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Rajiv Gandhi University

# BASOC302
# SOCIAL RESEARCH-I

## BA (SOCIOLOGY)

## 5TH SEMESTER

**Rajiv Gandhi University**
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# SOCIAL RESEARCH

**BASOC-302**

**Part-I**

**Fifth Semester**

**RAJIV GANDHI UNIVERSITY**
Arunachal Pradesh, INDIA - 791 112

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# About the University

Rajiv Gandhi University (formerly Arunachal University) is a premier institution for higher education in the state of Arunachal Pradesh and has completed twenty-five years of its existence. Late Smt. Indira Gandhi, the then Prime Minister of India, laid the foundation stone of the university on 4th February, 1984 at Rono Hills, where the present campus is located.

Ever since its inception, the university has been trying to achieve excellence and fulfill the objectives as envisaged in the University Act. The university received academic recognition under Section 2(f) from the University Grants Commission on 28th March, 1985 and started functioning from 1st April, 1985. It got financial recognition under section 12-B of the UGC on 25th March, 1994. Since then Rajiv Gandhi University, (then Arunachal University) has carved a niche for itself in the educational scenario of the country following its selection as a University with potential for excellence by a high-level expert committee of the University Grants Commission from among universities in India.

The University was converted into a Central University with effect from 9th April, 2007 as per notification of the Ministry of Human Resource Development, Government of India.

The University is located atop Rono Hills on a picturesque tableland of 302 acres overlooking the river Dikrong. It is 6.5 km from the National Highway 52-A and 25 km from Itanagar, the State capital. The campus is linked with the National Highway by the Dikrong bridge.

The teaching and research programmes of the University are designed with a view to play a positive role in the socio-economic and cultural development of the State. The University offers Undergraduate, Post-graduate, M.Phil and Ph.D. programmes. The Department of Education also offers the B.Ed. programme.

There are fifteen colleges affiliated to the University. The University has been extending educational facilities to students from the neighbouring states, particularly Assam. The strength of students in different departments of the University and in affiliated colleges has been steadily increasing.

The faculty members have been actively engaged in research activities with financial support from UGC and other funding agencies. Since inception, a number of proposals on research projects have been sanctioned by various funding agencies to the University. Various departments have organized numerous seminars, workshops and conferences. Many faculty members have participated in national and international conferences and seminars held within the country and abroad. Eminent scholars and distinguished personalities have visited the University and delivered lectures on various disciplines.

The academic year 2000-2001 was a year of consolidation for the University. The switch over from the annual to the semester system took off smoothly and the performance of the students registered a marked improvement. Various syllabi designed by Boards of Post-graduate Studies (BPGS) have been implemented. VSAT facility installed by the ERNET India, New Delhi under the UGC-Infonet program, provides Internet access.

In spite of infrastructural constraints, the University has been maintaining its academic excellence. The University has strictly adhered to the academic calendar, conducted the examinations and declared the results on time. The students from the University have found placements not only in State and Central Government Services, but also in various institutions, industries and organizations. Many students have emerged successful in the National Eligibility Test (NET).

Since inception, the University has made significant progress in teaching, research, innovations in curriculum development and developing infrastructure.

# SYLLABI-BOOK MAPPING TABLE

## Social Research

| Syllabi | Mapping in Book |
|---|---|
| **Unit 1 Understanding Social Research**<br>Meaning, Scope and Significance of Social Research; Major Steps inSocial Research; Qualitative and Quantitative Research. | |
| **Unit 2 Hypothesis**<br>Conceptualisation and Formulation of Hypothesis; Importance ofHypothesis in Social Research and Source of Hypothesis. | |
| **Unit 3 Scientific Study of Social Phenomena**<br>The Scientific Method, Objectivity and Subjectivity, Debate in SocialResearch; Positivism in Sociology. | |
| **Unit 4 Analysis and Use of Statistics**<br>Analysis of Data, Coding, Tables, Graphs and Diagram. | |

# CONTENTS

## UNIT 4 ANALYSIS AND USE OF STATISTICS

# INTRODUCTION

NOTES

Research is the search for knowledge or a systematic investigation in order to establish facts. The basic aim of research is to discover, interpret and develop methods and systems to advance human knowledge on diverse scientific matters. Social research refers to the conduction of research on various groups of a society by social scientists. Research methodology refers to the way research can be conducted. It is also known as the process of collecting data for various research projects.

Social research pertains to research carried out by social scientists on various facets of society. Research plays a very significant role in the field of social science. In order to study the importance and relationship between social science and research, social research is conducted or undertaken. The research that attempts to measure, describe, explain and predict the social and economic phenomena or social behaviour of human beings is known as 'social research'.

The methodology of social research is the science of studying how research is conducted scientifically. It helps to understand both the products as well as the process of scientific enquiry. A research process involves selection and formulation of a research problem, research design, sample strategy or sample design, as well as the interpretation and preparation of research report. Research can be undertaken in the form of descriptive/ survey research, applied or fundamental research, quantitative or qualitative research, conceptual or empirical research, and other types of research.

This book, *Social Research*, is written in a self-instructional format and is divided into seven units. Each unit begins with an *Introduction* to the topic followed by an outline of the *Unit Objectives*. The content is then presented in a simple and easy-to-understand manner, and is interspersed with *Check Your Progress* questions to test the reader's understanding of the topic. A list of *Questions and Exercises* is also provided at the end of each unit, and includes short-answer as well as long-answer questions. The *Summary* and *Key Terms* section are useful tools for students and are meant for effective recapitulation of the text.

# UNIT 1 UNDERSTANDING SOCIAL RESEARCH

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**Structure**



## 1.0 INTRODUCTION

Simply defined, research is a search for knowledge. One can also define research as a scientific and systematic pursuit of information on a specific topic. Scientifically, research can also be termed as scientific investigation. Thus, research and scientific enquiry can be considered synonymous. The only difference between the two is that while it is possible to employ scientific method without research, it is not possible to conduct any research without employing scientific methods. Thus, research is a more specialized form of scientific enquiry which in turn is the result of gathering of data, information and facts for the specific purpose.

Social research pertains to research carried out by social scientists on various facets of society. Research plays a very significant role in the field of social science. In order to study the importance and relationship between social science and research, social research is conducted or undertaken. The research that attempts to measure, describe, explain and predict the social and economic phenomena or social behaviour of human beings is known as 'social research'. In this unit, you will get acquainted with the meaning, characteristics and objective of scientific research, aims and types of social research, steps in social research and the concept of qualitative and quantitative research.

## 1.1 UNIT OBJECTIVES

After going through this unit, you will be able to:

- Explain the meaning of the term social research
- Analyse the scope and significance of social research
- Assess the types of social research

- Describe the major steps involved in social research
- Assess the concept of qualitative and quantitative research

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## 1.2 MEANING OF SOCIAL RESEARCH

Society is an amalgamation of individuals with different needs, aspirations and goals in life. However, social individuals are also associated with each other through shared interests, familial bonds and common objectives. Social research is basically research conducted by social scientists in order to analyse a vast breadth of social phenomena. The methods used in social research find their roots in classical sociology and statistics. Social research methods may be divided into two broad divisions. These are: Qualitative and Quantitative methods. While the former approaches social phenomena through quantifiable evidence, the latter approaches social phenomena through observation, communication with partners and analysis of text. However, the choice of method depends largely on what the scientist wishes to investigate. Prof. Bent Flyvbjerg of Oxford University maintains that the divide between the quality and quantity oriented camps in social research is clearly unfortunate as good research methods require a combination of both.

### Definitions

While C.A. Moser defines social research as: 'A systematized investigation to gain new knowledge about social phenomenon and problems', P.V.Young maintains: 'Social research is a scientific undertaking which by means of logical methods, aim to discover new facts or old facts and to analyse their sequences, interrelationships, casual explanations and natural laws which govern them.'

### Objectivity in Social Research

Social scientists are often influenced by their biases, passions, likes and dislikes and preconceived notions. These are seen to interfere with the scientific objectivity that they would need while researching on social sciences. Objectivity is the capacity to represent truthfully and without prejudice, the results of one's research. A social researcher needs to be aware of his personal biases and prejudices and take adequate care that these do not affect the objectivity of the research. Max Weber, an exponent in social research argued, that actually, the thoughts and beliefs of the researchers *should* affect their topics of study. However, the social scientist needs to be value-neutral once the research question has been framed. Objectivity can be attained by sharing the results of research with experts who then may be asked to critically examine them. In his *Logic of Scientific Discovery* (1959), Karl Popper maintained that *confirmation* and *refutation* are the essence of scientific discovery. Social researchers publish their work so that their work can be scrutinized by others. Journals have dedicated teams to decide whether the research material lives up to the standard of the journal and should, therefore, be published. Once a research material is published, other scholars look at it critically, especially when they do not agree with the findings.

Some others may wish to replicate the study by changing the strategies and settings to check if the conclusion would remain the same.

### 1.2.1 Characteristics of Social Research

Social research possesses certain unique characteristics. These are as follows:

- Social research is directed towards finding solutions for social problems.
- It emphasizes the development of generalizations, theories and principles that help in predicting future occurrences.
- It is primarily based on empirical/observable experience.
- It requires meticulous observation.
- Though it may appear to be unsystematic, social research most often involves carefully designed procedure.
- It requires an expert researcher who is already acquainted with the previous nuances of the problem.
- It is characterized by patient and unhurried activity.

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### 1.2.2 Scope and Significance of Social Research

The subject matter of sociology is society. Sociologists study man's social behaviour in a variety of contexts. They use a number of methods in social research including 'comparative method', 'participant observer method', 'community studies', etc. Descriptive and explanatory research aims only at describing, in detail, a situation or set of circumstances. On the other hand, action research refers to 'that is done when some reform or change has been introduced. Its purpose is to monitor the effect of the change and to decide whether it has achieved what it was supposed to achieve.'

Most disciplines undertake research. Research is more of a way of thinking than a set of skills. Research entails critically examining aspects of the study; making guiding principles for testing particular procedure; developing testing theories, etc.

For any study undertaken to be called a 'research', it should adhere to the following three criteria:

- A set of philosophies guide the research
- Methods, techniques and procedures which have proven reliability and validity are used
- Research has to be objective as well as unbiased

The philosophical orientation of research may stem from one of the two paradigms in research—*positivism* and *interpretivism*. Validity ensures that in a research study correct procedures have been applied to find answers to a question. Reliability refers to quality of a measurement procedure. 'Unbiased and objective' means that researchers take each step and draws each conclusion to the best of their ability without introducing their own biases and prejudices. (Ranjit Kumar, 1999).

Research plays a very significant role in the field of social science. In order to study the importance and relationship between social science and research, social research is conducted or undertaken. Research that attempts to measure, describe, explain and predict the social and economic phenomena or social behaviour of human beings is known as 'social research'.

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One of the main objectives of conducting social research is to find information about the behaviour of an individual and solutions to the problems related to human relations. The outcome of social research provides the following benefits:

- It helps professionals in earning their livelihood.
- It helps students in knowing how to write a report for various findings.
- It helps philosophers to think on wider new perspectives.
- It helps in developing new styles for creative work.

In order to conduct social research and examine the social life of human beings, social scientists use different methods. Quantitative and qualitative research are the two methods of research that are generally used by social scientists to conduct a research. In quantitative method, numerical data is collected and then analysed in order to measure the social phenomena. Qualitative method is basically the study of data, such as words, pictures and objects. However, the data collected with the help of this method is not very effective and cannot be generalized very easily.

Social research is very helpful for a country as it helps the government to explore the following things:

- Social and economic structures
- Social attitudes
- Social values and behaviours
- Factors motivating individuals and groups of a society

Researchers share a close relationship with government analysts, such as economists, statisticians and operational researchers. The relationship between researchers and government analysts is essential in order to find out high quality research data. Social research also informs about development, implementation and evaluation of a wide range of government policies.

Social research also helps to examine the consequences of government policies and economic changes in an organization, and the effects of globalization and its impact on small-scale and cottage industries.

### 1.2.3 Types of Social Research

Sociologists employ a variety of methods to learn about the social world. These methods are not mutually exclusive. Since each research method has strengths and weaknesses, a good research strategy may use several of them. Appelbaum and Chambliss (1997:40) hold that the principal methods of social research include survey and fieldwork.

#### Survey

A survey entails administering a precisely worded questionnaire to a group of people in order to determine their characteristics, opinions and behaviours. First, the researcher has to define a *population universe* to which the study applies: this is the group of people about whom generalization is to be made. Once the population universe is identified, a *sample*—a subset of cases selected to represent the larger population—must be selected, since it is seldom economically feasible or desirable to interview everyone in a chosen population universe.

Two principal type of sampling are used: *probability* and *non-probability sampling.* In the most common type of probability sampling, termed *random sampling,*

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everyone in the population universe has an equal chance of being in the sample. In *non-probability sampling*, subjects are deliberately chosen because of their specific characteristics. Once the sample is constructed or drawn, the questionnaire is administered. Questionnaires may contain *open- or close-ended questions.* In *close-ended questions,* the respondents are required to choose only from predetermined alternative responses. In *open-ended questions,* there are no fixed responses to choose from. The respondents are provided with a wide range of opportunities to express a wide range of feelings and opinions.

One of the strengths of survey method is that it permits the researcher to draw conclusions about a large number of people on the basis of a much smaller number of interviews. This is a major advantage in terms of time and money. Surveys also have some weaknesses. Sometimes, surveys can be superficial since in order to be feasible economically, they usually call for brief responses to close-ended questions. Many-a-times, responses are self-serving, just intended to make the interviewee look good in the eyes of the researcher.

## Fieldwork

Fieldwork consists of many methods. The most common fieldwork is that of *participant observation*. The researchers become a part of the community under study; immerse themselves completely in the daily life of the community and participate in the activities of the members of the community but with a sense of detachment. They then attempt to report all their findings on every aspect of their lives with a sense of impartiality and disinterestedness. Classic examples of fieldworks are William Whyte's (1915) *Street Corner Society (1943),* A Study of Italian-American Working-Class Men and B. Malinowski's *Study of the Tribes of Trobriand Island*.

Sometimes the research strategy requires that the researchers stay away from the people they are studying, and simply observe what is going on. Asociologist studying crowd behaviour at a rally or student participation in a seminar would be an example. The researcher in such a study tries to be a 'fly on the wall', invisible and unobtrusive, yet constantly records what is going on. This technique is called *detached observation.*

*Interview* is another method of fieldwork. It is a detailed conversation designed to obtain in-depth information about a person. In a *structured interview*, researchers have a detailed list of specific questions to ask. In the *semi-structured interview*, the researchers have a list of topics to cover depending on the interview situation, to determine the course of questioning and the details of the question.

*Participatory research* is another method under fieldwork. It is designed to involve the subjects of the research in the research process itself, with an eye to empowering them to overcome some difficulty or problem. This research is usually tied with community action. It is conducted when a group or community wants to engage in some form of social change but lacks the expertise to do so. The researcher is invited to become a fully engaged member of the social change process, helping the members of the group to conduct the necessary research and training them in the techniques for doing so.

Another method is *experiment.* In it, two groups are chosen—*the experimental group* and *the control group*. An experimental group is one which is exposed to the independent variable. The control group is kept constant—no experiment is carried out on it. In the end, both the groups are compared to find out the resultant effects of the experiment.

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Working with *available information* is another strategy. This involves working with data collected by other people. Often such data are the only information available. Examples include statistical data, documentaryanalysis or comparative-historical research (study of several different countries as well as examination of changing historical patterns in a single country).

| APPROACH | WHENAPPRORIATE |
|---|---|
| **Survey** | Basic information about a large population is required and sampling is a feasible strategy. |
| **Interview** | In-depth information is desired and direct access to informants is possible. |
| **Detached observation** | Information should be gathered but the data gathering should be as unobtrusive as possible. |
| **Participant observation** | First hand knowledge of the direct experience of subjects is required. |
| **Participatory research** | Primary goal is empowerment: training people to acquire the necessary skill to do research themselves. |
| **Experiments** | To determine specific causal relationships. |
| **Using the available information** | Direct acquisition of data is either not feasible or not desirable. |

## 1.3 MAJOR STEPS IN SOCIAL RESEARCH

Research process includes steps or a series of actions and logical sequence of those steps to carry out research effectively. The various steps in a research process are not mutually separate, exclusive or discrete, but they at the same time need not always follow each other. The researcher, at each step, anticipates subsequent steps and requirements. The tentative order of the steps and the procedural guidelines of the research process are as given below:

**(i) Formulating the research problem:** At the very beginning of research, the researcher must clearly define the research problem, i.e., the area of interest, the matter to be inquired into, etc. The problem, before being solved, is initially stated in a broader perspective and then the researcher arrives at the specific question by gradually reducing the ambiguities, if any. Then, immediately after formulating the problem, the feasibility of different solutions is studied before choosing the right solution.

**(ii) Extensive literature survey:** After formulating the research problem, a brief summary of it should be prepared—this is an essential step. While writing a Ph.D. thesis a researcher has to prepare a synopsis of the topic and submit it to the appropriate committee or research board for approval. Synopsis preparation needs extensive survey of the literature connected with the problem.

**(iii) Development of a working hypothesis:** After surveying the literature, the researcher should clearly state the working hypothesis, which is a tentative assumption made before testing it in logical or empirical sequences. Hypothesis must be as specific as possible and should be limited to the intended research. This helps to choose the right process.

**(iv) Preparing the research design:** The next step, after clearly defining the research problem, is preparing the suitable research design. The research design includes the conceptual framework within which the research would be carried out. A

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good and planned research design helps to carry out the study in an efficient manner saving time and resources. It helps to gather the most useful information and assists in arriving at the accurate results. Simply put, a good research design facilitates the collection of relevant evidence with minimal expenditure of money, effort, time and other resources.

**(v) Determining sample design:** A universe or population includes all the items under inquiry. If all the items in the population are inquired then such an inquiry is called census inquiry. In a census survey, all the items are covered and so the highest accuracy is obtained. But this may not be practicable in surveys involving a big population. Census surveys need huge amounts of time, money and energy. Hence, quite often it is wise to select only a few items from the universe for the purpose of study. Technically, such a small and convenient number of items selected, is called a sample. Specified plan of the size and method of collecting the sample is technically known as sample design.

**(vi) Collecting the data:** In most cases, the data in hand is insufficient and there is always a need of fresh data. There are different ways of collecting the appropriate data which differ considerably in terms of relevance, expenditure, time and other resources. Therefore, the researcher must select the most appropriate method of collecting the data after considering the objective of the research, the nature of investigation, time and financial resources available, scope of the inquiry, and the desired degree of accuracy.

**(vii) Execution of the project:** This is an important step in the research process because if the execution proceeds on the correct lines, the collected data would be dependable, adequate and accurate. Therefore, systematic and timely execution of a project plays a crucial role in ensuring right results at the end.

**(viii) Analysis of data:** After collecting the data, the next step is analysing the data. The data analysis includes a number of closely-related operations like specifying different categories of data, differentiating and tabulating the data into different categories, applying the statistical techniques and formulae to the data, doing the right calculations and then drawing statistical inferences. Various tests, such as chi-square test, *t*-test, *F*-test, etc., help in data analysis.

**(ix) Hypothesis-testing:** After analysing the data, the researcher should test the working hypothesis against the statistical inferences obtained after analysing the data. The question that should be answered now is: Do the findings support the working hypothesis or do they contradict it?

**(x) Generalizations and interpretation:** If a hypothesis is tested and upheld sufficient number of times, the researcher can arrive at a generalization. The degree of success of a research is calculated on the basis of how close the arrived generalizations are to the acceptability. If the researcher starts with no hypothesis, the researcher will interpret his findings on the basis of some existing theory and this is known as **interpretation**. The process of interpretation often triggers new questions which lead to further researches.

**(xi) Preparation of the report or the thesis:** Finally, the researcher has to prepare the report of what has been studied. Report must be written with great care keeping the following layout in mind:

- **Preliminary pages:** These pages of the report should contain the title, the date, acknowledgments, foreword, table of contents, list of tables, list of graphs and charts (if any).

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- **Main text:** The main text of the report should have introduction, summary of findings, main report, conclusion and suggestions for future research.
- **Closure:** At the end of the report, appendices should be listed in respect of all technical data, followed by bibliography. Index terms should also be given specially in a published research report. All references should be cited as per the research writing formats.

## Flow Chart: Research Process

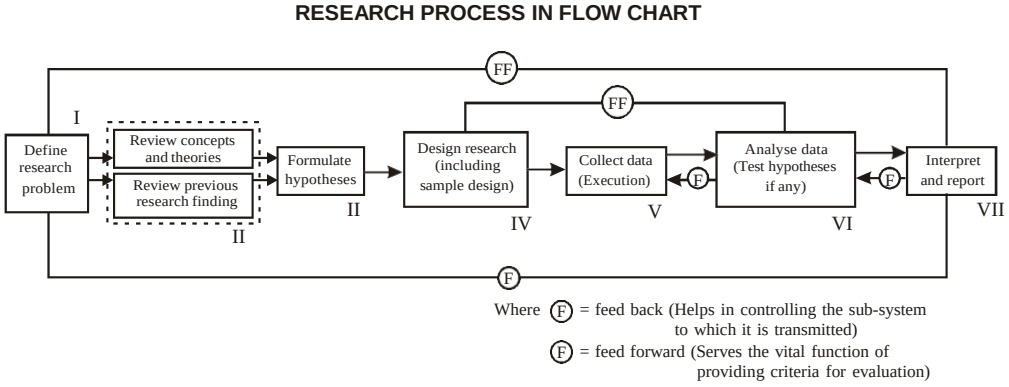


***Fig. 1.1*** *Research Process*

In Figure 1.1, the flow chart indicates the sequential steps to be followed in the research process, as studied in this section. We can recollect that the research process starts with defining the research problem along with reviewing the relevant literature in the field to become familiar with the concepts and theories relevant to the issue to be investigated. The next step is the formulation of the hypothesis, which is followed by the research design and sample selection. Then the collection of data and its analysis is to be attempted. After that the interpretation and the report writing stages complete the research report. These have to be written step by step and then edited and refined several times before preparing the final report.

## Criteria of Good Research

Whatever be the type of research one undertakes, certain common criteria of good scientific methods have to be followed. A good research follows logical methods, is systematic, and structured in accordance with well-defined sets of rules and practices to enable the researcher in arriving at dependable conclusions. Both, deductive reasoning and inductive reasoning, should be followed for meaningful research.

Good research also implies obtaining reliable data which provides sound validity to the research findings.

The following principles underlie a good research criteria:

- The aim and objective of the research being conducted should be clearly specified.
- The research procedure should be replicable so that if the research needs to be continued or repeated, it can be done easily.
- The research design should be so chosen that the results are as objective as possible.

