Attractively packaged	1	1	1	1	1	

(ii)Example of Interval Scale in Semantic Format

Please indicate your views on Balkan Olives by ticking the appropriate responses below					
	Excellent	Very Good	Good	Fair	Poor
Succulent					
Freshness freedom from skin blemish					
Value for money					
Attractiveness of packaging					

4.5.4 Ratio Scale

Ratio Scale is the highest level of measurement scales. This has the properties of an interval scale together with a fixed (absolute) zero point. The absolute zero point allows us to construct a meaningful ratio. The scale that contains the richest information about an object is ratio scaling. The ratio scale contains all of the information of the previous three levels plus it contains an absolute zero point. To use the example above, the ratio scale allows you to measure the stumps from the bottom of the lake; the bottom of the lake represents the absolute zero point.

The distinction between interval and ratio scales is an important one in the social sciences. Although both can capture continuous data, you have to be careful not to assume that the lowest possible score in your data collection automatically represents an absolute zero point.

Take extraversion captured using a psychometrically sound survey instrument. The items that capture this construct may range from zero to ten on the survey but there is no guarantee that a score of zero on the survey places a subject at the absolute zero point on the extraversion construct. You know that a subject with a score of eight on the scale is more extraverted than someone with a score of seven, but those numbers only exist for comparison between each other, not in comparison to some absolute score of zero extraversion.

Exercise 4.1

Question 1 The main difference between interval scale and the ratio scale in terms of their properties?
Question 2 Define Measurement and Scaling?

4.6 Summary & Conclusion

In this chapter we have studied about Variables and their types, we have also discussed measurement and scaling and the different kind of scales. The four kinds of scales discussed above have an important impact on how you collect data and how you analyze them later. Collect at the wrong level, and you will end of having to adjust your research, your design, and your analyses. Make sure you consider carefully the level at which you collect your data, especially in light of what statistical procedures you intend to use once you have the data in hand.

4.7 Glossary

- **Variables-** A variable is the characteristic or attribute of an individual, group, educational system, or the environment that is of interest in a research study. Variables can be straightforward and easy to measure, such as gender, age, or course of study.
- **Measurement-** Measurement refers to the assignment of numerals to objects to represent the amount of property or characteristics possessed by the object
- **Scaling-** Result of measurement is a scale which comprises of a set of numerals on which an object score is placed using a certain rule of assignment.
- **Ordinal Scale-** The ordinal scale contains all of the information captured in the nominal scale but it also ranks data from lowest to highest. Rather than simply categorize data by placing an object either into or not into a category, ordinal data give you some idea of where data lie in relation to each other.
- **Nominal Scale-** The lowest measurement level you can use, from a statistical point of view, is a nominal scale. A nominal scale, as the name implies, is simply some placing of data into categories, without any order or structure. The nominal scale (also called dummy coding) simply places people, events, perceptions, etc. into categories based on some common trait.
- **Interval Scale-** Unlike the nominal scale that simply places objects into or out of a category or the ordinal scale that rank orders objects, the interval scale indicates the distance one object is from another. In this scale the numbers are used to rank attributes such that numerically equal distances on the scale represent equal distance in the characteristic being measured. An interval scale contains all the information of an ordinal scale, but it also one allows to compare the difference/distance between attributes.

4.8 Self Assessment Test

Exercise 4.1

Answer 1: Refer to section 4.5
Answer 2: Refer to section 4.3 & 4.4

4.9 Terminal Questions

Question 1 What are the different levels of measurement? Explain any two of them.

Question 2 Discuss briefly different issues you consider for selecting an appropriate scaling technique for measuring attitudes.

4.10 Suggested Readings

1. Goode and Hatt, Research Methodology, Prentice Hall Publications, 1959.

2. Kothari, C.R. Research Methodology, Methods and Techniques, New Age International Publisher.

3. Donald R. Cooper and Pamela S. Schindler, Business Research methods, 9th Edition, Tata McGraw Hill, 2006.

4. Ghosh, B.N. Research Methodology, Himalayan Publishing House, New Delhi.

5. Alan Bryman and Emma Bell, Business Research methods, Oxford University Press, New Delhi, 2008.

6. Uma Sekaran, Research methods for Business, Wiley India, New Delhi, 2006.

7. K. N. Krishnaswamy, Appa Iyer Sivakumar and M. Mathirajan, Management Research Methodology, Pearson Education, New Delhi, 2006.

8. Sadhu A.N. and A. Singh, Research Methodology in Social Sciences, Himalaya Publishing House.

9. Gopal, M.H., Research Methodology in Social Sciences, Asia Publishing House, New Delhi.

10. Gupta K. Shashi & Rangi Praneet, Research Methodology in Commerce, Kalyani Publishers

LESSSON 5

CONSTRUCTION OF QUESTIONNAIRE

Structure

5.0 Objectives

After going through this lesson you will be able to:

- Understand the meaning of Questionnaire and instruments
- Explain the characteristics of good questionnaire
- Understand the attributes of a well-designed questionnaire
- Explicate the construction of instruments

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5.1 Introduction

No survey can achieve success without a well-designed questionnaire. Unfortunately, questionnaire design has no theoretical base to guide the marketing researcher in developing a flawless questionnaire. All the researcher has to guide himself/herself for a lengthy list of do's and don'ts born out of the experience of other researchers past and present. Hence, questionnaire design is more of an art than a science.

5.2 Questionnaire

A questionnaire is a form containing a set of questions, which are filled by the respondents. According to Goode Hatt, “in general, the questionnaire refers to a device for securing answers to questions by using a form which the respondent fills in himself.” The objective of a questionnaire is twofold:

i) To collect information from respondents scattered in a wide area.

ii) To achieve success in collecting reliable and dependable information in a short span of time.

5.2.1Characteristics of good Questionnaire

1. Brief and Limited Questionnaire: The number of questions in a schedule should be brief and limited as possible. Only relevant questions to the problem under investigation should be added.

2. Simple and Clear: The questions should be simple, clear and precise. Its language should be very simple so that informants may easily understand.

3. Unambiguous Questions: All unambiguous questions should be avoided at all, complicated and long-worded questions irritate the respondents which results in careless; replies.

4. No Personal Questions: No personal question should be asked from, respondents. Such questions should be avoided.

5. Use of Proper Words: Questions should be framed with right words. This ensures the validity.

6. Avoidance of Calculations: Questions should not be based on calculations. Only those questions should be asked which the respondents may reply immediately. Moreover, questions should avoid memories.

7. Only Objective Questions: The questions should be objective. It should be based on opinions of the individuals.

8. Sequence of the Questions: The arrangement of the questions should be such so that no question may slip back. It must involve a logical flow of questions.

9. Pre-testing: Before sending the questionnaire to the respondents, it must be properly tested.

10. Instructions: Precise and simple instructions of filling the questionnaire should be added in the foot note.

11. Cross Examination: The questionnaire should be set in such a way that there may be cross examination of the information supplied by the informants. In fact, it is a check on false or inaccurate answers.

12. Secret Information: Every respondent should be ensured that information given by them shall be kept secret.

13. Attractive Questionnaire: Proper care should be taken to make the questionnaire attractive. A well set questionnaire will certainly impress the recipient.

5.2.2 Questionnaire design

Perhaps the most important part of the survey process is the creation of questions that accurately measure the opinions, experiences and behaviors of the public. Accurate random sampling and high response rates will be wasted if the information gathered is built on a shaky foundation of ambiguous or biased questions. Creating good measures involves both writing good questions and organizing them to form the questionnaire.

Questionnaire design is a multiple-stage process that requires attention to many details at once. Designing the questionnaire is complicated because surveys can ask about topics in varying degrees of detail, questions can be asked in different ways, and questions asked earlier in a survey may influence how people respond to later questions. Researchers also are often interested in measuring change over time and therefore must be attentive to how opinions or behaviors have been measured in prior surveys.

Surveyors may conduct pilot tests or focus groups in the early stages of questionnaire development in order to better understand how people think about an issue or comprehend a question. Pre testing a survey is an essential step in the questionnaire design process to evaluate how people respond to the overall questionnaire and specific questions.

For many years, surveyors approached questionnaire design as an art, but substantial research over the past thirty years has demonstrated that there is a lot of science involved in crafting a good survey questionnaire. Here, we discuss the pitfalls and best practices of designing questionnaires.

5.3 Construction of Questionnaire

(i) Determine what information is needed- A questionnaire has two functions firs, it translates research objective into specific questions which the respondent can answer and second, it motivates the respondent to furnish the desired information correctly. Therefore, before a questionnaire can be formulated, a specific statement of the information needed must be made. The researcher has to first decide the topic of the study and then decide the type of information required such as awareness, facts, opinions, attitudes, reasons and future plans etc.

(ii) Type of Questionnaire- There are several types to ask a questions. Questionnaire can be directly given to the respondents or can be mailed. They can also be used for personal interview or on telephone. The choice of type of questionnaire to be used for the study depends upon the kind of the information to be gathered and the type of the respondents from whom it is to be obtained. It is necessary to determine the type of questionnaire because the questions asked, the way in which they are asked, and the sequence in which they are asked is all influenced by the type of questionnaire.

(iii) Decide on type of questions- After deciding the type of questionnaire the researcher has to decide what type of questions will be asked. The questions can be opened ended or close ended. Open ended questions are those in which respondents are free to answer in their own words. In closed ended questions respondents has to choose an alternative and cannot give his own judgment. Close ended questions may be dichotomous having only two answers “Yes” and “No” or multiple choice where respondent has to choose among alternatives or has to rate the alternatives.

(iv) Decide language of the questions- The language of the question and the kind of words used in the questionnaire are extremely important. Slight changes in language and wording of particular question could have a large impact on how the respondent interprets them. Researchers strive for objectivity in surveys and therefore, he must be careful not to lead the respondent into giving a desired answer. The language of the questions should be simple as that they are unambiguous and easily understood.

(v) Decide on layout- The next step in constructing questionnaire is to decide the layout of the questionnaire. The researcher has to decide what will be the format and sequence of questions. Presentation of the questions should be simple and straightforward. It should facilitate analysis and interpretation. Always try to follow the funnel sequence and move from general to specific questions on the topic.

(vi) Pretest- A questionnaire must be pre tested before giving it a final shape. Questionnaire should be tested with a small number of respondents before conducting the main interview. Ideally, the questionnaire should be tested on the same kinds of people which will be included in the main study. The pretest is a preview of any possible inconsistency or ambiguity with question wording, instructions to skip questions, etc. It can help see the researcher if the interviewees understand questions and are giving the answers.

(vi) Revise and prepare final questionnaire- After the questionnaire has been subjected to a thorough pilot test it should be revised to correct spellings, to place the questions in correct order, to remove the unfamiliar words and to remove the insignificant questions. Now the final form of the questions and questionnaire will evolve and final questionnaire can be prepared. This will involve grouping and sequencing questions into an appropriate order, numbering questions, and inserting instructions.

5.4 Instruments

An instrument is a mechanism for measuring phenomena, which is used to gather and record information for assessment, decision making, and ultimately understanding. An instrument such as a questionnaire is typically used to obtain factual information, support observations, or assess attitudes and opinions. For example, a survey may ask respondents to list the type of soap they purchase (factual information), recall how often they purchased the item in the past year (an observation), and consider the factors that influenced their purchase, such as smell, touch, or appearance (attitudes toward the product). The term subjective describes information that originates within an individual and is reflected by items that measure attitudes, feelings, opinions, values, and beliefs. Information that is objective attempts to be free of personal interpretation and is typified by data that are observable.

Some instruments consist of all objective items, like the medical history questionnaire. Respondents are asked to provide demographic information such as their weight, height, and age as well as information about their physical health, such as allergies and previous illnesses. Conversely, some instruments are designed to obtain primarily subjective responses, such as information about political preferences. Although political polls include objective demographic questions, the body of the instrument consists of items that require the respondent to express an opinion or attitude.

In the social sciences most instruments are of the paper-and-pencil variety, meaning that the individual completing the instrument is expected to record information on a form. Even when other media are to be used, a paper-and-pencil instrument will probably need to be developed initially. For example, a marriage counselor might use videotape to record the interactions between a husband and wife. However, a written instrument might then be applied to count the number of times a particular word or phrase or body gesture is used or to rate a type of interaction. A marketing survey organization might collect information over the telephone but record responses with a paper-and-pencil instrument. More and more, instruments are being constructed that

can be completed on a computer. This medium has the advantage of reaching many people quickly and the software often allows the user to tabulate results easily. However, even when the process of collecting or entering information varies—pen, pencil, keyboard, mouse, or verbal encoding—the basic construction of the instrument remains the same, regardless of the medium.

We can categorize instruments in several ways. One approach is based on a mode of administration: who is responsible for completing the instrument? Some instruments, such as polls or medical history questionnaires, rely on self-report, where the respondent supplies the information directly. For example, many interviews, telephone surveys, and some psychometric assessments are initiated by a second party; nonetheless, because the information is provided directly by the respondent, we classify these instruments as self-report.

Another mode of administration is observation, where information about an individual is obtained by someone external. Examples of observation instruments are employee performance appraisals, student assessments of faculty, and behavior checklists. These instruments collect data about characteristics intrinsic to an individual even though the respondent is not queried directly. For example, as part of conducting a screening process for attention deficit disorder, a teacher might use a behavior checklist to record the number of times a student is off task. An external rater or observer is also used when information is needed about things rather than people. For example, a medical records director might develop a checklist to assess whether all the required documentation has been filed in a clinical chart. Similarly, when researchers need information from existing sources, such as medical, personnel, or student records, they may need an instrument designed specifically for data extraction. External raters usually require training to ensure that they obtain the data in the manner required by the instrument developer and are consistent with other observers or raters.

Some instruments use a combination of approaches and formats. The Achenbach questionnaires (Achenbach, 1991) consist of three instruments that provide information about a child's behaviors and emotional state. The Youth Self-Report (YSR), which has various item formats, such as checklists, fill in the blanks, and rating scales, is completed directly by the youngster who is the focus of evaluation.

As its title implies, the mode of administration is self-report. The Child Behavior Checklist (CBCL) is completed by the child's parent or guardian and consists essentially of the same items as the YSR, although worded slightly differently. The Teacher Report Form (TRF) attempts to measure the same attributes, but the questions are formulated to address the child's behaviors in an academic setting. Thus both the CBCL and the TRF are based on parent, guardian, or teacher observation and assessment. The results from each of these three instruments can be used, either individually or collectively, for assessment and diagnostic purposes by a mental health professional.

Both approaches provide the instrument designer with challenges. For example, one of the advantages of constructing an instrument for completion by external raters is the opportunity to interact with and train the observers. This can produce very high levels of consistency between raters. However, this is also time consuming and costly. Conversely, self-report instruments are subject to each respondent's personal interpretation of an item, which may or may not be what you, as instrument designer,

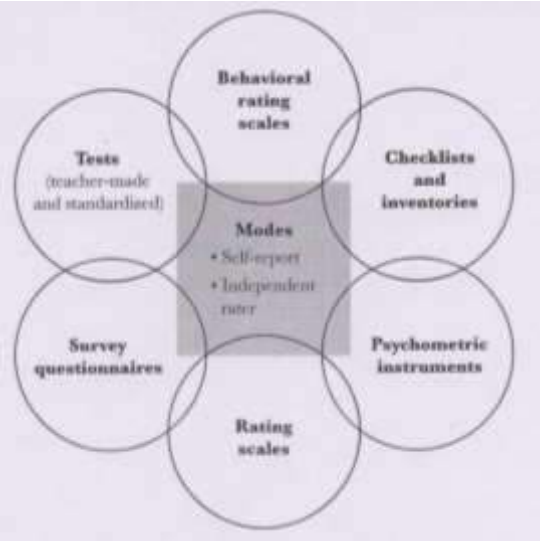
had intended. In either case it is important to test and revise the instrument to minimize these potential problems.

We can also try to classify instruments by use or purpose. Although this approach provides a nomenclature for describing instruments, as we shall see, it is not easy to make distinctions based solely on intended use. The array of instruments used in the social sciences, ranges from academic tests to survey questionnaires. It is perhaps better to think of them as a continuum (as in Figure 5.1), rather than as distinct categories, as these instruments may be put to use for more than one purpose and often share common elements. For example, results on an achievement test can be used as a measure of cognition in the same manner as an intelligence test, although the latter would more likely be categorized as a psychometric instrument than a test. Additionally, some instruments, such as tax forms, may not fit easily into a single grouping. The overlapping circles in Figure 5.1 illustrate that these are not distinct or exclusive categories.

One major group of instruments listed in Figure 5.1 is tests. “A test is a collection of items developed to measure some human educational or psychological attribute” (Worthen & Sanders, 1987, p. 302). One aspect of a test is that a correct answer or level of performance is anticipated. Although tests and other instruments share commonalities, the theories and properties underlying test development are sufficiently different from those underlying instruments as to exclude tests from further discussion in this text.

Rating scale is a generic term describing instruments that are evaluative and that make use of an item format where response choices are ordered on a continuum. The system of judging athletic performances in such events as ice skating and diving is an example of a rating scale. A rating scale differs from a ranking in that the instrument designer predetermines the scale and the respondent selects one value, such as strongly agree on a scale that ranges from strongly disagree to strongly agree . During the process of ranking, the respondent creates a hierarchy, placing all the values in order, for example from strong to weak, or from most important to least important.

FIGURE 5.1: CATEGORIES OF SOCIAL SCIENCE INSTRUMENTS



Performance and behavior rating instruments use rating scales specifically designed to measure an individual's ability to complete a task or perform an activity. Examples of performance instruments are employee job evaluations and the assessment instruments used in rehabilitation and education. These instruments are typically completed by an external observer or rater. Behavior measures may be designed to be descriptive and not evaluative, that is, not judging the value of what is observed but establishing whether it occurred. Such an instrument might use items with a response choice of present or not present. Behavior measures may also be primarily evaluative, as in a job performance appraisal where the task is to make a qualitative assessment of performance. In that case the response choices might rate an aspect of job performance from satisfactory to unsatisfactory, or from occurring none of the time to all of the time.

Checklists are used to determine the presence or absence of an attribute and to count the prevalence of an item or event. These instruments may use a variety of item formats, including scales, rank order, dichotomous choices (yes or no, present or not present), and open-ended questions. One example of a checklist is an instrument used to count the number of computers and computer accessories in a school building. The checklist might be used to indicate if the computer equipment is located where it was originally assigned and to record the property number. The checklist might also include criteria for making qualitative assessments; for example, it might contain a rating scale for evaluating aspects of equipment quality, such as working condition and need for hardware upgrades.

Checklists may be designed to be self-report instruments or to be completed by an independent observer or rater. Moreover, they may be completed for just one entity (such as one individual) or for multiple entities, possibly chosen by sampling methods. For example, if you are developing a checklist for auditing records (such as medical charts or personnel files) and there are hundreds or thousands of them, you could use random sampling to obtain a representative sample of the records, rather than auditing all of them.

In the broadest terms, an inventory is simply a list of objects, goods, or attributes. The word is also used as a verb to describe the process of compiling the list; one might inventory one's supplies, for example. In the social sciences the term inventory describes an instrument used to assess a person's interests, characteristics, or skills. One example is the Vineland Adaptive Behavior Scales (Sparrow, Balla, & Cicchetti, 1984), a developmental inventory that measures adaptive living skills, such as ability to dress oneself and manage a personal budget. An important aspect of developmental inventories is that the items are usually listed sequentially where acquisition of basic skills is a precursor to demonstrating more complex skills; a child typically acquires the ability to hold a spoon, knife, or fork before the ability to cut up food without assistance.

As with other instruments, the mode of administration can be either self report or observer based. A patient recovering from a stroke might be asked to complete (self-report) an inventory of skills developed as a result of participating in physical therapy. An external rater completing a developmental inventory might observe the same person completing activities of daily living (toileting, personal hygiene, and so forth) and check off whether the individual can or cannot complete the task. An inventory may set a

threshold at which observations stop, such as when the individual cannot complete five items in a row. The information obtained can be weighed against normative data to provide a comparative level of functioning. For example, an adaptive living inventory might indicate that, as the result of a stroke, an elderly individual's physical functioning (gross motor skills to carry out the activities of daily living) is significantly diminished in comparison to the functioning of similarly aged adults.

Survey, poll, attitude scale, and questionnaire are terms used interchangeably to describe instruments designed to obtain factual information and to assess beliefs, opinions, and attitudes. Questionnaires typically make use of rating scales and open-ended questions. Specific sampling methodologies may be used to obtain responses that are representative of the population of interest (see the following discussion). Questionnaires are typically designed as self-report instruments.

Psychometric instrument is a broad term used to describe an array of instruments designed to assess cognitive, affective, and physical functioning and personality traits. Consequently, some psychometric instruments can be just as easily categorized as behavior rating instruments or inventories, such as the Vineland Adaptive Behavior Scales. Examples include instruments designed to assess depression or psychosis, intelligence, self-esteem, and hyperactivity. Psychometric instruments developed to assess vocational abilities and aptitudes are used to predict an individual's suitability for an occupation or a specific job. Some psychometric instruments are very specialized and make use of pictorial response sets. For example, the Children's Apperception Test (Bellak & Bellak, 1993) and the Rorschach inkblot test (Exner & Weiner, 1994) use drawings and abstract designs to solicit responses. Psychometric instruments can be completed through self-report or by an independent observer.

A unique subcategory of psychometric instruments consists of those designed for behavior analysis. Behaviors are measured before, during, and after treatment to determine if an intervention is producing the desired effect as evidenced by changes in the frequency or duration, or both, of a targeted behavior. The number of times the behavior occurs may be counted, or a behaviors may be classified into discrete categories such as occurred or did not occur, or correct or incorrect (Kazdin, 1982). Frequency counts are typically tallied for predetermined blocks of time (such as fifteen-minute intervals) or by providing a list of frequency ranges for each observation (such as "Number of Occurrences: 0 to 1, 2 to 4, 5 to 7, 8 or more"), or the observer may just count the occurrences.

5.3.1 Components of an Instrument

Typically, there are six parts to an instrument and all or most will be included regardless of the intended purpose or the process used to collect the data. Although we explain the purpose of each component individually, in reality the components function together to create an integrated document. The ability of a respondent or a rater to complete an instrument is based on the quality of each component as well as the instrument as a whole.

(i)Title- The title helps to convey the purpose of the instrument. It is placed at the top center (usually) of the instrument and is the first thing that someone will see when

handling the document. The title should be consistent with the instrument's intended purpose.

(ii)Introduction- The purpose of an introduction is to explain why you constructed the instrument, how you will use it, and the type of information you want to obtain. It may also contain information about how the instrument and its contents will be managed—for example, how you will ensure the respondent's confidentiality as a participant. The introduction may be conveyed on a separate page or as a separate section at the beginning of the instrument.

(iii)Directions or instructions- Directions should be given at the beginning of the instrument and within the instrument where respondents need guidance to complete items—for example, when there is a change in item format. External raters or observers will also need comprehensive directions, to ensure inter rater consistency. The purpose of directions is to guide the respondent through the instrument and to assist in obtaining the type of information sought. They should be brief and clear; the directions on the workshop evaluation are concisely stated in one sentence.

(iv)Items- At the heart of the instrument are the items. Selection items provide the respondent with potential choices (that is, choices given in advance) from which the respondent makes a selection. A rating item consists of a stem, which is a phrase, sentence, or question that elicits information, and the response set, from which the respondent makes the selection. The response choices may form a graded continuum, or scale, or they may be alternatives. An example of a selection item with a scaled response set is being asked to rate your experience with a product as satisfactory, somewhat satisfactory, somewhat unsatisfactory, or unsatisfactory. An example of an item with alternative choices is being asked to select your age from a list of age ranges. Another example of a selection item is being asked to rank your choices. In this case you must consider, compare, and order all the response alternatives, rather than selecting just one of them.

(v)Supply items- such as open-ended questions; require respondents to provide the answer themselves. Such responses tend to be more descriptive and provide opportunities for more elaboration. However, they may also measure more than the respondent's knowledge; for example, they may also reflect writing skills and language development. Consider the following question, written first as a selection item and then as a supply item: Supply items, such as open-ended questions, require respondents to provide the answer themselves. Such responses tend to be more descriptive and provide opportunities for more elaboration. However, they may also measure more than the respondent's knowledge; for example, they may also reflect writing skills and language development. Consider the following question, written first as a selection item and then as a supply item:

EXAMPLES

1. I would recommend this organization as a place of employment (circle one):

Strongly Disagree, Disagree, Agree, Strongly Agree

2. What would you recommend about this organization as a place of employment?

In the first example, the selection item, the responses may be easier to score and categorize. This might be a factor if the question is to appear in an instrument administered to hundreds of people. However, the second example, the supply item, may elicit a better sample of the respondent's range of knowledge or attitudes, producing more information than the first example would provide. However, analysis of hundreds of lengthy narratives would be more labor intensive.