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- Interpretation of any research should be done keeping in mind the flaws in the procedural design and the extent to which it has an effect on the results.
- Research should be carried out systematically. It should progress in pre-defined stages, and researchers should avoid using their intuition or guesswork to arrive at conclusions.
- Research should be logical so that it is meaningful, and help in decision-making.
- Research should be empirical as far as possible.
- The results of the research should only be used and generalized for the population for which the data provides an adequate basis.
- The validity and reliability of the data used in research should be double checked.

A good research produces results that are examinable by peers, methodologies that can be replicated, and knowledge that can be applied to real-world situations.

### Problems Encountered by Researchers in India

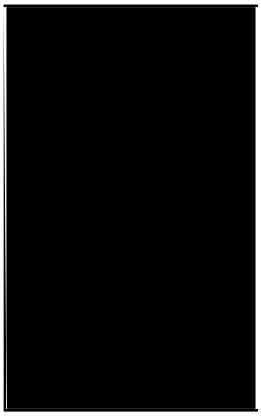
There are some common problems faced by researchers in developing countries and India is no exception. Essentially, there is a dearth of tools required for good research. Many of the universities and research institutions are now providing computers with Internet connection to researchers but the facilities provided are not adequate. Luckily, the costs of both hardware and Internet bandwidth have reduced over a period of time. While Indian researchers now have easy access to these tools, there is still the problem of low visibility of papers published by them. Indian researchers often become demotivated to continue further research. Other factors like lack of scientific training in the methodology of research and a non-existent code of conduct also serve as challenges for the Indian researcher. There is also insufficient interaction between the researchers and the end-users. End-users of research are the ones who stand to benefit from the research and if they are not made aware of the benefit they can derive, getting sponsors to provide funds for research would be difficult.

There is also a lack of safeguards against any violation of confidentiality in data collection. Research studies that overlap lead to unnecessary repetition. There is an absence of research culture in our country.

Other problems that Indian researchers face that are common to developing countries are:

- Limited or no access to international research journals
- Lack of infrastructure except in a few metropolitan cities
- Low investment in research due to financial constraints
- Inadequate library facilities and where such facilities exist, they are not easily accessible
- Poor encouragement to do research

These problems need to be surmounted effectively in order to promote research as a professional activity.



## 1.4 QUALITATIVE AND QUANTITATIVE RESEARCH

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In this section, we will study qualitative and quantitave research.

### 1.4.1 Logical Positivism: Quantitave Research

Logical positivism uses quantitative approach in the verification of theoretical propositions. It is based on statements such as 'anything that exists in a certain quantity and can be measured.' Quantification is essentially to enhance precision in the description of variables and the discernment of the relationships among them. It is structuring an empirical event into a mathematical model which, when juxtaposed on a specific mathematical proposition already formulated, verifies the latter.

Quantitative approach uses 'measurement' as the most precise and universally accepted method for assigning quantitative values to the characteristics or properties of objects or events for the purpose of discovering relationships between variables under study.

Measurement is defined as the assignment of numbers to objects and events according to logically accepted rules. There are certain properties of numbers that must have parallels in the observed phenomena. These properties are described as under:

1. ***The property of identity:*** A number has identity. Every number is unique and no other number is exactly the same.
2. ***The property of order:*** In the number system, numbers have their order or rank, i.e., one number being greater than another.
3. ***The property of additivity:*** In the system of numbers, summing of a certain number with certain other number must yield a unique number. This property is the basis for almost all useful operations that can be performed with numbers, because if the numbers can be added, they can also be subtracted, multiplied and divided.

It is not necessary that the phenomena to which the numbers are applied must have all the three properties of identity, order, and additivity in order to measure those phenomena. However, the advantage of the numbers used in measurement depends upon how many of the three properties do apply. There are several levels of measurement, the use of which are dependent upon the number of those properties that do apply. A convenient way of classification of the measurement levels is made by Stevens (1951). According to this classification, there are four levels of measurement scales:

1. ***Nominal scales*:** Nominal scales of measurement are used when a set of objects among two or more categories are to be differentiated on the basis of qualitative differences. Usually, a number of symbols or numerals are chosen to represent all objects in a given category, thus taking the advantage of the property of identity. We may assign individuals to such categories as sex (male and females), nationality (Indians and Americans), educational level (school students and college students), professional rank (lecturers, readers and professors), etc.

   Each individual can be a member of only one category and all the members of the category have the same defined characteristics. Nominal scales are non-orderable and the only arithmetical operation applicable to such scales is counting, the mere enumeration of individuals in each category, class or set. The nominal scale is

primitive form of measurement and the statistical techniques based on counting are permissible in this type of measurement.

2. ***Ordinal scales:*** The ordinal scales of measurement correspond to quantitative classification of a set of objects. The sets or classes of objects are ordered on some continuum in a series ranging from lowest to highest according to the characteristics we wish to measure. The ranking of students in class for height, weight or scholastic achievement are the examples of ordinal scale of measurement. It may be noted that the successive intervals between consecutive points on the ordinal scale may not be equal throughout the entire scale. Suppose we place three students Ram, Sham and Ali in the order of height with Ram being the tallest, and assign the numbers 3, 2 and 1 respectively. All we have is information about serial arrangement. We cannot say that Ram, is as much taller than Sham as Sham is taller than Ali, even though the three numbers assigned to them are equally spaced on the scale of measurement. The common arithmetical operations — addition, subtraction, multiplication, and division — cannot be legitimately used with ordinal scales, but statistical procedures based on ranks are appropriate.

3. ***Interval scales:*** Taking the previous example, we actually measure the height of the three students Ram, Sham and Ali by using a metre scale and find their heights to be 185 cm, 172 cm and 159 cm., respectively, then we have measurements on a scale of equal units. This scale of measurement is called an interval scale. By this type of measurement we can make certain exact and meaningful decisions. We can say that Ram is 13 cm taller than Sham and 26 cm taller than Ali. We can also infer that the difference in heights between Ram and Ali is twice than that between Ram and Sham.

   In the interval scale, the differences between consecutive points on the scale are equal over the entire scale but there is no true zero point on it. The zero point of the scale is chosen conventionally or arbitrarily. Most psychological tests and inventories are based on interval scales. They have no real zero point. It is true that a student may occasionally get a score of zero on a test of mathematics or general science. However, this does not mean that the student has no knowledge of mathematics or general science.

   We can perform the operations of addition and subtraction on interval scales. The statistical techniques based on these arithmetical operations are permissible. The operations of multiplication and division cannot be legitimately used with interval scales, since these operations presuppose the existence of an exact zero point.

4. ***Ratio scales:*** The fourth and highest level of measurement is the ratio scale. All the four operations of addition, subtraction, multiplication and division can be used with ratio scales. All statistical techniques are permissible with such scales. These scales have all the characteristics of interval scales, with the additional advantage of a true zero point. It is possible to indicate the complete absence of an attribute. For example, the zero point on a centimetre scale indicates the complete absence of length or height.

   The numerals of the ratio scale can be expressed in ratio relationships. For example, the weight of 4 grams is one-half of 8 grams; the height of 10 cm is one-third of 30 cm, and so on.

   Ratio scales are almost non-existent in psychological measurement, except in the area of psycho-physical judgement. For example, when we measure reaction time, we use the customary time units, seconds and fractions of a second.

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Ratio scales permit us to perform operations of (1) equality of magnitudes, (2) equality of differences, and (3) equality of ratios.

It may be noted that each higher scale can be transformed into a lower category scale but no lower category scale can be transformed into a higher category scale. The statistics permissible under higher category scale would also include the statistics that is permitted under the lower category scale. The higher we go in the hierarchy of the scales, the more relevant information is provided. If the nature of the variables permits, the scale that provides the most precise description should be used.

Quantitative research emphases: (*i*) concepts and their measurement in numbers (phenomenalism), (*ii*) establishment of casual relationships between independent and dependent variables, (*iii*) law-like generalizability of phenomena, (*iv*) replicability, (v) methodological individualism, and (*vi*) objectivity in the collection, analysis and interpretation of data, and reporting of results. It is dominated by the largely unquestioned, natural science paradigm of hypothetico-deductive methodology. Quantitative research actually goes beyond just analysing numbers. Using a deductive approach, it seeks to establish facts, make predictions, and test hypotheses that have already been stated.

## Characteristics of Quantitative Research

The chief characteristics of quantitative research are mentioned as under:

1. Quantitative research uses deductive or 'top-down' approach. The researcher formulates and uses hypotheses and theory with data.
2. It is based on logical-positive paradigm which utilises experimental methods and quantitative measures to test specific hypothetical generalizations with narrow-angle lens.
3. Quantitative research uses scientific method with 'hard science' trappings. The researchers treat their subjects of study as having an existence independent of themselves and without any intrinsic meaning.
4. Behaviour of the subjects under study is assumed to be regular and predictable.
5. Most of the common research objectives in quantitative approach aim at description, explanation and prediction of social phenomenon. The emphasis is not on the deep understanding of the phenomenon or content.
6. Quantitative research attempts to study behaviour under controlled conditions. The nature of observation is objective, *i.e.*, different observers agree on what is observed.
7. Closed ended structured questionnaires, tests, attitudes scales, rating scales, etc. are used to collect quantitative data based on precise measurement.
8. The dominant sampling strategy in quantitative research is probability sampling, which depends on the selection of a random and representative sample from a larger population. The purpose of probability sampling is subsequent generalization of the research findings to the population from which the sample was selected. Generally, large samples are used in quantitative survey studies.
9. Quantitative research is deductive in that it tests theories which have already been proposed. It aims at analysis of representative and validated quantitative data, through the use of sophisticated statistical methods and software packages.

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10. The findings are based on identified statistical relationships and generalizable findings. Using the principles of probability, quantitative research makes predictions representative of a large population.
11. The form of final report is statistical with details about the use of various types of statistics, e.g., correlations, comparison of means, percentages, etc. and their statistical significance.

In conclusion, quantitative research involves successive phases of hypothesis formulation, data collection, analysis and interpretation. Using deductive approach, it seeks to establish facts, make predictions, and test hypotheses that have already been stated.

## Major Types of Quantitative Research

Keeping in view the distinguishing characteristics of quantitative research, following are the main types of approaches to quantitative research:

1. ***Descriptive survey research:*** This type of research attempts to answer questions about the current status of a phenomenon under study. Usually, it involves studying the preferences, attitudes, practices, concerns, or interests of some group of people.
2. ***Correlation research:*** These studies are conducted to determine whether, and to what degree, a relationship exists between two or more variables.
3. ***Causal-comparative research:*** This type of research seeks to discover a cause-effect relationship between two or more different programmes, methods, or groups. It is also called *ex-post-facto* research because in this type, the researcher usually does not have control over the causal factor or independent variable as it is studied after the occurrence of the fact.
4. ***Experimental research:*** The experimental research also looks for a cause-effect relationship between two or more variables. But this relationship is studied under the controlled condition which is not the case in causal-comparative research. Various types of experimental designs are used in conducting experimental research. The selection and use of a particular experimental design depends upon the nature of problem and its objectives.

## Advantages of Quantitative Research

Quantitative research has played a significant role in conducting educational studies because of the following advantages:

1. The results are statistically reliable. Quantitative research mostly uses statistical methods in drawing comparison between concepts, ideas, products, packages, etc.
2. Quantitative research involves quantifications based on numbers. Thus, it is well-suited to addressing the 'who', 'what', 'when' and 'where' of individual (consumer) behaviour.
3. The results of quantitative research can be generalized. The findings can be projected to the whole population.
4. The use of multivariate methods and analysis is helpful in measuring and controlling the variable or variables which intervene between the independent and dependent variables.

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### Limitations of Quantitative Research

Despite a number of advantages of the quantitative research, there are also many disadvantages. Some of those are mentioned as under:

1. Quantitative research uses quantitative data. These data are closed-ended and hence do not provide depth and detail.
2. Advance formulation of specific hypotheses is an important requirement of quantitative research. In certain research contexts, especially in the field of education, it is not always possible to formulate specific hypothetical generalizations.
3. The occurrence of an event is both quantitative and qualitative. Hence, its measurement on the basis of selective observation and selective recording of information may involve researcher 'bias'.
4. The primary disadvantage of quantitative research is that issues are only measured if they are known prior to the beginning of the study especially in the survey research.
5. Quantitative research is neither appropriate nor cost effective for studying why people act or think as they do. In such cases it is difficult to quantify the action or thinking of people. The selection and use of large samples for drawing reliable statistics also involve lot of efforts in terms of money and manpower.

## 1.4.2 Phenomenological Inquiry: Qualitative Research

Phenomenological inquiry uses qualitative approach to the verification of proposition, which takes into consideration the totality of a phenomenon and does not attempt at analysing it into quantifiable (measurable) components. It employs a naturalistic approach based on phenomenological paradigm, which uses a variety of interpretive research methodologies, that seeks to understand phenomenon in context-specific settings. Qualitative research, in contrast to quantitative approach, is by some regarded as less 'scientific'and 'softer'. It describes social phenomena as they occur naturally. No attempt is made to manipulate the situation under study. Qualitative research emphasises: (*i*) an 'emic' perspective viewing events, actions, values, beliefs, etc. from the point of view of people who are being studied (phenomenological), (*ii*) detailed perspectives of the participants in the 'naturalistic' setting, (*iii*) contexualising behaviour, events, etc. within a holistic frame, (*iv*) an inductive, open and flexible approach, and (*v*) a definite preference for 'theory generation' rather than theory testing during the research process.

### Characteristics of Qualitative Research

Qualitative research has some characteristics which distinguish it from quantitative research. Best and Kahn (2002, pp. 184-185) has quoted ten themes proposed by Patton (1990, pp. 40-41) which highlight the following main characteristics of qualitative research:

1. Qualitative research makes use of naturalistic inquiry. It aims at studying real world situations as they unfold naturally without any manipulation and pre-determined constraints on outcomes.
2. It employs inductive or 'bottom-up' approach. The researcher generates new hypotheses and grounded theory from data collected during field work. It aims to discover important categories, dimensions, and interrelationships. In the process of induction the researcher begins by exploring genuinely open questions rather

than testing theoretically derived (deductive) hypotheses. The data are used to develop concepts and theories that help the researcher to understand the phenomenon.

3. Most of the common research objectives in qualitative research aim at description, exploration, and discovery using 'wide-angle' and 'deep-angle' lens approach so as to examine the breadth and depth of phenomenon and to learn more about it. The whole phenomenon under study is 'understood as a complex system that is more than the sum of its parts; focus on complex interdependencies not meaningfully reduced to a few discrete variables and linear, cause-effect relationships'.
4. The behaviour of the subjects under study is assumed to be fluid, dynamic, situational, social, contextual and personal. The behaviour is studied in the natural environments not under the controlled conditions.
5. Qualitative research makes use of qualitative data which are gathered from natural settings. These include 'detailed, thick description; inquiry in depth; direct quotations capturing people's personal perspectives and experiences'. The researcher attempts to observe and describe the settings as they are, maintaining what Patton calls 'emphatic neutrality'. The total emphasis is on understanding of the situation in all its complexities by not proving something, not advocating, not advancing personal opinions and views, but researcher includes his personal experiences and emphatic insight as part of the relevant data while taking a 'neutral nonjudgemental stance toward whatever content may emerge'.
6. Purposive sampling is the dominant strategy in qualitative research. The researcher uses small samples. He has direct contact with and gets close to the people, situation, and phenomenon under study. He collects qualitative data using in-depth interviews, participant observation, field notes, and open-ended questions. The researcher is the primary data collection instrument, 'researcher's personal experiences and insights are an important part of inquiry and critical to understanding the phenomenon'. The data are in the form of words, images, and categories.
7. Qualitative research emphasises 'unique case orientation'. It assumes each case is special and unique. Cross-case analysis follows from and depends on the quality of individual case studies.
8. The analysis of qualitative data requires organizing raw data into logical, meaningful categories, and examining them in holistic fashion for interpretation to others. The reports are narrative with contextual description and direct quotations from research participants.

The characteristics described above indicate that qualitative research is not one single method or strategy for research but a wide range of discrete strategies and methods. These strategies normally have one thing in common that they analyse complex and unique data through exploration. Qualitative research is concerned with the opinions, experiences and feelings of individuals producing subjective data. It is a 'kind of research that produces findings not arrived at by means of statistical procedures or other means of quantification' (Strauss and Corbin, 1990, p. 17). Whereas quantitative research seeks causal determination, prediction, and generalization of findings, qualitative research seeks understanding, exptrapolation and explanation to similar situations.

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## Major Types of Qualitative Research

The variety in types of qualitative research is directly based on the varieties in the methods as well as varieties in the sources of data. For example, a researcher may focus on different sources of data like:

1. One's own immediate experience;
2. Others' experiences, which one might seek to understand through:
   (i) their speaking or writing,
   (ii) their other behaviours,
   (iii) their other products: technology, artwork, etc.
3. Collecting data which concern past, present or future:
   (i) collecting things that are the results of past, like artifacts or literature,
   (ii) observing or introspecting what is happening now,
   (iii) eliciting data, making things to happen, as in interview or a project.

The questions and problems which most often come from real-world observations, contents or situations also provide a number of different ways to view the theoretical perspectives of various types of qualitative research. Patton (1990, p. 88) has suggested a list of ten theoretical perspectives of qualitative research alongwith their disciplinary roots and the questions they pose. These include: (1) Ethnography; (2) Phenomenology; (3) Heuristics; (4) Ethnomethodology; (5) Symbolic interactionism; (6) Ecological psychology; (7) Systems theory; (8) Chaos theory: nonlinear dynamics; (9) Hermeneutics; and (10) Orientational, qualitative.

## Advantages of Qualitative Research

Qualitative research based upon the phenomenological paradigm has the following advantages:

1. Qualitative research is not a unitary approach. In reality, it is a variety of alternative approaches to the traditional, positivistic research. Thus, this approach has the advantage of studying a phenomenon in a holistic perspective.
2. It utilises qualitative data which are detailed and descriptive. These data indicate what people have said in their own words about their experiences and interactions in natural setting, and after careful analysis, the data provide useful and depth answers to the research questions of decision makers and information users.
3. Qualitative research is most suitable in the study of human behaviour which is fluid, dynamic, situational, social, contextual and personal.
4. It does not start with the advance formulation of specific deductive hypotheses as is the case with quantitative research. The researcher uses inductive analysis for generating new hypotheses from the details and specifics of the data during field work. He/she begins by exploring genuinely open questions rather than testing theoretically derived deductive hypotheses.
5. Qualitative research utilises flexible design and 'avoids getting locked into rigid designs.' Design flexibility permits the researcher to adjust the direction of the research process to the selection and use of tools as well as samples.
6. The researcher has direct and close contact to the people, situation, and phenomenon under study which are helpful in understanding a phenomenon in depth and detail.

7. Qualitative research is cost effective. It uses case study, small and purposive sampling strategies in collecting detailed information about the phenomenon.
8. The final reports of qualitative research studies are detailed and interesting narrations about the phenomenon.

### Limitations of Qualitative Research

Qualitative research has some limitations also which are mentioned as under:

1. Subjective bias is a constant threat to objective data gathering tools and analysis techniques. For example, an individual may intentionally attempt to exhibit an artificial behaviour when he/she knows that he is being observed during observation. Similarly during an interview, the interviewees may not respond freely, frankly and accurately. There is a constant danger of subjectivity on the part of an observer/ interviewer during observation/interview.
2. The findings of qualitative research lack generalizations because of the nature and size of samples used for data collection. The samples are small in size and mostly purposive. Pure subjectivity in the selection of such samples undermines their credibility.
3. Qualitative research utilizes a variety of methodologies in studying a phenomenon in holistic perspective. In certain cases, it is difficult to focus on complex interdependencies of its parts and understand the meaning of the phenomenon as a whole.

In view of the above discussion on the nature, advantages and limitations of the quantitative (logical positivism) and qualitative (phenomenological inquiry) research paradigms, no particular paradigm can claim to be the sole and appropriate approach which may be used for conducting educational research. Education as a discipline has a wide base with diverse concerns, thus many of its problems can certainly be meaningfully investigated by means of different approaches. Moreover, with increased diversification in the context of education, there is a need for adopting multi-method approach, involving both qualitative and quantitative paradigms, to the methodology of educational studies.

## 1.5 SUMMARY

- Research that attempts to measure, describe, explain and predict the social and economic phenomena or social behaviour of human beings is known as 'social research'.
- The outcomes of social research provide the following benefits: helps professionals in earning their livelihood, helps students in knowing how to write a report for various findings, helps philosophers to think on wider new perspectives and helps in developing new styles for creative work.
- Social research helps the government to explore the following things: social and economic structures, social attitudes, social values and behaviours and factors motivating individuals and groups of a society.
- The subject matter of sociology is society. Sociologists study man's social behaviour in a variety of contexts. They use a number of methods in social research including comparative method, participant observer method, community studies, etc.

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- For any study undertaken to be called a 'research', it should adhere to the following three criteria: a set of philosophies guide the research, methods, techniques and procedures which proven reliability and validity are used, research has to be objective as well as unbiased.
- The application of scientific methods practised in natural sciences like physics and chemistry in researching various areas in social sciences is known as the positivist approach.
- The approach in which in order to explain human behaviour, social researchers need to be conversant with people's interpretations of social phenomena is known as interpetivism.
- Objectivity is the capacity to represent truthfully and without prejudice, the result of one's research. A social research needs to be aware of his/her personal biases and prejudices and take adequate care that these do not affect the objectivity of the research.
- The following are the different types of social research: survey and fieldwork. Fieldwork further has different classifications including interview, participatory research, experiment and working with available information.
- Major steps in social research include: formulating the research problem, extensive literature survey, development of a working hypothesis, preparing the research design, determining sample design, collecting data, execution, analysis, hypothesis testing, generalization and interpretation and preparation of the report or the thesis.
- A good research follows logical methods, is systematic, and structured in accordance with well-defined sets of rules and practices to enable the researcher in arriving at dependable conclusions.
- Problems encountered by researchers in India include dearth of tools, infrastructural problems, lack of scientific training, insufficient interaction and difficulty in getting sponsors, etc.
- Logical positivism uses quantitative approach in the verification of theoretical propositions. Quantitative approach uses 'measurement' as the most precise and universally accepted method for assigning quantitative values to the characteristics or properties of objects or events for the purpose of discovering relationships between variables under study.
- Major types of quantitative research include: descriptive survey research, correlation research, causal-comparative research and experimental research.
- Phenomenological inquiryuses qualitative approach to the verification ofproposition which takes into consideration the totality of a phenomenon and does not attempt at analysing it into quantifiable components.

## 1.6 KEY TERMS

- **Social research:** It refers to that research which attempts to measure, describe, explain and predict the social and economic phenomena or social behaviour of human beings.
- **Quantitative approach:** It is an approach in social research where measurement is used the most precise and universally accepted method for assigning quantitative

values to the characteristics or properties of objects or events for the purpose of discovering relationships between variables under study.

- **Ex-post facto:** It is a term used to define an action taken to change the effect given to a set of circumstances.
- **Positivist approach:** The application of scientific methods practiced in natural sciences like physics and chemistry in researching various areas in social sciences is known as the positivist approach.
- **Interpretivism:** In order to explain human behaviour, social researchers need to be conversant with people's interpretations of social phenomena. This approach is known as interpretivism.

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## 1.7 ANSWERS TO 'CHECK YOUR PROGRESS'

1. Social scientists are often influenced by their biases, passions, likes and dislikes and preconceived notions. These are seen to interfere with the scientific objectivity that they would need while researching on social sciences.
2. Social research is very helpful for a country as it helps the government to explore the following things:
   - Social and economic structures
   - Social attitudes
   - Social values and behaviours
   - Factors motivating individuals and groups of a society
3. A population universe is the group of people about whom generalization is to be made in a survey.
4. A researcher considers the objective of the research, the nature of the investigation, time and financial resources available, scope of the inquiry, and the desired degree of accuracy for selecting the most appropriate method of collecting the data.
5. The preliminary pages of the report contain the title, the date, acknowledgements, foreword, table of contents, list of tables, list of graphs and charts (if any).
6. The only arithmetical operation applicable to nominal scales is counting, the mere enumeration of individuals in each category, class or set.
7. We cannot use the operations of multiplication and division with interval scales legitimately since these operations presuppose the existence of an exact zero point.
8. A causal-comparative research is also called ex-post-facto research because in this type of research, the researcher usually does not have control over the casual factor or independent variable as it is studied after the occurrence of the fact.

## 1.8 QUESTIONS AND EXERCISES

### Short-Answer Questions

1. What is social research?
2. What are the qualities of good research?

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3. How can the qualitative approach to research be classified?
4. What is the similarity between experimental research and ex-post facto research?
5. List the nature and scope of a good and effective research.
6. Describe the positivist and interpretivist approach to research.
7. What is a fieldwork? Describe the various methods of fieldwork.
8. State the problems faced by researchers in India.
9. Briefly list the characteristics of qualitative research.

**Long-Answer Questions**

1. Evaluate the characteristics of good research.
2. Critically analyse the aims of social research.
3. 'Appelbaum and Chambliss (1997:40) hold that the principal methods of social research include survey and fieldwork.' With regard to this statement, assess the two types of social research.
4. Describe the major steps involved in social research.
5. Discuss the characteristics of quantitative research with its major types.
6. What are the advantages and limitations of quantitative research?
7. Explain the advantages and disadvantages of qualitative research.

## 1.9 FURTHER READING

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# UNIT 2 HYPOTHESIS

**Structure**



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## 2.0 INTRODUCTION

A hypothesis is an assumption or a statement that may or may not be true. The hypothesis is tested on the basis of information obtained from a sample. A well formulated or good hypothesis helps the researchers to focus/concentrate on the key points of investigation. A hypothesis is significant because it guides the research. The researchers or investigators refer to the hypothesis in order to direct their thought processes toward the result of the research problem or sub-problems. There are several reasons why hypothesis is significant and these will be dealt in the unit.

It is important that the hypothesis formulated guides the researcher in the right direction. For this, it is important that one knowns the characteristics of valid research. It is only after this that the steps in the formulation of a hypothesis can be understood well. Further, knowing the source of hypothesis is also crucial for the researcher. You will also learn about the hypothesis testing. First step is to establish the hypothesis to be tested. The next step in the testing of hypotheses exercise is to choose a suitable level of significance. The level of significance denoted by a is chosen before drawing any sample.

## 2.1 UNIT OBJECTIVES

After going through this unit, you will be able to:

- Explain the meaning of hypothesis
- Discuss the characteristics of valid hypothesis
- Describe the steps in the formulation of a hypothesis
- Identify the importance of hypothesis in social research
- Discuss the sources of hypothesis
- Explain the steps in the hypothesis testing exercise

## 2.2 CONCEPTUALISATION AND FORMULATION OF HYPOTHESIS

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A hypothesis is an approximate assumption that a researcher wants to test for its logical or empirical consequences. It can contain either a suggested explanation for a phenomenon or a proposal having deductive reasoning to suggest a possible interrelation between multiple phenomena. A deductive reasoning can be defined as a type of reasoning that can be derived from previously known facts.

Some definitions of hypothesis are:

- According to Townsend, 'Hypothesis is defined as suggested answer to a problem.'
- According to McGuigan, 'A hypothesis is a testable statement of a potential relationship between two or more variables.'
- According to Uma Sekaran, 'A hypothesis is defined as a logically conjectured relationship between two or more variables in the form of testable statement. These relationships are based on theoretical framework formulated for the research problem. The hypotheses are often statements about population parameters like expected value and variance, for example a hypothesis might be that the expected value of the height of 10-year-old boys in the Scottish population is not different from that of 10-year-old girls.'
- According to Kerlinger, 'A good hypothesis is one which satisfies the following criteria:
  (i) Hypothesis should state the relationship between variables.
  (ii) They must carry clear implications for testing the stated relations.'

This means that: (a) statements contain two or more variables which can be measured, (b) they must state clearly how the two or more variables are related, and (c) it is important to note that facts and variables are not tested but relations between variables exist.

### Characteristics of Valid Hypothesis

There are several characteristics of hypothesis, which are as follows:

- **Conceptually clear and accurate:** The hypothesis must be conceptually clear. The concepts and variables should be clearly defined operationally. The definition should use terms which are commonly accepted and it should ensure that communication is not hindered. Hypothesis should be clear and accurate so as to draw a consistent conclusion.
- **Statement of relationship between variables:** If a hypothesis is relational, it should state the relationship between the different variables.
- **Testability:** A hypothesis should have empirical referents which means that it should be testable through the empirical data. Hypothesis involving mystical or supernatural arenas are impossible to test. For example, the hypothesis 'education brings all-round development' is difficult to test because it is not easyto operationally isolate the other factors that might contribute towards all-round development. Since a hypothesis predicts the outcome of a study and it must relate variables

that are capable of being measured. The hypothesis such as 'there is a positive relationship between the learning style and academic achievement of 8th grade students' can be tested since the variables in the hypothesis are operationally defined, and therefore can be measured.

- **Specific with limited scope:** A hypothesis, which is specific with limited scope, is easily testable than a hypothesis with limitless scope. Therefore, a researcher should give more time to conduct research on such a kind of hypothesis.
- **Simplicity:** A hypothesis should be stated in simple and clear terms to make it understandable.
- **Consistency:** A hypothesis should be reliable and consistent with established and known facts.
- **Time limit:** A hypothesis should be capable of being tested within a reasonable amount of time. In other words, the excellence of a hypothesis is judged by the time taken to collect the data needed for the test.
- **Empirical reference:** A hypothesis should explain or support all the sufficient facts needed to understand what the problem is all about.

A few more characteristics of a good hypothesis are as follows:

- It ensures that the sample is readily approachable.
- It maintains a very apparent distinction with what is called theory, law, facts, assumptions and postulates.
- It ideally has logical simplicity, large number of consequences and is expressed in quantified form.
- It displays equal chances of confirmation and rejection.
- It permits the application of deduction reasoning.
- Its tools and data are easily available and effectively used.
- It is based on the study of previous literature and an existing theory, and verifiable.

As soon as a research question is formulated, it makes the hypothesis formulation imperative since a *hypothesis* is a tentative solution or an intelligent guess about a research question under study. It is an assumption or proposition whose tenability is to be tested on the basis of its implications with empirical evidence and previous knowledge. Modern investigators agree that, whenever possible, research should proceed from a hypothesis. In the words of Van Dalen (1973), 'a hypothesis serves as a powerful beacon that lights the way for the research worker'.

### 2.2.1 Formulating a Hypothesis

As per the Concise Oxford Dictionary (1990) hypothesis is 'A proposition made as a basis for reasoning, without the assumption of its truth, a supposition made as a starting point for further investigation from known facts'.

Leedy and Ormrod (2001) have defined the term hypothesis as 'A hypothesis is a logical supposition, a reasonable guess, an educated conjecture. It provides a tentative explanation for a phenomenon under investigation'.

There is no certainty that the hypothesis formulated for a problem is true or correct. Formulated hypothesis is the initial point, a statement that the researcher has to

prove true after further research and investigations. It is also possible that after further research the researcher might find that this hypothesis is not valid for the problem and that it needs modifications.

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## Why is a Hypothesis Required?

A well formulated or good hypothesis helps the researchers to focus/concentrate on the key points of investigation. Also a hypothesis is significant because it guides the research. The researchers or investigators refer to the hypothesis in order to direct their thought processes toward the result of the research problem or sub-problems. The hypothesis also helps the researcher or investigator to collect the right, precise and accurate data required for the research or investigation. As per Leedy and Ormrod (2001), 'Hypotheses are exceptionally essential and significant because they help an investigator or researcher to locate information needed to resolve the research problem or sub-problems'.

## Accepting or Rejecting Hypothesis

'A hypothesis is never proved or disproved. In fact, an investigator or researcher who sets out to prove a hypothesis would lose the impartiality of the research investigation' (Leedy and Ormrod, 2001).

In research, an investigator or researcher is proficient to either accept (support) or reject a hypothesis. If a hypothesis is rejected, it will lead an investigator or researcher to develop new hypothesis to explain the phenomenon in question. If a hypothesis is continually supported or accepted, then it may evolve into a '**Theory**' (Leedy and Ormrod, 2001).

Therefore, when a hypothesis is continually accepted or supported over time by a growing body of data, then it becomes a **theory**. As per Leedy and Ormrod (2001), 'A theory is an organized body of concepts and principles intended to explain a particular phenomenon'. Atheory is similar to a hypothesis in that it presents a tentative explanation for a phenomenon that new data will either support or not support. Both are supported or rejected based on the testing performed by various investigators or researchers under different conditions. An example of a well known theory is 'Einstein's Theoryof Relativity' (Leedy and Ormrod, 2001).

Further, a theory that is continually validated over time by a growing body of data becomes a '**Law**'. An example of a well known law is the 'Law of Gravity'(Leedy and Ormrod, 2001).

## Steps in Hypothesis Generation

Often times, an investigator will formulate a hypothesis based on the problem or sub-problems of the research. Typically, the hypothesis is driven by the research question (Leedy and Ormrod, 2001). The following steps helps in generating or writing an effective hypothesis:

- **Step One: Preliminary Research:** The researcher or investigator must review the information collected up to now and then decide which information is significant for the research and how it will help to develop the hypothesis.
- **Step Two: Write Your Hypothesis:** The hypothesis is a statement that the researcher or investigator intend to prove through the research. It should state or

affirm the focus of research. When the final hypothesis is written, verify it to be certain that it has the following criteria:

1. It is written in the form of a concise statement.
2. It reflects a situation specified by the researcher or investigator.
3. It is arguable and a contrary situation can be taken.
4. It requires research to determine whether or not it is true.
5. It is a significant theme to social scientists.
6. It is a complex notion, dealing with a number of variables.
7. It is not written in the first person.
8. It can be tested.

- **Step Three: Test It Against the Criteria in Step Two:** Take the hypothesis and verify to perceive if it has the criteria listed in Step Two. If it is not so, then the researcher or investigator has to again check the formulated hypothesis for the research problem. It should be reworked such that it fits well with the research assumptions. Also the researcher or investigator has to be certain that they are diverting from the focus of research.

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## Formulating the Hypothesis and Research Question

Formulating a hypothesis helps bydefining an initial explanation to be tested in the research process. The following are the essential key points that must be defined at the time of hypothesis formulation:

- Hypotheses are testable explanations of a problem, phenomenon or observation.
- Both quantitative and qualitative research involves formulating a hypothesis to address the research problem.
- Hypotheses that suggest a causal relationship involve at least one independent variable and at least one dependent variable; in other words, one variable which is presumed to affect the other.
- An independent variable is one whose value is manipulated by the researcher or investigator.
- A dependent variable is a variable whose values are presumed to change as a result of changes in the independent variable.

In an equation, a dependent variable is the variable whose value depends on one or more variables in the equation. An independent variable in an equation is any variable whose value is not dependent on any other variable in the equation. Hypothesis is a tentative assumption explaining an observation, phenomenon or scientific problem that can be tested by further observation, investigation or experimentation. Characteristically, the research is a process of investigation of a particular/specific topic of study with the aim of studying a problem or question. The research topic for study is established by the researcher o investigator according to the specific assignment that needs to be explored.

After the final section of topic, the researcher or investigator has to develop a question for research and hypothesis that relates to the research being conducted. The formulation of a research question must be made before the researcher initiates conducting research on specified topic. This will be a question developed from the purpose statement and will be the specification that the researcher intents to find out by conducting the research. The question selected will guide the researcher or investigator through their

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research process and will also concentrate on the objective of the research. As already discussed, the hypothesis is a prediction regarding the outcome of the research being conducted. The key objective for the researcher or investigator in developing a hypothesis statement is to test and ultimately accept or reject it when the assessment of the research is performed.

A well researched and planned research question will help and ensure the researcher or investigator that they are collecting the appropriate data. This is a critical and most significant step in the research process. The research question determines *what, where, when* and *how* the data are collected as it is an important association between the abstract, theoretical, conceptual and logistic aspects of the research plan.

## 2.3 IMPORTANCE AND SOURCE OF HYPOTHESISIN SOCIAL RESEARCH

In this section, we will have a look at the significance of hypothesis in social research along with the sources of hypothesis.

### 2.3.1 Importance of Hypothesis in Social Research

The reasons for formulating a hypothesis are as follows:

- A hypothesis directs, monitors and controls the research efforts. It provides tentative explanations of facts and phenomena and can be tested and validated. Such explanations, if held valid, lead to generalizations, which help significantly in understanding a problem. They, thereby, extend the existing knowledge in the area to which they pertain and thus help in theorybuilding and facilitate the extension of knowledge in an area.
- The hypothesis not only indicates what to look for in an investigation but also how to select a sample, choose the design of research, how to collect data and how to interpret the results to draw valid conclusions.
- The hypothesis orients the researcher to be more sensitive to certain relevant aspects of the problem so as to focus on specific issues and pertinent facts. It helps researchers to delimit their study in scope so that it does not become broad and unwieldy.
- The hypothesis provides rational statements to the researcher, consisting of elements expressed in a logical order of relationships, which seek to describe or explain conditions or events that have not been confirmed by facts. Some relationships between elements or variables in a hypotheses are known facts, and others transcend the known facts to give reasonable explanations for known conditions. Hypothesis help researchers to relate logically known facts to intelligent guesses about unknown conditions (Ary, *et al.*, 1972, pp. 73–74).
- Hypothesis formulation and its testing add a scientific rigour to all types of researches. A well thought set of hypothesis places a clear and specific goal before the researcher and equips him/her with understanding. It provides the basis for reporting the conclusions of the study on the basis of these conclusions. Researchers can make their research report interesting and meaningful to the reader. The importance of a hypothesis is generally recognized more in the studies which aim to make predictions about some outcome. In an experimental study, the researcher is interested in making

predictions about the expected outcomes and hence the hypothesis takes on a critical role. In the case of historical or descriptive studies, however, the researcher investigates the history of an event, or the life of a man, or seeks facts in order to determine the *status quo* of a situation and hence may not have a basis for making a prediction of the results. In studies of this nature, where finding facts is the objective of the study, a hypothesis may not be required.

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Most historical or descriptive studies involve fact finding as well as the interpretation of facts in order to draw generalizations. For all such major studies, including social research a hypothesis is recommended so as to explain observed facts, conditions or behaviour and to serve as a guide in the research process. If a hypothesis is not formulated, researchers may waste time and energy in gathering extensive empirical data, and then find that they cannot state facts clearly and detect relevant relationships between variables as there is no hypothesis to guide them.

### 2.3.2 Sources of Hypothesis

Since the mind is fed by innumerable streams and sources, it is difficult to pinpoint how a particular good idea comes to a researcher. The following are some of the popularly known sources of research hypothesis:

- **Scientific theories:** A systematic review and analysis of theories developed in the field ofpsychology, sociology, economics, political science and biological science may provide the researcher with potential clues for constructing a good and testable hypothesis.
- **Expert opinions:** Discussion with the experts in the field of research may further help the researcher obtain necessary insight and skill into the problem and in the formulation of a hypothesis.
- **Method of related difference:** When we find that two phenomena differ constantly and the other circumstances remain the same, we suspect a causal connection. For example, when we find uncontrolled traffic in a locality, resulting in a greater number of road accidents, we suspect a causal connection between uncontrolled traffic and road accidents. This method also suggests hypothesis.
- **Intellectual equipment of researcher:** Intellectual abilities of a researcher like creative thinking and problem solving techniques are very helpful in the formulation of a good hypothesis.
- **Related literature:** Related literature is the most important source of hypothesis formulation. A review of this literature may reveal to the researcher the variables that have been considered important in relation to his/her problem, which aspects have already been studied and which are left to be studied, which theories have supported the relationships and which theories present a contradictory relationship. Familiarity with related literature may give the researcher a tremendous advantage in the construction of hypothesis.
- **Experience:** One's own experience may be a rich source of hypothesis generation. Personal experiences of an individual which has been gained through reading biographies, autobiographies, newspaper readings or through informal talks among friends, etc., can be a potential source of generation of a hypothesis. For example, a researcher who is working on the effectiveness of guidance in teaching, can think of factors such as the teacher's polite behaviour, techniques of counselling, mastery over the subject, effective use of teaching skills, decision-

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making capability, perception of his/her competence, perception of student's capacity for better interaction, use of communication skills, etc.

- **Analogies:** Several hypotheses in a branch of knowledge may be made by using analogies from other sciences. Models and theories developed in a discipline may help, through extrapolation, in the formulation of hypothesis in another discipline. By comparing the two situations, analysing their similarities and differences, some rationale may emerge in the mind of the researcher which may take the form of a hypothesis for testing. For example, in a research problem like studying the factors of unrest among college level students, the researcher insightfully thinks: 'Why was unrest found among school students?' and 'What has changed them: quality of teaching or quality of leadership?'

  Arguing analogically in this way may lead the investigator to some conclusions which may be used for identifying variables and relationships, which form the basis of hypothesis construction. If a researcher knows from previous experience that the old situation is related to other factors Y and Z as well as to X, he/she may reason out that the new situation may also be related to Y and Z.
- **Methods of residues:** When the greater part of a complex phenomenon is explained by some causes already known, we try to explain the residual part of phenomenon according to the known law of operation. It also provides possible hypothesis.
- **Induction by simple enumeration:** Sometimes scientists take common experience as a starting point of their investigation. For example, after observing a large number of scarlet flowers that are devoid of fragrance, we frame a hypothesis that all scarlet flowers are devoid of fragrance. Thus, induction by simple enumeration is a source of discovery.
- **Formulation of hypothesis:** It may also originate from the need and practice of present times.
- **Existing empirical uniformities:** In terms of common sense proposition, the existing empirical uniformities may form the basis for scientific examination.
- **A study of general culture:** It is also a good source of hypothesis.
- **Suggestions:** When given by other researchers in their reports, suggestions are quite helpful in the establishment of hypothesis for future studies.

## 2.4 TESTING OF HYPOTHESES

Till now, we have learnt about the formulation and sources of hypothesis, let us now more towards the testing of hypothesis. The testing of hypothesis requires an understanding of some important concepts.

Below are discussed some concepts on testing of hypotheses:

- **Null hypothesis:** The hypotheses that are proposed with the intent of receiving a rejection for them are called null hypotheses. This requires that we hypothesize the opposite of what is desired to be proved. For example, if we want to show that sales and advertisement expenditure are related, we formulate the null hypothesis that they are not related. If we want to prove that the average wages of skilled workers in town 1 is greater than that of town 2, we formulate the null hypotheses that there is no difference in the average wages of the skilled workers in both the towns. A null hypothesis is denoted by $H_0$.

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- **Alternative hypotheses:** Rejection of null hypotheses leads to the acceptance of alternative hypotheses. The rejection of null hypothesis indicates that the relationship between variables (e.g., sales and advertisement expenditure) or the difference between means (e.g., wages of skilled workers in town 1 and town 2) or the difference between proportions have statistical significance and the acceptance of the null hypotheses indicates that these differences are due to chance. The alternative hypotheses are denoted by $H_1$.
- **One-tailed and two-tailed tests:** A test is called one-sided (or one-tailed) only if the null hypothesis gets rejected when a value of the test statistic falls in one specified tail of the distribution. Further, the test is called two-sided (or two-tailed) if null hypothesis gets rejected when a value of the test statistic falls in either one or the other of the two tails of its sampling distribution. For example, consider a soft drink bottling plant which dispenses soft drinks in bottles of 300 ml capacity. The bottling is done through an automatic plant. An overfilling of bottle (liquid content more than 300 ml) means a huge loss to the company given the large volume of sales. An underfilling means the customers are getting less than 300 ml of the drink when they are paying for 300 ml. This could bring bad reputation to the company. The company wants to avoid both overfilling and underfilling. Therefore, it would prefer to test the hypothesis whether the mean content of the bottles is different from 300 ml. This hypothesis could be written as:

$$H_0 : \mu = 300 \text{ ml.}$$
$$H_1 : \mu \neq 300 \text{ ml}$$

The hypotheses stated above are called two-tailed or two-sided hypotheses.

However, if the concern is the overfilling of bottles, it could be stated as:

$$H_0 : \mu = 300 \text{ ml.}$$
$$H_1 : \mu > 300 \text{ ml.}$$

Such hypotheses are called one-tailed or one-sided hypotheses and the researcher would be interested in the upper tail (right hand tail) of the distribution. If however, the concern is loss of reputation of the company (underfilling of the bottles), the hypothesis may be stated as:

$$H_0 : \mu = 300 \text{ ml.}$$
$$H_1 : \mu < 300 \text{ ml.}$$

The hypothesis stated above is also called one-tailed test and the researcher would be interested in the lower tail (left hand tail) of the distribution.

**Type I and type II error:** The acceptance or rejection of a hypothesis is based upon sample results and there is always a possibility of sample not being representative of the population. This could result in errors, as a consequence of which inferences drawn could be wrong. The situation could be depicted as given in Figure 2.1.

| | Accept $H_0$ | Reject $H_0$ |
|---|---|---|
| $H_0$ True | Correct decision | Type I Error |
| $H_0$ False | Type II Error | Correct decision |

***Fig. 2.1*** *Type I and Type II Errors*

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If null hypothesis $H_0$ is true and is accepted or $H_0$ when false is rejected, the decision is correct in either case. However, if the hypothesis $H_0$ is rejected when it is actually true, the researcher is committing what is called a Type I error. The probability of committing a Type I error is denoted by alpha (□). This is termed as the level of significance. Similarly, if the null hypothesis $H_0$ when false is accepted, the researcher is committing an error called Type II error. The probability of committing a Type II error is denoted by beta (□). The expression 1 – □ is called power of test. To decrease the riskof committing both types of errors, you may increase the sample size.