(vi)Demographics- The demographic section gathers such information about the respondent as age, gender, occupation, and marital status. It should solicit only information that is vital to the project. An instrument used to obtain information about an object will solicit descriptive information about that object.

(vii)Closing section- Depending on the purpose of the instrument, it may include a closing section. A survey, for example, might use this section to thank the individual for responding and also to repeat certain information, such as the return address.

5.3.2 The Process of Instrument Construction

As we discussed earlier, artists typically go through a number of steps in the creation of a painting. First, they may draft a number of preliminary sketches of their subject, drawing the subject from different angles, varying the lighting, and if painting the human figure, trying different poses. Some artists like to make color sketches in pastel chalks or watercolors before committing to a final product in oil or acrylic paint. And even after they have begun applying paint to canvas, they may make changes during the process of actually completing the painting.

This process of constantly revising a composition is an iterative process, and instrument construction, like painting a picture, should be viewed as a systematic yet creative activity that requires continual refinement and revision (Figure 5.2). Although there are clearly steps that must be completed in this process, instrument construction may not always progress sequentially. For example, after you receive feedback from a friend, colleague, or potential user of the instrument, you may find you need to rewrite specific items or reorganize the instrument itself. Consequently, the following activities should be viewed as part of a creative cycle.

(i)Articulate the purpose and focus of the study- This is perhaps the most important activity, and yet it is often overlooked or minimized. Specifying the purpose helps you identify the themes or concepts you want to understand, the methodology you might use, the type of instrument to develop, and the questions or items that you might include in the instrument to obtain the information you seek. Part of this process involves reviewing literature (books, journal articles, and so on) relevant to the topic. Discussing your project with others who are familiar with its topic can help you identify aspects to focus on or exclude from the study. This is important if the study has been commissioned, as you may need to negotiate the purpose and content of the study. Additionally, you may want to speak with potential respondents, as they too can provide

information and their personal perspective about the topic. In considering the approach to use to collect and analyze the data (that is, the methodology), ask whether the topic lends itself to qualitative approaches such as interviews or focus groups, to examination of archival data, to a survey, or to an experimental design. Failure to complete this activity could result in obtaining information that does not answer your question or that does not provide useful and accurate information for decision making. Drafting a purpose statement can also assist in specifying how the data will be collected and who will complete the instrument.

(ii)Activity review and check- It is important to share your purpose statement with others and to obtain feedback that can clarify and focus the project.

(iii)Formulate items- This is both a technical and creative process. It is based on your knowledge of the topic, the information you have described in your purpose statement, and your review of supportive information to help in the creation of specific items. For example, if you are going to conduct an assessment of employee satisfaction, you will probably want to know, prior to designing the questionnaire, what the organization does and how it is organized. Additionally, you will want to understand some of the management theories and concepts that apply to the understanding of employee satisfaction. This information will assist you in brainstorming and writing out questions or items. This process may also involve examining similar instruments to see how others have carried out this measurement. (You may even decide that rather than create a new instrument you will use or adapt an existing instrument, being sure to cite the original source[s], respect copyright, and pay a fee if the instrument is proprietary.)

This creative process may be a solitary or a group endeavor. At this stage, items may be written as questions or statements, and no attempt is made to format them into, for example, open-ended questions or selected response items. Additionally, during this activity decisions can be made about the specific information to obtain. For example, if you have decided to create a survey that will be administered only to women, there is no need to include a demographic question asking for the respondent's gender.

(iv)Activity review and check- Obtain feedback from others on item validity: do the items appear to ask for information that will answer your question or obtain the information you need for decision making? Modify your items based on this feedback.

(v)Structure and format the items- The next activity is to decide on the item format or formats that will provide the information you need efficiently and effectively. This decision will depend in part on the purpose of your study. For example, an instrument designed to support observations of another's behaviors might suggest the use of a behavior rating scale, whereas an instrument with items that ask for opinions will likely suggest the use of a scale measuring the respondent's level of agreement with a statement. And depending on what you want to measure, you might incorporate a variety of item formats in the instrument.

(vi)Activity review and check- Obtain feedback from content experts (individuals knowledgeable in the subject you are studying) as well as from potential respondents.

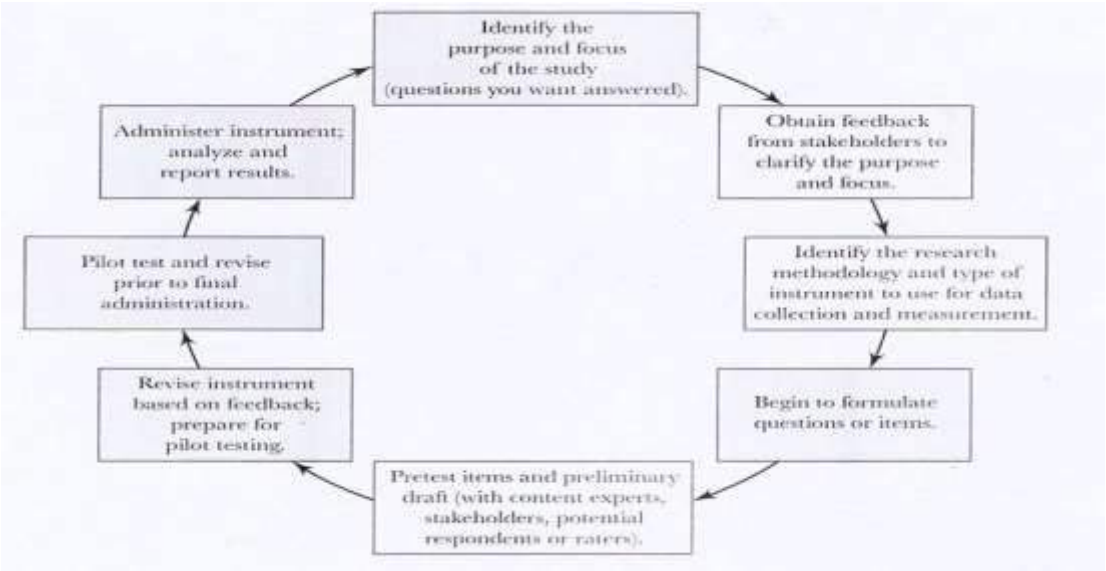
This feedback is used to determine whether the items make sense and are unambiguous and whether the information you obtain from the items will provide you with the information you want. This feedback can also assist in identifying problems with instrument administration. Do individuals who will use an observational instrument agree on the meaning of the items and what they are supposed to observe and report?

(vii) Organize and format the instrument- At this stage you are ready to organize items so that they flow in a logical order, and depending on the purpose of the instrument, you may need to consider the content of the instructions and the demographic section.

(viii) Activity review and check- Typically, you will want to pretest the instrument as a complete document rather than item by item. This pretest determines how long it takes to complete the instrument and identifies places where respondents or raters had difficulty completing the instrument due to bottlenecks or confusing items or instructions. This is an important activity, as an incomprehensible or awkwardly formatted instrument may result in a low response rate (for a survey questionnaire) or unreliable data (for a checklist or behavior rating instrument).

(ix) Administer and revise the instrument- Even though you have taken steps to correct problems during instrument design and construction, the responses from the first administration may suggest improvements, and you may find that the instrument requires further revision if you intend to use it again. Such revision is a common activity with instruments used to measure performance, as repeated administrations will certainly highlight shortcomings or portions of the instrument that need to be corrected. You may find problems in the administration of the instrument that can be improved as well.

Figure 5.2: Steps in the Instrument Construction Process



Exercise 5.1

Question1 Define Questionnaire?

Question 2 Explain the steps in the construction of a Questionnaire?

Question 3 What do you understand by instrument in research?

5.4 Summary

In this chapter we have studied about questionnaire and the steps involved in the construction of a questionnaire. We also discussed about Instrument, and listed the steps in the instrument construction process. A questionnaire is a form containing a set of questions, which are filled by the respondents. Instrument construction is an iterative process— as you will find yourself repeatedly revising and refining the instrument in response to feedback—and therefore it is an activity that is both technical and creative.

5.5 Glossary

- **Questionnaire-** A questionnaire is a form containing a set of questions, which are filled by the respondents. According to Goode Hatt, “in general, the questionnaire refers to a device for securing answers to questions by using a form which the respondent fills in himself.”
- **Questionnaire Design-** Questionnaire design is a multiple-stage process that requires attention to many details at once. Designing the questionnaire is complicated because surveys can ask about topics in varying degrees of detail, questions can be asked in different ways, and questions asked earlier in a survey may influence how people respond to later questions. Researchers also are often interested in measuring change over time and therefore must be attentive to how opinions or behaviors have been measured in prior surveys.
- **Instrument-** An instrument is a mechanism for measuring phenomena, which is used to gather and record information for assessment, decision making, and ultimately understanding. An instrument such as a questionnaire is typically used to obtain factual information, support observations, or assess attitudes and opinions.
- **Research-** Research in common parlance refers to a search for knowledge. One can also define research as a scientific and systematic search for pertinent information on a specific topic

5.6 Self Assessment Test

Exercise 5.1

Answer 1: Refer to section 5.2
Answer 2: Refer to section 5.3
Answer 3: Refer to section 5.4

5.7 Terminal Questions

Question 1 Explain the steps involved in constructing a questionnaire?

Question 2 Explicate the procedure of constructing an instrument?

5.8 Suggested Readings

1. Goode and Hatt, Research Methodology, Prentice Hall Publications, 1959.

2. Kothari, C.R. Research Methodology, Methods and Techniques, New Age International Publisher.

3. Donald R. Cooper and Pamela S. Schindler, Business Research methods, 9th Edition, Tata McGraw Hill, 2006.

4. Ghosh, B.N. Research Methodology, Himalayan Publishing House, New Delhi.

5. Alan Bryman and Emma Bell, Business Research methods, Oxford University Press, New Delhi, 2008.

6. Uma Sekaran, Research methods for Business, Wiley India, New Delhi, 2006.

7. K. N. Krishnaswamy, Appa Iyer Sivakumar and M. Mathirajan, Management Research Methodology, Pearson Education, New Delhi, 2006.

8. Sadhu A.N. and A. Singh, Research Methodology in Social Sciences, Himalaya Publishing House.

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LESSON 6

SAMPLING

STRUCTURE

6.0 Objectives

After going through this lesson you will be able to:

- Define Sampling
- Explain sample size and determinants of optimal sample size
- Elucidate Sampling Techniques
- Explicate Probability Vs Non- Probability sampling methods

6.1 Introduction

The primary purpose of any research effort is to look for solutions to problem with the intention of discovering principles having universal application. However to establish universality it is neither economical nor operationally feasible to study the entire target population. Hence an alternative is to develop a sample out of the universe in such a manner that it truly represents the characteristics of the universe. Such a sample allows

a researcher to valid inferences or generalization on the basis of careful observation of variables within a relatively small proportion of the population. It is therefore necessary that care should be taken while drawing a sample. The current chapter introduces us to some of the basic concepts pertinent to the sample, sample size and sampling method.

6.2 Sampling plan

A sampling plan is the detailed outline of which measurements will be taken at what times, in what manner and by whom. The development of a sampling plan follows the selection of the research approach and the instruments that will be used to collect data. The processes that are involved in identifying and obtaining a sample are known collectively as the sampling plan. The steps involved in a sampling plan are:

1. **Define Sample-** sample unit is the basic level of the population that the researcher wants to measure. It may be element itself i.e., the object on which measurements are taken or a unit in which element is contained.
2. **Obtain a sample frame-** Once the unit is correctly defined, the researcher needs to obtain a sample frame. A sample frame is a complete list of the population from which the sample is selected. A map, a telephone directory, census records etc are examples of sample frame.
3. **Determine the sample size-** the sample size directly affects how accurate the findings, but it is also more expensive. So, how do we determine the sample size? As explained earlier keeping in mind statistical and non-statistical factors determine the sample size.
4. **Decide method of sampling-** There are two different techniques of sampling, probability and non-probability. Probability sampling methods are those wherein the samples are gathered in a process that gives all the individuals in the population equal chances of being selected. Sample units are selected from the population at random using probabilities methods. Non-probability methods are subjective, and the probability cannot be calculated.
5. **Asses the sample-** The final step is the assessment of the sample to ensure quality sample sources are used. If the assessment fails, re-sampling should be done.

6.3 Sample size

The question of how large a sample should be is a difficult one. Sample size can be determined by various factors (like time, funds, manpower, population size, purpose of study etc. For example, if the available funds for study are limited then the researcher may not be able to spend more than a fixed proportion of the total fund available with him/her. In general, sample size depends on the nature of the analysis to be performed, the desired precision of the estimates one wishes to achieve, number of variables that have to be examined simultaneously and how heterogeneous is the population spread.

Moreover, technical considerations suggest that the required sample size is a function of the precision of the estimates one wishes to achieve, the variance of the population and statistical level of confidence one wishes to use. The higher the precision and confidence level required, the larger the sample size should be.

6.3.1 Determinants optimal sample size

One of the most common question which is asked in sampling is asked "How large a sample should be?" The answer depends on a number of statistical and non-statistical factors.

(A) Statistical Factors

1. **Nature of Population-** The nature of population means the degree of heterogeneity present in it. The greater the heterogeneity in the population the bigger should be the sample and vice-versa. The size of sample also depends on how much variance do we expect in responses? The safe decision is to use 5. This is the most forgiving number and ensures that your sample will be large enough.
2. **Level of precision (Confidence Interval) -** No sample can be perfect, so we need to decide how much error to allow. The confidence interval determines how much higher or lower than the population mean we are willing to let our sample mean fall. Thus, if a survey finds the 70% of people have voted in favour of the ruling party in the elections. Samples have adopted a recommended practice with a precision rate of $\pm$ 5%, then we can conclude that between 65% and 75% of people in the population have voted in favour of ruling party.
3. **Confidence Level-** How confident do you want to be that the actual mean falls within your confidence interval? The most common confidence intervals are 95% confident and 99% confident. If we select 95% level of confidence, this means that, 95 out of 100 samples will have the true population value within the range of precision specified earlier.

(B) Non- Sampling Factors

1. **Nature of Study-** For intensive study small samples are enough but in case of extensive large samples are required.
2. **Resources Available-** Large the samples larger is the precision in information. If we have much time and money available a big sample should be taken.

3. **Method of Sampling-** method of sampling also effect the sample size. The probability sampling methods need smaller samples sizes whereas in case of non-probability methods sample size should be large.
4. **Nature of Respondents-** The size of the sample should be big researcher expects a high non-response rate. Otherwise a small sample can serve the purpose.

6.4 Sampling techniques available.

To select a representative sample different techniques are. These techniques can be divided into two groups namely Probability Sampling Methods and Non-Probability Sampling Methods.

6.4.1 Probability Vs Non–probability sampling methods.

1. **Probability Sampling Methods-** Probability Sampling Methods also called random Sampling method. In probability sampling if the sampling process is random the law of probability can be applied. It is to be remembered that the term random sample is not used to describe the data in the sample but the process employed to select the sample. Randomness is thus a property of the sampling procedure. Major forms of Probability Sampling Methods are (i) Simple random sampling (ii) Stratified Random Sampling (iii) Systematic Random Sampling (iv)Multistage Random Sampling (v) Cluster Sampling. We discus each of them

(i) Simple random Sampling- The most commonly used random sampling method is simple random sampling method. A simple random sample is one in which each item in the total population has an equal chance of being included in the sample. In addition, the selection of one item for inclusion in the sample should in no way influence the selection of another item. Simple random sampling should be used with a homogeneous population, that is, a population consisting of items that possess the same attributes that the researcher is interested in. The characteristics of homogeneity may include such as age, sex, income, social/religious/political affiliation, geographical region etc. For random sampling we use certain methods. Most important among them are:

(a) **Lottery Method-** In this method the numbers of all the elements of the universe are written on different tickets or pieces of papers of equal size. Then all these tickets are put in a pot or box and thoroughly shuffled. Then the tickets are drawn at a random, their numbers noted and the corresponding individuals or objects are studied. The number of tickets drawn is equal to sample size.

(b) **Table of Random Numbers**- A random number table consists of a group of digits that are arranged in random order i.e. rows, table and diagonals of table contain digits which are not in a systematic order. Manny random number tables are there

like Tippet's table, Fisher and Yate's table, Kendall and Raington table etc. Among all these tables, Tippet's table is widely used. There are 41600 numbers in Tippett's table and it is of the form

2952	6641	3992	9792
3170	5524	4167	9525
7203	4356	1300	2693
3408	2762	3536	6107

Suppose from 100 units 10 units are to be selected. Then from Tippett's table the units of 29. 31, 72, 34, 66, 55, 43, 27, 39, 41 numbers can be selected. For selecting units one can move vertically, horizontally or diagonally in Tippett's table.

(c) **Grid Systems-** This method is generally used for selecting sample of an area. In this method a map of area is drawn. After that screen of squares is placed upon the map and some of the squares are selected at random. The area falling within the selected squares are taken as examples.

(ii)Stratified Random Sampling

The stratified sampling method is used when the population is heterogeneous rather than homogeneous. A heterogeneous population is composed of unlike elements such as male/female, rural/urban, literate/illiterate, high income/low income groups, etc. In such cases, use of simple random sampling may not always provide a representative sample of the population. In stratified sampling, we divide the population into relatively homogenous groups called strata. Then we select a sample using simple random sampling from each stratum. There are two approaches to decide the sample size from each stratum, namely, proportional stratified sample and disproportional stratified sample. With either approach, the stratified sampling guarantees that every unit in the population has a chance of being selected. The stratified sampling method is used when the population is heterogeneous rather than homogeneous. A heterogeneous population is composed of unlike elements such as male/female, rural/urban, literate/illiterate, high income/low income groups, etc. In such cases, use of simple random sampling may not always provide a representative sample of the population. In stratified sampling, we divide the population into relatively homogenous groups called strata. Then we select a sample using simple random sampling from each stratum. There are two approaches to decide the sample size from each stratum, namely, proportional stratified sample and disproportional stratified sample. With either approach, the stratified sampling guarantees that every unit in the population has a chance of being selected. We will now discuss these two approaches of selecting samples.

a. **Proportional Stratified Sample:** If the number of sampling units drawn from each stratum is in proportion to the corresponding stratum population size, we say the sample is proportional stratified sample.

b. **Disproportional Stratified Sample:** In a disproportional stratified sample, sample size for each stratum is not allocated on a proportional basis with

the population size, but by analytical considerations of the researcher such as stratum variance, stratum population, time and financial constraints etc.

(iii) Systematic Sampling

Systematic sampling is a very versatile and simple form of probability sampling. In this method every n^{th} item within a defined population is selected in the sample. It involves beginning with a random start of an element in the range of 1 to n. The sample ratio vis-à-vis the total number of entries is worked out and after a random start every n^{th} item is chosen e.g. every 20^{th} person in the list or every 10^{th} house could be chosen as a part of the sample.

Major advantage of the systematic sampling is that there is no need to assign a unique number to each element or use random number tables. It s statistically more efficient if the population elements have similar characteristics. The systematic sampling suffers from two major drawbacks viz., periodicity and monotonic trend. In case there is periodicity in the population that coincides with the sampling ratio, then the randomness is lost e.g. if systematic sampling is used to generate weekly store sales from a sampling frame containing weekly sales of past two years and the sample interval is 7, then the sample would not affect the weekly variation in sales. This is because the sample interval coincides with the period of data collection. The second problem arises if there is a 'monotonic trend' in population i.e. the sampling frame has been arranged in some order like a chronological order or from smallest to largest etc. e.g. the population of India's software industry comprises of 3000 companies which have been arranged from the smallest to largest order and a sample of 100 is drawn with a sample of 15. Let the draw start randomly from a company listed on number 12. Then drawing every 15^{th} company would exclude the top or largest companies from the sample.

(iv) Multistage Random Sampling

We have already covered two stage sampling. Multi stage sampling is a generalization of two stage sampling. As the name suggests, multi stage sampling is carried out in different stages. In each stage progressively smaller (population) geographic areas will be randomly selected. For example, we want to select 3000 households from Punjab. At first stage, the state may be divided into districts and few districts are selected at random. At the second stage districts may be divided into blocks and sample of blocks may be chosen. In the third stage blocks may be subdivided into villages and a sample of villages may be taken at random and finally 3000 households may be selected from the villages.

(v) Cluster Sampling

In cluster sampling, groups of elements that are ideally speaking, are heterogeneous in nature within group, are chosen randomly. Unlike stratified sampling where groups are homogenous and few elements are randomly chosen from each group, in cluster sampling the group with intra group heterogeneity are developed and all the elements within the group become a part of the sample. Whereas stratified sampling has intra group homogeneity and inters group heterogeneity, cluster sampling has intra group heterogeneity e.g., a committee comprising of number members from different departments has a high degree of heterogeneity. When from number of such committees, few are chosen randomly, and then it is a case of cluster sampling.

This is an example of one stage cluster sampling. If from each cluster which has been randomly chosen, few elements are chosen randomly using simple random sampling or any other probability method then it is a two stage cluster sampling. A cluster sample can be a multiple stage sampling, when the choice of element in a sample involves selection at multiple stages e.g. if in a national survey on insurance products a sample of insurance companies is to be drawn, then it requires developing clusters at multiple stages. In the first stage the clusters are formed on the basis of public and private companies. At the next stage a group of companies is chosen randomly from each cluster developed earlier. In the third stage the office location of each chosen company from where data is to be collected is chosen randomly. Thus in multistage sampling, probability sampling of primary units is done, then from each primary unit a sample of secondary sampling units is drawn and then the third level, till we reach the final stage of breakdown for the sample units.

2 Non Probability Sampling

Non-probability sampling methods ate those wherein the samples are gathered in a process that does not give all the individuals in the population equal chances of being selected. In non-probability sampling, the selection of the subjects is arbitrary or subjective. The sample is selected in such a way that the chance of being selected of each unit within the population or universe is unknown. Major forms of non probability Sampling methods are (i) Convenience Sampling (ii) Judgment Sampling (iii) Extensive Sampling (iv) Snowball Sampling (v) Quota Sampling

(i) Convenience Sampling

The most common type of non probability sampling done without any restrictions is convenience sampling. In this the researcher has the freedom of choosing any respondent based on his convenience. Respondents become a part of the sample because they happen to be at the right place and at the right time, e.g. in surveys conducted at a retail outlet or shopping mall interviews, people who happen to be at these places at the time the response was being taken become a part of the sample. Convenience sampling is an economical method and is generally used in exploratory phase of a research project. The sampling units are cooperative, easily accessible and

reachable. However convenience sampling suffers from the drawback like bias, less precision and lack of proper representation of the population.

(ii) Judgment Sampling

It is kind of purposive sampling where those respondents are deliberately made a part of a sample, by virtue of their position, knowledge or any other criteria, which meet research purpose. In this case the researcher uses his own judgment and expertise to decide who would be a part of the sample e.g. if a survey is being conducted on finding out what it takes to be a student union leader, then it is the people who are in this position i.e. student union leaders, or those who frequently interact with such people, who can give first hand information. This method is particularly suitable when only a limited number of people have access to the knowledge or information required for research. This sampling does not allow for generalizability to a specific population since it does not represent a population explicitly.

(iii) Quota Sampling

This method is used when a researcher needs certain group to be adequately represented. In this, groups are created which are homogenous with respect to certain characteristics within group. A quota is fixed for each group and sample units are drawn from the group. The quota sampling is similar to stratified sampling except for the fact that no sampling frame is used and sample units are drawn on convenience basis instead of random basis. The researcher while drawing the sample, using this method, tries to ensure that the composition of sample is the same as the composition of population with respect to the characteristics of interest. It is also possible to assign quotas to a group which is greater than the proportion of that group in the population e.g. while studying consumer behavior it may be desirable to oversample heavy users of a product so that their behaviour can be studied in detail. Quota sampling tries to make the sample representative at a low cost.

(iv) Snow Ball Sampling

In this a set of respondents are selected initially and interviewed. After this, these respondents are asked to list the names of other people who in their opinion are a part of the target population. Thus it is like setting the ball in motion whereby referrals are obtained from referrals, thus creating a snow ball effect which keeps on growing in size as it rolls down. It has been seen that people referred by the respondents have greater demographic and psychographic characteristics similar to them than try would occur by chance. This technique has the advantage of locating right people with the desired characteristics at a low cost.

(v) Extensive Sampling

In this sampling, sample size is taken almost as big as population itself like 90% the section of the population. Only those units are left out for which data collection is very difficult or almost impossible. Due to very large sample size, the method has greater level of accuracy. Intensive study of the problem becomes possible but this method involves heavy resources at disposal.

Exercise 6.1

Question 1 Briefly explain the following terms:

(a) Probability Sampling (b) Stratified Sampling

(c) Judgment Sampling (e) snowball Sampling

Question 2 What is the difference between probability and non-probability sampling?