### Steps in Testing of Hypothesis Exercise

The following steps are followed in the testing of a hypothesis:

**Setting up of a hypothesis:** The first step is to establish the hypothesis to be tested. As it is known, these statistical hypotheses are generally assumptions about the value of the population parameter; the hypothesis specifies a single value or a range of values for two different hypotheses rather than constructing a single hypothesis. These two hypotheses are generally referred to as (1) the null hypotheses denoted by $H_0$ and (2) alternative hypothesis denoted by $H_1$.

The null hypothesis is the hypothesis of the population parameter taking a specified value. In case of two populations, the null hypothesis is of no difference or the difference taking a specified value. The hypothesis that is different from the null hypothesis is the alternative hypothesis. If the null hypothesis $H_0$ is rejected based upon the sample information, the alternative hypothesis $H_1$ is accepted. Therefore, the two hypotheses are constructed in such a way that if one is true, the other one is false and vice versa.

**Setting up of a suitable significance level:** The next step is to choose a suitable level of significance. The level of significance denoted by □ is chosen before drawing anysample. The level of significance denotes the probability of rejecting the null hypothesis when it is true. The value of □ varies from problem to problem, but usually it is taken as either 5 per cent or 1 per cent. A 5 per cent level of significance means that there are 5 chances out of hundred that a null hypothesis will get rejected when it should be accepted. When the null hypothesis is rejected at any level of significance, the test result is said to be significant. Further, if a hypothesis is rejected at 1 per cent level, it must also be rejected at 5 per cent significance level.

**Determination of a test statistic:** The next step is to determine a suitable test statistic and its distribution. As would be seen later, the test statistic could be *t*, *Z*, □$^2$ or F, depending upon various assumptions to be discussed later in the book.

**Determination of critical region:** Before a sample is drawn from the population, it is very important to specify the values of test statistic that will lead to rejection or acceptance of the null hypothesis. The one that leads to the rejection of null hypothesis is called the critical region. Given a level of significance, □, the optimal critical region fora two-tailed test consists of that□/2 per cent area in the right hand tail of the distribution plus that □/2 per cent in the left hand tail of the distribution where that null hypothesis is rejected.

**Computing the value of test-statistic:** The next step is to compute the value of the test statistic based upon a random sample of size *n*. Once the value of test statistic is computed, one needs to examine whether the sample results fall in the critical region or in the acceptance region.

**Making decision:** The hypothesis may be rejected or accepted depending upon whether the value of the test statistic falls in the rejection or the acceptance region. Management decisions are based upon the statistical decision of either rejecting or accepting the null hypothesis.

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In case a hypothesis is rejected, the difference between the sample statistic and the hypothesized population parameter is considered to be significant. On the other hand, if the hypothesis is accepted, the difference between the sample statistic and the hypothesized population parameter is not regarded as significant and can be attributed to chance.

## Test Statistic for Testing Hypothesis about Population Mean

In this section, we will take up the test of hypothesis about population mean in a case of single population.

One of the important things that have to be kept in mind is the use of an appropriate test statistic. In case the sample size is large ($n > 30$), $Z$ statistic would be used. For a small sample size ($n \leq 30$), a further question regarding the knowledge of population standard deviation ($\sigma$) is asked. If the population standard deviation $\sigma$ is known, a $Z$ statistic can be used. However, if $\sigma$ is unknown and is estimated using sample data, a t test with appropriate degrees of freedom is used under the assumption that the sample is drawn from a normal population. It is assumed that you have the knowledge of $Z$ and $t$ distribution from the course on statistics. However, these would be briefly reviewed at the appropriate place. Table 2.1 summarizes the appropriateness of the test statistic for conducting a test of hypothesis regarding the population mean.

***Table 2.1*** *Appropriateness of Test Statistic in Testing Hypotheses about Means*

| Sample Size | Knowledge of Population Standard Deviation ($\sigma$) | |
|---|---|---|
| | Known | Not Known |
| Large ($n > 30$) | Z | Z |
| Small ($n \leq 30$) | Z | t |

## Tests Concerning Means-the Case of Single Population

In this section, a number of illustrations will be taken up to explain the test of hypothesis concerning mean. Two cases of large sample and small samples will be taken up.

## Case of large sample

As mentioned earlier, in case the sample size n is large or small but the value of the population standard deviation is known, a $Z$ test is appropriate. There can be alternate cases of two- tailed and one-tailed tests of hypotheses.

Corresponding to the null hypothesis $H_0 : \mu = \mu_0$, the following criteria could be used as shown in Table 2.2.

The test statistic is given by,

$$Z = \frac{\bar{X} - \mu_{H0}}{\frac{\sigma}{\sqrt{n}}}$$

NOTES

Where,

$\bar{X}$ = Sample mean

$\sigma$ = Population standard deviation

$\mu_{H0}$ = The value of $\mu$ under the assumption that the null hypothesis is true.

$n$ = Size of sample.

***Table 2.2*** *Criteria for Accepting or Rejecting Null Hypothesis under Different Cases of Alternative Hypotheses*

| S. No. | Alternative Hypothesis | Reject the Null Hypothesis if | Accept the Null Hypothesis if |
|---|---|---|---|
| 1. | $\mu < \mu_0$ | $Z < -Z_\alpha$ | $Z \geq -Z_\alpha$ |
| 2. | $\mu > \mu_0$ | $Z > Z_\alpha$ | $Z \leq Z_\alpha$ |
| 3. | $\mu \neq \mu_0$ | $Z < -Z_{\alpha/2}$ or $Z > Z_{\alpha/2}$ | $-Z_{\alpha/2} \leq Z \leq Z_{\alpha/2}$ |

If the population standard deviation $\sigma$ is unknown, the sample standard deviation $s = \sqrt{\frac{1}{n-1}\sum(X - \bar{X})^2}$ is used as an estimate of $\sigma$. It may be noted that $Z_\alpha$ and $Z_{\alpha/2}$ are $Z$ values such that the area to the right under the standard normal distribution is $\alpha$ and $\alpha/2$ respectively. Below are solved examples using the above concepts.

**Example 2.1:** A sample of 200 bulbs made by a company give a lifetime mean of 1540 hours with a standard deviation of 42 hours. Is it likely that the sample has been drawn from a population with a mean lifetime of 1500 hours? You may use 5 per cent level of significance.

**Solution:**

In the above example, the sample size is large ($n = 200$), sample mean ($\bar{X}$) equals 1540 hours and the sample standard deviation (s) is equal to 42 hours. The null and alternative hypotheses can be written as:

$H_0$ : $\mu$ = 1500 hrs

$H_1$ : $\mu \neq$ 1500 hrs

It is a two-tailed test with level of significance ($\alpha$) to be equal to 0.05. Since n is large ($n > 30$), though population standard deviation $\sigma$ is unknown, one can use $Z$ test. The test statistics are given by:

$$Z = \frac{\bar{X} - \mu_{H0}}{\sigma_{\bar{X}}}$$

Where, $\mu_{H0}$ = Value of $\mu$ under the assumption that the null hypothesis is true $\sigma_{\bar{X}}$ = Estimated standard error of mean

Here $\mu_{H0} = 1{,}500, \sigma_{\bar{X}} = \frac{\hat{\sigma}}{\sqrt{n}} = \frac{s}{\sqrt{n}} = \frac{42}{\sqrt{200}} = 2.97$

(Note that $\hat{\sigma}$ is estimated value of $\sigma$.)

$$Z = \frac{\bar{X} - \mu_{H0}}{\frac{s}{\sqrt{n}}} = \frac{1{,}540 - 1{,}500}{2.97} = \frac{40}{2.97} = 13.47$$

The value of  = 0.05 and since it is a two-tailed test, the critical value *Z* is given by – $Z_{/2}$ and $Z_{/2}$ which could be obtained from the standard normal table given in Appendix 1 at the end of the book.

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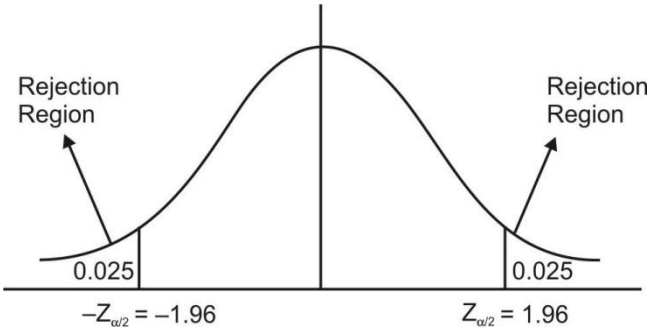



**Rejection regions for Example 2.1**

Since the computed value of *Z* = 13.47 lies in the rejection region, the null hypothesis is rejected. Therefore, it can be concluded that the average life of the bulb is significantly different from 1,500 hours.

**Example 2.2:** On a typing test, a random sample of 36 graduates of a secretarial school averaged 73.6 words with a standard deviation of 8.10 words per minute. Test an employer's claim that the school's graduates average less than 75.0 words per minute using the 5 per cent level of significance.

**Solution:**

$H_0 : \mu = 75$

$H_1 : \mu < 75$

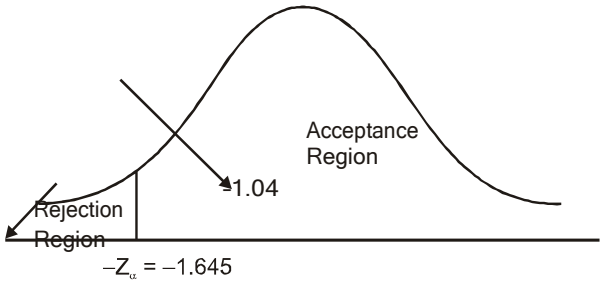
$\bar{X}$ = 73.6, *s* = 8.10, *n* = 36 and  = 0.05. As the sample size is large(*n* > 30), though population standard deviation  is unknown, *Z* test is appropriate.

The test statistic is given by:

$$Z = \frac{\bar{X} - \mu_{H0}}{\hat{\sigma}_{\bar{x}}} = \frac{73.6 - 75}{1.35} = \frac{-1.4}{1.35} = -1.04$$

$$\left( \frac{\hat{\sigma}}{x} = \frac{s}{\sqrt{n}} = \frac{8.10}{\sqrt{36}} = \frac{8.10}{6} = 1.35 \right)$$

Since it is a one-tailed test and the interest is in the left hand tail of the distribution, the critical value of *Z* is given by – $Z_{}$ = –1.645. Now, the computed value of *Z* lies in the acceptance region, and the null hypothesis is accepted as shown below:



## Rejection region for Example 2.2

### Case of small sample

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In case the sample size is small ($n$ ? 30) and is drawn from a population having a normal population with unknown standard deviation ?, a *t* test is used to conduct the hypothesis for the test of mean. The *t* distribution is a symmetrical distribution just like the normal one. However, *t* distribution is higher at the tail and lower at the peak. The *t* distribution is flatter than the normal distribution. With an increase in the sample size (and hence degrees of freedom), *t* distribution loses its flatness and approaches the normal distribution whenever $n > 30$. Acomparative shape of *t* and normal distribution is given in Figure 2.2.

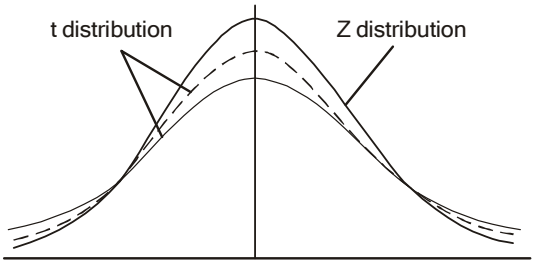



***Fig. 2.2*** *Shape of t and Normal Distribution*

The procedure for testing the hypothesis of a mean is similar to what is explained in the case of large sample. The test statistic used in this case is:

$$t_{n-1} = \frac{\bar{X} - \mu_{H0}}{\hat{\sigma}_{\bar{x}}}$$

Where, $\frac{\hat{\sigma}}{x} = \frac{s}{\sqrt{n}}$ (where s = Sample standard deviation)

$$n - 1 = \text{degrees of freedom}$$

A few examples pertaining to '*t*' test are worked out for testing the hypothesis of mean in case of a small sample.

**Example 2.3:** Prices of share (in ₹) of a company on the different days in a month were found to be 66, 65, 69, 70, 69, 71, 70, 63, 64 and 68. Examine whether the mean price of shares in the month is different from 65. You may use 10 per cent level of significance.

**Solution:**

$H_0$ : $\mu = 65$

$H_1$ : $\mu$ ? 65

Since the sample size is $n = 10$, which is small, and the sample standard deviation is unknown, the appropriate test in this case would be *t*. First of all, we need to estimate the value of sample mean ($\bar{X}$) and the sample standard deviation (*s*). It is known that the sample mean and the standard deviation are given by the following formula.

$$\bar{X} = \frac{\sum X}{n} \quad s = \sqrt{\frac{1}{n-1}\sum \left(X - \bar{X}\right)^2}$$

The computation of $\bar{X}$ and s is shown in Table 10.3.

$$\sum X = 675, \quad \bar{X} = \frac{\sum X}{n} = \frac{675}{10} = 67.5$$

$$\sum \left(X - \bar{X}\right)^2 = 70.5$$

$$s^2 = \frac{1}{n-1}\sum \left(X - \bar{X}\right)^2 \frac{70.5}{9} = 7.83$$

$$s = \sqrt{7.83} = 2.80$$

***Table 2.3*** *Computation of Sample Mean and Standard Deviation*

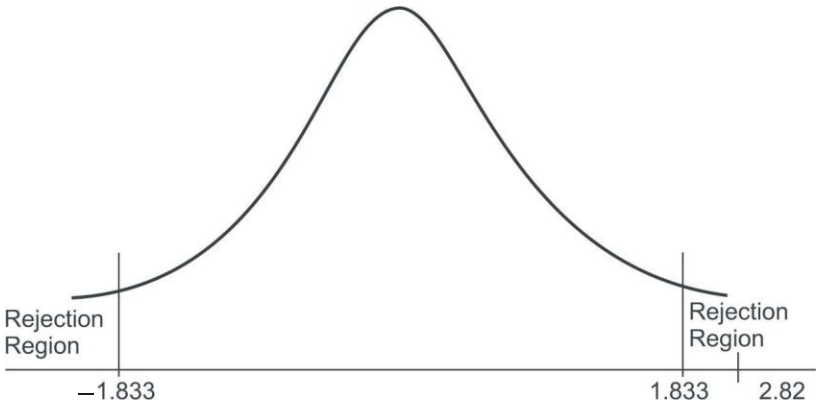
| S. No. | $X$ | $X - \bar{X}$ | $(X - \bar{X})^2$ |
|---|---|---|---|
| 1 | 66 | - 1.5 | 2.25 |
| 2 | 65 | - 2.5 | 6.25 |
| 3 | 69 | 1.5 | 2.25 |
| 4 | 70 | 2.5 | 6.25 |
| 5 | 69 | 1.5 | 2.25 |
| 6 | 71 | 3.5 | 12.25 |
| 7 | 70 | 2.5 | 6.25 |
| 8 | 63 | - 4.5 | 20.25 |
| 9 | 64 | - 3.5 | 12.25 |
| 10 | 68 | 0.5 | 0.25 |
| Total | 675 | 0 | 70.5 |

The test statistic is given by:

$$t_{n-1} = \frac{\bar{X} - \mu_{H0}}{\hat{\sigma}_{\bar{x}}} = \frac{\bar{X} - \mu_{H0}}{\frac{s}{\sqrt{n}}} = \frac{67.5 - 65}{\frac{2.8}{\sqrt{10}}} = \frac{2.5 \times \sqrt{10}}{2.8}$$

$$= 2.5 \times 3.16/2.8 = 7.91/2.8 = 2.82$$

The critical values of t with 9 degrees of freedom for a two-tailed test are given by –1.833 and 1.833. Since the computed value of *t* lies in the rejection region (see figure below), the null hypotheses is rejected.



**Rejection regions for Example 2.3**

Therefore, the average price of the share of the company is different from 65.

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**Example 2.4:** Past records indicate that a golfer has averaged 82 on a certain course. With a new set of clubs, he averages 7 over five rounds with a standard deviation of 2.65. Can we conclude that at 0.025 level of significance, the new club has an adverse effect on the performance?

**Solution:**

$H_0 : \mu = 82$

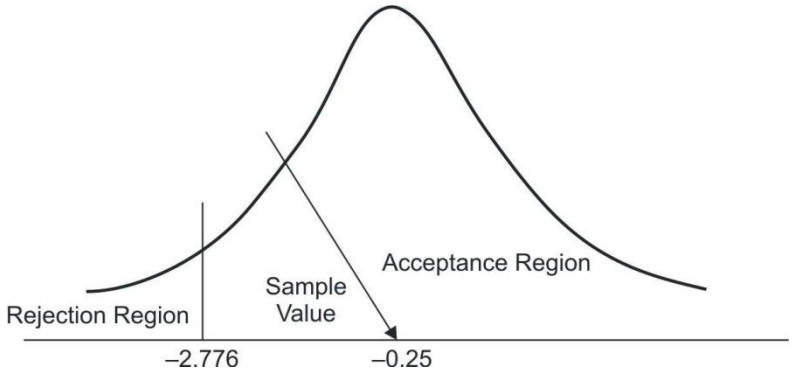
$H_1 : \mu < 82$

$\overline{X}$ = 7.9, n = 5, s = 2.65, □ = 0.025. As the population standard deviation is unknown and the sample size is small ($n < 30$), a *t* test would be appropriate. The test statistic is given by:

$$t_{n-1} = \frac{\overline{X} - \mu_{H_0}}{\hat{\sigma}_{\overline{x}}} = \frac{\overline{X} - \mu_{H_0}}{s/\sqrt{n}} = \frac{7.9 - 8.2}{1.185} = \frac{-0.3}{1.185} = -0.25$$

$$\left( \hat{\sigma}_{\overline{x}} = \frac{s}{\sqrt{n}} = \frac{2.65}{\sqrt{5}} = 1.185 \right)$$

The critical value of *t* at 0.025 level of significance with four degrees of freedom is given by $-t_{□} = -2.776$ (see Appendix 2). As the sample *t* value of –0.25 lies in the acceptance region, the null hypothesis is accepted (see figure below).




**Rejection region for Example 2.4**

Therefore, there is no adverse effect on the performance due to a change in the club and the performance can be attributed to chance.

## Tests for Difference between two Population Means

So far, we have been concerned with the testing of means of a single population. We took up the cases of both large and small samples. It would be interesting to examine the difference between the two population means. Again, various cases would be examined as discussed below:

## Case of large sample

In case both the sample sizes are greater than 30, a *Z* test is used. The hypothesis to be tested may be written as:

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$H_0 : \mu_1 = \mu_2$

$H_1 : \mu \neq \mu_2$

Where,

$\mu_1$ = mean of population 1

$\mu_2$ = mean of population 2

The above is a case of two-tailed test. The test statistic used is:

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)H_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

$\overline{X}_1$ = Mean of sample drawn from population 1

$\overline{X}_2$ = Mean of sample drawn from population 2

$n_1$ = size of sample drawn from population 1

$n_2$ = size of sample drawn from population 2

If $\sigma_1$ and $\sigma_2$ are unknown, their estimates given by $\hat{\sigma}_1$ and $\hat{\sigma}_2$ are used.

$$\hat{\sigma}_1 = s_1 = \sqrt{\frac{1}{n_1 - 1}\sum_{i=1}^{n_1}(X_{1i} - \overline{X}_1)^2}$$

$$\hat{\sigma}_2 = s_2 = \sqrt{\frac{1}{n_2 - 1}\sum_{i=1}^{n_2}(X_{2i} - \overline{X}_2)^2}$$

The *Z* value for the problem can be computed using the above formula and compared with the table value to either accept or reject the hypothesis. Let us consider the following problem:

**Example 2.5:** A study is carried out to examine whether the mean hourly wages of the unskilled workers in the two cities—Ambala Cantt and Lucknow are the same. The random sample of hourly earnings in both the cities is taken and the results are presented in the Table 2.4.

***Table 2.4*** *Survey Data on Hourly Earnings in Two Cities*

| City | Sample Mean Hourly Earnings | Standard Deviation of Sample | Sample Size |
|---|---|---|---|
| Ambala Cantt | ₹ 8.95 ($\overline{X}_1$) | 0.40 ($s_1$) | 200 ($n_1$) |
| Lucknow | ₹ 9.10 ($\overline{X}_2$) | 0.60 ($s_2$) | 175 ($n_2$) |

NOTES

Using a 5 per cent level of significance, test the hypothesis of no difference in the average wages of unskilled workers in the two cities.

*Solution:* We use subscripts 1 and 2 for Ambala Cantt and Lucknow respectively.

$H_0 : \mu_1 = \mu_2 \quad \Rightarrow \quad \mu_1 - \mu_2 = 0$

$H_1 : \mu_1 \neq \mu_2 \quad \Rightarrow \quad \mu_1 - \mu_2 \neq 0$

The following survey data is given:

$$\overline{X}_1 = 8.95,\ \overline{X}_2 = 9.10, s_1 = 0.40, s_2 = 0.60, n_1 = 200, n_2 = 175, \alpha = 0.05$$

Since both $n_1$, $n_2$ are greater than 30 and the sample standard deviations are given, a *Z* test would be appropriate.

The test statistic is given by:

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)H_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

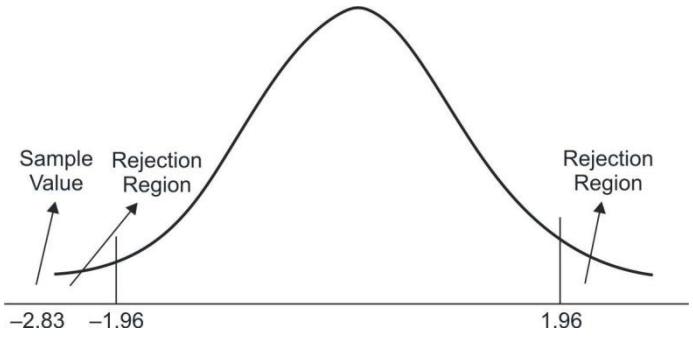
As $\sigma_1$, $\sigma_2$ are unknown, their estimates would be used.

$$s_1 = \hat{\sigma}_1, \quad s_2 = \hat{\sigma}_2$$

$$\sqrt{\frac{\hat{\sigma}_1^2}{n_1} + \frac{\hat{\sigma}_2^2}{n_2}} = \sqrt{\frac{(0.4)^2}{200} + \frac{(0.6)^2}{175}} = \sqrt{0.0028} = 0.0053$$

$$Z = \frac{(8.95 - 9.10) - 0}{0.053} = -2.83$$

As the problem is of a two-tailed test, the critical values of *Z* at 5 per cent level of significance are given by $-Z_{\alpha/2} = -1.96$ and $Z_{\alpha/2} = 1.96$. The sample value of $Z = -2.83$ lies in the rejection region as shown in the figure below:




**Rejection regions for Example 2.5**

## Case of small sample

If the size of both the samples is less than 30 and the population standard deviation is unknown, the procedure described above to discuss the equality of two population means is not applicable in the sense that a t test would be applicable under the assumptions:

(a) Two population variances are equal.

(b) Two population variances are not equal.

## Population variances are equal

If the two population variances are equal, it implies that their respective unbiased estimates are also equal. In such a case, the expression becomes:

NOTES

$$\sqrt{\frac{\sigma_1^2}{n_1}+\frac{\sigma_2^2}{n_2}} = \sqrt{\frac{\hat{\sigma}^2}{n_1}+\frac{\hat{\sigma}^2}{n_2}} = \hat{\sigma}\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}$$

(Assuming $\hat{\sigma}_1^2 = \hat{\sigma}_2^2 = \hat{\sigma}^2$)

To get an estimate of $\hat{\sigma}^2$, a weighted average of $s_1^2$ and $s_2^2$ is used, where the weights are the number of degrees of freedom of each sample. The weighted average is called a 'pooled estimate' of $\sigma^2$. This pooled estimate is given by the expression:

$$\hat{\sigma}^2 = \frac{(n_1-1)s_1^2+(n_2-1)s_2^2}{n_1+n_2-2}$$

The testing procedure could be explained as under:

$H_0 : \mu_1 = \mu_2 \quad \mu_1 - \mu_2 = 0$

$H_1 : \mu_1 \neq \mu_2 \quad \mu_1 - \mu_2 \neq 0$

In this case, the test statistic t is given by the expression:

$$t_{n_1+n_2-2} = \frac{(\overline{X}_1-\overline{X}_2)-(\mu_1-\mu_2)H_0}{\hat{\sigma}\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}}$$

Where,

$$\hat{\sigma} = \sqrt{\frac{(n_1-1)s_1^2+(\mu_2-1)s_2^2}{n_1+n_2-2}}$$

Once the value of *t* statistic is computed from the sample data, it is compared with the tabulated value at a level of significance $\alpha$ to arrive at a decision regarding the acceptance or rejection of hypothesis. Let us work outa problem illustrating the concepts defined above.

**Example 2.6:** Two drugs meant to provide relief to arthritis sufferers were produced in two different laboratories. The first drug was administered to a group of 12 patients and produced an average of 8.5 hours of relief with a standard deviation of 1.8 hours. The second drug was tested on a sample of 8 patients and produced an average of 7.9 hours of relief with a standard deviation of 2.1 hours. Test the hypothesis that the first drug provides a significantly higher period of relief. You may use 5 per cent level of significance.

**Solution:** Let the subscripts 1 and 2 refer to drug 1 and drug 2 respectively.

$H_0 : \mu_1 = \mu_2 \quad \mu_1 - \mu_2 = 0$

$H_1 : \mu_1 \neq \mu_2 \quad \mu_1 - \mu_2 \neq 0$

The following survey data is given:

$$\overline{X}_1 = 8.5, \overline{X}_2 = 7.9, s_1 = 1.8, s_2 = 2.1, n_1 = 12, n_2 = 8$$

NOTES

As both $n_1$, $n_2$ are small and the sample standard deviations are unknown, one may use a *t* test with the degrees of freedom = $n_1 + n_2 - 2 = 12 + 8 - 2 = 18$ d.f.

The test statistics is given by:

$$t_{n_1+n_2-2} = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)H_0}{\hat{\sigma}\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

Where,

$$\hat{\sigma} = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}$$

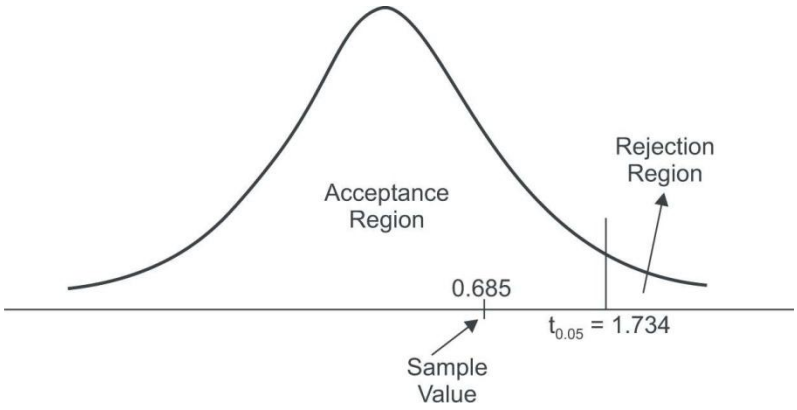
$$= \sqrt{\frac{(12-1)(1.8)^2 + (8-1)(2.1)^2}{12 + 8 - 2}} = \sqrt{\frac{11 \times 3.24 + 7 \times (4.41)}{18}}$$

$$= \sqrt{\frac{35.64 + 30.87}{18}} = \sqrt{\frac{66.61}{18}} = \sqrt{3.698} = 1.92$$

$$t_{18} = \frac{(8.5 - 7.9) - (0)}{1.92\sqrt{\frac{1}{12} + \frac{1}{8}}} = \frac{0.6}{1.92\sqrt{0.2083}}$$

$$= \frac{0.6}{1.92 \times 0.456} = \frac{0.6}{0.8755} = 0.685$$

The critical value of *t* with 18 degrees of freedom at 5 per cent level of significance is given by 1.734. The sample value of $t = 0.685$ lies in the acceptance region as shown in figure below:




**Rejection region for Example 2.6**

Therefore, the null hypothesis is accepted as there is not enough evidence to reject it. Therefore, one may conclude that the first drug is not significantly more effective than the second drug.

## When population variances are not equal

NOTES

In case population variances are not equal, the test statistic for testing the equality of two population means when the size of samples are small is given by:

$$t = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)H_0}{\sqrt{\frac{\hat{\sigma}_1^2}{n_1} + \frac{\hat{\sigma}_2^2}{n_2}}}$$

The degrees of freedom in such a case is given by the expression:

$$d.f = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{1}{n_1 - 1}\left(\frac{s_1^2}{n_1}\right)^2 + \frac{1}{n_2 - 1}\left(\frac{s_2^2}{n_2}\right)^2}$$

The procedure for testing of hypothesis remains the same as was discussed when the variances of two populations were assumed to be same. Let us consider an example to illustrate the same.

**Example 2.7:** There were two types of drugs (1 and 2) that were tried on some patients for reducing weight. There were 8 adults who were subjected to drug 1 and seven adults who were administered drug 2. The decrease in weight (in pounds) is given below:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Drug 1** | 10 | 8 | 12 | 14 | 7 | 15 | 13 | 11 |
| **Drug 2** | 12 | 10 | 7 | 6 | 12 | 11 | 12 | |

Do the drugs differ significantly in their effect on decreasing weight? You may use 5 per cent level of significance. Assume that the variances of two populations are not same.

**Solution:**

$H_0$ : $\mu_1 = \mu_2$

$H_1$ : $\mu_1 \neq \mu_2$

Let us compute the sample means and standard deviations of the two samples as shown in Table 2.5.

***Table 2.5*** *Intermediate computations for sample means and standard deviations*

| S.No. | $X_1$ | $X_2$ | $(X_1 - \bar{X}_1)$ | $(X_2 - \bar{X}_2)$ | $(X_1 - \bar{X}_1)^2$ | $(X_2 - \bar{X}_2)^2$ |
|---|---|---|---|---|---|---|
| 1 | 10 | 12 | -1.25 | 2 | 1.5625 | 4 |
| 2 | 8 | 10 | -3.25 | 0 | 10.5625 | 0 |
| 3 | 12 | 7 | 0.75 | -3 | 0.5625 | 9 |
| 4 | 14 | 6 | 2.75 | -4 | 7.5625 | 16 |
| 5 | 7 | 12 | -4.25 | 2 | 18.0625 | 4 |
| 6 | 15 | 11 | 3.75 | 1 | 14.0625 | 1 |
| 7 | 13 | 12 | 1.75 | 2 | 3.0625 | 4 |
| 8 | 11 | | -0.25 | | 0.0625 | |
| Total | 90 | 70 | 0 | 0 | 55.5 | 38 |
| Mean | 11.25 | 10 | | | | |

NOTES

$$n_1 = 8, \qquad n_2 = 7,$$

$$\bar{X}_1 = \frac{\Sigma X_1}{n_1} = \frac{90}{8} = 11.25 \qquad \bar{X}_2 = \frac{\Sigma X_2}{n_2} = \frac{70}{7} = 10$$

$$s_1^2 = \frac{\Sigma(X_1 - \bar{X}_1)^2}{n_1 - 1} = \frac{55.5}{7} = 7.93$$

$$s_2^2 = \frac{\Sigma(X_2 - \bar{X}_2)^2}{n_2 - 1} = \frac{38}{6} = 6.33$$

$$\hat{\sigma}_{\bar{X}_1 - \bar{X}_2} = \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}} = \sqrt{\frac{7.93}{8} + \frac{6.33}{7}} = \sqrt{0.99 + 0.90} = \sqrt{1.89} = 1.37$$

$$d.f. = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{1}{n_1 - 1}\left(\frac{s_1^2}{n_1}\right) + \frac{1}{n_2 - 1}\left(\frac{s_2^2}{n_2}\right)} = \frac{\left(\frac{7.33}{8} + \frac{6.33}{7}\right)^2}{\frac{1}{7}\left(\frac{7.33}{8}\right)^2 + \frac{1}{6}\left(\frac{6.33}{7}\right)^2}$$

$$= \frac{3.314}{0.12 + 0.136} = \frac{3.314}{0.12 + 0.136} = 12.996 = 13 \text{ (approx.)}$$

$$t = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)H_0}{\sqrt{\frac{\hat{\sigma}_1^2}{n_1} + \frac{\hat{\sigma}_2^2}{n_2}}}$$

$$t = \frac{11.25 - 10}{1.37} = \frac{1.25}{1.37} = 0.912$$

The table value (critical value) of *t* with 13 degrees of freedom at 5 per cent level of significance is given by 2.16. As computed t is less than tabulated *t*, there is not enough evidence to reject $H_o$.

### Tests Concerning Population Proportion-the Case of Single Population

We have already discussed the tests concerning population means. In the tests about proportion, one is interested in examining whether the respondents possess a particular attribute or not.

The random variable in such a case is a binary one in the sense it takes only two values—yes or no. As we know that either a student is a smoker or not, a consumer either uses a particular brand of product or not and lastly, a skilled worker may be either satisfied or not with the present job. At this stage it may be recalled that the binomial distribution is a theoretically correct distribution to use while dealing with proportions. Further, as the sample size increases, the binomial distribution approaches the normal distribution in characteristic. To be specific, whenever both np and nq (where n = number of trials, p = probability of success and q = probability of failure) are at least 5, one can use the normal distribution as a substitute for the binomial distribution.

## The case of single population proportion

NOTES

Suppose we want to test the hypotheses,

$H_0 : p = p_0$

$H_1 : p \neq p_0$

For large sample, the appropriate test statistic would be:

$$Z = \frac{\bar{p} - p_{H_0}}{\sigma_{\bar{p}}}$$

Where,

$\bar{p}$ = sample proportion

$p_{H_0}$ = the value of p under the assumption that null hypothesis is true

$\sigma_{\bar{p}}$ = Standard error of sample proportion

The value of $\sigma_{\bar{p}}$ is computed by using the following formula:

$$\sigma_{\bar{p}} = \frac{\sqrt{p_{H_0} q_{H_0}}}{n}$$

Where, $q_{H_0} = 1 - p_{H_0}$

$n$ = Sample size

For a given level of significance $\alpha$, the computed value of $Z$ is compared with the corresponding critical values, i.e. $Z_{\alpha/2}$ or $-Z_{\alpha/2}$ to accept or reject the null hypothesis. We will consider a few examples to explain the testing procedure for a single population proportion.

**Example 2.8:** An officer of the health department claims that 60 per cent of the male population of a village comprises smokers. A random sample of 50 males showed that 35 of them were smokers. Are these sample results consistent with the claim of the health officer? Use a level of significance of 0.05.

**Solution:**

Sample size (n) = 50

Sample proportion = $\bar{p} = \frac{x}{n} = \frac{35}{50} = 0.70$

$H_0 : p = 0.60$

$H_1 : p > 0.60$

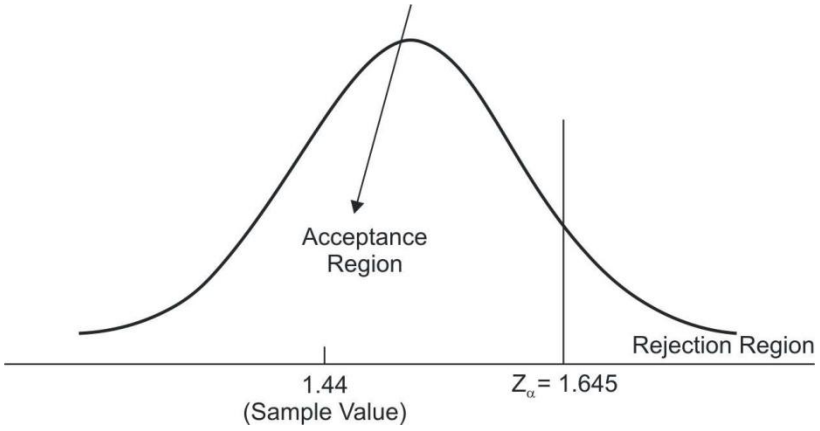
The test statistic is given by:

$$Z = \frac{\bar{p} - p_{H_0}}{\sigma_{\bar{p}}} = \frac{0.70 - 0.60}{0.069} = \frac{0.10}{0.069} = 1.44$$

$$\left( \frac{\sigma}{p} = \sqrt{\frac{P_{H_0} q_{H_0}}{n}} = \sqrt{\frac{0.6 \times 0.4}{50}} = \sqrt{\frac{0.24}{50}} = 0.069 \right)$$

It is a one-tailed test. For a given level of significance □ = 0.05, the critical value of $Z$ is given by $Z_{□} = Z_{0.05} = 1.645$. It is seen that the sample value of $Z = 1.44$ lies in the acceptance region as shown below (see figure).

NOTES




**Rejection region for Example 2.8**

Therefore, there is not enough evidence to reject the null hypothesis. So it can be concluded that the proportion of male smokers is not statistically different from 0.60.

### Tests for Difference between two Population Proportions

Here, the interest is to test whether the two population proportions are equal or not. The hypothesis under investigation is:

$H_0 : p_1 = p_2$ □ p – p = 0H

: p □ p$_1$ $_2$ □ p – p □ 0

The alternative hypothesis assumed is two sided. It could as well have been one sided. The test statistic is given by:

$$Z = \frac{\bar{p}_1 - \bar{p}_2 - (p_1 - p_2)H_0}{\sigma_{\bar{P}_1 - \bar{P}_2}}$$

Where,

$\bar{p}_1$ = Sample proportion possessing a particular attribute from population 1

$\bar{p}_2$ = Sample proportion possessing a particular attribute from population 2

$\sigma_{\bar{P}_1 - \bar{P}_2}$ = Standard error of difference between proportions.

$(p_1 - p_2)_{H0}$ = Value of difference between population proportion under the assumption that the null hypothesis is true.

The formula for $\sigma_{\bar{P}_1 - \bar{P}_2}$ is given by:

$$\sigma_{\bar{P}_1 - \bar{P}_2} = \sqrt{\frac{p_1 q_1}{n_1} + \frac{p_2 q_2}{n_2}}$$

We do not know the value of $p_1$, $p_2$, etc., but under the null hypothesis $p_1 = p_2 = p$.

$$\sigma_{\bar{P}_1 - \bar{P}_2} = \sqrt{\frac{pq}{n_1} + \frac{pq}{n_2}} = \sqrt{pq\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}$$

NOTES

The best estimate of $p$ is given by:

$$\hat{p} = \frac{x_1 + x_2}{n_1 + n_2}$$

Where,

$x_1$ = Number of successes in sample 1

$x_2$ = Number of successes in sample 2

$n_1$ = Size of sample taken from population 1

$n_2$ = Size of sample taken from population 2

It is known that $\bar{p}_1 = \frac{x_1}{n_1}$ and $\bar{p}_2 = \frac{x_2}{n_2}$.

Therefore, $x_1 = n_1 \bar{p}_1$ and $x_2 = n_2 \bar{p}_2$

Therefore, $\hat{p} = \frac{n_1 \bar{p}_1 + n_2 \bar{p}_2}{n_1 + n_2}$

Therefore, the estimate of standard error of difference between the two proportions is given by:

$$\hat{\sigma}_{\bar{P}_1 - \bar{P}_2} = \sqrt{\hat{p}\hat{q}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}$$

Where $\hat{p}$ is as defined above and $\hat{q} = 1 - \hat{p}$. Now, the test statistic may be rewritten as:

$$Z = \frac{\bar{p}_1 - \bar{p}_2 - (p_1 - p_2)H_0}{\sqrt{\hat{p}\hat{q}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

Now, for a given level of significance , the sample $Z$ value is compared with the critical $Z$ value to accept or reject the null hypothesis. We consider below a few examples to illustrate the testing procedure described above.

**Example 2.9:** A company is interested in considering two different television advertisements for the promotion of a new product. The management believes that advertisement A is more effective than advertisement B. Two test market areas with virtually identical consumer characteristics are selected. Advertisement A is used in one area and advertisement B in the other area. In a random sample of 60 consumers who saw advertisement A, 18 tried the product. In a random sample of 100 customers who saw advertisement B, 22 tried the product. Does this indicate that advertisement A is more effective than advertisement B, if a 5 per cent level of significance is used?

NOTES

**Solution:**

$H_0 : p_a = p_b$

$H_1 : p_a > p_b$

$$n_A = 60, \quad x_A = 18, \quad n_B = 100, \quad x_B = 22$$

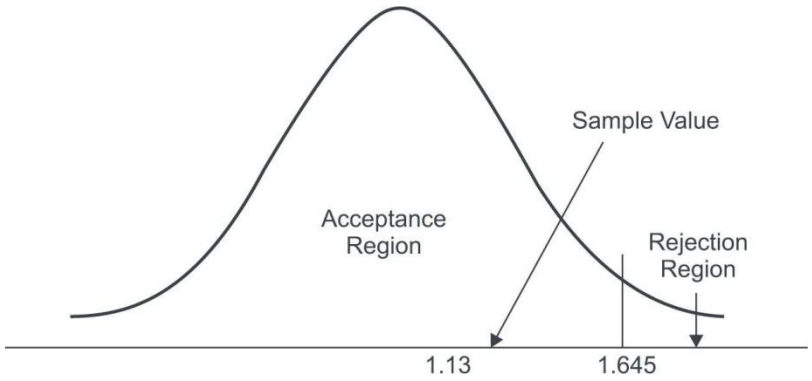
$$\left(\bar{p}_A = \frac{x_A}{n_A} = \frac{18}{60} = 0.3\right) \quad \left(\bar{p}_B = \frac{x_B}{n_B} = \frac{22}{100} = 0.22\right)$$

$$Z = \frac{\bar{P}_A - \bar{P}_B - (p_A - p_B)H_0}{\sigma_{P_A - P_B}} = \frac{0.3 - 0.22 - 0}{\sqrt{\hat{p}\hat{q}\left(\frac{1}{n_A} + \frac{1}{n_B}\right)}}$$

$$= \frac{0.08}{\sqrt{0.25 \times 0.75\left(\frac{1}{60} + \frac{1}{100}\right)}} = \frac{0.08}{\sqrt{0.25 \times 0.75(0.0267)}} = \frac{0.08}{0.071} = 1.3$$

$$\left(\hat{p} = \frac{x_A + x_B}{n_A + n_B} = \frac{18 + 22}{60 + 100} = \frac{40}{160} = 0.25\right)$$

The critical value of $Z$ at 5 per cent level of significance is 1.645. The sample value of $Z = 1.13$ lies in the acceptance region as shown in the figure below:




**Rejection region for Example 2.9**

**Case Study**

**M LSteel Works Ltd**

Mr. Mohan Lal is the proprietor of M L Steel Works Ltd., a company that manufactures and sells stainless steel utensils. Mr. Mohan Lal had set up the business in 2001. It was growing at an annual growth rate of 7 per cent and in 2008 its sales turnover was ₹75 lakh. Mr. Mohal Lal was happy with the growth of the company. However, after 2008 its sales got stagnant at ₹75 lakh. This was a matter of concern to Mr. Lal since the cost of production was going up resulting in reduced profitability.

Mr. Kapoor, the friend of Mr. Lal who was working for a consulting organization advised him to send his sales people for training. Mr. Lal had chosen 36 salesmen and sent them for a one-week training programme. After the training programme, it was noticed that the average sales for their salesmen has increased to ₹80 lakh with a standard deviation of ₹3 lakh. Mr. Lal was wondering whether it was due to chance or was it due to the effectiveness of the training programmes.

**Discussion Question**

Formulate a suitable hypothesis to test that training programme is effective. Test it using 5% level of significance.

(Hint: You need to test the following hypothesis.)

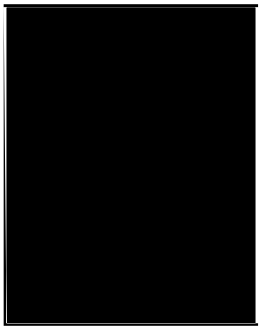
$H_0$ : $\square = 75$

$H_1$ : $\square > 75$

NOTES

## 2.5 SUMMARY

- A hypothesis is an approximate assumption that a researcher wants to test for its logical or empirical consequences. It can contain either a suggested explanation for a phenomenon or a proposal having deductive reasoning to suggest a possible interrelation between multiple phenomena.
- The following are the characteristics of a valid hypothesis: conceptually clear and accurate, statement of relationship between variables, testability, specific with limited scope, simple, consistent, has a time limit or frame, provides empirical evidence, etc.
- There is no certainty that the hypothesis formulated for a problem is true or correct. Formulated hypothesis is the initial point, a statement that the researcher has to prove true after further research and investigations. It is also possible that after further research the researcher might find that this hypothesis is not valid for the problem and that it needs modifications.
- A well formulated or good hypothesis helps the researchers to focus/concentrate on the key points of investigation. Also a hypothesis is significant because it guides the research. The researchers or investigators refer to the hypothesis in order to direct their thought processes toward the result of the research problem or sub-problems.
- In research, an investigator or researcher is proficient to either accept (support) or reject a hypothesis. If a hypothesis is rejected, it will lead an investigator or researcher to develop new hypothesis to explain the phenomenon in question. If a hypothesis is continually supported or accepted, then it may evolve into a theory.
- Steps in hypothesis generation are: preliminary research, writing your hypothesis, and testing it against the criteria in set while writing the hypothesis.
- Hypothesis is a tentative assumption explaining an observation, phenomenon or scientific problem that can be tested by further observation, investigation or experimentation. Characteristically, the research is a process of investigation of a particular/specific topic of study with the aim of studying a problem or question.
- The key objective for the researcher or investigator in developing a hypothesis statement is to test and ultimately accept or reject it when the assessment of the research is performed.
- The importance of hypothesis in social research is that: is directs, monitors and controls research efforts; it indicates the sample selection procedure, design of research, data collection, etc.; it orients the researcher towards relevant aspects of the problem; provides rational statements to the researcher, adds a scientific rigour to the research.