6.6 Summary & Conclusion

In this chapter we discussed sampling, sampling size and various sampling techniques which include probability and non probability techniques. A sample is a part of population. In other words, selected or sorted units from the population are known as a sample. In fact, a sample is that part of the population which we select for the purpose of investigation. Probability Sampling Methods are also called random Sampling method. In probability sampling if the sampling process is random the law of probability can be applied. It is to be remembered that the term random sample is not used to describe the data in the sample but the process employed to select the sample. Various probability techniques are (i) Simple random sampling (ii) Stratified Random Sampling (iii) Systematic Random Sampling (iv) Multistage Random Sampling (v) Cluster Sampling. Non-probability sampling methods on the other hand are those wherein the samples are gathered in a process that does not give all the individuals in the population equal chances of being selected. In non-probability sampling, the selection of the subjects is arbitrary or subjective. The sample is selected in such a way that the chance of being selected of each unit within the population or universe is unknown. major forms of non probability techniques are (i) Convenience Sampling (ii) Judgment Sampling (iii) Extensive Sampling (iv) Snowball Sampling (v) Quota Sampling.

6.7 Glossary

- **Sample-**A part of population is called a sample. In other words, selected or sorted units from the population are known as a sample. In fact, a sample is that part of the population which we select for the purpose of investigation.
- **Quota Sampling-** This method is used when a researcher needs certain group to be adequately represented. In this, groups are created which are homogenous with respect to certain characteristics within group. A quota is fixed for each

group and sample units are drawn from the group. The quota sampling is similar to stratified sampling except for the fact that no sampling frame is used and sample units are drawn on convenience basis instead of random basis.

- **Multistage Sampling-** Multi stage sampling is a generalization of two stage sampling. As the name suggests, multi stage sampling is carried out in different stages. In each stage progressively smaller (population) geographic areas will be randomly selected. For example, we want to select 3000 households from Punjab. At first stage, the state, may be divided into districts and few districts are selected d at random. At the second stage districts may be divided into blocks and sample of blocks may be chosen. In the third stage blocks may be subdivided into villages and a sample of villages may be taken at random and finally 3000 households may be selected from the villages.
- **Probability Sampling-** Probability Sampling Methods also called random Sampling method. In probability sampling if the sampling process is random the law of probability can be applied. It is to be remembered that the term random sample is not used to describe the data in the sample but the process employed to select the sample.
- **Non-Probability Sampling-** Non-probability sampling methods ate those wherein the samples are gathered in a process that does not give all the individuals in the population equal chances of being selected. In non-probability sampling, the selection of the subjects is arbitrary or subjective. The sample is selected in such a way that the chance of being selected of each unit within the population or universe is unknown.

6.8 S elf Assessment Test

Exercise 6.1

Answer 1: Refer to section 6.4.1

Answer 2: Refer to section 6.4.1

6.9 Terminal Questions

Question 1 Define Sampling? Explain various sampling methods.

Question 2 What is the difference between Probability and Non-Probability method Sampling?

10.10 Suggested Readings

1. Goode and Hatt, Research Methodology, Prentice Hall Publications, 1959.

2. Kothari, C.R. Research Methodology, Methods and Techniques, New Age International Publisher.

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LESSON 7

PROCESS OF DATA ANALYSIS

Structure

7.0 Objectives

After going through this lesson you will be able to:

- Evaluate the steps involved in processing of data,
- Define the terms: Editing, Coding, and Tabulation
- Describe various types of diagrams and illustrate how to present the data through an appropriate diagram,

7.1 Introduction

The data collection stage is followed by the processing of data. The data, after collection, has to be processed and analyzed in accordance with the outline laid down for the purpose at the time of developing the research plan. This is essential for a scientific study and for ensuring that we have all relevant data for making contemplated comparison and

analysis. The data collected from the field has to be processed as laid down in the research plan. This is possible only through systematic processing of data. Data processing involves editing, coding, classification and tabulation of the data collected so that they are amenable to analysis. This is an intermediary stage between the collection of data and their analysis and interpretation. In this chapter, therefore, we will learn about different stages of processing of data in detail.

7.2 Process of data analysis

Processing of data refers to the task of consolidation, editing, and regrouping of data. Details regarding data processing should be included in the research design itself so that chances of encountering problems in data analysis are reduced to a considerable extent. While planning for data processing, the researcher should try to correlate the techniques of data processing with the nature of data. During this stage there is a need for the researcher to be continuously in touch with the codes and staffers responsible for the data processing. Data processing is done in three distinct stages: (i) Editing (ii) Coding (iii) Tabulation. We discuss the three of them one by one in detail in the following paragraphs.

7.2.1Editing

Editing is the first step in data processing. Editing is the process of examining the data collected in questionnaires/schedules to detect errors and omissions and to see that they are corrected and the schedules prepared for tabulation. In other words editing of data is a process of examining the collected raw data(specially in surveys) to detect errors and omissions and to correct these when possible. As a matter of fact, editing involves a careful scrutiny of the completed questionnaires and/or schedules. Editing is done to assure that the data are accurate, consistent with other facts gathered, uniformly entered, as complete as possible and have been well arranged to facilitate coding and tabulation.

Editing is done with the objective of achieving the following:

i**) Completeness-** It ensures that there is no answer left incomplete, no section left unattempted. In case of any blank question, it is important to understand the reason for this i.e., is it to due oversight on the researcher's part or is it due to unwillingness of the respondent to answer the question. In some situation the response to the blank questions can be deduced from other data on the questionnaire. In this case of interview schedule, the interviewer may be able to fill it from the memory.

ii) Comprehensibility- An answer may not convey anything specific or the researcher may not be able to comprehend it. In such a situation the researcher should immediately get in touch with the concerned field.

(iii) Consistency- If the answers show too much inconsistency between themselves it is a cause for concern. Editing looks out for such inconsistencies so that they can be

corrected. If the level of inconsistency is too high, then it indicates carelessness in administration of the instrument or ambiguity in the instrument.

(iv) Regularity- It refers to uniformity in asking the questions and recording the answers. Regularity ensures that there is no basis in the data collected. Generally if the interviewer sticks to the exact wording of the questions, chances of irregularity is reduced. Similarly in certain situations respondents may not be able to give factually correct answers e. g., illiterate people may not know their exact age however they may be able to quote their birth in terms of major event e.g., a war that happened in the year they were born. In such a situation the interviewer should record the answer as given by the respondent and leave the interpretations for the later date.

Editing is done in two stages (i) Field Editing and (ii) Central editing

(i) **Field Editing**- It is done immediately after the instrument has been administered. Field editing removes any glaring errors and omissions in the questionnaire form. Common problems like use of ad hoc abbreviations, special symbols should be interpreted into complete answers immediately so that their true meaning is not lost. In case the context of the answer cannot be recollected then the alternative is to make an immediate callback. Through field editing, the objectives mentioned above i.e., completeness, comprehensibility, consistency and regularity are established in the data. If the survey is a small one, the field editing is done by the researcher himself and in case of large projects the field editing is done by the field supervisor.

(ii) **Central editing-** The field editing is followed by central editing, which is a more complete and exacting scrutiny and correction of the completed returns. Central editing is more thorough in nature and is generally conducted by a single editor, so that high level of consistency is maintained. In case of large projects, more than one editor may be employed; however each editor is assigned a section of the instrument. This way there will be no inconsistency within each section. However inconsistency in answers between different sections will not be spotted, hence one editor can be appointed specifically for looking into such a problem.

7.2.2 Coding

Coding is a process/operation by which data/responses are organized into classes/ categories and numerals or other symbols are given to each item according to the class in which it falls. In other words, coding involves two important operations (i) deciding the categories to be used and, (ii) allocating individual answers to them. These categories should be appropriate to the research problem, exhaustive of the data, mutually exclusive and undimensional. Since coding eliminates much of information in raw data, it is important that the researcher design category set carefully in order to utilize the available data more fully.

The study of the answer is the first step in coding. In case of pre coded questions, coding begins at the preparation of interview schedules. Secondly, coding frame is

developed by listing the possible answers to each questions and assigning code numbers or symbols to each of them which are the indicators used for coding. The coding frame is an outline of what is coded and how it is to be coded. That is, a coding frame is a set of explicit rules and conventions that are used to base classification of observations variables into values which are transformed into numbers. Thirdly, after preparing the sample frame the gradual process of fitting the answers to the questions must be begun. Lastly, transcription sheet is large. Transcription may not be necessary when only simple tables are required and the numbers of respondents are few.

Rules of Coding

(i) Give code numbers for each respondent for identification. Generally while giving identification number, different digits are used to identify the area, institution and the department also.
(ii) Give code numbers for each question.
(iii) Give code numbers for each response. In this context categorization assumes significance.
(iv) Give numbers for qualitative responses also.
(v) Do not delegate the work of categorization to others. The researcher himself should undertake the work, because categorization is not a routine work.
(vi) Prepare the coding frame.
(vii) Decide on the instructions to coders.
(viii) Prepare and supply coders, instruction manual.
(ix) May take the services of trained coders with close supervision.
(x) Carefully scrutinize every coded item in the initial stages of coding.
(xi) Afterwards have a random checking of the coded names.
(xii) The researcher himself should decide on any change in coding due to change in the nature of data or importance of data after collection.

Coding of Open Questions: Coding the responses of open questions is always a difficult task. Sometimes, the responses are recorded verbatim. In such cases, note the basic or essential aspect of the possible responses. Give a number to each aspect. Clarify each response according to the basic content and code them accordingly.

Coding of Don't Know/No Opinion Responses: In some cases, these answers themselves become significant meaning something. For instance, in a study to measure the knowledge of the respondent of the work of the institution, no knowledge is significant. Similarly, in opinion surveys, no opinion may mean neutrality. In such cases, give a number for such response and accordingly proceed with the analysis.

In other cases, where no answer does not mean anything if the number of responses is too small, ignore them. On the other hand, if the responses to many questions are such, the researcher may not get adequate data. In such cases, examine the reasons for no answer. If it is due to unwillingness on the part of the respondent, change the wordings carefully so as to extract the response. It is due to the inefficiency of the interviewer, change the interviewer. Pilot study and pre-testing help this.

Codes can be recorded on the questionnaire/schedules themselves. In such cases record the code numbers in the margin with colour pencils. Transcription sheets can also be used for recording the codes. Though it amounts to duplication, it will facilitate further analysis. However, pre coding will avoid the use of transcription sheets.

7.2.3 Tabulation

Presentation of collected data in the tabular form is one of the techniques of data presentation. The two other techniques are diagrammatic and graphic presentation. Arranging the data in an orderly manner in rows and columns is called tabulation of data. Sometimes data collected by survey or even from publications of official bodies are so numerous that it is difficult to understand the important features of the data. Therefore it becomes necessary to summarize data through tabulation to an easily intelligible form. It may be noted that there may be loss of some minor information in certain cases, but the essential underlying features come out more clearly. Quite frequently, data presented in tabular form is much easier to read and understand than the data presented in the text.

Tables can be divided into: (i) Frequency tables, (ii) Response tables, (iii) Contingency tables, (iv) Univariate tables, (v) Bivariate tables, (vi) Statistical tables, and (vii) Time series tables.

Generally a research table has the following parts: (a) table number, (b) title of the table, (c) caption, (d) stub (row heading), (e) body, (f) head-note, (g) foot-note.

As a general rule the following steps are necessary in the preparation of the table:

(i) **Title of the table-** The table should be first given a brief, simple and clear title which may express the basis of classification.
(ii) **Columns and Rows-** Each table should be prepared in just adequate number of columns and rows.
(iii) **Captions and Stubs-** The columns and rows should be given simple and clear captions and stubs.
(iv) **Ruling-** Columns and rows should be divided by means of tin or thick rulings
(v) **Arrangement-** Comparable figures should be arranged side by side.
(vi) **Derivations-** These should be arranged in the column ner the original data so that their presence may easily be noted.
(vii) **Size of Columns-** This should be according to the requirement.
(viii) **Arrangement of items-** This should be according to the problem.
(ix) **Special Emphasis-** This can be done by writing important data in bold or special letters.
(x) **Unit of measurement-** This unit should be noted below the line.
(xi) **Approximation-** This should also be noted below the title.
(xii) **Foot-notes-** These may be given below the table.
(xiii) **Total-** Totals of each column and grand total should be one line.

It is not always necessary to present facts in form if they can be presented more simply in the body of the text. Tabular presentation enables the reader to follow quickly than textual presentation. A table should not merely repeat information

covered in the text. The same information should not, of course, be presented in tabular form and graphical form. Smaller and simpler tables may be presented in the text while the large and complex tables may be placed at the end of the chapter or report.

Types of Tabulation

Evaluation can be simple one way tabulation or it can be complex cross tabulation.

(a) **Simple Table-** One way tables are best used to depict the frequency of a variable than with studying its correlates. Other than frequency, the one way tabulation may also depict percentages e.g. a table showing the number of workers across wage groups in a firm can be depicted as:

Table 7.1 Frequency Distribution of Daily Wages of 65 Labourers

Daily Wages of Labourers (Rs)	**No. of Labourers**
20-30	2
30-40	5
40-50	21
50-60	19
60-70	11
70-80	5
80-90	2
Total	65

Table 7.1 shows the wage group in column 1, number of labourer in column 2.

Simple table's offers number of uses:

(i) It helps in communicating the results of the study. The frequency associated with each class of the variable can be studied through one-way table.

(ii) The degree of item non-response can be determined. The number of survey instruments having the problem of non-response can be determined.

(iii) One way tabulation also locates blunders. Blunders refer to errors made in the process of editing, coding or tabulating the data. E.g. if the number of workers in a particular category has been read as '3' instead of '8' then such

an error will be revealed by the one-way table since the workers total will not sum up to the total surveyed.

(iv) It is possible to locate outliers in the data. Outliers refer to observing those values which are entirely different in magnitude from the rest of the observations that the researcher treats them as special case. In tabulation such observations can easily be spotted and then they can either be eliminated or they may demand a deeper analysis with the cause of such observations.

(b)**Complex Table –** This is formed on the basis of more than one quality or characteristics, e.g., distribution of students on the basis of sex and marks obtained, etc. If complex table is based on two qualities it is called two-way table and if it is based on three qualities, it is named as three-way table. If there are more than three qualities, it is called manifold-table.

Table 7.2 Wages and Number of Workers in Different Plants

Wages	Number of Workers		Total Number of workers
	Plant A	Plant B	
0-1000	07	01	08
1000-2000	10	09	19
2000-3000	11	16	27
3000-4000	05	10	15
4000-5000	02	09	11
Total	35	45	80

Table 7.3 gives a more detailed comparison showing that there are more workers (45) employed in plant b than in plant A. Further workers in plant A are primarily working on wages less than Rs. three thousand whereas there are very few workers in the wage group of Rs. 0-2000 in Plant B. This helps is in answering questions like; Does the number of workers in each plant differ on wage distribution? Thus data is represented across two variables i.e., wages and plant. The table can further be made in a greater detail to introduce a third variable e.g. gender, as shown in table 7.3

Table 7.3 Wages distribution in workers across gender and plant in a firm

Number of Workers									
Wages	Plant A			Plant B			Total		
Rupees	M	F	Total	M	F	Total	M	F	Total
0-1000	04	03	07	01	00	01	05	03	08
1000-2000	05	05	19	06	03	09	11	08	19
2000-3000	08	03	11	11	05	16	19	08	27
3000-4000	02	03	05	06	04	10	08	07	15
4000-5000	00	02	02	05	04	09	05	06	11
Total	19	16	35	29	16	45	48	32	80

Thus complex table makes it possible to represent large number of variables and express relationship among the variables as well as between the variables.

Methods of Tabulation

(i) Hand Tabulation- When the survey is a small survey and a few questionnaires are filled in, it is simple to sort them out manually. Generally cards are used in collecting information. A card is a thick paper in which collected information is recorded as it is or in a coded manner. The questionnaire or cards are put in different lots, for example, we can sort them out (i) male workers and (ii) female workers. We can count them out and get the desired information.

(ii) Mechanical Tabulation- It is used when there are a large number of questionnaires involved in a survey. Mechanical sorting and tabulation help us to organize the work speedily and accurately. But the system is pretty costly and can be used only when the study is very extensive.

7.2.4 Diagrams

As you know, diagrammatic presentation is one of the techniques of visual presentation of statistical data. It is a fact that diagrams do not add new meaning to the statistical facts but they reveal the facts of the data more quickly and clearly. Because, examining the figures from tables becomes laborious and uninteresting to the eye and also confusing. Here, it is appropriate to state the words of M. J. Moroney, “cold figures are uninspiring to most people. Diagrams help us to see the pattern and shape of any complex situation.” Thus, the data presented through diagrams are the best way of

appealing to the mind visually. Hence, diagrams are widely used in practice to display the structure of the data in research work.

(a) Rules for Preparing Diagrams

As we have discussed earlier, the prime objective of diagrammatic presentation of data is to highlight their basic hidden facts and relationships. To ensure that the presentation of numerical data is more attractive and effective, therefore, it is essential to keep the following general rules in mind while adapting diagrams in research work. Now, let us discuss them one by one.

1) You must have noted that the diagrams must be geometrically accurate. Therefore, they should be drawn on the graphic axis i.e., 'X' axis (horizontal line) and 'Y' axis (vertical line). However, the diagrams are generally drawn on a plain paper after considering the scale.

2) While taking the scale on 'X' axis and 'Y' axis, you must ensure that the scale showing the values should be in multiples of 2, 5, 10, 20, 50, etc.

3) The scale should be clearly set up, e.g., millions of tons, persons in Lakhs, value in thousands etc. On 'Y' axis the scale starts from zero, as the vertical scale is not broken.

4) Every diagram must have a concise and self explanatory title, which may be written at the top or bottom of the diagram.

5) In order to draw the readers' attention, diagrams must be attractive and well proportioned.

6) Different colours or shades should be used to exhibit various components of diagrams and also an index must be provided for identification.

7) It is essential to choose a suitable type of diagram. The selection will depend upon the number of variables, minimum and maximum values, objects of presentation.

(b) TYPES OF DIAGRAMS

Generally, diagrams are classified on the basis of their length, width and shape. There are various types of diagrams namely, one dimensional diagrams, two dimensional diagrams, three dimensional diagrams, charts, pictograms, cartograms etc. However, in this chapter, we will discuss the important types of diagrams, which are more frequently used in social science research in general, particularly in business research. Therefore, we have restricted ourselves to study only one dimensional bar diagrams, pie diagrams, and structure diagrams.

(i) Bar Diagram- The bar diagram uses bars whose length is used to represent the data. The width of each bar is supposed to be uniform. The bars can be represented vertically or horizontally. A good bar diagram is accompanied by the figures against

each bar in order to make it more clear and representable. A bar diagram can have a single bar or can have divided or multiple bars.

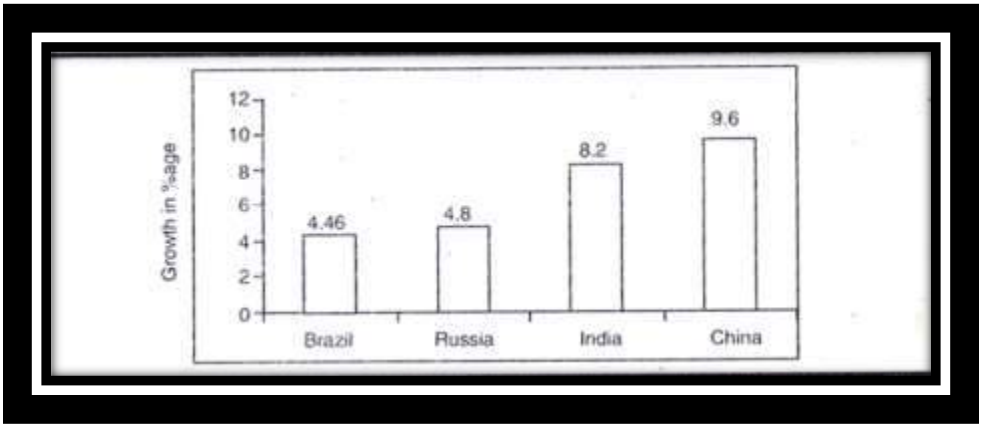
Illustration 1: The following table represents the growth rate in percentage of the BRIC nations for the year 2011.

Country	Growth Rate in %age
Brazil	4.46%
Russia	.4.8%
India	8.2%
China	9.6%

Represent the following data using a suitable diagram

Solution:

Figure 7.1: Growth Rate of BRIC Countries



The data has been represented using a simple bar diagram and the length of each bar is descriptive of the growth rate of each of the BRIC countries.

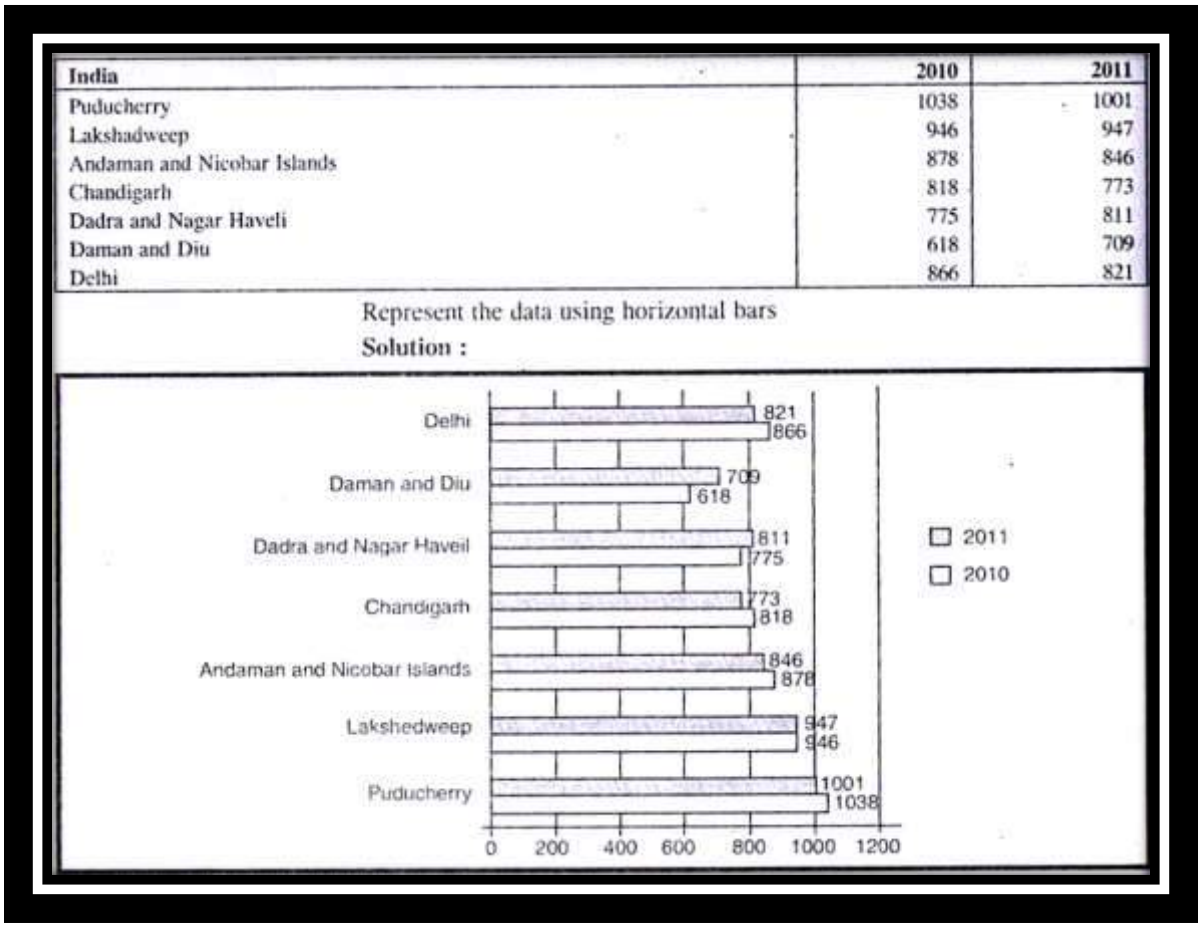
Illustration 2: The sex ratio of India given as number of females per 1000 males for the seven union territories of India for the year 2010 and 2011 is as follows:

India	**2010**	**2011**
Pondicherry	1038	1001
Lakshadweep	946	947
Andaman and Nicobar Islands	878	846
Chandigarh	818	773
Dadra and Nagar Haveli	775	811
Daman and Diu	618	709
Delhi	866	821

Represent the data using horizontal bars.

Solution:

Figure 7.2: Sex Ratio in India for 2010 and 2011



India	2010	2011
Puducherry	1038	1001
Lakshadweep	946	947
Andaman and Nicobar Islands	878	846
Chandigarh	818	773
Dadra and Nagar Haveli	775	811
Daman and Diu	618	709
Delhi	866	821

Represent the data using horizontal bars

Solution :

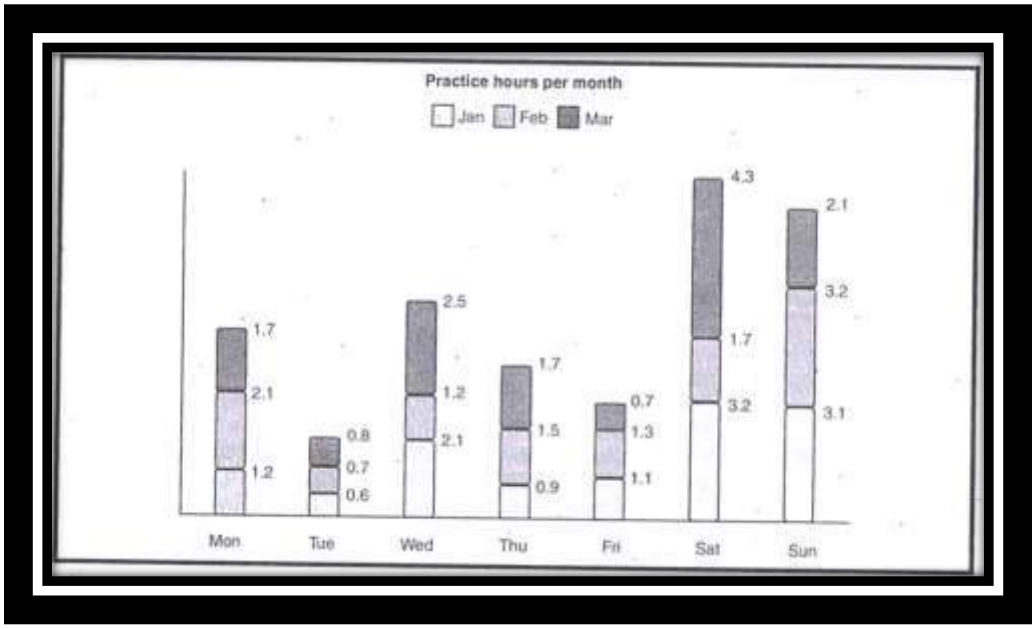
The data has been represented using multiple bars. In multiple bar diagram, two or more bars are used to represent two or more sets of interrelated data. In figure 7.2, there are two sets of horizontal bars that show the sex ratio data for India for two years 2010 and 2011.

Illustration 3: draw a suitable diagram to represent the division of practice hours per month for various activities adopted by a school for its students across the entire week.

	Excursion	**Library**	**Sports**
Monday	1.2	2.1	1.7
Tuesday	0.6	0.7	0.8
Wednesday	2.1	1.2	2.5
Thursday	0.9	1.5	1.7
Friday	1.1	1.3	0.7
Saturday	3.2	1.7	4.3
Sunday	3.1	3.2	2.1

Solution: The data represents three different activities each of which is being performed on all days of the week. Since the data is divided in terms of hours devoted per day in a month this requires that a divided bar diagram be used for representing the data.

Figure 7.3: Practice Hour per Month



(iii) **Pie Diagram-** The pie diagrams are frequently used in situations where a percentage breakdown is to be represented. Hence a prerequisite for this diagram is that it is based on percentage figures and not on absolute figures. In case where absolute figures are available the same are first converted into percentage values. Thereafter the sectors are arranged according to its size. Thus pie diagram is a circular diagram divided into sectors where each pie represents a piece of whole number. The pie chart is suitable only where the proportion of each sector is significant. In situations where the series comprises of large number of components the pie chart becomes very congested and in certain situations may not even be able to represent the smaller sections. With the availability of sophisticated software pie diagrams can now be created with color-coded information and 3-D effects. Color code

pie diagrams make it easier to locate the section of data wherein each part of the pie is labeled with the corresponding percentage.

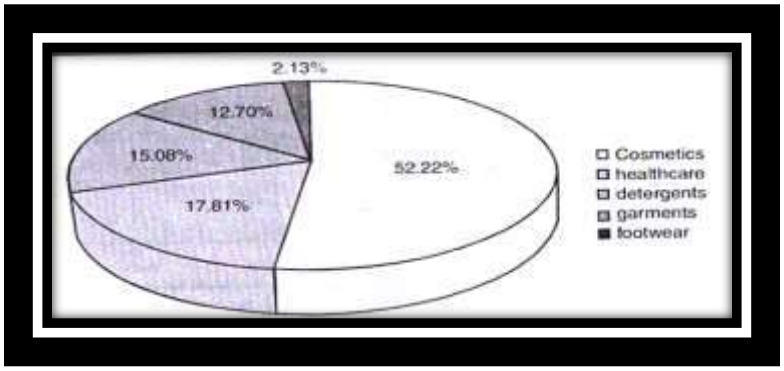
Illustration 4: Show the sales contribution of each product type using a pie diagram

Product Type	**Sales Contribution**
Cosmetics	89,707,754
Garments	21,888,851
Healthcare	30,591,000
Detergents	3,669,050
Footwear	25,903185

Solution: In order to show the above figures using a pie diagram the sales contributions have to be converted in percentage terms. A new column of percentage share gets added to the table. Thereafter the data is arranged according to the size with the product having the largest percentage contributions coming first followed by the other product types.

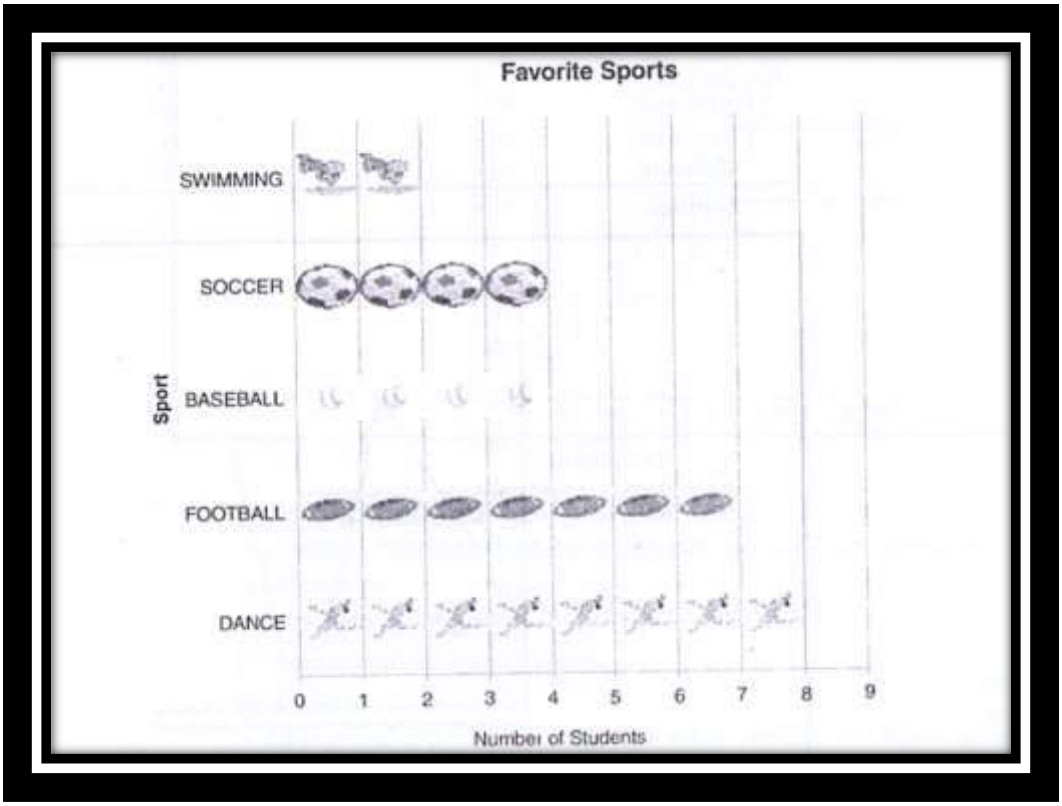
Product Type	**Sales Contribution**	**%age Share**
Cosmetics	89,707,754	52.22
Garments	21,888,851	17.81
Healthcare	30,591,000	15.08
Detergents	3,669,050	12.7
Footwear	25,903185	2.13

Figure 7.4: Sales Contribution of Different products



(iii)Pictograph-A pictograph uses pictures to represent statistical data. It uses symbolic pictures or figures to match frequencies of different kind of data. Use of lines, bars, and circles makes the presentation inanimate, whereas pictures lend more meaning to the data and make it look more attractive. While drawing a pictograph care should be taken that the picture used is self explanatory and clearly conveys the meaning behind the picture.

Figure 7.5: A Pictograph Showing the Number of Students Playing Different Kinds of Sports



Cartograms are another type of diagram that use geographical maps to represent data. Generally different shades of colours are used to show the distribution of different kinds of variables on a map e.g. a cell phone service provider may use a cartogram to identify areas where the concentration of its customers is maximum and also identify the areas where the customer base is thin.

Exercise 7.1

Question1 Define Data processing?

Question 2 What do you mean by editing and coding?

Question 3 Define multiple bar diagrams?

7.3 Summary & Conclusion

Once data collection is over, the next important steps are editing, coding, and tabulation. Editing helps in maintaining consistency in quality of data. Editing is the first stage in data processing. It is the process of examining the data collected to detect errors and omissions and correct them for further analysis. Coding makes further computation easier and necessary for efficient analysis of data. Coding is the process of assigning some symbols to the answers. A coding frame is developed by listing the answers and by assigning the codes to them, data may be summarized by means of tabulations and frequency distributions. Complex tabulation is particularly useful as it provides some clue about relationship and its direction between two variables.

Statistical data not only requires a careful analysis but also make sure an attractive and communicative display. The work of the researcher is to understand the facts of the data himself/herself and also to present them in such a form that their significance may be understandable to a common reader. In order to achieve this objective, we have, in this chapter, discussed the techniques of diagrammatic and graphic presentation of statistical data. Besides, presenting the data in the form of tables, data can also be presented in the form of diagrams and graphs. Such presentation of data allows relation between numbers to be exhibited clearly and attractively, makes quick comparison between two or more data sets easier, brings out hidden facts and the nature of relationship, saves time and effort, facilitates the determination of various statistical measures.

7.4 Glossary

- **Bar-** Is a thick line where the length of the bars should be proportional to the magnitude of the variable they represent.

- **Flow Chart-** Presents the information which flows through various situations to the ultimate point.

- **Frequency Polygon-** A line graph connecting the mid-points of each class in a data set.

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- **Histogram-** A graph of a frequency distribution, composed of a series of rectangles, each proportional in width to the range of a class interval and proportional in height to the number of observations falling in the class.

- **Pie Diagram-** A circle divided into slices showing the relative areas of various components of the variable.
- **Coding-** A method to categorize data into groups and assign numerical values or symbols to represent them.

7.5 Self Assessment Test

Exercise 7.1

Answer 1: Refer to section 7.2
Answer 2: Refer to section 7.2.1&7.2.2
Answer 3. Refer to section 7.2.3

7.6 Terminal Questions

Question 1 Describe the major operations involved in data processing.

Question 2 What is the objective of editing?

7.7 Suggested Readings

1. Goode and Hatt, Research Methodology, Prentice Hall Publications, 1959.

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LESSON 8

THE COMPUTERS: ROLE IN RESEARCH

Structure

8.0 Objectives

After going through this lesson you will be able to:

- Define Computer
- Explain the different types of Computers
- Elucidate the use of Computers in Research
- Understand the role of Computers in Coding, Data Tabulation & Graphic presentation of Data

8.1 Introduction

Problem solving is an age old activity. The development of electronic devices specially the computer has given added impetus to this activity. Problems which could not be solved earlier due to sheer amount of computations involved can now be tackled

with the aid of computer accurately and rapidly. Today people use computer in all walks of life. To the researcher the use of computer to analyze complex data had made complicated research design practical. Electronic computers became an indispensible part of research students in physical and behavioural sciences as well as in humanities. In the current times, the use of computers is visible in varied fields like traffic lights timings, airline or railway booking, fax and e-mail, banking, weather forecasting and of course research areas which have started relying heavily on computers and information technology. The term computer has been derived from ‘compute meaning to ‘calculate’. These days, however, computers are being used beyond mere calculation and are helpful in planning, forecasting and decision making. The current chapter will introduce the researcher to the world of computers and will discuss its special role in research.

8.2 Meaning

A computer is an electronic machine that is used for storing, organizing, and finding words, numbers, and pictures, for doing calculations, A computer is a device that accepts information (in the form of digitalized data) and manipulates it for some result based on a program or sequence of instructions on how the data is to be processed. Complex computers also include the means for storing data (including the program, which is also a form of data) for some necessary duration. A program may be invariable and built into the computer or different programs may be provided to the computer (loaded into its storage and then started by an administrator or user). Today's computers have both kinds of programming. Computers can be classified on the basis of purpose, size, generations and data processing techniques.

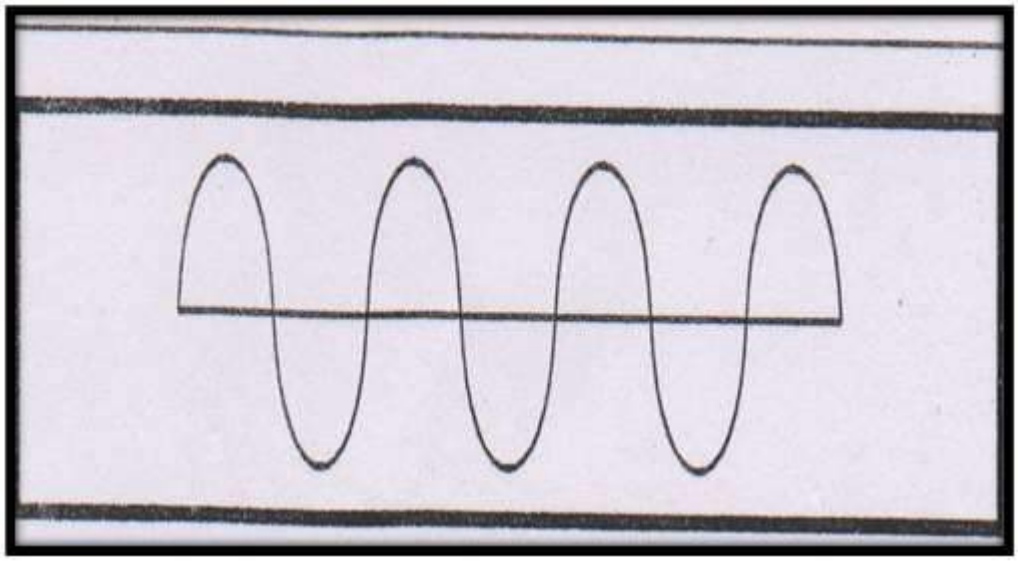
5.3 Types of Computers

1.On the Basis of Data Processing Techniques

This classification is based on the type of data that they need for processing.

(a) Analog Computers- Such computers recognize data as a continuous flow as shown in figure 8.1

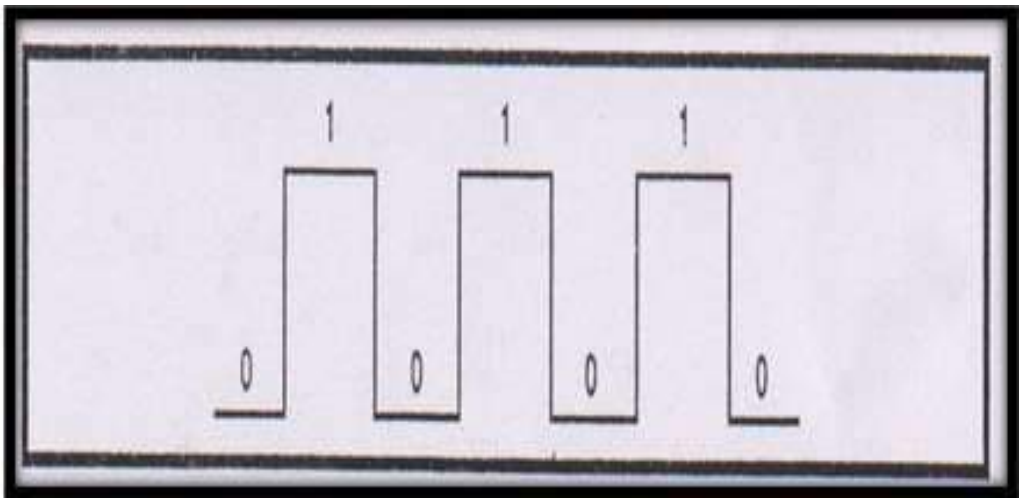
Figure 8.1 Analog Signal



The data flow represented as an analog signal is of varying frequency and amplitude and is generally used in broadcast and phone transmission. Such type of computers, based on analog signal, are used in process industry like in a furnace thermostat, a mechanical watch and in instruments that can directly measure data like a electric current and voltage.

(b) Digital Computer- Most of the computers these days are digital computers in which data is read in the form of discrete signal as high (on or 1) and low (off or 0), as shown in figure 8.2.

Figure 8.2 Digital Signal



These discrete signal represented by two states positive (1) and non-positive (0) is referred to as a bit. These computers perform high speed complex calculations and are used for varied purposes e.g. in the defense industry their application can be seen in missile technology, weapon designing and in normal day to day in banking, manufacturing industries, etc.

(c) Hybrid Computers- These computers use both the analog as well as the digital signal to generate output e.g. the CT Scan Machine first reads the data about humans, let us say a scan of the human brain and then this data which has been read by an analog computer is sent to a digital computer to generate output. Their application can be seen extensively in the telecommunication industry also.

2. On the basis of size

On the basis of size as well as processing speed the computers can be classified into four categories:

(a) Super Computers- These computers are highly sophisticated and powerful computers that can perform complex calculations at a rapid speed of almost millions of processes in a second. Traditionally these computers were used in scientific and military work but their application is being seen in business also. They use parallel processing i.e., two or more microprocessors work simultaneously on the part of the same problem and can perform billions and even trillions of calculations per second. The purchase processes for large supercomputers are in the $5 million to $50 million range. These computers are non-portable, require special cooling systems, consume huge power and hence are used by big organizations that can afford their maintenance.

(b) Main frame Computers- They are big computers with massive memory and rapid processing power and are used in large organizations like banks, airlines, railways and other big business organizations. Mainframes are becoming a popular business computing platform for data mining and warehousing, and electronic commerce application. These computers are cheaper than super computers but are still very costly requiring the same kind of maintenance.

(c) Mild-range Computers- These computers are less powerful, less expensive and smaller than main frame computers and can be further classified as ‘Mini computers’ and ‘servers’. Mini computers are small general purpose computers and are used in systems for universities, factories or research laboratories. Servers are generally used in a network environment that can satisfy the data sharing needs of the other computers on the network.

(d) Micro Computers- Also known as personal computers, these are designed to meet the requirements of individuals. They can be placed on a desk top and are portable.

These days PCs are available with high processing speed and large storage capacities. A laptop is also a micro computer that can be easily carried in our hand and does not require an external power source. They are costlier than personal computers, small in size and very light in weight

3. On the basis of Generations

Generation in computer technology means a step in technology. There are five generations of computers:

(a) **First Generation (1942-55) -** These computers were built using 'vacuum tubes' which could perform computations in milli seconds. They used machine and assembly level languages and hence could only be used by specialist. The memory of these computers was constructed using electromagnetic relays and data instructions were put into the system using punched cards.

(b) **Second Generation (1955-1964) -** These computers used a new electronic switching device called 'transistors'. They were made of semiconductor material and were faster, economical and smaller then vacuum tubes. Their memory comprised of magnetic cores. Magnetic disk and magnetic tapes were the main secondary storage media. These computers used high level languages. Whereas the first generation computers were used only for scientific computation, the second generation computers were used in business and industry also.

(c) **Third Generation (1964-1975) -** The third generation is marked by the arrival of 'integrated Circuits or ICs'. An IC is a small silicon semi conductor crystal called a chip that contained electronic components like transistors, diodes, resistors and capacitors. They were interconnected to form an electronic circuit. There was a standardization of high level programming languages, time sharing was introduced which allowed large number of users to access and share resources. This period saw the development of mini computers.

(d) **Fourth Generation (1975-1989) –** There was an even more reduction in size and 'microprocessors' evolved. It integrated about one million in electronic components on a single chip. It became possible to perform arithmetic logic and control functions and all other core activities of all computers on a single chip. It saw the development of high speed computer networking. New operating systems like MS-DOS and MS-Windows were developed which made the computer user friendly.

(e) **Fifth Generation (1989 and Present) –** The fifth generation computers are based on 'artificial intelligence' and are still evolving. Artificial intelligence makes the computers behave like human beings. Games, expert system, robos are some examples of application of artificial intelligence. People interact with computers using natural languages. This generation saw the emergence of new

medium of storage like optical disks, growth of computer networks and emergence of popularity of internet.

8.4 Important Characteristics of Computers

1. Speed:-Computers can perform calculations in just a few seconds that human beings would need weeks to do by hand. This has led to many scientific projects which were previously impossible.

2. Diligence: - Being a machine, a computer does not suffer from the human traits of tiredness and lack of concentration. If two million calculations have to be performed, it will perform the two million calculations with exactly the same accuracy and speed as the first.

3. Accuracy: - The computer's accuracy is consistently high. Errors may occur very rarely but it can detect very easily. The errors are due to the imprecise thinking by the programmer or due to in accurate poorly designed systems.

4. Automation: - Once a programme is in computers memory all that is needed is the individual institution to it which are transferred one after the other, to the control unit of execution. The CPU follows these instructions until it meets a last instruction which says "stop programme execution".

5. Binary Digits:- Computers use only the binary number system (a system in which all numbers are represented by a combination of two digits-one and zero) and thus operates to the base of two compared to the ordinary decimal arithmetic which operates on a base of ten.

6. Storage:- Although the storage capacity of the present day computer is much more than its earlier counterpart but even then the internal memory of the CPU is only large enough to retain a certain amount of information just as the human brain selects and retains what it feels to be important and regulates unimportant details to the back of the mind or just forgets them. Hence it is impossible to store all types of information inside the computer records. If need be all unimportant information/data can be stored in auxiliary storage devices and the same may be brought into the main internal memory of the computer as and when required for processing.

8.5 Use of Computers in Research

Performing calculations almost at the speed of light, the computer has become one of the most useful research tools in modern times. Computers are ideally suited for data analysis concerning large research projects. Researchers are essentially concerned with huge storage of data, their faster retrieval when required and processing of data with the aid of various techniques. In all these operations, computers are of great help. Their use, apart expediting the research work, has reduced human drudgery and added to the quality of research activity.

Researchers in economics and other social sciences have found, by now ,electronic computers to constitute an indispensable part of their equipment. The computers can perform many statistical calculations easily and quickly. Computation of means, standard deviation, correlation coefficients, 't' tests, analysis of variance, analysis of covariance, multiple regression, factor analysis and various nonparametric analyses are just a few of the programs and subprograms that are available at almost all computer centers. Similarly, canned programs for linear programming, multivariate analysis, monte carlo simulation etc. are also available in the market. In brief, software packages are readily available for the various simple and complicated analytical and quantitative techniques of which researchers generally make use of. The only work a researcher has to do is to feed in the data he/she gathered after loading the operating system and particular software package on the computer. The output, or say the result, will be ready within seconds or minutes depending upon the quantum of work.

Techniques involving trial and error process are quite frequently employed in research methodology. This involves lot of calculations and work of repetitive nature. Computer is best suited for such techniques, thus reducing the drudgery of researchers on the one hand and producing the final result rapidly on the other. Thus, different scenarios are made available to researchers by computers is no time which otherwise might have taken days or even months.

The storage facility which the computers provide is of immense help to a researcher for he can make use of stored up data whenever he requires to do so.

Thus, computers do facilitate the research work. Innumerable data can be processed and analyzed with greater ease and speed. Moreover, the results obtained are generally correct and reliable. Not only this, even the design, pictorial graphing and report are being developed with the help of computers. Hence, researchers should be given computer education and be trained in the line so that they can use computers for their research work.

Researchers interested in developing skills in computer data analysis, while consulting the computer centers and reading the relevant literature must be aware of the following steps:

(i) Data organization and coding
(ii) Storing tag data in the computer
(iii) Selection of appropriate statistical measures/techniques
(iv) Selection of appropriate software package
(v) Execution of the computer program

In spite of all this sophistication we should not forget that basically computers are machines that only compute, they do not think. The human brain remains supreme and will continue to be so for all times. As such, researchers should be fully aware about the following limitations of computer-based analysis:

1. Computerized analysis requires setting up of an elaborate system of monitoring, collection and feeding of data. All these require time, effort and money. Hence, computer based analysis may not prove economical in case of small projects.

2. Various items of detail which are not being specifically fed to computer may get lost sight of.

3. The computer does not think; it can only execute the instructions of a thinking person. If poor data of faulty programs are introduced into the computer, the data analysis would not be worthwhile. The expression “garbage in, garbage out” describes this limitations very well.

8.5.1Coding

Coding is a process/operation by which data/responses are organized into classes/ categories and numerals or other symbols are given to each item according to the class in which it falls. In other words, coding involves two important operations (i) deciding the categories to be used and, (ii) allocating individual answers to them. These categories should be appropriate to the research problem, exhaustive of the data, mutually exclusive and undimensional. Since coding eliminates much of information in raw data, it is important that the researcher design category set carefully in order to utilize the available data more fully.