NOTES

- The sources of hypothesis include: scientific theories, expert opinions, method of related difference, intellectual equipment of researcher, experience, analogies, formulation of hypothesis, induction by simple enumeration, a study of general culture, etc.
- The important concepts in the testing of hypothesis includes an understanding of the topics: null hypothesis, alternate hypothesis, one-tailed and two-tailed tests, type I and type II errors.
- The following are the steps in testing of hypothesis exercise: setting up of a hypothesis, setting up of a suitable significance level, determination of a test statistic, determination of critical region, computing the value of test-statistic and making the decision.

## 2.6 KEY TERMS

- **Hypothesis:** It is an approximate assumption that a researcher wants to test for its logical or empirical consequences.
- **Null hypothesis:** It refers to the hypotheses that is proposed with the intent of receiving a rejection for them.
- **Critical region:** It refers to the region that leads to rejection of null hypothesis.
- **Level of significance:** It is the probability of committing a Type 1 error.

## 2.7 ANSWERS TO 'CHECK YOUR PROGRESS'

1. The characteristics of hypothesis are:
   - Simplicity: Ahypothesis should be stated in the most simple and clear terms to make it understandable.
   - Consistency: A hypothesis should be reliable and consistent with established and known facts.
2. As soon as a research question is formulated, it makes the hypothesis formulation imperative since a hypothesis is a tentative solution or an intelligent guess about a research question under study.
3. The key objective for the researcher or investigator in developing a hypothesis statement is to test and ultimately accept or reject it when the assessment of the research is performed.
4. The hypothesis not only indicates what to look for in an investigation but also how to select a sample, choose the design of research, how to collect data and how to interpret the results to draw valid conclusions.
5. A hypothesis may not be required in historical or descriptive studies where finding facts is the objective.
6. A review of related literature helps in the formulation of hypothesis by revealing to the researcher the variables that have been considered important in relation to his/her problem, which aspects have already been studied and which are left to be studied, which theories have supported the relationships and which theories present a contradictory relationship.

7. A test is called one-sided (or one-tailed) only if the null hypothesis gets rejected when a value of the test statistic falls in one specified tail of the distribution.
8. If the null hypothesis $H_0$ when false is accepted, the researcher is committing an error which is called Type II error.
9. The level of significance is a step in the testing of hypothesis exercise which denotes the probability of rejecting the null hypothesis when it is true. It is denoted by Q.

## 2.8 QUESTIONS AND EXERCISES

### Short-Answer Questions

1. List the essential key points that must be defined at the time of hypothesis formulation.
2. How does a hypothesis add scientific rigour to the research process?
3. Write the difference between null hypothesis and alternative hypothesis.
4. Explain the difference between one-tailed and two-tailed tests.
5. What are Type I and Type II errors?

### Long-Answer Questions

1. Discuss the characteristics of valid hypothesis.
2. Describe the steps in the formulation of hypothesis with the help of example.
3. Examine the importance of hypothesis.
4. Discuss the sources of hypothesis.
5. Explain the steps in testing of hypothesis.
6. Discuss what happens if the two population variances are equal.

## 2.9 FURTHER READING

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# UNIT 3 SCIENTIFIC STUDY OF SOCIAL PHENOMENA

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**Structure**



## 3.0 INTRODUCTION

A very important part of understanding the nuances of social research is the scientific study of the social phenomenon. How is science related to society and its element? Can science and its method be used for analysing the society? Social research, too involves scientific methods of study. The basic elements that define scientific methods are known as concepts, yet all concepts are by and large only abstractions. Facts are logical constructions of concepts. A close relationship exists between a theory and fact where a theory is only a speculation and it has to be proved before it can be called a theory definitively. When a theory is proved, it becomes a fact.

There are various methods of scientific enquiry. The two most important ones are—deductive and inductive reasoning. Deductive reasoning is one where the researcher moves from the general to the specific part of the research. Inductive reasoning is also called the bottom-up approach. It tends to move from particular observations to wide generalizations.

There is an ongoing debate on the subject of objectivity or subjectivity of research carried out by researchers where the researchers are supposed to be unbiased and objective rather than subjective. Herein, value neutrality is the duty of sociologists to strive to be impartial and overcome their biases as they conduct their research. There is also a very common debate in sociology pertaining to the approach that is used in the social research: quantitative or qualitative.

But understanding the method of scientific study will be incomplete without a discussion on its background. Positivism is a very dominant philosophy to sociology. As a philosophical ideology and movement, positivism first assumed its distinctive features in the work of the French philosopher Auguste Comte, who named the systematized science of sociology. It then developed through several stages known by various names, such as Empiriocriticism, Logical Positivism and Logical Empiricism and finally in the

mid-20th century flowed into the movement known as Analytic and Linguistic philosophy.

In its basic ideological posture, positivism is worldly, secular, anti-theological and anti-metaphysical. In this unit, you will learn about the scientific method, objectivity and subjectivity, debate in social research and positivism in sociology.

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## 3.1 UNIT OBJECTIVES

After going through this unit, you will be able to:

- Discuss the nature of science
- Describe the scientific method
- Explain the concept of objectivity and subjectivity
- Examine the debate in social research
- Explain the theory of positivism in sociology

## 3.2 THE SCIENTIFIC METHOD

Science refers to organized knowledge, but this knowledge and these facts are seldom conclusive. New experiences and additional information constantly alter the previous findings and replace them with generalizations that confirm the latest findings.

The same is the case with social sciences. The scientific method can also be applied to subjects in social sciences.

### 3.2.1 The Nature of Science

The method which integrates the most important aspects of the deductive and inductive methods of research is recognized as *scientific method*. It is generally attributed to Charles Darwin.

The scientific method is a back-and-forth movement of thought in which man first operates inductively from partially known or sometimes confused information learned from experience, previous knowledge, reflective thinking, observation and so on, towards a meaningful whole or hypothesis, and then deductively from suggested whole or hypothesis to the particular parts in order to connect these with one another in a meaningful pattern to find valid relationships. In the words of (Dewey 1933, p. 87):

While induction moves from fragmentary details (or particulars) to a connected view of situation (universal), deduction begins with the latter and works back again to particulars, connecting them and binding them together.

Although, in practice, scientific method involves a double movement of reasoning from induction to deduction, in its simplest form, it consists of working inductively from observations to hypotheses and then deductively from the hypotheses to the logical implications of the hypotheses in relation to what is already known.

Scientific method differs from other methods of acquiring knowledge on the basis of generalizations from authority, tradition, experience, and syllogism. It also differs from the methods of chance, of trial-and-error, and of intuition. When using the scientific method, one engages himself in a thinking process called *reflective thinking*. The five stages of reflective thinking furnished by Dewey (1911) may be summarised as under (Van Dalen 1973, p. 13; Whitney 1964, p. 3):

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1. ***The occurrence of a felt difficulty***. Man comes across some obstacle, experience, or problem that puzzles him.
   (a) He lacks the means to achieve the end desired.
   (b) He feels difficulty in identifying the character of an object.
   (c) He is unable to explain an unexpected event.
2. ***Identification and definition of the difficulty in terms of a problem statement.*** Man makes observations and gathers facts so that he is able to define his difficulty more precisely.
3. ***Suggested solutions of the problem—hypotheses.*** Man makes intelligent guesses about possible solutions of the problem from the preliminary study of the facts. Such guesses that he makes to explain the facts about the cause of difficulty are called *hypotheses*.
4. ***Deriving consequences of the suggested solutions with the help of deductive reasoning.*** With the help of deductive arguments, man reasons that if each hypothesis is true, certain consequences should follow.
5. ***Experimental verification of the hypotheses.*** Man verifies each hypothesis by searching for observable evidence that will confirm whether or not the consequences that follow actually occur. This process enables him to test which hypothesis is in conformity with observable facts.

The stages involved in reflective thinking presented above suggest a pattern that is employed in the scientific method. It will be seen that the pattern describing this method runs parallel to the stages involved in reflective thinking.

From the earlier times, man has been curious about anything he could not understand. Slowly and gradually he developed the scientific method of thinking and of investigating his problems which, today is producing astonishing results. It is an orderly system of searching for truth which, by basing conclusions upon factual evidence, and by using reasoning as a means of showing relationship between ideas, has given him better and more accurate answers to his many problems, not only in physical and biological sciences, but also in behavioural and social sciences. By attempting to apply this method of inquiry to behavioural and social sciences, the fields of psychology, economics, political science, sociology, anthropology, and education have become recognized as sciences. The term *science*, therefore, is now thought of as a method or attitude rather than a field of subject matter. It is described as a method of inquiry that permits man to examine the phenomena of interest to him.

Science is based on certain beliefs and assumptions which are briefly described as under:

1. All events in nature are, at least to a degree, lawful or ordered, predictable and regular. This order, predictability and regularity of nature can be discovered through the activities of the scientific method.
2. Truth can ultimatelybe derived onlyfrom observation. Scientist does not depend upon authority as a source of truth, but relies upon empirical observation. Thus, the phenomena that can actually be observed to exist are within the domain of scientific method.
3. The scientist maintains a doubtful attitude towards data. He regards findings as tentative unless they are verified. Verification of the findings requires that

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other scientists must be able to repeat the observations and get the same results.

4. The scientist is objective, impartial and logical in collecting and interpreting data or making observations. His personal bias does not in any way influence the truth and facts even when they are not in conformity with his own opinions.
5. Scientist does not bother about the moral implications of his findings. He always deals with facts and does not consider what finding is good or what is bad for us.
6. The ultimate goal of science is to integrate and systematise findings into a meaningful pattern or *theory*. The theory, however, is regarded as tentative and not the ultimate truth. It is subject to revision or modification as new evidence is found.

Theories are statements that explain a particular segment of phenomena by specifying certain relationships among variables. According to Kerlinger (1978, p. 9):

A theory is a set of interrelated constructs (concepts), definitions, and propositions that present a systematic view of phenomena by specifying relations among variables, with the purpose of explaining and predicting the phenomena.

This definition emphasises three things:

- First, a theory is a set of statements comprising of interrelated constructs, definitions and propositions.
- Secondly, a theory sets out the relations among the set of constructs, definitions or propositions in order to present a systematic view of the phenomena.
- Thirdly, a theory explains a phenomenon by specifying what variables are related to what variables and how they are related, thus, enabling the scientist to predict from certain variables to certain other variables.

A teacher, for example, has a theory of low academic achievement. His variables might be home environment, intelligence, verbal and numerical aptitudes, anxiety, economic factors and achievement motivation. The phenomenon to be explained is low academic achievement. It is explained by specified relations between each of the seven variables and low academic achievement, or by combinations of the seven variables and low academic achievement. The teacher seeks to understand low academic achievement with the help of this set of relations or constructs. He is then able to 'explain' and to some extent at least 'predict' it. Moreover, he can also to some extent 'control' the low academic achievement by making changes in the environment or manipulating some of the variables.

Scientific theories serve as means and ends in the development of science. As means, they provide a framework which guides scientist in making observation and discovery. Theories summarize knowledge and put in order the knowledge within a given field. They also clarify and provide meaning to this summarized knowledge comprising of isolated empirical findings. As ends, theories provide scientists explanations for observed events and relationships for specific phenomena with maximum objectivity. They do so by showing what variables are related and how they are related. On the basis of such relationships, scientists make deductions and predict about what will happen in certain situations under specified conditions. In this way, theories help in the development of new knowledge.

A sound theory must meet the following criteria if it is to serve its purpose in the development of science.

1. A theory must be stated in simple and precise terms. A theory that explains the most in a simple form is preferred to one that has more complexities and assumptions. This is the *Law of Parsimony*.
2. A theory must be in conformity both with the observed and with the previously established body of knowledge or validated theories.
3. A theory must provide means for its own interpretation and verification. In other words, it must provide deductions which can be tested empirically.
4. A theory must guide new discoveries and identify areas which are in need of investigation. It can do so if it is based on empirical facts and relationships.

Theories often offer a crude and general explanation of phenomena. They are refined and modified as knowledge in the form of facts accumulates. The discovery of pertinent facts is essential in order to determine whether a theory can be confirmed or should be rejected or reformulated. For example, if the facts found do not substantiate the theory, a scientist must reject or reformulate the theory to fit the new facts.

### 3.2.2 Steps, Process and Objecives of Scientific Method

In this section, we will study, in detail, the steps, process, objectives and characteristics of the scientific method.

#### Steps in Scientific Method

The steps involved in the scientific method are as follows:

- Collection of data as per the problem in hand, according to some adequate plan and their systematic observation.
- Observations are made with a well-defined purpose and they are recorded in definite terms.
- Classification and organization of data on the basis of similarities, variations, activities, causes and results.
- Generalization of data for the purpose of formulating principles and theories. The principles and theories must be specifically defined so that it can solve the problems in the related field.
- Verification of generalizations through controlled experiments by tested prediction of results and by repetition of experiments. Correlation coefficient of original as well as verification of results is also calculated and probable errors are estimated. It is also determined whether the error lies in procedure or apparatus.
- Assumptions and limitations are noted down on the basis of verification of results.
- Reporting the research in detail.
- Announcement of the results before the general public for practical use.

#### Steps in Scientific Process

The steps involved in a scientific process are as follows:

**(i) Purposeful observation:** Observation should be accurate and extensive, and it must be done under various controlled conditions.

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**(ii) Analysis-synthesis:** This includes the following:

- The essential elements in a problematic situation must be selected by analysis.
- Similarities as well as dissimilarities must be isolated.
- Exceptions are to be given special attention.

**(iii) Selective recall:** A wide range of experiences is essential.

**(iv) Hypothesis:** It is a tentative solution to the problem. There may be more than one solution depending on the nature of the problem.

**(v) Verification by inference and experiment:** Here, only one variable is manipulated and judgment is made on the adequacy and accuracy of data.

## Objectives of Scientific Research

The terms research and scientific method are sometimes used inter changeably.

Research is a systematic process for developing a theory by applying scientific methods. It is an impartial, objective, empirical and logical analysis and recording of controlled observation that finally leads to the development of a theory, principles, laws, etc., and helps us to predict about the phenomenon in future.

A research is said to begin with a question or a problem. The purpose of a research is to find out solutions through the application of systematic and scientific methods. Thus, research is a systematic approach to a purposeful investigation.

The main aim of research is to uncover answers to questions by applying scientific procedures. Research aims to discover hidden truths. While each research initiative has a particular purpose, the objectives of research can be broadly characterized as follows:

- **Exploratory/formulative research:** It attempts to get familiar with a concept or to develop new insights into it.
- **Descriptive research**: It seeks to accurately portray the key characteristics of an individual, a situation or a group.
- **Diagnostic research:** It establishes the frequency with which an event occurs, or the frequency with which it is associated with something else.
- **Hypothesis-testing research:** This type of research tests the hypotheses of a causal relationship between variables.

## Characteristics of Good Research

The process of research helps to increase the creative ability of a decision-maker. The various characteristics of research are as follows:

- **Interdisciplinary team approach:** This approach is based on the principle of using expertise and experience of different personnel working in different disciplines within an organization. An individual cannot be an expert in all the areas of operation. So, researchers take help from other experts, who are specialists in their respective fields. Under interdisciplinary team approach, an expert may use old solutions, which were used in the past as research material for finding the most appropriate solution to a problem.
- **Methodological process:** The researcher uses scientific methods and techniques to provide optimum solution to problems. The scientific methods include observing and defining a problem and formulating hypothesis related to the results of the

NOTES

scientific methods and techniques. If the hypothesis is accepted, its results should be executed in an organization; but if the hypothesis is not accepted, another hypothesis is formulated.

- **Objectivistic approach:** The aim of an organization is to have optimal solutions to various problems. It is essential to measure the desirability of a solution for achieving the organizational objective. This measured desirabilityhelps in comparing the alternative courses of action with respect to their outcomes.
- **Economical in nature:** In an uncertain and complex situation, research helps in reducing the costs of inventory, thereby improving profits. For example, in inventory control, research can provide scientific rules for reducing acquisition costs and inventory-carrying costs.

The qualities of good research are as follows:

- **Good research is systematic:** This means that the research lays out clear steps in a specified sequence in compliance with well-defined rules. Being systematic does not mean that the research cannot be based on creative thinking. On the other hand, it dramatically reduces guesswork-based and intuitive conclusions.
- **Good research is logical:** This implies that the use of sound logic provides a foundation for reasoning, induction and deduction, which are of great significance for carrying out high quality research. Induction entails reasoning from a part to the whole, while deduction is the process of reasoning, wherein a premise is driven to a conclusion which is based on that very premise. In fact, logical reasoning leads to more meaningful research and better eventual decision-making.
- **Good research is empirical:** This means that research is related to one or several aspects of a real situation and uses concrete data which provides a basis for external validity to the research results.
- **Good research is replicable:** Good research allows for research results to be verified by replicating the study, thereby building a sound basis for decisions.

Further, Best and Kahn (1992) have summarized the main characteristics of research as follows:

- Research seeks to find a solution to a problem. In this objective, it could answer a question or even determine the relationship between several variables.
- Research creates generalizations, principles and theories that enable the prediction or anticipation of future occurrences. Research studies specific objects, groups or situations and then applies these characteristics observed to a larger population than the sample observed. Research goes beyond just simply retrieving or gathering information. There are many schools where the research teams gather and tabulate statistical information. This information can be used for decision-making, but it is not necessary to do so.
- Research is based on observations or empirical evidence. There are many questions which are interesting or relevant but, since they cannot be observed, they do not become research procedures. Research does not accept revelation or dogma as a basis for establishing knowledge. Research only accepts that which can be verified by observation.
- Research requires accuracy of observation and description. Researchers rely on quantitative or numerical measuring devices which are accepted as precise means

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of description. They identify or create appropriate data gathering instruments or procedures and employ effective mechanical, electronic, or psychometric techniques to improve human observation, recording, computation and analysis of data.

- Research entails obtaining new data from first-hand sources, or uses existing data towards a new purpose. Teachers often guide their students to undertake a project which requires them to write a paper detailing the life of a prominent person. The students consult encyclopaedias, books, or periodicals and summarize the information in writing. This is not research, the information is not new. Simply rewriting or representing what is already known may be a valuable learning experience, but it is not research. It does not provide any new information.
- Research may sometimes appear to be random or unsystematic. However, it is actually always based on carefully designed procedures and rigorous analysis. Although researchers may sometimes employ trial and error methodologies, research is not a blind, random investigation, where the researcher is just experimenting to see what happens.
- A good researcher requires significant expertise. He/She is already aware of what is known about the problem including the investigations carried out by others. The researcher familiar with the related literature and also understands the terminology, concepts and technical skills necessary to thoroughly assess the data that he/she has gathered.
- Researchers must apply objectivity and logic and must also remove all their personal biases. They must employ all possible tests in order to comprehensively validate the procedure followed, the data sourced, and the results or conclusions that have been arrived at. Researchers should not make any effort to be additionally persuasive in order to prove an emotionally held conviction by them. Their focus must be on testing, and not on proving the hypothesis. Total objectivity is just as rare as absolute righteousness, and therefore, researchers must not allow bias or emotion to affect their analysis.
- Research involves the quest for answers to unsolved problems. Pushing back the frontiers of ignorance is its goal, and originality is frequently the quality of a good research project. However, previous important studies are deliberately repeated, using identical or similar procedures, with different subjects, different settings, and at different times. This process is a replication, a fusion of the words, repetition and duplication. Replication is always desirable to confirm or to raise questions about the conclusions of a previous study.
- Research must be carried out patiently and not in a rushed manner. It's outcome and result are mundane rather than spectacular, and the research team must be prepared to face disappointment in the pursuit of answers to their unanswered questions.
- The process and outcomes of research are meticulously recorded. Every key term is defined, restrictive factors are acknowledged, procedures are carefully described, all references are recorded, results are objectively documented, and the final outcomes are presented with caution and restraint. The final research reports and supporting data are made available for associates and other scholars to study, analyse, evaluate and even replicate.

## 3.3 OBJECTIVITY-SUBJECTIVITY DEBATE

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It is important for a study to be objective in nature, no matter which discipline it represents. Whether it is natural or social science research, a study which is subjective in nature does not produce results which can be depended upon. That is because being objective in social science means being able to check and examine the evidences which the study has produced. An objective study is free from personal biases and beliefs of the researcher. Objective studies are not speculative in nature but are dominated by actual observations.

When compared with natural sciences, it is much more difficult to obtain objectivity in social sciences. This is largely because social sciences deals with humans who live in a society and pursue their own interests. Both of these are highly dynamic and their attitudes and approaches to life can change at any given time and also evolve with time. Therefore, while objectivity is important, it is difficult to obtain the same in social sciences as personal views and biases often enter the researcher's work. There are hindrances like emotional values, complex subjects, uniformity problems, self-interest, lack of time for research, and bias and prejudices. Among all these, the most severe in terms of research are prejudices and biases which can greatly affect the nature of the study. These biases can enter different stages of research, like during the collection of the sample, in the choice of the participants, during data collection, analysis and finally in the findings.

### Value Neutrality

Value neutrality is the duty of sociologists to strive to be impartial and overcome their biases as they conduct their research. A researcher can easily mix his past experiences and present them as part of the present study. This leads to inclusion of subjectivity in the study. Biases can also enter during the supply of information because many times information is collected by those who may carry their own prejudices. They may present information which is suited to their needs, thus keeping the wholesome information out of reach of the researcher. All these can increasingly influence the findings of the study and mar the objectives with which it was undertaken in the first place. There are several ways by which subjectivity can be removed from research. These are, first, depending less on the investigation. This means that while data is critical to social science research, the researcher can avoid hiring other investigators and have first-hand information of the field to avoid subjectivity. Second, use of statistical measurements and methods can be made wherein data can be correlated and checked to remove subjectivity. Third, concepts and terms could be standardized to avoid multiple usage and inculcate clear and precise use to suit the views of the researcher. Fourth, the introduction of a questionnaire through which information is collected can lead to clarification and also provision of matter which can be cross-checked any time. Fifth, at various stages, the researcher can employ counter-checks and compare findings at several stages to avoid biases and prejudices from entering the study. Another method is that of random sampling with which the researcher can select participants from different shades to avoid his own prejudice that might enter the study during the collection of the sample.

### Problems of Subjectivity and Objectivity

Qualitative methodology is familiar with the fact that the subjectivity of the researcher is a deep ingredient of his scientific research. Everything is guided by subjectivity, beginning

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from the choice of topic that one studies, to devising hypotheses, to selection of methodology and interpretation of data. Qualitative methodology motivates researchers to mirror the values and objectives brought by them into their research and the manner in which they influence the research project. It also motivates other researchers to replicate the values used by a particular investigator.