There are many software’s like SPSS, SAS, STATA available which can code the piles of research data in few minutes. In excel, Macros can be used for recording and coding of data. Steps involved in using Macros:

Step1 Click “Developer” in Excel’s menu bar

Step 2 Click the visual Basic icon in the ribbon’s Code tab to launch the Visual Basic for Applications window.

Step 3 Select the macro in the window’s Project box that you want to read excel’s data.

Step 4 Type the line of code: Suppose you want number of men as Integer. This declares a variable to store the cell’s data.

Step 5 Replace the integer with string if the cell contains a string. Replace “Integer” with “Date” if the cell contains a date.

Step 6 Add the following line, which extracts a cell’s data:

Content=Range (“A1”) value

Step 7 Replace “A1” with the address of the cell whose data the macro must read. Visual Basic will store the cell’s contents in the variable.

Using various computer languages and programmes you can code document sources-well as memos and externals- based on paragraphs or paragraphs styles. If you are working with structured documents the coding can help you to organize the material into nodes for further exploration.

8.5.2 Use of Computers in Data Tabulation

Presentation of collected data in the tabular form is one of the techniques of data presentation. Arranging the data in an orderly manner in rows and columns is called tabulation of data. Sometimes data collected by survey or even from publications of official bodies are so numerous that it is difficult to understand the important features of the data. Therefore it becomes necessary to summarize data through tabulation to an easily intelligible form. It may be noted that there may be loss of some minor information in certain cases, but the essential underlying features come out more clearly. Quite frequently, data presented in tabular form is much easier to read and understand than the data presented in the text.

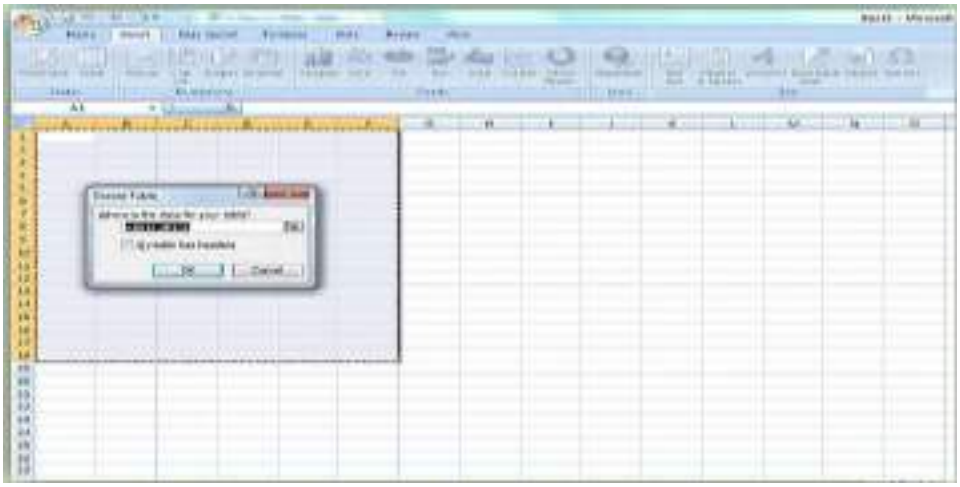
Step 1: Select a range of cells. The cells can contain data or they can be empty, or a combination of both. You don't have to pick your cells before you create the table if you aren't sure yet.

Step 2: Insert the table. To start the table creation process, you will need to insert a table into your spreadsheet.

- In Excel 2003, click the Data menu and select List.
- In Excel 2007, 2010, and 2013 select either "Table" on the Insert menu ribbon or "Format as Table" in the Styles group on the Home menu ribbon. (The former option applies Excel's default table style, while the other lets you choose a style when you create the table. You can later apply or change the table style by selecting one of the options from the Table Styles group in the Table Tools Design menu ribbon.)

Step 3: Provide a data source for your table. If you did not previously select a group of cells, you will need to select the cells now. After you pick your range, a dialog box will appear, either the Create Table dialog (Create List dialog in Excel 2003) or the Format As Table dialog.

- The "Where is the data for your table?" field displays the absolute reference(s) for the current cell(s) selected. If you want to change this information, you can type in a different cell or range reference.

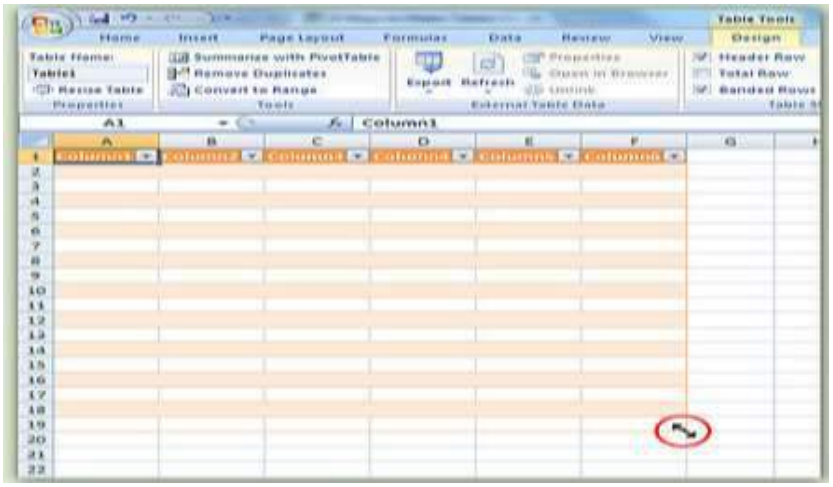


Step 4: Indicate whether your table has headers. If your table has headers, check the "My table has headers" box. If you don't check this box, the table will display default header names ("Column 1," "Column 2," etc.).

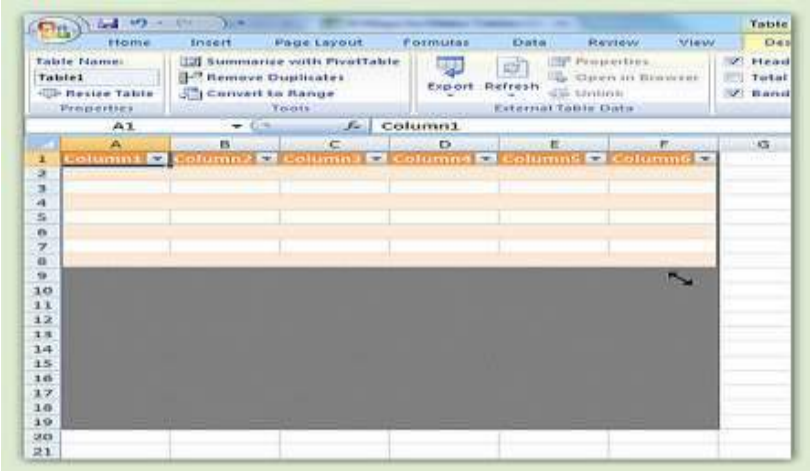
- You can change a column name by selecting the header and typing in your own name in the formula bar.

- **Enlarging and Reducing Table Size**

Grab the corner of the table. Move your mouse cursor over the sizing handle at the lower right corner of the table. Your cursor will change to a 2-sided diagonal arrow. Click and hold to “grab” the corner.

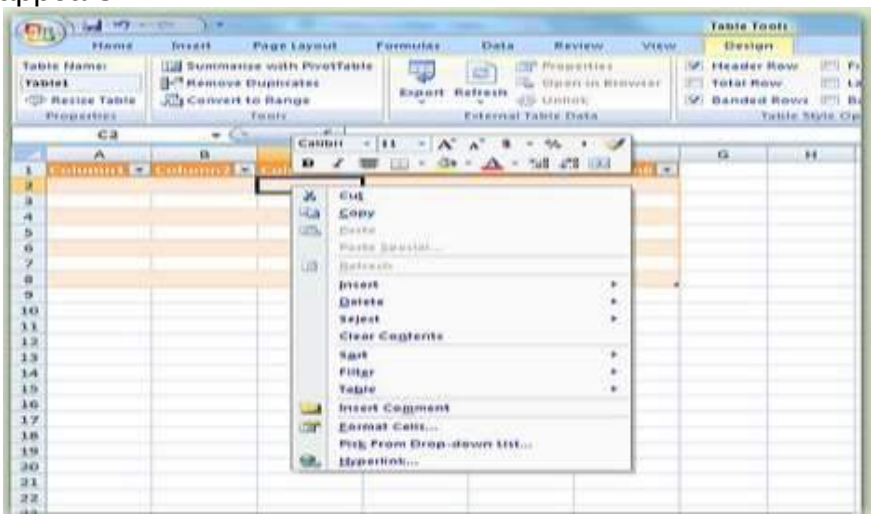


1. **Resize the table.** Drag your cursor inward to reduce the table size, outward to enlarge it. Dragging your cursor adds or reduces the number of rows and columns.
    - Dragging your cursor up toward the column header reduces the number of rows in the table, while dragging your cursor down increases the number of rows.
    - Dragging your cursor to the left reduces the number of columns in the table, while dragging it to the right increases the number of columns. A new column header is created when a new column is added.



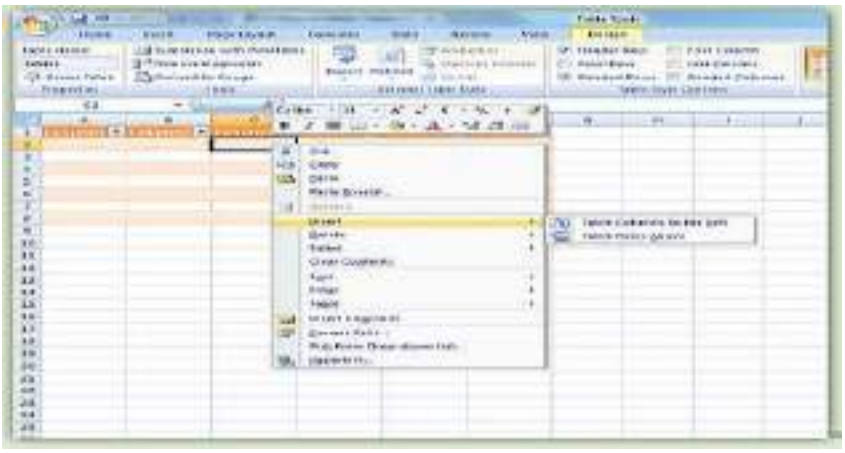
- **Inserting and Deleting Table Rows and Columns**

Step 1: Right-click the table cell where you wish to insert or delete a row or column. A popup menu appears.



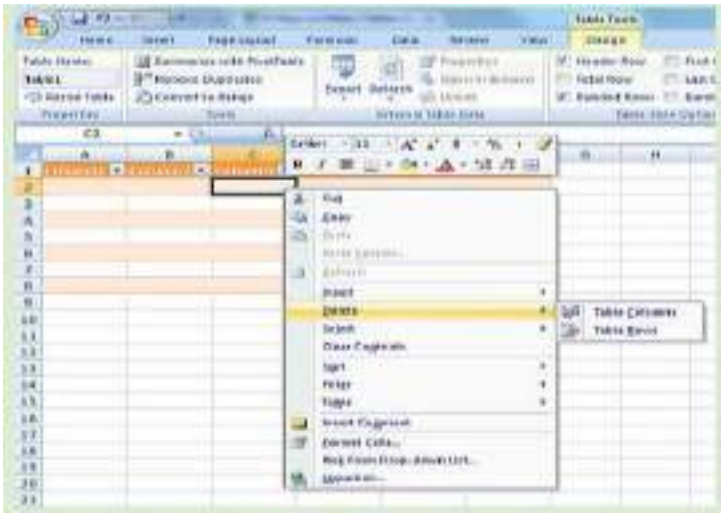
Step2: Select "Insert" from the popup menu. Choose one of the Insert submenu options.

- Select "Insert Columns to the Left" or "Insert Columns to the Right" to insert a new column in the table.
- Select "Insert Rows Above" or "Insert Rows Below" to insert a new row in the table.



Step3: Select "Delete" from the popup menu. Choose one of the Delete submenu options.

- Select "Table Columns" to delete the entire column(s) containing the selected cell(s).
- Select "Table Rows" to delete the entire row(s) containing the selected cell(s).

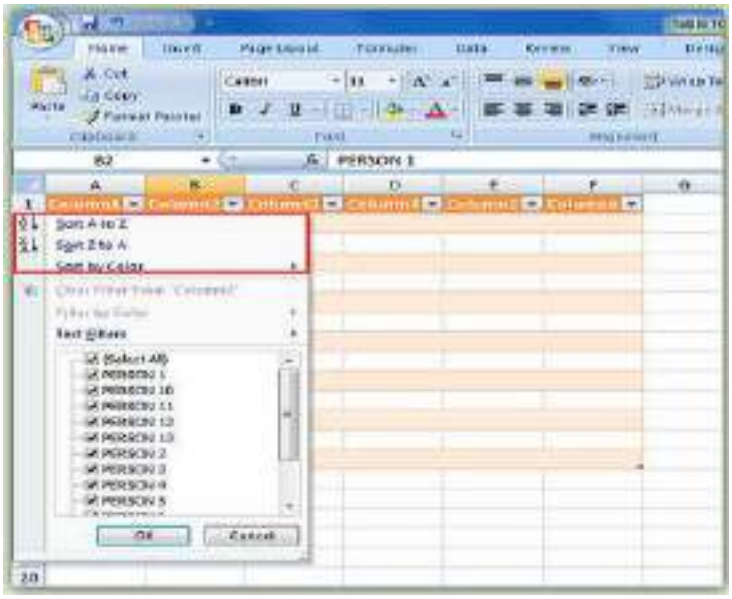


- **Sorting Table Rows**

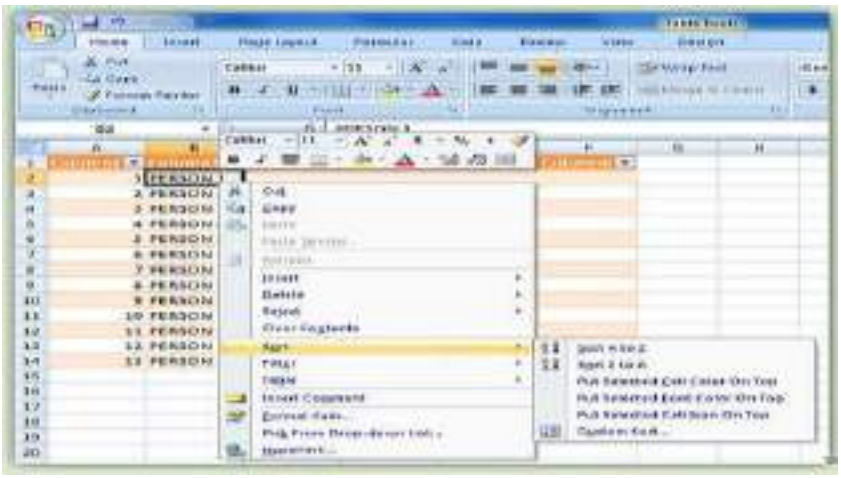
Click the down-arrow to the right of the header of the column you wish to sort by. **A dropdown menu will appear.**

Step1: Choose one of the sort options displayed. The sort options appear at the top of the dropdown menu.

- Choose "Sort A to Z" (or "Sort Smallest to Largest" if the data is numeric) to sort items in ascending order.
- Choose "Sort Z to A" (or "Sort Largest to Smallest" if the data is numeric) to sort items in descending order.
- Choose "Sort By Color" and then select "Custom Sort" from the submenu to set up a custom sort. If your data is displayed in multiple colors, you can select one of the colors from this submenu to sort your data by.

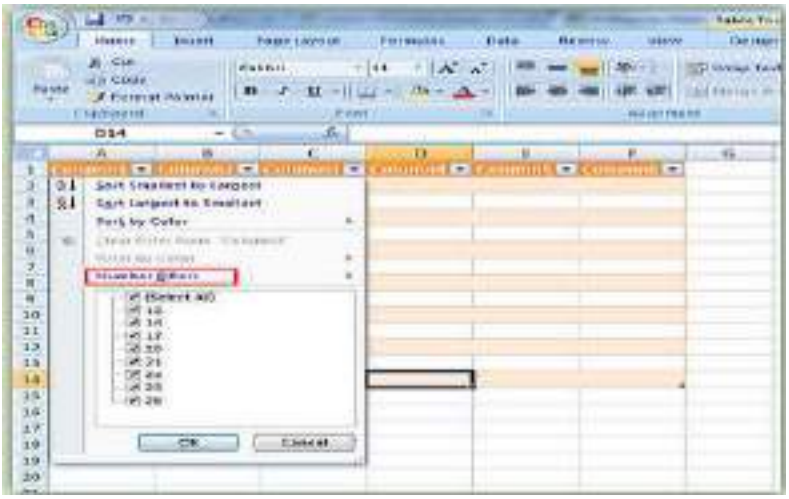


Step2: Access additional options. You can access additional sort options by right-clicking on any cell in a column and selecting "Sort" from the popup menu. In addition to the options above, you can also sort by cell or font color or by cell icon.



- **Filtering Data in Tables**

Step1: Click the down-arrow to the right of the header of the column you wish to filter. A dropdown menu will appear.



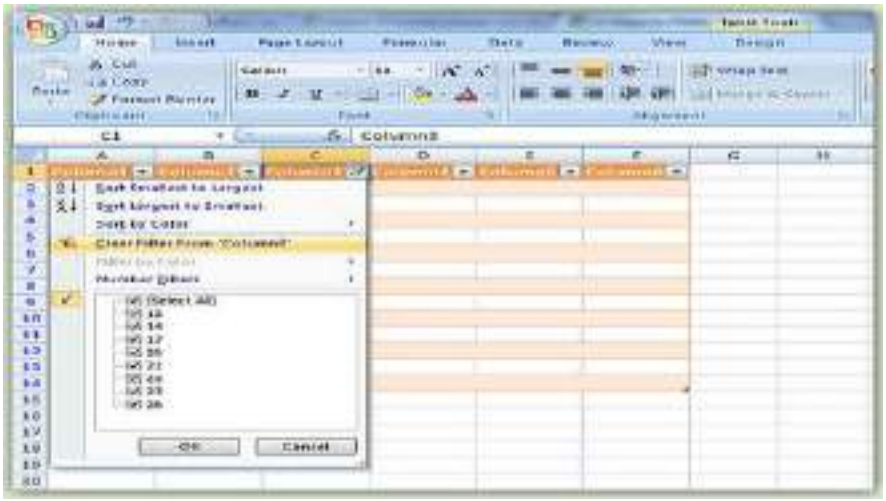
Step2: Choose one of the filtering options displayed. Three sets of filtering options are available: "Filter by Color," "Text Filters," and "Number Filters." (The "Text Filters" option is displayed only when the column entries contain text, while the "Number Filters" option is displayed only when the column entries contain numbers.) Below that is a set of check boxes.

- The "Filter by Color" option is enabled when the text or numbers are show in multiple colors. Select the color you wish to filter the data by.
- The "Text Filters" option includes the options "Equals," "Does Not Equal," "Greater Than," "Begins With," "Ends With," "Contains," "Does Not Contain," and a "Custom Filter" option.
- The "Number Filters" option includes the options "Equals"," Does Not Equal," "Greater Than," "Greater Than or Equal To," "Less Than," "Less Than or Equal

To," "Between," "Top 10," "Above Average," "Below Average," and a "Custom Filter" option.

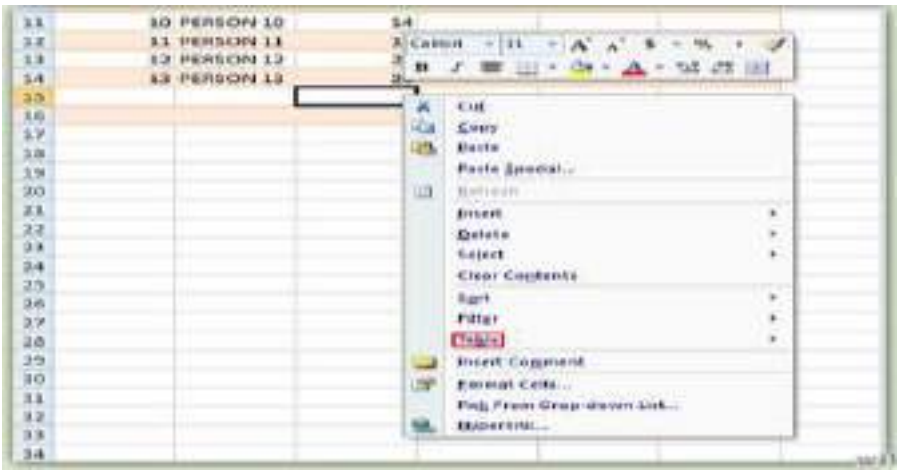
- The check boxes below these options include a "Select All" and "Blanks" option to display all data meeting the filtering criteria or all rows with blank cells in that column, as well as a listing of each unique data element (such as the same name) in that column. Check or uncheck the combination of boxes that will let your display only those rows with a cell that meets your criteria, such as checking the elements "Smith" and "Jones" to display sales figures for only those 2 individuals.
- Excel 2010 and 2013 offer an additional filtering option: enter text or a number in the Search field and the display will be restricted to only those rows with an item in the column that matches the contents of that field.

Step3: Remove the filter when finished with it. To restore the original display, select "Clear Filter From [Column Name]" from the dropdown menu. (The actual name of the column is displayed in this option.)

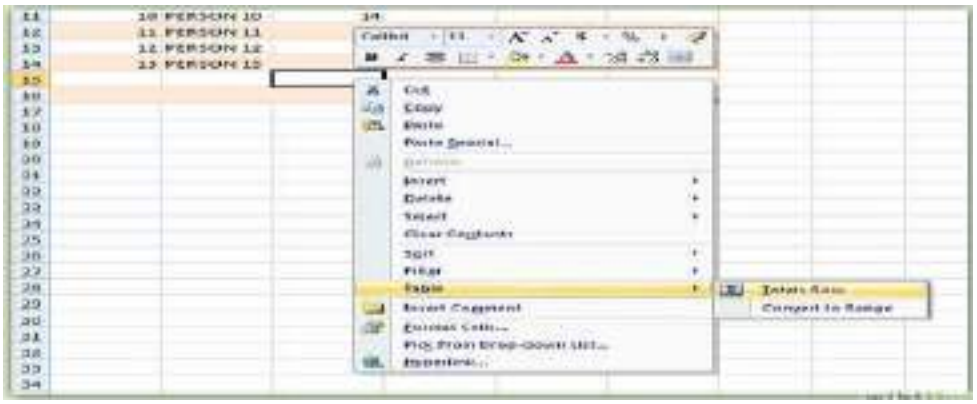


- **Adding a Totals Row to a Table**

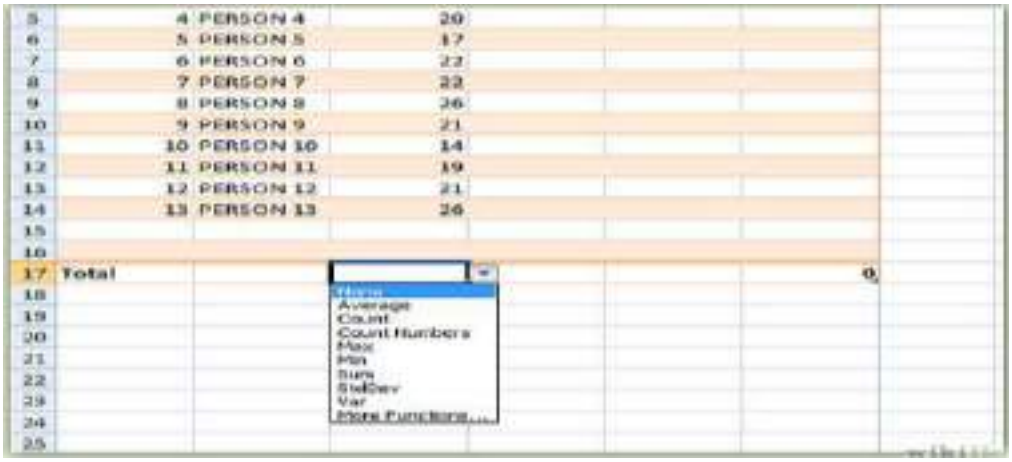
Step1: Right-click any cell in the table. This displays a popup menu. Select "Table" from the popup menu.



Step2: Select "Totals Row" from the Table submenu. A totals row will appear below the last row of the table, displaying a total of all the numeric data in each column.

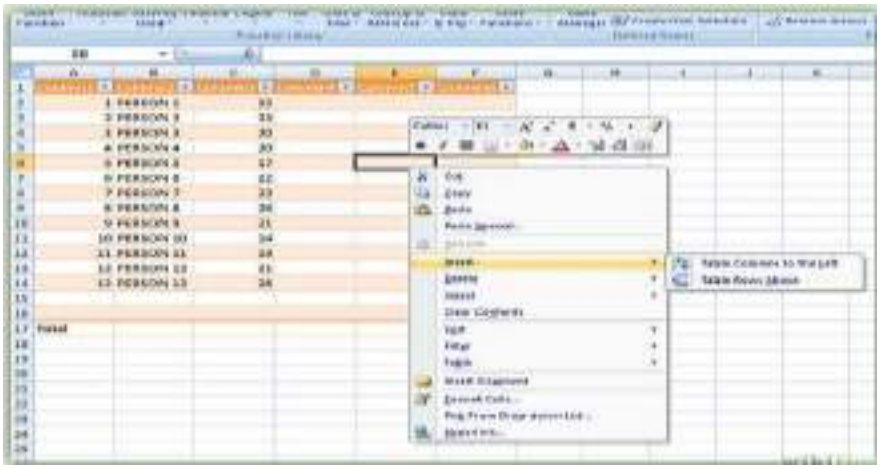


Step3: Change the displayed value. Click the menu on the Totals line for the value you want to adjust. You can choose what function you would like displayed. You can show the Sum, the Average, the Count, and more.



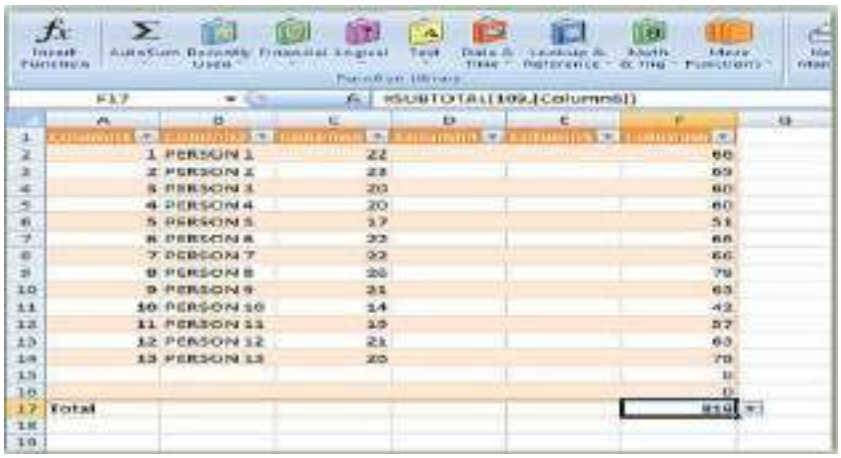
- **Adding a Calculated Column to a Table**

Step1: Select a cell in a blank column. If necessary, you'll have to add a blank column first. See "Enlarging and Reducing Table Size" and "Inserting Table Rows and Columns" for the methods to do this.

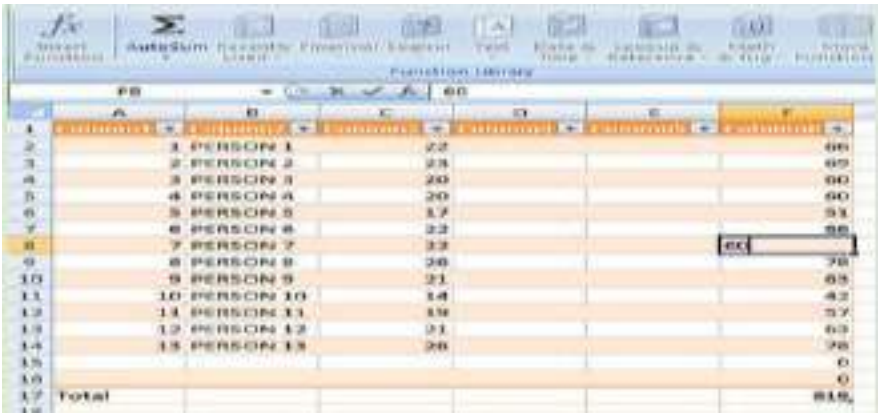


Step2:Type the calculation formula into any blank cell, other than the header. Your formula is automatically copied into all the column's cells, whether above or below the cell you entered the formula in. You can also copy the formula into the column cells manually.

- You can enter the formula in any row of the spreadsheet beneath the table, but you can't refer to any cells in those rows in the table reference.
- You can type or move the formula into a column that already has data, but to make it a calculated column, you'll need to click the "AutoCorrect Options" button to overwrite the existing data. If you copy the formula, however, you'll have to manually overwrite the data by copying the formula into those cells.



Step3: Create exceptions. After creating the calculated column, you can later go back and create exceptions by typing data other than a formula in any of the cells, deleting the formula from 1 or more cells, or copying a different formula into some of the cells. Any exceptions to the calculated column formula, other than a formula deletion, will be clearly marked.



8.5.3 Graphic Presentation of the Data

Suppose we have to present graphically the % allocation of budget to different sectors. The steps involved are:

Step 1: Enter your data into Excel spreadsheet in table format. Your data should have column headers, rows headers and data in the middle to make the most out of your graph.

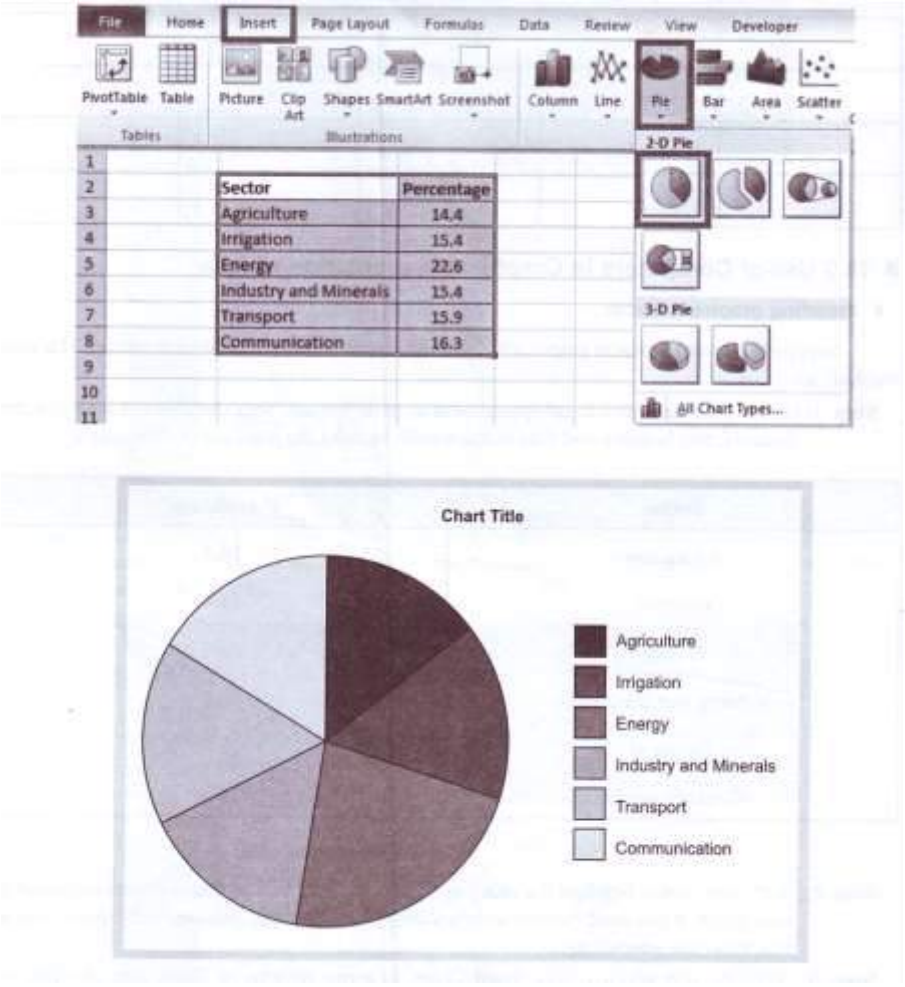
Sectors	**Percentage**
Agriculture	14.4%
Irrigation	15.4%
Energy	22.6%
Industry and Minerals	15.4%
Transport	15.9%
Communication	16.3%

Step2: with your cursor, highlight the cells that contain the information that you want to appear in your graph. If you want the column labels and the row labels show up in the graph, ensure that you are selected also

Step3: With the text selected, click Insert Chart. In some versions of Excel, you can also try navigating to the Charts tab in the Ribbion tab and selecting the specific kind of graph you'd like to use.

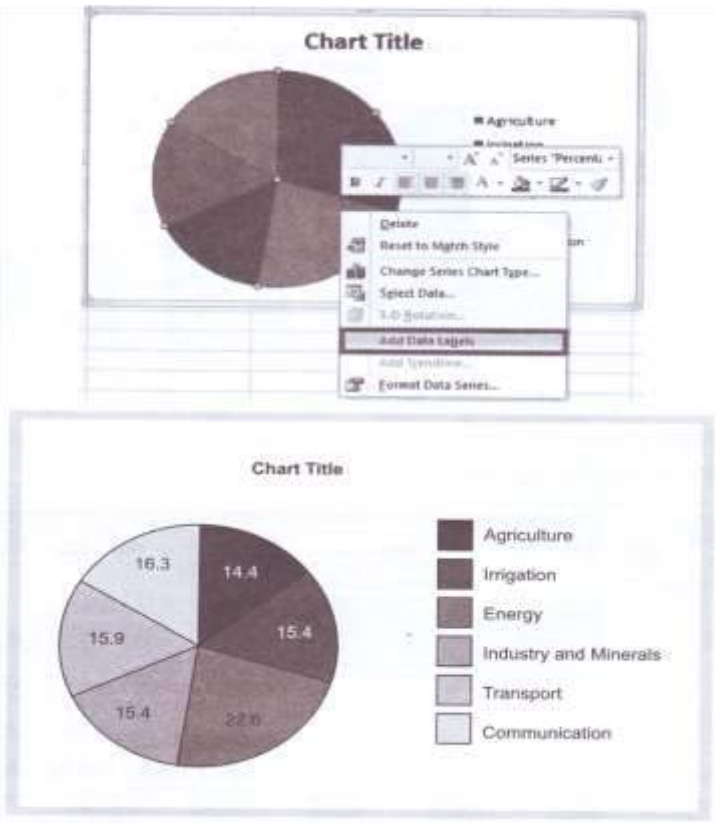
Example:

(a) Pie Chart

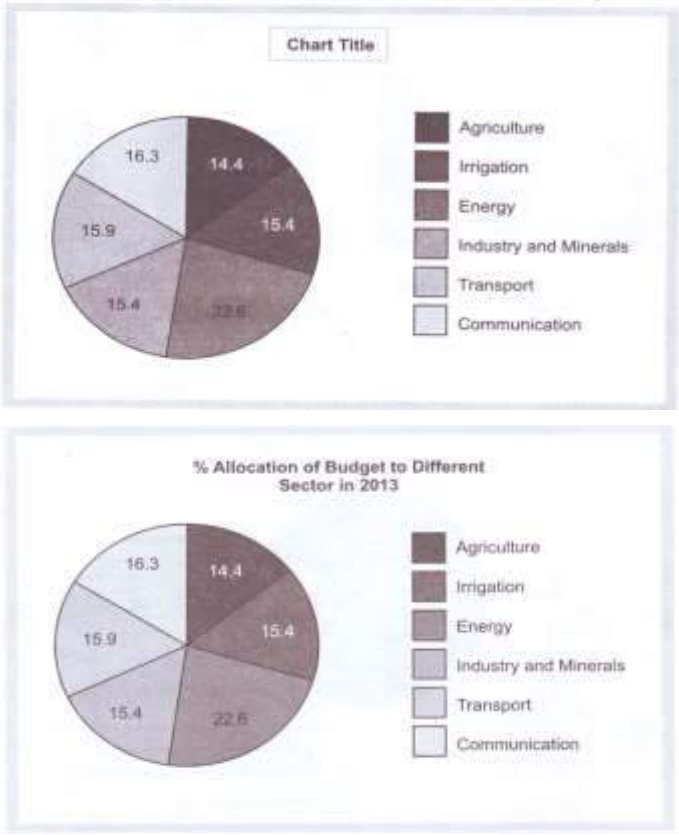


Editing your Graph: the graph can be edited for labels, values and title.

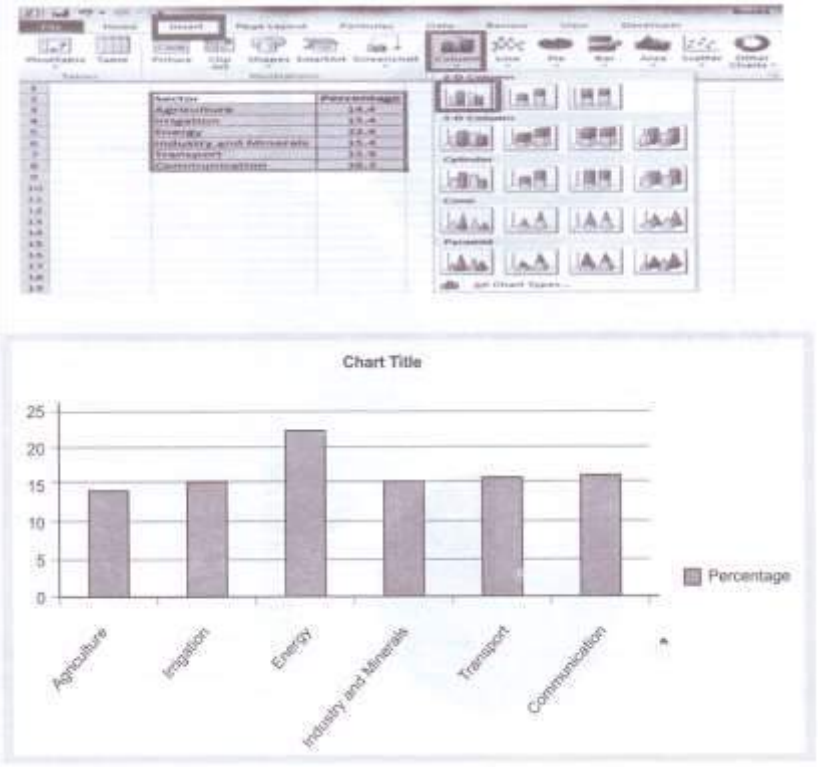
Add Data Labels: Right click on the pie chat area and select 'Add Data Lables' to display the data labels on the pie chart.



Edit the chart title: Double click the chart title and edit the same as required.

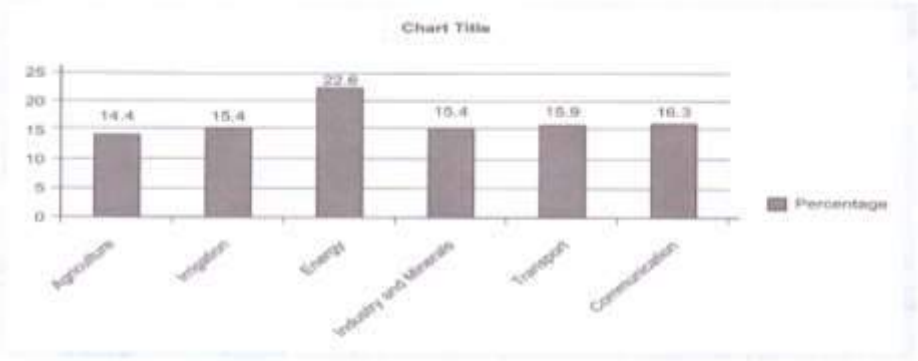


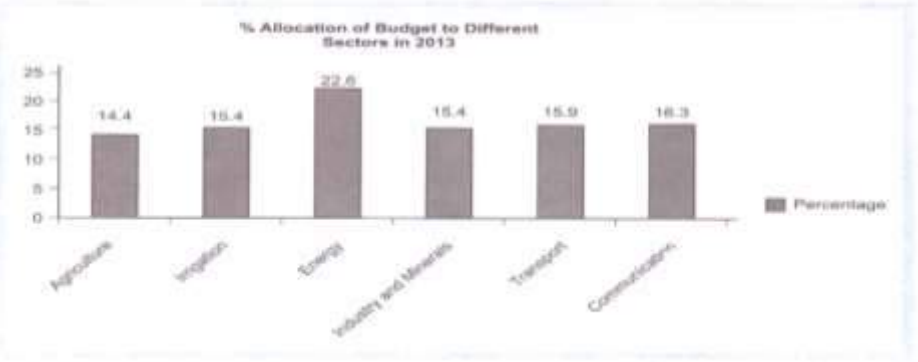
(b)Column Chart: The different chart types available under this category include 2D/3D columns, cylinder, cone and pyramids.



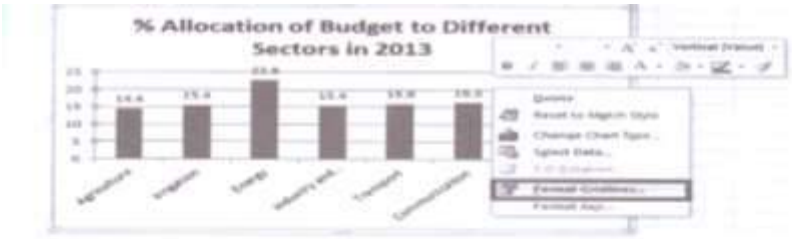
Adding Data Label: Right click on the Column chart area select “Add Data Labels” to display the data labels on the column chart.

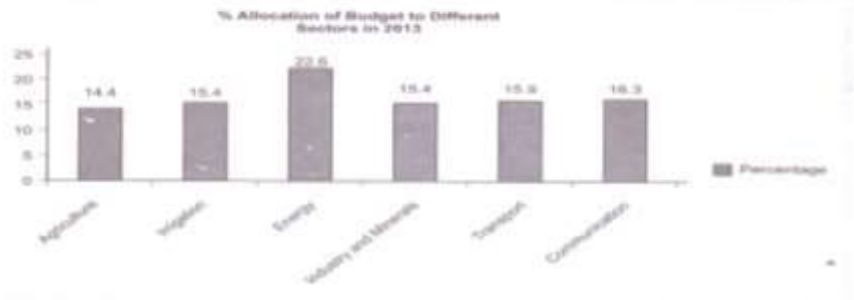
Edit the chart title: Double click the chart title and edit the same as required.



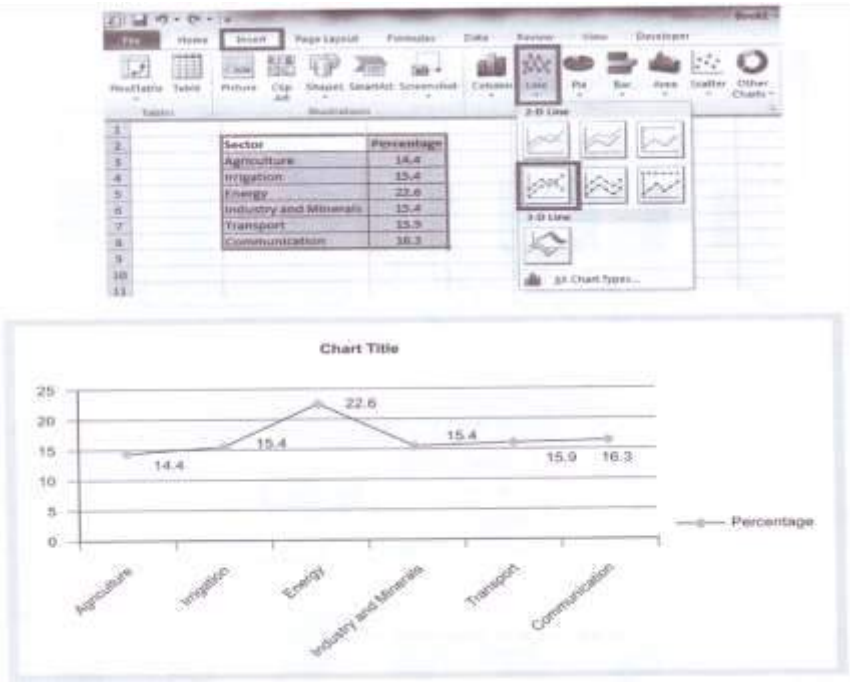


Removing the Gridlines: Select the chart area and right click on the same. Select 'Format Gridlines' and then 'No lines' in the next pop up window.

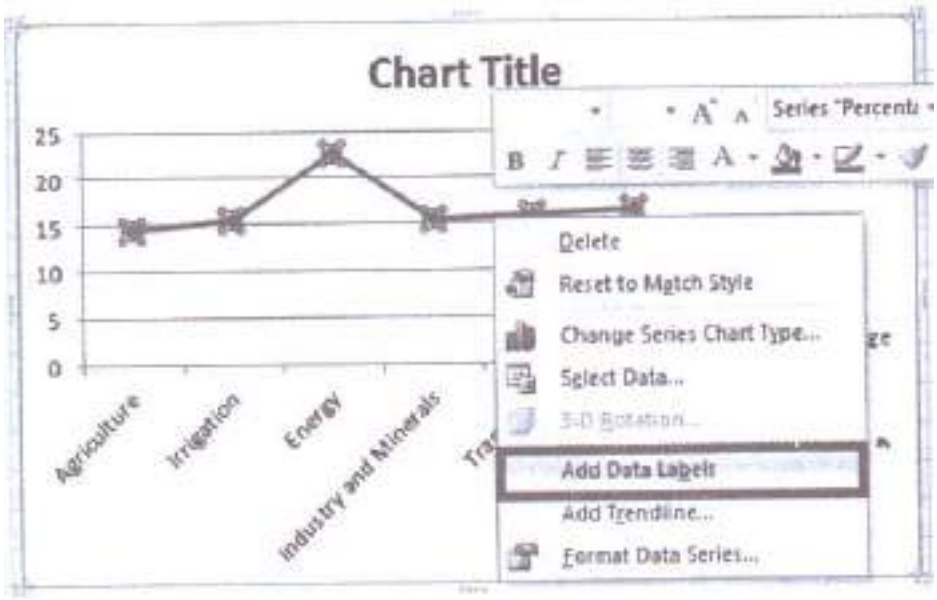


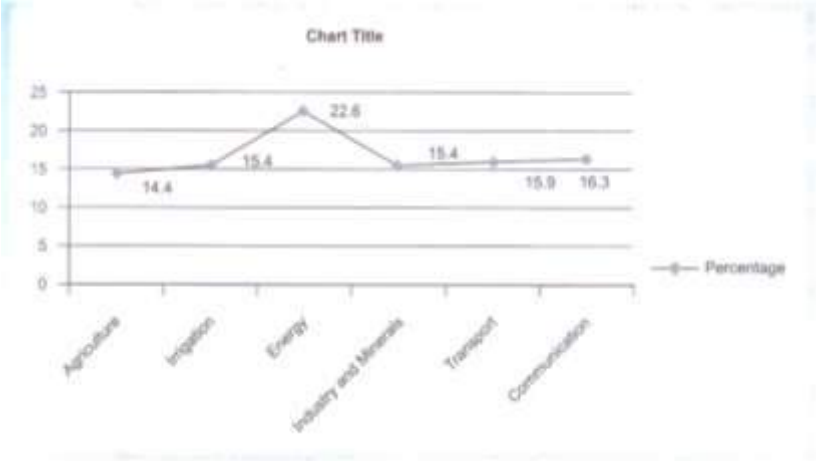


(C)Line Chart: Steps to be followed in creating a line chart

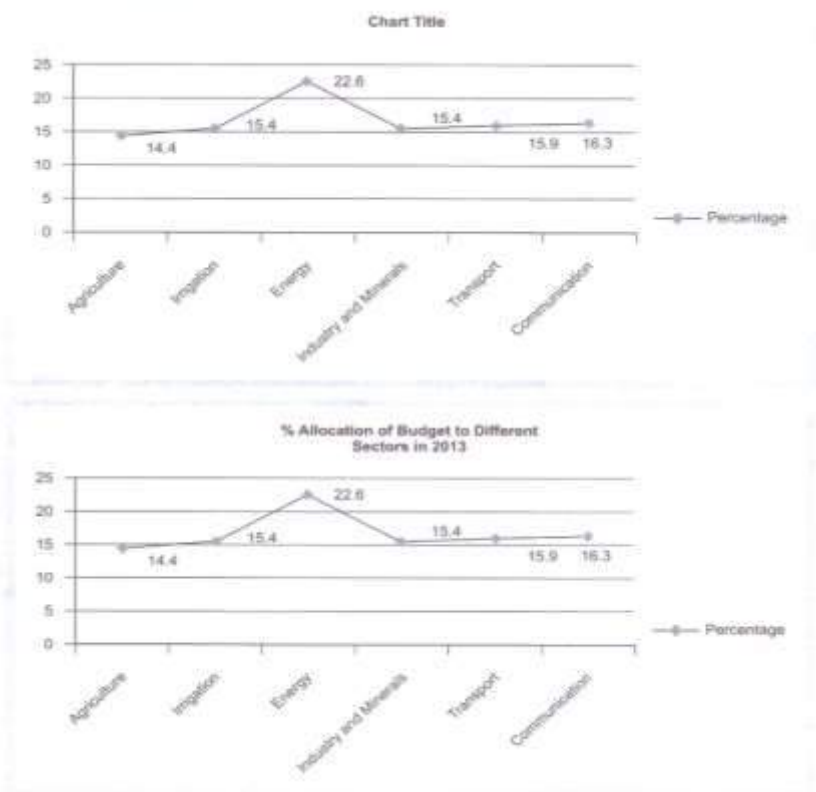


Adding Data Labels: Right click on the Line chart area select 'Add Data Labels' to display the data labels on the Line chart.