The most important issue that comes up when subjectivity is recognized, is its impact on objectivity. Two types of arrangements have been expressed. Many qualitative researchers make subjectivity and objectivity counterbalance each other. It is believed that objectivity negates subjectivity. The reason for this is because it makes the observer an inert recipient of external information, without an agency. The subjectivity of the researcher is said to negate the possibility of objectivity, knowing a social psychological world. The investigator's values are said to define the world that is studied. It never happens that one really sees or talks about the world, per se. However, one only sees and talks about what one's values dictate.

Subjectivity is usually considered as the most essential and initiating part of qualitative methodology. Nevertheless, this is not true. Qualitative methodology also has traces of objectivity. Objectivity indicates that the subjectivity of a researcher can empower him to precisely understand the world in its true state. Beyond doubt, subjectivity can cause prejudice to affect the researcher and rule out objective understanding of a subject's psychological reality. However, this is not unavoidable. In the true sense, one of the benefits of getting to recognize subjectivity is to reflect on whether it makes objective comprehension easy or obstructs it. Distorting values can then be replaced by values that improve objectivity.

Objectivism puts subjectivity and objectivity together since it reasons that objective knowledge needs active, sophisticated and subjective processes like: perception, analytical reasoning, synthetic reasoning, logical deduction and the ability to differentiate essences from appearances. On the other hand, subjective processes can augment objective conception of the world.

Objectivism is the highest form of the subjects being studied as part of research methodology. It considers psychological reality as something meaningful and important which must be accurately comprehended. Subjectivism either denies a psychological reality to subjects, or else makes it unknowable. The psychology of other people is clouded by the subjectivity of the observer and is not recognized for what it (truly) is.

## 3.4 DEBATE IN SOCIAL RESEARCH

We have learnt about the two paradigms of research in Unit 1: quantitative and qualitative research. Both of them have different advantages and disadvantages. Their uses too are not similar.

### Use of Quantitative Research

There are four chief categories of research questions that quantitative research can answer:

- The first type of research question that demands a quantitative answer is: For instance, How many students from below poverty line have opted for studying education? Quantitative research can be used for answering this type of question.

- Only quantitative methods can be used to study numerical changes accurately: Is the number of girls in our university falling or rising? Is there any improvement in performance or is it dipping? A quantitative study is needed to answer these questions.
- Generally, for explaining phenomena: What factors relate to change in the livelihood of socially backward classes over time?
- The ultimate activity which requires quantitative research is the testing of hypotheses: For example: Whether there is a relationship between students' achievements and their self-esteem and social background can be explained with the help of quantitative research. One could come up with the hypothesis that lower social class background leads to low self-esteem, which would in turn, be related to low achievement. Using quantitative research, we can try to test this model.

## Use of Qualitative Research

Qualitative research is extensively employed where small sections of the population (or groups of people who have common traits) particularly interest the researcher. Some of the main reasons for carrying out qualitative researches are as follows:

- For assessing a market, product or consumer, in the absence of any other information.
- For identification and investigation of concepts.
- Apprise the researchers about a group of consumers, if they are not aware of them.
- For identification of behavioural patterns, values, approaches, views and purpose.
- For setting up precedence among types of behaviour, beliefs, opinions and attitudes.
- For detailed identification of problems and to build models for further research.
- To append to the points emerging from a pilot or major survey.
- For providing verbatim remarks and anecdotes from participants, so that the outcome of the research can be made available to the client.
- For testing the functioning of a questionnaire, by going through questions related to routing, signposting, understanding and ambiguity.

***Table 3.1*** *Comparison of Qualitative and Quantitative Researches*

| Criteria | Qualitative Research | Quantitative Research |
|---|---|---|
| **Purpose** | Describes individuals and events in their natural setting | Explores, describes, tests or assesses phenomena |
| **Group studied** | Smaller and not randomly selected | Larger and randomly selected |
| **Variables** | Study of the whole, not variables | Specific variables studied |
| **Types of data collected** | Words, images, or objects | Numbers and statistics |
| **Forms of data collected** | Qualitative data such as open-ended responses, interviews, participant observations, field notes, and reflections | Quantitative data based on precise measurements using structured and validated data-collection instruments |

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| | | |
|---|---|---|
| **Type of data analysis** | Identify patterns, features, themes | Identify statistical relationships |
| **Objectivity and subjectivity** | Subjectivity is expected | Objectivity is critical |
| **Role of the researcher** | Active (immersion) | Passive(immersion optional) |
| **Results** | Particular or specialized findings that are less generic | Generic findings that can be applied to other populations |
| **Scientific method** | Exploratory or bottom–up: the researcher generates a new hypothesis and theory from the data collected | Confirmatory or top-down: the researcher tests the hypothesis and theory with the data |
| **View of human behaviour** | Dynamic, situational, social and personal | Regular and predictable |
| **Most common research objectives** | Explore, discover and construct | Describe, explain and predict |
| **Focus** | Wide-angle lens: examines the breadth and depth of phenomena | Narrow-angle lens: tests a specific hypotheses |
| **Nature of observation** | Study behaviour in a natural environment | Study behaviour under controlled conditions; isolated causal effects |
| **Nature of reality** | Multiple realities; subjective | Single reality; objective |
| **Final report** | Narrative report with contextual description and direct quotations from research participants | Statistical report with correlations, comparisons of means and statistical significance of findings |

Quantitative and qualitative methods primarily differ in terms of their flexibility. In general, quantitative methods are quite rigid. When the researcher makes use of quantitative methods like surveys and questionnaires, for instance, all participants are presented with the same questions, in the same order. The types of responses given by the participants may either be closed-ended or fixed. The benefit of this rigidity is that it allows significant comparison of responses between participants and study sites. Nevertheless, it is important that the questioner knows which important questions to put across, the best way to frame them and the range of possible responses.

Qualitative methods are characteristically more elastic; i.e., they stir more spontaneous responses and adapt to the interface between the researcher and the study participant. For instance, qualitative methods comprise mostly open-ended questions that are not necessarily worded in exactly the same way for each participant. With open-ended questions, participants are free to write what they think and their responses are comprehensive.

The primary debate in social research pertains to these approaches to social research: quantitative and qualitative methods. Both the approaches not only have different uses and benefits, but also have different underlying assumptions. The question as to which ideology trumps the other is a complex one and not just a simple dichotomous choice. In fact, it will not be too far-fetched to say that a significant number of researchers now apply a consciously selected combination of the two approaches. There are varied schools which also believe that these two approaches are not polar opposites and can be substituted for each other while finding answers. It, ultimately depends on the researcher, the purpose of research and the research design as to which approach should be selected.

## 3.5 POSITIVISM IN SOCIOLOGY

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The approach of positivism was formulated by Auguste Comte. Auguste Comte was born in France in 1798 during the height of the French Revolution, a period of chaos and unrest. His parents were devout Catholics and ardent royalists. Comte was a brilliant student excelling in physics and math with an unusual memory. His early career was poorly organized and a rather self-destructive affair in which he proceeded to 'shoot himself in the foot' several times. Along with 14 others he was expelled from school after a student uprising over a geometry instructor, thus dashing hopes of an otherwise promising academic career.

He did, nonetheless, manage to become secretary to Henri St. Simon, another prominent thinker with whom Comte shared many ideas. He met, and later married, a nineteen-year-old prostitute but had an unhappy married life. He had a falling out with St. Simon and organized on his own a subscription series of lectures on the 'Positive Philosophy'. Comte attempted suicide by throwing himself into the Seine and was rescued by a passer-by. Comte interpreted this Samaritan act as a sign that his mission in life was to complete and disseminate his positive philosophy.

In 1829, Comte completed the series of lectures, and between 1830 and 1842, published his *Cours de Philosophie Positive* in six volumes. In 1832, he managed to achieve a minor appointment at the Ecole Poly-technique, but, in 1844, he wrote a scathing article on St. Simon and the Ecole and was dismissed. During the same year, two other important events also occurred. Comte obtained a small stipend from the English philosopher, John Stuart Mill, who had been impressed by his *Positive Philosophy*, and he also began an affair with Madame Clotilde de Vaux. In 1846, she died in his arms and Comte was later to credit her with teaching him about the affective tendencies of human nature, a consideration which was to inform his suggestion for a 'religion of humanity'.

In fact, Comte was to see this religion of humanityas part of the practical application of his philosophy as recommended in his works—*The System of Positive Polity or Treatise of Sociology: Instituting the Religion of Humanity*. *Positive Philosophy* was the work in which he outlined his preferred way of knowing the world, and the *Positive Polity* contained his ideas about how to improve society, and how to establish what was, in his view, the best society possible by applying this knowledge.

According to Comte, a stable social order rested on a consistent form of thought. He saw his own thought as leading to the establishment of a more stable, industrial order. He saw this relationship between thought and practice as a natural, rather than a causal one and saw thought as evolving naturally towards the kind of philosophy which he was formulating and recommending. Ways of thinking, of philosophizing, of knowing the world, were, in his view, primary, both in the history of humankind and in his own practice. In other words, Comte believed that people acted in such a way as to correspond with the way they thought. In different societies or periods of history, furthermore, a person's way of thinking, of knowing their world, was responsible for producing the kind of society in which they lived.

### Science of Sociology

According to Comte, sociology is a social, organic science. Sociology is a relatively new, evolving science dependent upon all the foregoing theories in science. However, it is quite clear that sociology is gradually moving towards the goal of a *definite* science.

NOTES

Comte had a very wide conception of sociology. According to him, all other social sciences are subsumed under it. He believed in a unified integral study of all social sciences taken together. He posited that the subject matter of sociology is society. It studies the structure of the society and the set of rules governing its functions.

Since sociology tries to explore the principles which help society to stay integrated and in order, it is essential that the law of sociology should be scientific. In order to make the societal laws scientific, they should pass through the full circle of making of scientific laws, namely *observation*, *experimentation*, *comparison* and *classification*. What needs to be emphasized here is the fact that in making these societal laws, use of full scientific technique is necessary.

Comte maintained that the positive science of society called sociology must pursue the method which was followed by definite sciences like astronomy, physics, chemistry, and biology. He insisted that the new science must be *positive*. Positive means pursuing scientific methods of analysis and prognosis. The method of sociology includes observation as well as experimentation. Observation must be guided by a theory of social phenomena. Experimentation is controlled observation. In sociology, experimentation involves the study of pathological cases. According to him, central to sociology is the comparison of different co-existing states of human society on the various parts of the earth's surface. By this method, he argued, the different stages of evolution may be allowed once. These conventional methods of science, like observation, experimentation and comparison, must be used in combination with the historical method.

## Law of Human Progress

The law of human progress is one of Comte's the most important central ideas. He proposed that the evolution of the human mind is parallel to the evolution of any individual mind. The development of the individual human organism is termed as ontogeny. This forms the basis for the development of phylogeny or the development of the human race. In our childhood, we all believed in imaginary worlds; when we become adults, we start accepting the world with its vices and virtues. Mankind has also undertaken quite a similar journey; from believing in the make-belief to the maturity of adulthood.

According to Comte:

> Each of our leading conceptions—each branch of our knowledge passes successively through three different theoretical conditions: the Theological or fictitious; Metaphysical or abstract; and the Scientific or positive. In theological state, human mind, seeking the essential nature of beings, the first and final causes (the origin of purpose) of all effects supposes all phenomena to be produced by the immediate action of supernatural beings. In Metapysical state the mind supposes abstract forces, veritable entities (that is personified abstractions) capable of producing all phenomena. In the final, the positive state, the mind has given over the vain search after Absolute notions, the origin of destination of the universe, and the causes of phenomena, and applies itself to the study of their laws, that is, their invariable relations of succession and resemblance

## Theological or Fictitious State: Law of Three Stages

According to Comteian proposition, all theoretical conceptions, whether general or special, bear a supernatural influence. This kind of thinking is found among the primitive people and sometimes the thinking of children. At this state, there is substantial lack of logical and orderly thinking. However, Comte argues that the primitive man as well as children do have scientific outlook also. Owing to theological state of their minds, their understanding is characterized by an unscientific outlook. The main subject matter of

NOTES

the theological state is natural events. The unusual and unintelligible events of nature tend man towards theological or fictitious interpretation of events. Unable to discover the natural causes of various happenings, the primitive man attributed them to imaginary or divine force. The explanation of natural events in non-natural, divine or imaginary conditions is known as theological or fictitious state. The theological state implies belief in the other world wherein reside divine forces which control the events in this world. It is clear that theological state implies a belief in divine and extraterrestrial forces. Comte has classified the theological state further in three stages:

- **Fetishism:** The first and primary stage in the theological state is that of *fetishism*. Fetishism is a belief that there is some living spirit in non-living objects. This is also known as *animism*. The concept of animism signifies that the inanimate objects are not dead but are possessed by living spirits. One can argue that in India, particularly rural and tribal areas, there is a widespread belief that some deities reside in tree, stones and mountains. Therefore, it has been seen that people engage in the worship of a particular tree, stone mountain.
- **Polytheism:** With the gradual development in human thinking, there occurred a change in the form of thinking. *Polytheism* is the next stage to fetishism. In this stage, man had classified god and every natural force had a presiding deity. Each god had some definite function and his scope and area of action was determined.
- **Monotheism:** The last and most developed form of theological state is seen manifested in *monotheism*. As the very term monotheism implies, at this level of human thinking a belief in one god had replaced the earlier belief in many gods. The monotheistic thinking symbolizes the victory of human intellect and reason over non-intellectual and irrational thinking. In monotheism, it is believed that one God is supreme and that he is responsible for the maintenance of order and system in the world.

### Metaphysical or abstract state

The metaphysical or abstract thinking marks the second stage in the evolution of human mind. According to Comte, each successive stage is an improvement upon the earlier stage. With the gradual improvement in human mind, human problems also become more intricate. The theological state was not adequate to tackle these improvements efficiently. The appearance of conflicting and opposite forces in the world presented problems which could not be successfully tackled by monotheism. It was difficult to believe that the same god was responsible for prehistoric creation as well as destruction. A single god could not account for simultaneous creation and destruction. In order to resolve this intellectual query, metaphysical thinking was developed. Under metaphysical thinking, people believe that an abstract power or force guides and determines the events in the world. Metaphysical mind disregards belief in the presence of several gods.

### Scientific or positive state

This state is the most advance and developed form of the human mind. All metaphysical knowledge is based upon speculation and is at best inferential knowledge. There are no direct means to confirm the findings of metaphysical knowledge; it is purely a matter of belief or temperament. The modern temperament of man is such that it cannot remain satisfied with mere guesswork; it craves for positive knowledge which can be scientifically confirmed. The positive and scientific knowledge is based upon facts, and these facts are gathered by observation and experience. The observation and classification of facts

NOTES

are the beginning of scientific knowledge. From these facts we generalize and draw conclusions. These conclusions, in turn, are subjected to verification. Once verified, these become established laws, which can be relied upon in gathering and classifying the facts. Scientific thinking is thoroughly rational and in it there is no place for any belief or superstition. According to Comte, the human mind before reaching the state of positivism, must have passed through the two earlier stages of theological and metaphysical states.

The three stages suggested by Comte have a strong idealistic basis. Yet he correlated every stage of evolution of the human mind with social organizations present in that period. The theological stage that corresponds roughly with the ancient age is dominated by the rule of the army and priests. In the metaphysical state, society was dominated by clergy and lawyers. This state roughly falls during the Middle Ages and the Renaissance. The modern era marks the beginning of the positive state and is generally ruled by industrialists and scientific moral guides. In the first state, the family takes centrestage, while in the second, the State rises to prominence. In the third state, however, the entire civilization has become an operative social unit.

## 3.6 SUMMARY

- Science refers to organized knowledge, but this knowledge and these facts are seldom conclusive. New experiences and additional information constantly alter the previous findings and replace them with generalizations that confirm the latest findings.
- The method which integrates the most important aspects of the deductive and inductive methods of research is recognized as *scientific method*. It is generally attributed to Charles Darwin.
- Although, in practice, scientific method involves a double movement of reasoning from induction to deduction, in its simplest form, it consists of working inductively from observations to hypotheses and then deductively from the hypotheses to the logical implications of the hypotheses in relation to what is already known.
- Scientific method differs from other methods of acquiring knowledge on the basis of generalizations from authority, tradition, experience, and syllogism. It also differs from the methods of chance, of trial-and-error, and of intuition. When using the scientific method, one engages himself in a thinking process called *reflective thinking*.
- Scientific theories serve as means and ends in the development of science. As means, they provide a framework which guides scientist in making observation and discovery. Theories summarize knowledge and put in order the knowledge within a given field. They also clarify and provide meaning to this summarized knowledge comprising of isolated empirical findings.
- The steps involved in a scientific process are as follows: purposeful observation, analysis-synthesis, selective recall, hypothesis, and verification by inference and experiment.
- Characteristics of a good research: interdisciplinary team approach, methodological process, objectivistic approach, economical approach and economic in nature.
- It is important for a study to be objective in nature, no matter which discipline it represents. Whether it is natural or social science's research, a study which is

subjective in nature does not produce results which can be dependent upon. That is because being objective in social science means being able to check and examine the evidences which the study has produced.

- Value neutrality is the duty of sociologists to strive to be impartial and overcome their biases as they conduct their research.
- Qualitative methodology is familiar with the fact that the subjectivity of the researcher is a deep ingredient of his scientific research. Everything is guided by subjectivity, beginning from the choice of topic that one studies, to devising hypotheses, to selection of methodology and interpretation of data.
- Many qualitative researchers make subjectivity and objectivity counterbalance each other. It is believed that objectivity negates subjectivity. The reason for this is because it makes the observer an inert recipient of external information, with an agency.
- Objectivism puts subjectivity and objectivity together since it reasons that objective knowledge needs active, sophisticated and subjective processes like: perception, analytical reasoning, synthetic reasoning, logical deduction and the ability to differentiate essences from appearances. On the other hand, subjective processes can augment objective conception of the world.
- Quantitative and qualitative methods primarily differ in terms of their flexibility. In general, quantitative methods are quite rigid. Qualitative methods are characteristically more elastic; i.e., they stir more spontaneous responses and adapt to the interface between the researcher and the study participant.
- The primary debate in social research pertains to these approaches to social research: quantitative and qualitative methods. Both the approaches not only have different uses and benefits, but also have different underlying assumptions. The question as to which ideology trumps the other is a complex one and not just a simple dichotomous choice. It, ultimately depends on the researcher, the purpose of research and the research design as to which approach should be selected.
- According to Comte, sociology is a social, organic science. Sociology is a relatively new, evolving science dependent upon all the foregoing theories in science. However, it is quite clear that sociology is gradually moving towards the goal of a *definite* science.
- The positive and scientific knowledge is based upon facts, and these facts are gathered by observation and experience. The observation and classification of facts are the beginning of scientific knowledge. From these facts we generalize and draw conclusions. These conclusions, in turn, are subjected to verification. Once verified, these become established laws, which can be relied upon in gathering and classifying the facts.

## 3.7 KEY TERMS

- **Scientific method:** It refers to the process of working inductively from observations to hypotheses and then deductively from the hypotheses to the logical implications of the hypotheses in relation to what is already known.
- **Deductive reasoning:** It is one where the researcher moves from the general to the specific part of the research.

NOTES

- **Objective study:** It refers to a study which is free from personal biases and beliefs of the researcher.
- **Value neutrality:** It is the duty of sociologists to strive to be impartial and overcome their biases as they conduct their research.
- **Positivism:** It is a sociological philosophy as per which positive means pursuing scientific methods of analysis and prognosis. The method of sociology includes observation as well as experimentation. Observation must be guided by a theory of social phenomena. Experimentation is controlled observation.

## 3.8 ANSWERS TO 'CHECK YOUR PROGRESS'

1. The knowledge obtained from science is seldom conclusive because the new experiences and additional information constantly alter the previous findings and replace them with generalizations that confirm the latest findings**.**
2. Scientific method differs from other methods of acquiring knowledge on the basis of generalizations from authority, tradition, experience, and syllogism. It also differs from the methods of chance, of trial-and-error, and of intuition. When using the scientific method, one engages himself in a thinking process called *reflective thinking*.
3. The analysis-synthesis step in the scientific process includes the following points: the essential elements in a problematic situation must be selected by analysis, similarities as well as dissimilarities must be isolated and exceptions are to be given special attention.
4. Being objective in social science means being able to check and examine the evidences which the study has produced. An objective study is free from personal biases and beliefs of the researcher. Objective studies are not speculative in nature but are dominated by actual observations.
5. Biases can enter during the supply of information because many times information is collected by those who may carry their own prejudices. They may present information which is suited to their needs, thus keeping the wholesome information out of reach of the researcher.
6. Objectivism is the highest form of the subjects being studied as part of research methodology.
7. Qualitative methods are characteristically more elastic; i.e., they stir more spontaneous responses and adapt to the interface between the researcher and the study participant.
8. The main subject matter of the theological state is natural events. The unusual and unintelligible events of nature tend man towards theological or fictitious interpretation of events. Unable to discover the natural causes of various happenings, the primitive man attributed them to imaginary or divine force.
9. The metaphysical or abstract thinking marks the second stage in the evolution of human mind. According to Comte, each successive stage is an improvement upon the earlier stage. With the gradual improvement in human mind, human problems also become more intricate.

10. The first and primary stage in the theological state is that of fetishism. Fetishism is a belief that there is some living spirit in non-living objects. This is also known as animism.

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## 3.9 QUESTIONS AND EXERCISES

### Short-Answer Questions

1. What is scientific method? List and describe its various steps.
2. List the qualities of good research.
3. State the various ways by which subjectivity can be removed from research.
4. What is value neutrality?
5. How is sociology moving towards definite science?

### Long-Answer Questions

1. What is science? Discuss the role of scientific theories in the development of science.
2. Critically analyse the debate on objectivity and subjectivity in the field of research.
3. Compare the quantitative and qualitative approach in research.
4. Explain Comte's theory of positivism in sociology.
5. Assess the law of three stages.

## 3.10 FURTHER READING

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# UNIT 4 ANALYSIS AND USE OF STATISTICS

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**Structure**



## 4.0 INTRODUCTION

The unit will begin with a discussion on data processing. The processing of data involves analysis and manipulation of the collected data by performing various functions. The data has to be processed in accordance with the outline laid down at the time of developing the research plan. Processing of data is essential for ensuring that all relevant data has been collected for performing comparisons and analyses. Editing of data involves the testing of data collection instruments in order to ensure maximum accuracy. Coding of data can be defined as representing the data symbolically using some predefined rules. You will also learn about the classification of data. Classification of data involves arrangement of data in groups or classes on the basis of some common characteristics. The methods of classification can be divided under the two headings: classification according to attributes and classification according to class intervals. Further, you will learn about the tabulation of data. In simple terms, tabulation means placing the data collected and results from research in a tabular form. Tabulation can be done by hand or mechanically using various electronic devices. Several factors like the size and type of study, cost considerations, time pressures and availability of tabulating machines decide the choice of tabulation. You will also learn about the analysis of data. Analysis of data is the process of transforming data for the purpose of extracting useful information,

NOTES

which in turn facilitates the discovery of some useful conclusions. Finding conclusions from the analysed data is known as interpretation of data. However, if the analysis is done, in the case of experimental data or survey, then the value of the unknown parameters of the population and hypothesis testing is estimated. Moreover, you will learn about the statistical; tools for data analysis. There are certain basic statistical methods which can be classified into three groups: descriptive statistics, inferential statistics and measures of central tendency and dispersion. The unit will also discuss the measures of central tendency and dispersion.