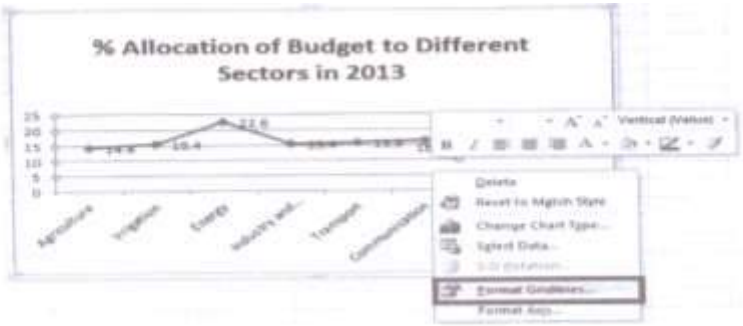


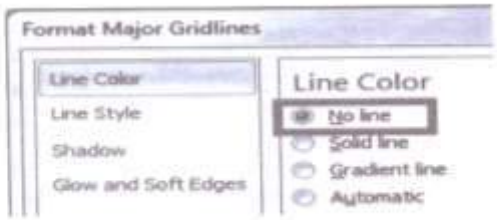


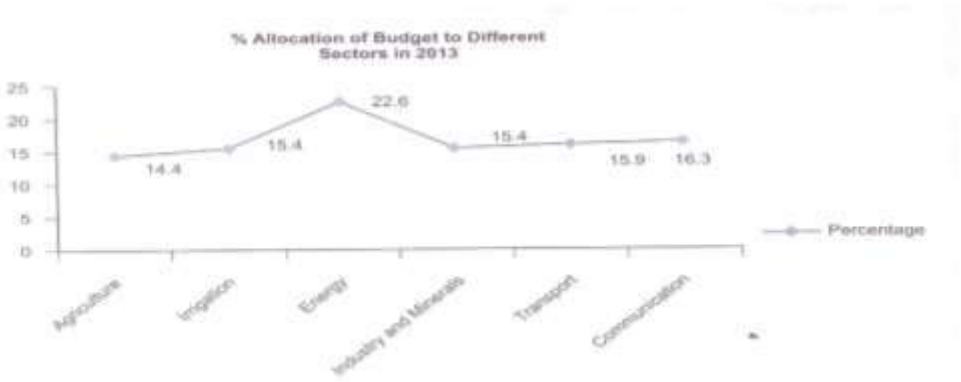
Editing the chart title: Double click the chart title and edit the same as required



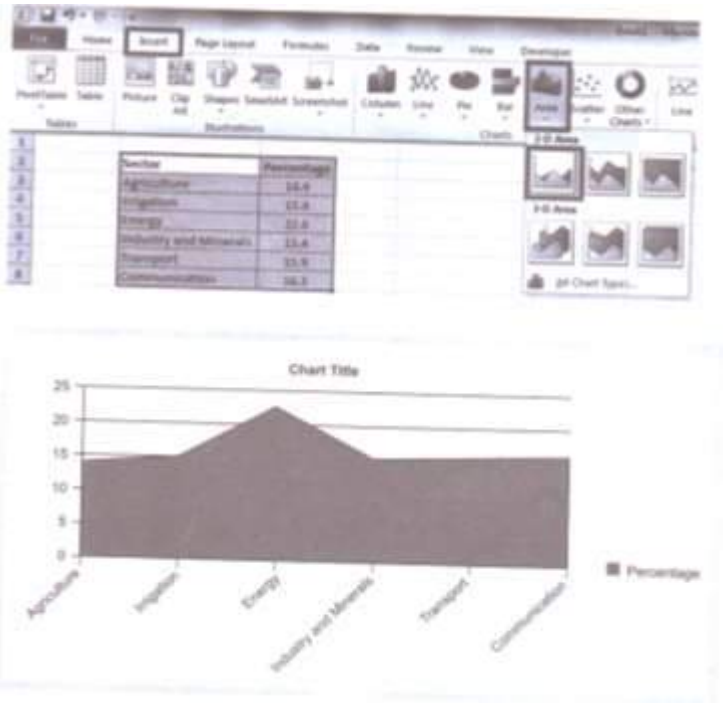
Removing the Gridlines: Select the chart area and right click on the same. Select ‘Format Gridlines and then ‘No Lines’ in the next pop up window.



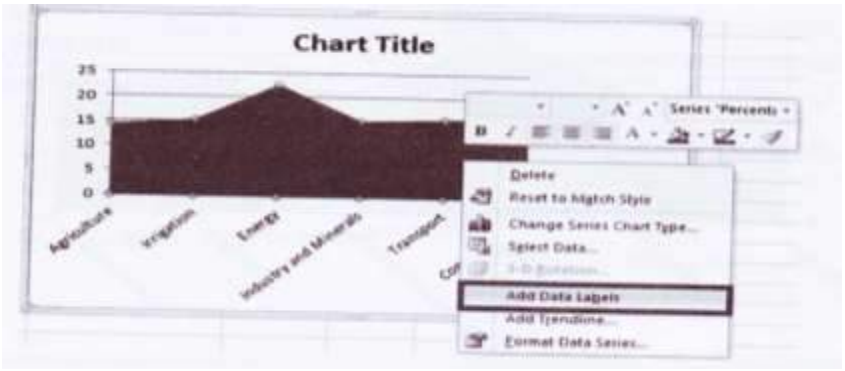


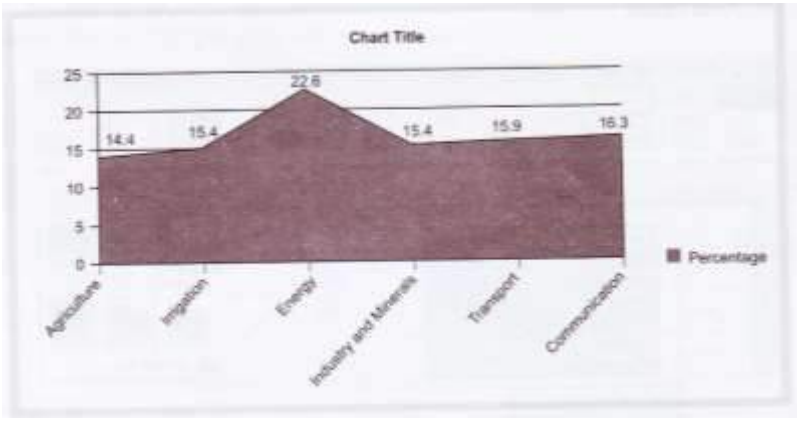


(d) Area Chart:

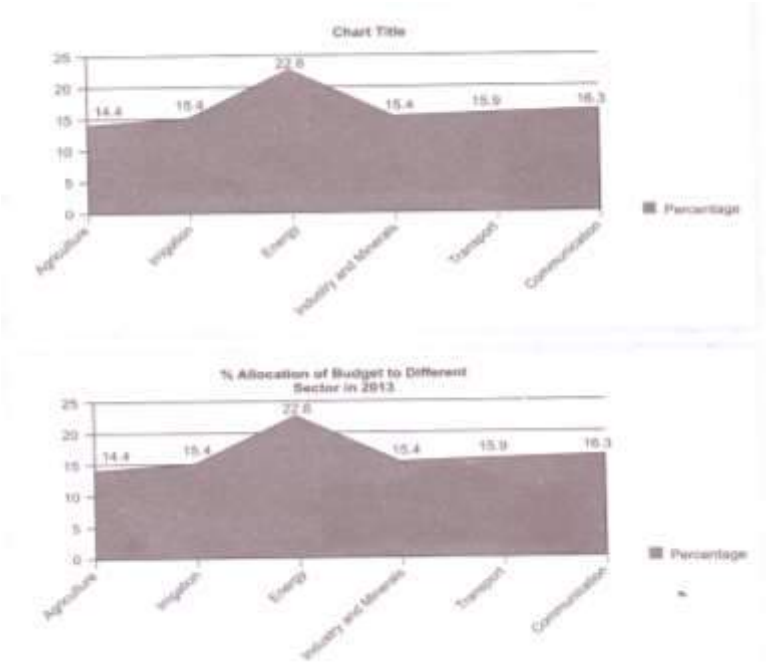


Adding Data Labels: Right click on the chart area and select "Add Data Labels' to display the data labels on the Area chart.

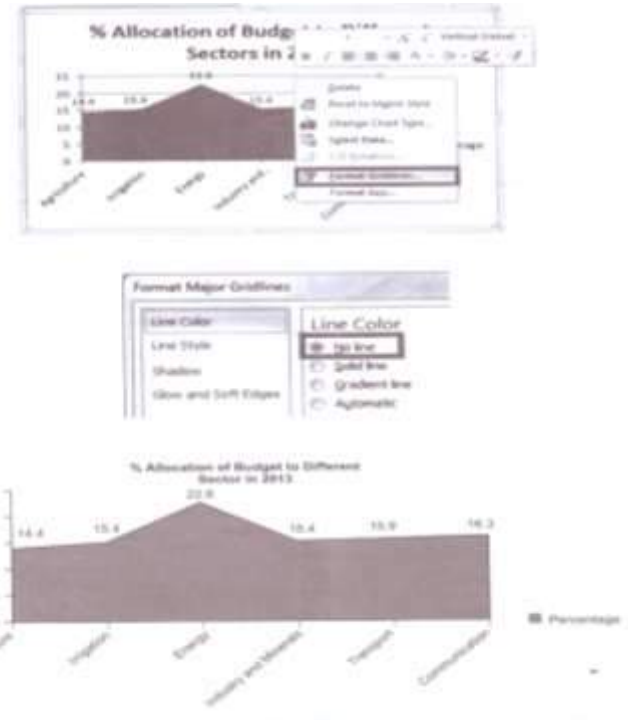




Edit the chart title: Double click the chart title and edit the same as required



Removing the Gridlines: Select the chart area and right click on the same. Select 'Format Gridlines and then 'No Lines' in the next pop up window.



There are many other charts types available in Excel. These include Scatter, Stock, Surface, Doughnut, Bubble, Radar chart types. All these types of charts can be created using similar steps described above.

Exercise 8.1

Ques 1 Define a computer?

Ques 2 Explain the meaning of the following terms in context of computer:

(a) Mini Computer

(b) Analogue Computer

(c) Digital Computer

(d) Hybrid Computers

(e) Super Computers

8.6 Summary & Conclusion

In this chapter we discussed about computers it meaning and its various types. We have also studied about the use of computers in research and have understood the fact that computers have become an indispensable part of social science research. Computers are ideally suited for data analysis concerning large research projects. Researchers are essentially concerned with huge storage of data, their faster retrieval when required and processing of data with the aid of various techniques. In all these operations, computers are of great help. Their use, apart expediting the research work, has reduced human drudgery and added to the quality of research activity.

8.7 Glossary

- **Computer-** A computer is an electronic machine that is used for storing, organizing, and finding words, numbers, and pictures, for doing calculations, A computer is a device that accepts information (in the form of digitalized data) and manipulates it for some result based on a program or sequence of instructions on how the data is to be processed.
- **Digital Computer-** Most of the computers these days are digital computers in which data is read in the form of discrete signal as high9on or1) and low (off or 0).
- **Hybrid Computers-** These computers use both the analog as well as he digital signal to generate output e.g. the CT Scan Machine first reads the data about humans, let us say a scan of the human brain and then this data which has been read by an analog computer is sent to a digital computer to generate output.
- **Super Computers-** These computers are highly sophisticated and powerful computers that can perform complex calculations at a rapid speed of almost millions of processes in a second. Traditionally these computers were used in scientific and military work but their application is being seen in business also.

- **Micro Computers-** Also known as personal computers, these are designed to meet the requirements of individuals. They can be placed on a desk top and are portable.
- **Fifth Generation (1989 and Present) –** The fifth generation computers are based on 'artificial intelligence' and are still evolving. Artificial intelligence makes the computers behave like human beings. Games, expert system, robos are some examples of application of artificial intelligence.
- **Mild-range Computers-** These computers are less powerful, less expensive and smaller than main frame computers and can be further classified as 'Mini computers' and 'servers'. Mini computers are small general purpose computers and are used in systems for universities, factories or research laboratories.

8.8 Self Assessment Test

Exercise 8.1

Answer 1: Refer to section 8.2

Answer 2: Refer to section 8.3

8.9 Terminal Questions

Question 1 What is a computer? Point out the difference between Mild- range computers and digital computers.

Question 2 How computers are used as a tool in research? Explain giving examples.

8.10 Suggested Reading

1. Goode and Hatt, Research Methodology, Prentice Hall Publications, 1959.

2. Kothari, C.R. Research Methodology, Methods and Techniques, New Age International Publisher.

3. Donald R. Cooper and Pamela S. Schindler, Business Research methods, 9th Edition, Tata McGraw Hill, 2006.

4. Ghosh, B.N. Research Methodology, Himalayan Publishing House, New Delhi.

5. Alan Bryman and Emma Bell, Business Research methods, Oxford University Press, New Delhi, 2008.

6. Uma Sekaran, Research methods for Business, Wiley India, New Delhi, 2006.

7. K. N. Krishnaswamy, Appa Iyer Sivakumar and M. Mathirajan, Management Research Methodology, Pearson Education, New Delhi, 2006.

8. Sadhu A.N. and A. Singh, Research Methodology in Social Sciences, Himalaya Publishing House.

9. Gopal, M.H., Research Methodology in Social Sciences, Asia Publishing House, New Delhi.

10. Gupta K. Shashi & Rangi Praneet, Research Methodology in Commerce, Kalyani Publishers

LESSON 9

T-TEST, Z- TEST AND CHI-SQUARE TEST

Structure

9.0 Objectives

After going through this lesson you will be able to:

- Define Z-test, T-test and Chi-Square test
- Explain the requirements for applying Z-test, T-test and Chi-Square test
- Explicate the steps followed in testing hypothesis with Z-test.

9.1 Introduction

Test of significance are classified into parametric and non-parametric tests. Parametric tests make the assumption about the underlying distribution from which sample populations are selected. Examples of parametric tests are Z-test and T-Test. Non-Parametric tests of the null hypothesis do not assume any particular distribution for the data. Instead they look at the category or rank order of the values and ignore the absolute difference between them. Consequently non-parametric analysis is used on nominal and ordinal data as well as quantitative data that are not normally distributed. Non-parametric tests are used to verify other features of the distribution of a character (including its parameters). The most widely used non-parametric test is chi-square. The following chapter discusses all these three test in detail.

9.2 Meaning of T-Test

The t-statistic was introduced in 1908 by William Sealy Gosset, a chemist working for the Guinness brewery in Dublin, Ireland ("Student" was his pen name). Gosset had been hired due to Claude Guinness's policy of recruiting the best graduates from Oxford and Cambridge to apply biochemistry and statistics to Guinness's industrial processes. Gosset devised the t-test as a cheap way to monitor the quality of stout. The Student's t-test work was submitted to and accepted in the journal Biometrika and published in 1908. Company policy at Guinness forbade its chemists from publishing their findings, so Gosset published his mathematical work under the pseudonym "Student". Guinness had a policy of allowing technical staff leave for study (so-called "study leave"), which Gosset used during the first two terms of the 1906–1907 academic year in Professor Karl Pearson's Biometric Laboratory at University College London. Gosset's identity was then known to fellow statisticians and to Editor-in-chief Karl Pearson. It is not clear how much of the work Gosset performed while he was at Guinness and how much was done when he was on study leave at University College London.

T-test is a univariate test that uses t-distribution for testing sample mean and proportion when the size of sample is small (i.e. less than 30). The T-distribution is a symmetrical bell-shaped curve. The variance of T-distribution approaches the variance of standard normal distribution as the sample size increases.

9.2.1 Definition of T- Test

A statistical examination of two population means. A two-sample t-test examines whether two samples are different and is commonly used when the variances of two normal distributions are unknown and when an experiment uses a small sample size. For example, a t-test could be used to compare the average floor routine score of the U.S. women's Olympic gymnastics team to the average floor routine score of China's women's team.

9.2.2 Requirements for applying t-test

(i) **Size of Sample-** t-test is used for small samples. To use t-test sample size should be less than 30.

(ii) **Independent Distribution-** Data points should be independent from each other.

(iii) **Normal Distribution-** Data should be normally distributed.

(iv) **Random Selection-** Data should be normally selected from a population, where each item has an equal chance of being selected.

(v) **Equality of sample size-** If two samples are being compared, sample sizes should be equal.

(vi) **Same Variance-** The variance of the samples should be same.

9.3 Meaning of Z-Test

Z test is a popular test for judging the significance of mean and proportions. The Z test is used for t-distribution and binomial or poisson distribution also, when the size of the sample is very large on the presumption that such a distribution tends to approximate normal distribution as a sample size becomes larger. The critical Z value is found out from the table showing the area under a normal curve at a specified level of significance of measure concerned.

9.3.1 Definition of Z-Test

A statistical test used to determine whether two population means are different when the variances are known and the sample size is large. The test statistic is assumed to have a normal distribution and nuisance parameters such as standard deviation should be known in order for an accurate z-test to be performed.

9.3.2 Requirements for applying a Z-test

To apply Z-test for testing of hypothesis certain conditions are to be met. These are:

(i) **Size of the sample-** Z-test is used for large samples. To use Z-test sample size should be greater than 30.
(ii) **Independent data points-** Data points should be independent from each other.
(iii) **Normal distribution-** Data should be normally distributed.
(iv) **Random Selection-** Data should be randomly selected from a population, where each item has an equal chance of being selected.
(v) **Equality of sample size-** If two samples are being compared, sample sizes should be equal if at all possible

(vi) **Same variance-** The variance of all the samples should be same.

(vii) **Nuisance Parameters-** While applying Z test nuisance parameters should be known, or estimated with high accuracy. A nuisance parameter is any parameter which is not of immediate interest but which must be accounted for in the analysis of those parameters which are of interest. For example standard deviation in a one-sample test.

9.3.4 Steps followed in testing hypothesis with Z-test

Steps followed in testing hypothesis with Z-test

Step1: State a Null Hypothesis and an Alternative Hypothesis

Step2: Choose a level of significance

Step3: Calculate the Z-Statistics

$$Z= \frac{\bar{x}-\mu}{\sigma/\sqrt{n}}$$

Step4: Find the critical value of Z in Z table.

Step5: Compare the test statistics to the critical Z Value and decide if you accept or reject the Null hypothesis.

9.4 Meaning of Chi Square-Test

The Chi-Square test is one of the several tests of significance developed by statisticians. It is a statistical measure used in the context of sampling analysis for comparing a variance to a theoretical variance. Chi-Square test can be used to determine if categorical data shows dependency or if two classifications are independent. It can also be used to make comparisons between theoretical populations and actual data hence categories are used. The values of chi-square is used to study the divergence of actual and exact frequencies and from this value coefficient of contingency is calculated to find out if there is any associations between the attributes in question. Thus, chi-square is a measure of actual divergence of the observed and expected frequencies. The chi-square test is applicable to a large number of problems. With the use of this technique, all the researchers are immediately benefited in the following ways:

(i) Test the goodness of it.
(ii) Test the significance of association between two attributes, and
(iii) Test the homogeneity or the significance of population variance.

Chi-Square is a measure for comparing variance in sampling studies; we never expect that there will be perfect coincidence between actual and observed frequencies and the question that has to be tackled is about the extent to which the difference between actual and observed frequencies can be ignored as arising due to sampling

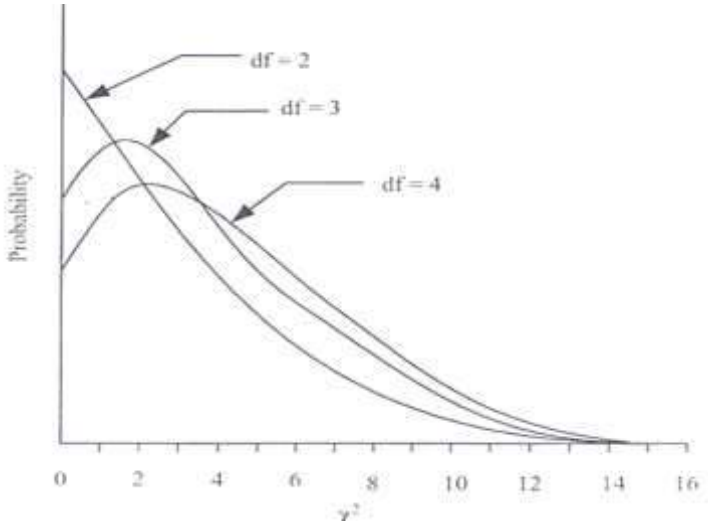
fluctuations. The chi-square value is used to judge the significance of population variance.

9.4.1Definition of Chi-Square

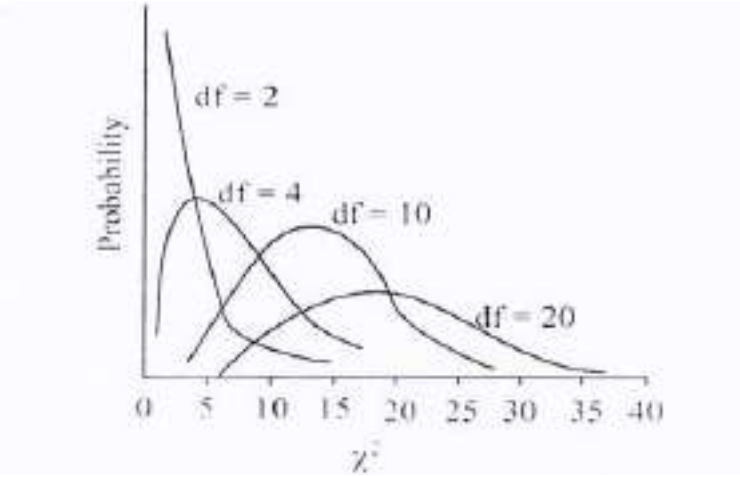
The chi-square distribution is a probability distribution. Under some proper conditions the chi-square distribution can be used as a sampling distribution of chi-square. The chi-square distribution is known by its only parameter. Number of degree of freedom. The meaning of degrees of freedom is the same as the one you have used in student t-distribution. Figure 9.1 shows the three different chi square distributions for three different degrees of freedom.

The chi-square distribution is a probability distribution. Under some proper conditions the chi-square distribution can be used as a sampling distribution of chi-square. The chi-square distribution is known by its only parameter number of degrees of freedom. The meaning of degrees of freedom is the same as the one you have used in student t-distribution. Figure 9.1 shows the three different chi square distributions for three different degrees of freedom.

Figure 9.1. Chi-Square Sampling Distributions for df =2, 3 and 4



It is to be noted that as the degrees of freedom are very small, the chi-square distribution is heavily skewed to the right. As the number of degrees of freedom increases, the curve rapidly approaches symmetric distribution. You may be aware that when the distribution is symmetric, it can be approximated by normal distribution. Therefore, when the degrees of freedom increase sufficiently, the chi-square distribution approximates the normal distribution. This is illustrated in Figure 9.2.



Like student t-distribution there is a separate chi-square distribution for each number of degrees of freedom.

9.4.2 Requirements for Chi-Square Test

(i) **Quantitative data-** The data in Chi-Square should be quantitative and not qualitative.
(ii) **One or more categories-** A Chi-Square test is designed to analyze categorical data which means that that data has been counted and divided into categories. It cannot be applied to parametric or continuous data.
(iii) **Mutually Exclusive –** The categories in Chi-Square data should be mutually exclusive which means that all the observation belong to only one category.
(iv) **Adequate sample size-** The sample should be at least 10
(v) **Simple random Sample-** The sample should be random.
(vi) **Data in Frequency form-** The data in a Chi-Square should be in the form of percentages, or anything. It should be a frequency (count) data.
(vii) **Enough Data-** There should be enough data in each category to perform a Chi-Square test. Chi-Square should not be calculated if the expected value in any category is less than 5.

Exercise 9.1

Ques 1.What is Z-test?

Ques 2 What is T-test?

9.5 Summary Conclusion

In this chapter we have discussed the T-test, Z-test and Chi-Square test. T-test is a statistical examination of two population means. A two sample t-test examines whether two samples are different and is commonly used when the variances of two normal distributions are unknown and when an experiment uses a small sample size. For example, a t-test could be used to compare the average floor routine score of the U.S. women's Olympic gymnastics team to the average floor routine score of China's

women's team. Z-test is a statistical test used to determine whether two population means are different when the variances are known and the sample size is large. The test statistic is assumed to have a normal distribution and nuisance parameters such as standard deviation should be known in order for an accurate z-test to be performed and Chi-square is a statistical measure used in the context of sampling analysis for comparing a variance to a theoretical variance. Chi-Square test can be used to determine if categorical data shows dependency or if two classifications are independent. It can also be used to make comparisons between theoretical populations and actual data hen categories are used.

9.6 Glossary

- **T-test-** A statistical examination of two population means. A two-sample t-test examines whether two samples are different and is commonly used when the variances of two normal distributions are unknown and when an experiment uses a small sample size. For example, a t-test could be used to compare the average floor routine score of the U.S. women's Olympic gymnastics team to the average floor routine score of China's women's team.

- **Z-test-** A statistical test used to determine whether two population means are different when the variances are known and the sample size is large. The test statistic is assumed to have a normal distribution and nuisance parameters such as standard deviation should be known in order for an accurate z-test to be performed.
- **Hypothesis-** A hypothesis is proposition condition or principle which is assumed perhaps without belief in order to draw out its logical consequences and by this method to test its accord with facts which are known may be determined.
- **Chi-square-** is a statistical measure used in the context of sampling analysis for comparing a variance to a theoretical variance. Chi-Square test can be used to determine if categorical data shows dependency or if two classifications are independent. It can also be used to make comparisons between theoretical populations and actual data hen categories are used.
- **Goodness of Fit:** The chi-square test procedure used for the validation of our assumption about the probability distribution is called goodness of fit.

9.7 Self Assessment Test

Exercise 9.1

Answer 1: Refer to section 9.3

Answer 2: Refer to section 9.2

9.8 Terminal Questions

Question 1 Define Z-test. What are the requirements to apply Z-test? Also explain the uses of Z-test.

Question 2 What do you mean by Chi-Square test? What are conditions for applying t-test?

9.9 Suggested Readings

1. Goode and Hatt, Research Methodology, Prentice Hall Publications, 1959.

2. Kothari, C.R. Research Methodology, Methods and Techniques, New Age International Publisher.

3. Donald R. Cooper and Pamela S. Schindler, Business Research methods, 9th Edition, Tata McGraw Hill, 2006.

4. Ghosh, B.N. Research Methodology, Himalayan Publishing House, New Delhi.

5. Alan Bryman and Emma Bell, Business Research methods, Oxford University Press, New Delhi, 2008.

6. Uma Sekaran, Research methods for Business, Wiley India, New Delhi, 2006.

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8. Sadhu A.N. and A. Singh, Research Methodology in Social Sciences, Himalaya Publishing House.

9. Gopal, M.H., Research Methodology in Social Sciences, Asia Publishing House, New Delhi.

10. Gupta K. Shashi & Rangi Praneet, Research Methodology in Commerce, Kalyani Publishers

LESSON 10

REPORT WRITING

STRUCTURE

10.0 Objectives

After going through this lesson you will be able to:

- Define a Report,
- Explain the significance of report writing
- Discuss the different steps in writing the reports
- Identify the Mechanics in writing a research report
- Explain the ethics in research
- Explicate the presentation of research report

10.1Introduction

The last and final chapter of the voyage in research is writing of the report. After the collected data has been analyzed and interpreted and generalizations have been drawn the report has to be prepared. The task of research is incomplete till the report is presented. Writing of a report is the last step in a research study and requires a set of skills somewhat different from those called for in respect of the earlier stages of research. This task should be accomplished by the researcher with utmost care.

10.2 Significance of Report Writing

The significance of report writing can be understood from following points.

(i) **Report gives merged information-** Report presents large information in compressed form.

(ii) **Present complicated matters easily-** Report writing is best way to represent any complicated matter easily and attractively.

(iii) **Facilitates Decision making and planning-** Decisions can be easily made based on the recommendations given in report.

(iv) **Builds relationship-** report build relationship between author and reader. It creates impression on author's knowledge and philosophy between author and reader. It creates impression on author's knowledge and philosophy and also provides insight regarding his analytical and critical understanding.

(v) **Unveil Unknown Information-** Report gives its readers hitherto to unknown information about the problem or issue.

(vi) **Provides foundation for future research-** Report provides information in terms of tables, graphs, charts and illustration and therefore we can be aware of facts and figures as an update. One can re-use this information for future reference.

(vii) **Augment writing skills in presenting practical work-** Writing report is not a layman's task. The rewriting and editing again and again enhances the writing skills of researcher.

(viii) **Highlights important details about the research process-** Report highlights important details about the research process. By simply going through the report one can know the objectives, methodology and results of research.

(ix) **Permanent record and is easy to verify-** The written report is as a permanent record. When it is needed, important information can be easily collected from the preserved report. The information and messages that are

preserved can be verified easily. If there arises any misunderstanding any party can easily verify the information.

10.3 Different steps in writing the report

Research reports are the product of slow, painstaking, accurate inductive work. The usual steps involved in writing report are(a) logical analysis of the subject-matter;(b) preparation of the final outline;(c) preparation of rough draft;(d) rewriting and polishing; (e) preparation of the final bibliography; and (f) writing the final draft. Though all these steps are self explanatory, yet a brief mention of each one of these will be appropriate for better understanding. We discuss each of them in detail in the following paragraphs.

(i) Logical, analysis of the subject matter- It is the first step which is primarily concerned with the development of a subject. There are two ways in which to develop a subject- (a) logically and (b) chronologically. The logical development is made on the basis of mental connections and associations between the one thing and another by means of analysis. Logical treatment often consists in developing the material from the simple possible to the most complex structures. Chronological development is based on a connection or sequence in time or occurrence. The directions for doing or making something usually follow the chronological order.

(ii)Preparation of the final outline- It is the next step in writing the research report. “Outlines are the framework upon which long written works are constructed. They are an aid to the logical organization of the material and a reminder of the points to be stressed in the report’.

(iii) Preparation of the rough draft- This follows the logical analysis of the subject and the preparation of the final outline. Such a step is of utmost importance for the researcher who sits to write down what he has done in the context of his research study. He will write down the procedure adopted by him in collecting the material for his study along with various limitations faced by him, the technique of analysis adopted by him, the broad findings and generalizations and the various suggestions he wants to offer regarding the problem concerned.

(iv) Rewriting and polishing the rough draft- This step happens to be the most difficult part of all formal writing. Usually this step requires more time than the writing of the rough draft. The careful revision makes the difference between a mediocre and a good piece of writing. While rewriting and polishing, one should check the report for weakness in logical development or presentation. The researcher should also “see whether or not the material, as it is presented, has unity and cohesion; does the report stand upright and firm and exhibit a definite pattern, like a marble arch? Or does it resemble an old wall of moldering cement bricks and loose bricks”. In addition the researcher should give due attention to the fact that in his rough draft he has been consistent or not. He should check the mechanics of writing-grammar, spelling and usage.

(v) Preparation of the final bibliography – Next in order comes, the task of the preparation of the final bibliography. The bibliography, which is generally appended to the research report, is a list of books in some way pertinent to the research which has been done. It should contain all those woks which the researcher has consulted. The bibliography should be arranged alphabetically and may be divided into two parts; the first part may contain the names of books and pamphlets, and the second part may contain the names of magazine and newspaper articles. Generally, this pattern of bibliography is considered convenient and satisfactory from the point of view of reader, though it is not the only way of presenting bibliography. The entries on bibliography should be made adopting the following order:

For books and pamphlets the order may be as under:

1.Name of author, last name first.

2. Title, underlined to indicate italics.

3. Place, publisher, and date of publication

4. Number of volumes.

(vi) **Writing the final draft** – This constitutes the last step. The final draft should be written in a concise and objective style and in simple language, avoiding vague expressions such as “it seems”, there may be” and the like ones. While writing the final draft, the researcher must avoid abstract terminology and technical illustration and examples based on common experiences must be incorporated in the final draft as they happen to be most effective in communicating the research findings to others. A research report should not be dull, but must enthuse people and maintain interest and must show originality, It must be remembered that every report should be an attempt to solve some intellectual problem and must contribute to the solution of a problem and must add to the knowledge of both the researcher and the reader.

10.4 Mechanics of Writing a Research Report

There are very definite and set rules which should be followed in the actual preparation of the research report or paper. Once the techniques are finally decided, they should be scrupulously adhered to, and no deviation permitted. . The criteria of format should be decided as soon as the materials for the research paper have been assembled. The following points deserve mention so far as the mechanics of writing a report are concerned:

(i) **Size and Physical Design-** The manuscript should be written on unruled paper $8\frac{1}{2}$’’X11’ in size. If it is to be written by hand, then black or blue-black ink should be used. A margin of at least half an inch at the right hand of the paper. There should also be one –inch margins, top and bottom. The paper should be neat and legible /if the manuscript is to be typed, then all typing

should be double-spaced on one side of the page only except for the insertion of the long quotations.

(ii) **Procedure –** various steps in writing the report should be strictly adhered

(iii) **Layout-** Keeping in view the objective and nature of the problem, the layout of the report should be thought of and decided and accordingly adopted.

(iv) **Treatment of Quotations-** Quotations should be placed in quotation marks and double spaced, forming an immediate pat of the text. But if a quotation is of considerable length (more than four or five type written lines) then it should be single-spaced and indented at least half an inch to the right of the normal text margin.

(v) **The footnotes –** Regarding footnotes one should keep in view of the followings:

(a) The footnotes serve two purposes viz., the identification of materials used in quotations in the report and the notice of materials not immediately necessary to the body of the research text but still of supplemental value. In other words, footnotes are meant for cross references, citation of authorities and sources, acknowledgement and elucidation or explanation of a point of view. It should always be kept in view that footnote is neither an end nor a means of the display of scholarship. The modern tendency is to make the minimum use of footnotes for scholarship does not need to be displayed.

(b) Footnotes are placed at the bottom of the page on which the reference quotation which they identify or supplement ends. Footnotes are customarily separated from the textual material by a space of half an inch and a line about one and a half inch long.

(c) Footnotes should be numbered consecutively, usually beginning with 1 in each chapter separately. The number should be put slightly above the line, say at end of a quotation. At the foot of the page, again, the footnote number should be indented and typed a little above the line. Thus, consecutive numbers must be used to correlate the reference in the text with its corresponding note at the bottom of the page, except in the case of statistical tables and other numerical material, where symbols such as the asterisk(*) or the like one may be used to prevent confusion.

(d) Footnotes are always typed in single space though they are divided from one another by double space.

(6) **Documentation style–** regarding documentation, the first footnote reference to any given work should be complete in its documentation, giving all the essential facts about the edition used. Such documentary footnotes follow a general sequence. The common order may be described as under:

(i) Regarding the single-volume reference

1. Author's name in normal order(and not beginning with the last name as in a bibliography) followed by a comma;
2. Title of work, underlined to indicate italics;
3. Place and date of publication;
4. Pagination references(The page number)

(ii) *Regarding multivolumed reference*

1. Author's name in normal order(and not beginning with the last name as in a bibliography) followed by a comma;
2. Title of work, underlined to indicate italics;
3. Place and date of publication;
4. Pagination references(The page number)

(iii) *Regarding woks arranged alphabetically*

For works arranged alphabetically such as encyclopedia and dictionaries, no pagination reference is usually needed. In such cases the order is illustrated as under:

Example1

"Salamanca." Encyclopaedia Bitannica,14th Edition.

(iv) *Regarding periodicals reference*

1. Name of the author in n
2. Title of article, in quotation marks;
3. Name of periodical, underlined to indicate italics'
4. Volume Number
5. Date of issuance
6. Pagination

(v)*Regarding anthologies and collections reference*

Quotations from anthologies or collection of literary works must be acknowledged not only by author, but also by the name of the collector.

(vi)*Regarding second-hand quotations reference*

In such cases the documentation should be handled as follows:

1. Original autor an title'
2. 'quoted or cited in";
3. Second author and work.

Example

J.f.Jones, *Life in Ployensia,p.16, quoted in History of the Pacific Ocean area,* R.B, Abel,p.191.

(vii) *Case of multiple authorship*

If there are more than two authors or editors, then in the documentation the name of only the first is given and the multiple authorship is indicated by "et al." or "and others'.

Subsequent references to the same work need not be detailed as stated above. If the work is citied again without any other work intervening, it may be indicated as ibid, followed by a comma and the page number. A single page should be referred to as p., but more than one page be referred to as pp. If there are several pages referred to at a stretch, the practice is to use often the page number, for example, pp. 190ff, which means page number 190 and the following pages; but only for page 190 and the following page '190f'. Roman numerical is generally used to indicate the number of the volume of a book. Op. cit, (opera citato, in the work cited) or Loc. Cit. (loco citatao, in the place cited) are two of the very convenient abbreviations used in the footnotes. Op. cit, or Loc. Cit, after the writer's name would suggest that the references is to work by the writer which has been cited in detail in an earlier footnotes but intervened by some other references.

7. Punctuation and abbreviations in footnotes- the first item the number in the footnote is the author's name, given in the normal signature order. This is followed by a comma. After the comma, the title of the book is given: the article (such as "A", "An", "The" etc.) is omitted and only the first word and proper nouns and adjectives are capitalized. The title is followed by a comma. Information concerning the edition is given next. This entry is followed by a comma. The place of publication is then stated; it may be mentioned in an abbreviated form, N.Y. for New York, N.D. for New Delhi and so on. This entry is followed by a comma. Then the name of the publisher is mentioned and this entry is closed by a comma. It is followed by the date of publication and this entry is closed by a comma. It is followed by the date of publication if the date is given on the title page. If the date appears in the copyright

notice on the reverse side of the title page or elsewhere in the volume, the comma should be omitted and the date enclosed in square brackets[c 1978], [1978]. The entry is followed by a comma. Then follow the volume and page references and are separated by comma if both are given. A period closes the complete documentary reference .But one should remember that the documentation regarding acknowledgements from magazine articles and periodical literature follow a different form as stated earlier while explaining the entries in the bibliography.

8. Use of statistics, charts and graphs – A judicious use of statistics in research reports is often considered a virtue for it contributes a great deal towards the clarification and simplification of the material and research results. One may well remember that a good picture is often worth more than a thousand words. Statistics are usually presented in the form of tables, charts, bars and line-graphs and pictograms. Such presentation should be self explanatory and complete in itself. It should be suitable and appropriate looking to the problem at hand. Finally, statistical presentation should be neat and attractive.

9.The final draft – Revising and rewriting the rough draft of the report should be done with great care before writing the final draft. For the purpose, the researcher should put to himself questions like: Are the sentences written in the report clear? Are they grammatically correct? Do they say what is meant? Do the various points incorporated in the report fit together logically? “Having at least one colleague read the report just before the final revision is extremely helpful. Sentences that seem crystal clear to the writer may prove quite confusing to other people; a connection that had seemed self evident may strike others as a non-sequitur. A friendly critic, by pointing out passages that seem unclear or illogical, and perhaps suggesting ways of remedying the difficulties can be an invaluable aid in achieving the goal of adequate communication.”

10. Bibliography- Bibliography should be prepared and appended to the research report .

11. Preparation of the index- At the end of the report, an index should invariably be given, the value of which lies in the fact that it acts as a good guide to the reader. Index may be prepared both as subject index and as author index. The former gives the names of the subject-topics or concepts along with the number of pages on which they have appeared or discussed in the report, whereas the latter gives the similar information regarding the names of authors. The index should always be arranged alphabetically. Some people prefer to prepare only one index common for names of authors, subject-topics, concepts and the like ones.

10.5 Ethics in Research

Ethics are nothing but the accepted codes of conduct. The term is derived from a Greek word ethos which means custom, habit, character or disposition. In research, ethics are a method, procedure, or perspective for deciding how to act and for analyzing complex problems and issues. Ethics are applied on all stages of research, such as

planning, conducting and evaluation. Webster dictionary defines ethical (behavior) as conforming to the standards of conduct of a given profession or group."

10.5.1Ethical Principles in Research

In research it is impossible to construct general ethical principles. But in social science research there are some ethical principles which are very important.

(i) **Principle of Autonomy-** The principle of autonomy requires that protection be given to potentially vulnerable populations such as children, the elderly, the mentally ill, or prisoners. Individuals in these groups may be incapable of understanding information that would enable them to make an informed decision about study participation. They are considered potentially "vulnerable." Consequently, careful consideration of their situation and needs is required and extra care must be taken to protect them.

(ii) **Principle of non-maleficence –** The principle of "Non-Maleficence" requires an intention to avoid needless harm or injury that can arise through acts of commission or omission. Non-Maleficence asserts that the primary concern when carrying out a research is to do no harm.

(iii) **Principle of Beneficence** – Beneficence obligates the researcher to secure the well-being of all study participants. It is the responsibility of researcher to protect participants from harm, as well as ensure that they experience the possible benefits of involvement.

(iv) **Principle of Justice –** This principle of justice raises the question of who ought to receive the benefits of research and bear its burdens. An injustice occurs when some benefit to which a person is entitled is denied without good reason or when some burden is imposed unduly. It requires that the benefits and risks of research should be fairly distributed among people.

10.5.2 Important Ethical Guideline for Social Science Research

(i) **Integrity and Quality-** Integrity and Quality relate to the honesty of a research how honesty he or she undertakes a research. In research confidential communication, such as papers or grants submitted to publication, personal records, trade or military secrets, and patient records should be protected. The integrity of investigator is must because any breach of integrity and quality weakens or even invalidated the research.

(ii) **Objectivity –** A researcher should avoid personal bias and should try to bring objectivity in research. He should minimize bias or self-deception in experimental design, data analysis, data interpretation, peer review, grant writing and other aspects of research where objectivity is expected or required.

(iii) **Essentiality-** For undertaking research, a researcher should give adequate consideration to existing literature/ knowledge and its relevance. This will justify the need for the study. It may be possible that there are alternatives available on the subject/issue under the study and study is not required.

(iv) **Confidentiality-** The confidentiality of respondents should be maintained. They should be assured that identifying information will not be made available to anyone who is not directly involved in the study.

(v) **Anonymity-** Anonymity means that the participant will remain anonymous throughout the study-even to the researchers themselves. Clearly, it is standard of privacy, but it is some time difficult to accomplish, especially in situations where participants have to be measured at multiple time points like pre test and post test measurements, in different situations, etc.

(vi) **Free from coercion voluntary participants-** It requires that people should not be compelled or forced to participate in research. This is especially relevant where researchers has to rely on 'captive audiences' for their participants-prisons, universities, and places like that.

(vii) **Informed Consent-** The prospective research participants must be fully informed about the procedures and risks involved in research and should be taken in research only after they give their consent to participate.

(viii) **Legality-** A researcher should be aware of all the legal aspects of the research problem. He should know and obey relevant laws and institutional and governmental policies and follow them

(ix) **Maximization of public interest and of social justice-** In social sciences research is usually carried out for the benefit of society. A researcher should strive to promote social good and prevent or mitigate social harms through research. The research should be undertaken with the motive of maximization of public interest and social justice.

(x) **Accountability and transparency-** The research should be conducted in a fair and transparent way. The researcher should always be willing for social and financial review of his or her research. Researcher should also make appropriate arrangements for the preservation of research records for a reasonable period of time so that it can be verified.

(xi) **Independence and impartiality of researcher-** A researcher should work independently and impartially. He should not get influenced and pressurized by the funding agencies and authorities and should report and forecast factual results. He should also not indulge in pseudo-pilot studies.

10.6 Presentation of Research Report

Presentation of report is an important part of report writing, because a good presentation may disguise inadequate research, but a bad presentation can obscure even the best work. It is very important to know how a report should be presented. Presentation of report should be done with formal language, quality paper, good typing, consistent and appropriate formatting and attractive binding. One should use Subheadings, tables and figures in report. It should be ensured that the separate parts of report stand out clearly and pages are numbered. However oral presentation, is little difficult than the written presentation. This is because the reporter has to interact directly with the audience.

Oral presentation of the results of the study is considered effective, particularly in cases where policy recommendations are indicated by projects results. The merit of this approach lies in the fact that it provides an opportunity forgive and take decisions which generally lead to a better understanding of the findings and their implications. But the main demerit of this sort of presentation is the lack of any permanent record concerning the research details and it may be just possible that the findings may fade away from people's memory even before an action is taken.

In order to overcome this difficulty, a written report may be circulated before the oral presentation and referred to frequently during the discussion. Oral presentation is effective when supplemented by various visual devices. Use of slides, wall charts and blackboards is quite helpful in contributing to clarity and in reducing the boredom, if any. Distributing a board outline, with a few important tables and charts concerning the research results, makes the listeners attentive who have a ready outline on which to focus their thinking. This very often happens in academic institutions where the researcher discusses his research findings and policy implications with others either in a seminar or in a group discussion.

10.6.1 Steps in Successful Presentation of Report

Given below are the major steps usually involved in delivering a research report presentation:

Step 1 Understand the key factors for presentation- The key factors in a presentation are purpose, audience and logistics. Reporter should understand the purpose of his presentation whether it is to inform or to persuade or to get further research grants he/she should know who the audience is? Whether it is peer group or his seniors or the general people? What attitude do they have? He/she should know how much time he has to speak, what time of day it will be and how the room will be set up.

Step 2 Organize your Material- Oral presentations are designed to present a summary of a longer research in a way that enables the audience to understand the content of research and to decide if she/he should read the entire research. So organize your material and draft what you want to say.

Step 3 Summarize the draft- Once decided about the content to be spoken, the reporter should summarize the draft into key points to write on overheads and/or note cards.

Step 4 Prepare effective visual aids- Researcher should prepare visual aids for presentation. Using visual aids in presentation instead of words can double the chances of meeting your objectives. It will reinforce your points and help your audience to remember them.

Step 5 Rehearse Presentation- Practice your oral presentation before you give it in front of an audience. Read it out loud, may be in front of a mirror or to some friend, and time yourself as you read it.

Step 6 Deliver Presentation- Now deliver your presentation. Use simple language to deliver the presentation. Speak clearly, slowly and loudly enough for everyone in the room to hear you. Stand straight and comfortably holding your head up. While making presentation interact with the audience and be open to questions.

Step 7 Evaluate your Presentation- After making a presentation, evaluate how the presentation went. Did the audience "get" the key points? Were you able to answer the audience's questions related to the presentation? If possible, prepare written evaluation forms that can be reviewed after the presentation.

Exercise 10.1

Question 1 Explain report writing?

Question 2 What do you understand by ethics in research?

Question 3 Explain Mechanics of report writing?

10.7 Summary & Conclusion

In this chapter, we have discussed the mechanics of report writing, ethics in report writing and various components of presentation skills. A report is not a complete description of what has been done during study rather it is a brief statement of most significant facts that are necessary for understanding the generalizations drawn by the investigator. Presenter's Poise is one of the most important parts of presentation. The chapter concludes by suggesting as to what should presenter do in putting across his ideas.

10.8 Glossary

- **Ethics-** Ethics are nothing but the accepted codes of conduct. The term is deived from a Greek word ethos which means custom, habit, character or disposition. In research, ethics are a method, procedure, or perspective for deciding how to act and for analyzing complex problems and issues.

- **Plagiarism-**Plagiarism is using other people's work without acknowledging their contribution it can be of passing off somebody else's ideas, thoughts, theories, words or stories as own. It is a kind of stealing from the original author.

- **Fabrication-** Fabrication is the international act of making up data or results and recording or reporting them. For example suppose a researcher/interviewer completes a questionnaire for a fictitious subject that he never interviewed.

- **Falsification-** Falsification is manipulating research materials, equipments, or processes, of changing or omitting/ suppressing data or results without scientific or statistical justification, such that the research is not accurately represented.

10.9 Self Assessment Test

Exercise 10.1

Answer 1: Refer to section 10.2

Answer 2: Refer to section 10.5

Answer 3: Refer to section 10.4

10.10 Terminal Questions

Question 1 Describe, in brief, the layout of a research report, covering all relevant points.

Question 2 What do you understand by presentation of report?

10.11 Suggested Readings

1. Goode and Hatt, Research Methodology, Prentice Hall Publications, 1959.

2. Kothari, C.R. Research Methodology, Methods and Techniques, New Age International Publisher.

3. Donald R. Cooper and Pamela S. Schindler, Business Research methods, 9th Edition, Tata McGraw Hill, 2006.

4. Ghosh, B.N. Research Methodology, Himalayan Publishing House, New Delhi.

5. Alan Bryman and Emma Bell, Business Research methods, Oxford University Press, New Delhi, 2008.

6. Uma Sekaran, Research methods for Business, Wiley India, New Delhi, 2006.

7. K. N. Krishnaswamy, Appa Iyer Sivakumar and M. Mathirajan, Management Research Methodology, Pearson Education, New Delhi, 2006.

8. Sadhu A.N. and A. Singh, Research Methodology in Social Sciences, Himalaya Publishing House.

9. Gopal, M.H., Research Methodology in Social Sciences, Asia Publishing House, New Delhi.

10. Gupta K. Shashi & Rangi Praneet, Research Methodology in Commerce, Kalyani Publishers

11. Sharma Hemlata, Research Methodology in Social Sciences, VK Global Publications Pvt. Ltd.