## 4.1 UNIT OBJECTIVES

After going through this unit, you will be able to:

- Describe the concept of data processing
- Explain the analysis of data and coding
- Discuss the tools tables, graphs and diagrams
- Assess the use of statistics including mean, median, mode and standard deviation

## 4.2 DATA PROCESSING

Research does not merely consist of data that is collected. Research is incomplete without proper analysis of the collected data. **Processing** of data involves analysis and manipulation of the collected data by performing various functions. The data has to be processed in accordance with the outline laid down at the time of developing the research plan. Processing of data is essential for ensuring that all relevant data has been collected for performing comparisons and analyses. The functions that can be performed on data are as follows:

- Editing
- Coding
- Tabulation
- Classification

Usually, experts are of the opinion that processing and analysis of data are inter-related. Therefore, they should be thought as one and the same thing. It is argued that analysis of data generally involves a number of closely-related operations, which are carried out with the objective of summarizing the collected data and organizing it in such a way that they are able to answer the research questions associated with it.

However, in technical terms, the processing of data involves data representation in such a way that it is open to analysis. Similarly, analysis of data is defined as the computation of certain measures along with searching for the patterns of relationship that may exist among data groups.

### 4.2.1 Editing of Data

Editing of data involves the testing of data collection instruments in order to ensure maximum accuracy. This includes checking the legibility, consistency and completeness of the data. The editing process aims at avoiding equivocation and ambiguity. The collected raw data is also examined to detect errors and omissions, if any. A careful

scrutiny is performed on the completed questionnaires and schedules to assure that the data has the following features:

- Accuracy
- Consistency
- Unity
- Uniformity
- Effective arrangement

NOTES

The stages at which editing should be performed are as follows:

- **Field editing:** This involves reviewing the reporting forms by the investigator, that are written in abbreviated or illegible form by the informant at the time of recording the respondent's responses. Such type of editing must be done immediately after the interview. If performed after some time, such editing becomes complicated for the researcher, as it is difficult to decipher any particular individual's writing style. The investigator needs to be careful while doing such kind of editing and restrain the researcher from correcting errors or omission by guesswork.
- **Central editing:** This kind of editing involves a thorough editing of the entire data by a single editor or a team of editors. Such editing takes place when all the schedules created according to the research plan have been completed and returned to the researcher. Editors correct errors, such as data recorded in the wrong place or data recorded in months when it should be recorded in weeks. They can provide an appropriate answer to incorrect or missing replies by reviewing the other information in the schedule. At times, the respondent can be contacted for clarification. In some cases, if the answer is inappropriate or incomplete and an accurate answer cannot be determined on any basis, then the editor should delete or remove that answer from the collected data. He/she can put a note as 'no answer' in such a case. The answers that can be easily deciphered as wrong should be dropped from the final results.

Besides using the above-mentioned methods according to the data source, the researcher should also keep in mind certain points while doing the editing which are as follows:

- Familiarity with the instructions given to interviewers and coders
- Know-how of editing instructions
- Single-line striking for deleting an original entry
- Standardized and distinctive editing of data
- Initializing all the answers that have been changed

### 4.2.2 Coding of Data

**Coding of data** can be defined as representing the data symbolically using some predefined rules. Once data is coded and summarized, the researcher can analyse it and relationships can be found among various categories.

#### Checklist for Coding

The checklist enables the researcher to put the responses of the individuals into a limited number of categories or classes, which should possess the following important characteristics:

NOTES

- Classes should be appropriate and in accordance with the research problem under consideration.
- There must be a class for every data element.
- There should be mutual exclusivity, which means that a specific answer can be placed in one and only one cell of a given category set.
- The classes should be one-dimensional. This means that every class is defined in terms of only one concept.

### Significance of Coding

Coding of data is necessary for efficient analysis. It facilitates classification of data into a small number of classes. Thus, only important and critical information that is required for analysis is retained in the research. Coding decisions are usually taken at the designing stage of the questionnaire. This makes it possible to pre-code the questionnaire choices which, in turn, is helpful for computer tabulation.

However, in case of hand coding, some standard method may be used. One such method is to code in the margin with a coloured pencil. Another method is to transcribe data from the questionnaire to a coding sheet. Whatever method is adopted, you should note that coding errors are altogether eliminated or reduced to the minimum level.

## Classification of Data

Research studies involve extensive collection of raw data and usage of the data to implement a research plan. To make the research plan easier, the data needs to be classified in different groups for understanding the relationship among different phases of research plan. Classification of data involves arrangement of data in groups or classes on the basis of some common characteristics. The methods of classification can be divided under the following two headings:

- Classification according to attributes.
- Classification according to class intervals.

Figure 6.1 shows the classification of data.

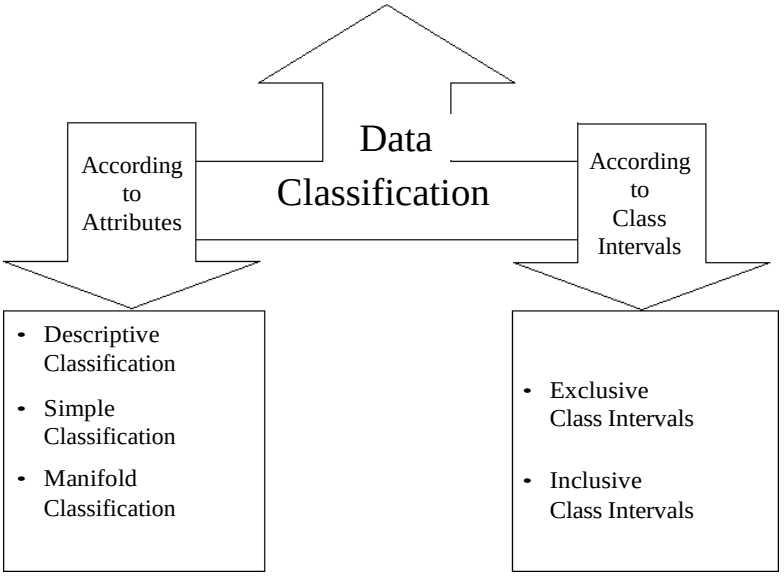


***Fig. 6.1*** *Data Classification*

### 4.2.3 Classification of Data According to Attributes

Data is classified on the basis of similar features, as follows:

- ***Descriptive Classification:*** This classification is performed according to the qualitative features and attributes, which cannot be measured quantitatively. These features can be either present or absent in an individual or an element. The features related to descriptive classification of attributes, can be literacy, sex, honesty, solidity, etc.
- ***Simple Classification:*** In this type of classification, the elements of data are categorized as those possessing the concerned attribute and those that do not.
- ***Manifold Classification:*** In this type of classification, two or more attributes are considered simultaneously and the data is categorized into a number of classes on the basis of those attributes. The total number of classes of final order is given by $2^n$, where $n$ = number of attributes considered.

NOTES

### Classification of Data According to Class Intervals

Classifying data according to class intervals is a quantitative phenomenon. Class intervals help categorize data which has similar numerical characteristics, such as income, production, age, weight, etc. Data can be measured with certain statistical tools like mean, mode and median. The different categories of data according to class intervals are as follows:

- ***Statistics of Variables:*** This term refers to measurable attributes, as these typically vary over time or between individuals. The variables can be discrete, i.e., taking values from a countable or finite set, continuous, i.e., having a continuous distribution function or neither. This concept of a variable is widely utilized in the social, natural, medical sciences.
- ***Class Intervals:*** These refer to a range of values of a variable. This interval is used to calibrate the scale of a variable in order to tabulate the frequency distribution of a sample. A suitable example of such data classification can be the categorizing of birth rate in a country. In this case, babies aged 0–1 year will form a group; those aged 2–5 years will form another group, and so on. The entire data is thus categorized into several numbers of groups or classes or in other words, class intervals. Each class interval has an upper limit as well as a lower limit, which is defined as 'the class limit.' The difference between two class limits is known as class magnitude. The classes can have equal or unequal class magnitudes.

The number of elements in a given class is called the frequency of the given class interval. All class intervals, with their respective frequencies, are taken together and described in a tabular form called the frequency distribution.

### Problems Related to Classification of Data

The problems related to classification of data on the basis of class intervals are divided into the following three categories:

**(a)** ***Number of classes and their magnitude:*** There are differences regarding the number of classes into which data can be classified. As such, there are no predefined rules for classification of data. It all depends upon the skill and experience of the researcher. The researcher should display the data in such a way that it should be clear and meaningful to the analyst.

NOTES

As regards the magnitude of classes, it is usually held that class intervals should be of equal magnitude, but in some cases unequal magnitudes may result in better classification. It is the researcher's objective and judgement that plays a significant role in this regard. In general, multiples of two, five and ten are preferred while determining class magnitudes. H.A. Sturges suggested the following formula for determining the size of class interval:

$$i = R/(1+ 3.3 \log N)$$

Where,

$i$ = Size of class interval.

$R$ = Range (difference between the values of the largest element and smallest element among the given elements).

$N$ = Number of items to be grouped.

Sometimes, data may contain one or two or very few elements with very high or very low values. In such cases, the researcher can use an open-ended interval in the overall frequency distribution. Such intervals can be expressed below two years; or twelve years and above. However, such intervals are not desirable, yet cannot be avoided.

**(b)** ***Choice of class limits:*** While choosing class limits, the researcher must determine the mid-point of a class interval. A mid-point is generally derived by taking the sum of the upper and lower limit, of a class and then dividing it by two. The actual average of elements of that class interval should remain as close to each other as possible. In accordance with this principle, the class limits should be located at multiples of two, five, ten, twenty and hundred and such other figures. The class limits can generally be stated in any of the following forms:

- **Exclusive Type Class Intervals:** These intervals are usually stated as follows:
  - 10–20
  - 20–30
  - 30–40
  - 40–50

  These intervals should be read in the following way:
  - 10 and under 20
  - 20 and under 30
  - 30 and under 40
  - 40 and under 50

  In the exclusive type of class interval, the elements whose values are equal to the upper limit of a class are grouped in the next higher class. For example, an item whose value is exactly thirty would be put in 30–40 class interval and not in 20–30 class interval. In other words, an exclusive type of class interval is that in which the upper limit of a class interval is excluded and items with values less than the upper limit, but not less than the lower limit, are put in the given class interval.

NOTES

- **Inclusive Type Class Intervals:** These intervals are normally stated as follows:
  - 11–20
  - 21–30
  - 31–40
  - 41–50

  This should be read as follows:
  - 11 and under 21
  - 21 and under 31
  - 31 and under 41
  - 41 and under 51

  In this method, the upper limit of a class interval is also included in the concerning class interval. Thus, an element whose value is twenty will be put in 11–20 class interval. The stated upper limit of the class interval 11–20 is twenty but the real upper limit is 20.999999 and as such 11–20 class interval really means eleven and under twenty-one. When data to be classified happens to be a discrete one, then the inclusive type of classification should be applied. But when data happens to be a continuous one, the exclusive type of class intervals can be used.

**(c)** ***Determining the frequency of each class:*** The frequency of each class can be determined using tally sheets or mechanical aids. In tally sheets, the class groups are written on a sheet of paper and for each item a stroke (a small vertical line) is marked against the class group in which it falls. The general practice is that after every four small vertical lines in a class group, the fifth line for the element falling in the same group is indicated as a diagonal line through the above said four lines. This enables the researcher to perform the counting of elements in each one of the class groups. Table 6.1 shows a hypothetical tally sheet.

***Table 6.1*** *Sample of a Tally Sheet*

| Income groups (Rupees) | Tally mark | Number of families (Class frequency) |
|---|---|---|
| Below 600 | 𝍸 𝍸 𝍸 III | 15 |
| 601-900 | 𝍸 𝍸 I | 9 |
| 901-1300 | 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 I | 25 |
| 1301-1500 | 𝍸 𝍸 𝍸 IIII | 16 |
| 1501 and above | 𝍸 𝍸 II | 10 |
| Total | | 75 |

In case of large inquiries and surveys, class frequencies can be determined by means of mechanical aids, i.e., with the help of machines. Such machines function either manually or automatically and run on electricity and can sort cards at a speed of around 25,000 cards per hour. Although this method increases the speed, it is an expensive method.

## 4.2.4 Tabulation of Data

In simple terms, tabulation means placing the data collected and results from research in a tabular form.

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### Methods of Tabulation

Tabulation can be done by hand or mechanically using various electronic devices. Several factors like the size and type of study, cost considerations, time pressures and availability of tabulating machines decide the choice of tabulation. Relatively, large data requires computer tabulation. Hand tabulation is preferred in case of small inquiries, when the number of questionnaires is small and they are of relatively short length. The different methods used in hand tabulation are as follows:

- ***Direct tally method:*** This method involves simple codes, where the researcher can directly tally from the questionnaire. The codes are written on a sheet of paper called tally sheet and for each response, a stroke is marked against the code in which it falls. Usually, after every four strokes against a particular code, the fifth response is indicated by drawing a diagonal or horizontal line through the strokes. These groups are easy to count and the data is sorted against each code conveniently.
- ***List and tally method:*** In this method, code responses may be transcribed into a large worksheet, allowing a line for each questionnaire. This facilitates listing of a large number of questionnaires in one worksheet. The tallies are then made for each question.
- ***Card sort method:*** This is the most flexible hand tabulation method, where the data is recorded on special cards of convenient sizes and shapes with a series of holes. Each hole in the card stands for a code. When the cards are stacked, a needle passes through a particular hole, thus representing a particular code. These cards are then segregated and counted. In this way, frequencies of various codes can be found out by a repetition of this technique.

### Significance of Tabulation

Tabulation enables the researcher to arrange data in a concise and logical order. It summarizes the raw data and displays the same in a compact form for further analysis. It helps in the orderly arrangement of data in rows and columns. The various advantages of tabulation of data are as follows:

- A table saves space and reduces descriptive and explanatory statements to a minimum.
- It facilitates and eases the comparison process.
- The summation of elements and detection of omissions and errors become easy due to a tabular description.
- A table provides a basis for statistical computations.

### Checklist for Tables

A table should communicate the required information to the reader in such a way that it becomes easy for him/her to read, comprehend and recall the information when required. There are certain conventions to be followed during tabulation, which are as follows:

- All tables should have a clear, precise and adequate title to make them intelligible enough without any reference to the text.

- Tables should be featured with clarity and readability.
- Every table should be given a distinct number to facilitate easy reference.
- The table should be of an appropriate size and tally with the required information.
- The columns and rows should be headed with bold font letters. It is a general rule to include independent variables in the left column or first row and dependent variables in the bottom row or right column.
- Displaying of numbers should be neat and readable.
- Explanatory footnotes, if any, regarding the table should be placed directly beneath the table, along with the reference symbols used in the table.
- The source of the table should be indicated just below the table.
- The table should contain thick lines to separate data of one class from data of another class and thin lines to separate the different subdivisions of each class.
- All column figures should be properly aligned.
- Abbreviations should be avoided in a table to the best possible extent.
- If the volume of data happens to be large, then it should not be crowded in a single table. It makes the table unwieldy and inconvenient.

Tabulation can also be classified into complex or simple. The former type of tabulation gives information about one or more groups of independent variables, whereas the latter shows the division of data into two or more categories.

## 4.3 ANALYSIS OF DATA

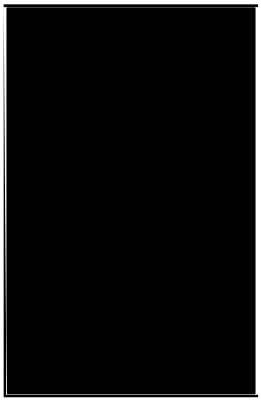
Analysis of data is the process of transforming data for the purpose of extracting useful information, which in turn facilitates the discovery of some useful conclusions. Finding conclusions from the analysed data is known as interpretation of data. However, if the analysis is done, in the case of experimental data or survey, then the value of the unknown parameters of the population and hypothesis testing is estimated.

Analysis of data can be either descriptive or inferential. Inferential analysis is also known as statistical analysis. Descriptive analysis is used to describe the basic features of the data in a study, such as persons, work groups and organizations. Inferential analysis is used to make inferences from the data, which means that we are trying to understand some process and make some possible predictions based on this understanding.

### 4.3.1 Types of Analysis

The various types of analyses are as follows:

- **Multiple Regression Analysis:** This type of analysis is used to predict a single dependent variable bya set of independent variables. In multiple regression analysis, the independent variables are not correlated to each other.
- **Multiple Discriminant Analysis:** In multiple discriminant analysis, there is one single dependent variable, which is very difficult to measure. One of the main objectives of this type of analysis is to understand group differences and predict the likelihood that an entity, i.e., an individual or an object, belongs to a particular class or group based on several metric-independent variables.



- **Canonical Correlation Analysis:** It is a method for assessing the relationship between variables. This analysis also allows you to investigate the relationship between two sets of variables.

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## Univariate, Bivariate and Multivariate Analysis

Many types of analyses are performed according to the variance that exists in the data. Such analyses is carried out to check if the differences between three or more variables are significant enough to evaluate them statistically. There are three types of such analyses, namely univariate, bivariate and multivariate analyses.

**(i) Univariate Analysis:** In this analysis, only a single variable is taken into consideration. It is usually the first activity pursued while analysing the data. It is performed with the purpose of describing each variable in terms of mean, median or mode, and variability. Examples of such analysis are averages or a set of cases that may come under a specific category amidst a whole sample.

**(ii) Bivariate Analysis:** This type of analysis examines the relationship between two variables. It tries to find the extent of association that exists among these variables. Thus, a bivariate analysis may help you; for example, to find whether the variables of irregular meals and migraine headaches are associated and up to what extent. Here, the two variables are thus statistically measured simultaneously.

**(iii) Multivariate Analysis:** This type of analysis involves observation and analysis of three or more than three statistical variables at a time. Such an analysis is performed using statistical tests or even in a tabular format. Thus, for example, you can study the variables of age, educational qualification and annual income of a given set of population at the same time using the multivariate analysis method.

***Table 6.2(a)*** *Bivariate Table*

| | 1991 | 1992 | 1993 |
|---|---|---|---|
| Percentage of students failed | 33 per cent | 38 per cent | 42 per cent |
| Percentage of students passed | 67 per cent | 62 per cent | 58 per cent |

Although the data in both tables is related, except the variable of 'attempts', the multivariate table has been displayed separately in this example. However, you should note that the tables have dealt simultaneously with two or more variables of the data.

***Table 6.2(b)*** *Multivariate Table*

| | 1991 | 1992 | 1993 |
|---|---|---|---|
| | First Attempt | Second Attempt | Third Attempt |
| Percentage of students who passed in Maths | 27 per cent | 35 per cent | – |
| Percentage of students who passed in English | 53 per cent | 60 per cent | 44 per cent |

### 4.3.2 Data Interpretation

Data interpretation refers to the identification of trends in different variables. The researcher uses statistics for this purpose. The researcher is required to be familiar with the knowledge of the scales of measurement. This enables him/her to choose the appropriate statistical method for his/her research project. The scales of measurement facilitate the allotment of numerical values to characteristics adhering to any specific rules. This measurement is also related to such levels of measurement of data like nominal, ordinal and internal and ratio levels. These levels can be explained as follows:

- **Nominal Measurement:** The nominal measurement assigns a numeral value to a specific characteristic. It is the fundamental form of measurement. The nominal measurement calculates the lowest level of data available for measurement.
- **Ordinal Measurement:** This type of measurement involves allotting a specific feature to numeral value in terms of a specific order. The ordinal scale displays the way in which an entity is measured. The ordinal scale of measurement is used to calculate and derive data pertaining to the median, percentage, rank order, correlations and percentile.
- **Interval Measurement:** A researcher can depict the difference between the first aspect of a data and another aspect using this level of measurement. The interval scale of measurement is useful for the researcher in several ways. It can be applied in the calculation of arithmetic mean, averages, standard deviations and determining the correlation between different variables.
- **Ratio Measurement:** In this method, there are fixed proportions (ratio) between the numerical data and the amount of the characteristics that it represents. A researcher should remember while measuring the ratio levels that a fixed zero point exists. The ratio level of measurement facilitates researchers in determining the appropriate data, if the aspects possess any certain characteristic. Almost any type of arithmetical calculations can be executed using this scale of measurement.

The most important feature of any measuring scale is its reliability and validity, which is explained as follows:

- **Reliability:** It is the term used to deal with accuracy. A scale measurement can be said to be reliable, when it exactly measures, only that what it is supposed to measure. In other words, when the same researcher repeats a test, i.e., with a different group but resembling the original group, he/she should get the same results as the former.
- **Validity:** According to Leedy, validity is the assessment of the soundness and the effectiveness of the measuring instrument. There are three types of validity, which can be stated as follows:
  - ***Content Validity:*** It deals with the accuracy with which an instrument measures the factors or content of the course or situations of the research study.
  - ***Prognostic Validity:*** It depends on the possibility to make judgements from results obtained by the concerned measuring instrument. The judgement is future oriented.
  - ***Simultaneous Validity:*** This involves comparing of one measuring instrument with another; one that measures the same characteristic and is available immediately.

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**Check Your Progress**

5. Define bivariate analysis.
6. When is the ordinal scale of measurement used?

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## 4.4 REPRESENTATION OF DATA

There can be a large amount of raw data collected from different sources. Such amount of data becomes quite cumbersome and confusing for the researcher to handle and analyse. It is almost impossible for the researcher to deal with all this data in raw form. Therefore, such data must be presented in a suitable and summarized form without any loss of relevant information so that it can be efficiently used for decision-making. Hence, we construct appropriate tables, graphs and diagrams to interpret, and summarize the entire set of raw data.

In view of the ever-increasing importance of statistical data in business operations and their management, the presentation of data in the form of graphs, tables and diagrams, their importance and use have been discussed in this section.

### 4.4.1 Tables

Classification of data is usually followed by tabulation, which is considered as the mechanical part of classification.

Tabulation is the systematic arrangement of data in columns and rows. The analysis of the data is done so by arranging the columns and rows to facilitate analysis and comparisons.

Tabulation has the following objectives:

(i) Simplicity is one of the main objectives of tabulation. The removal of unnecessary details gives a clear and concise picture of the data.

(ii) Economy of space and time.

(iii) Ease in comprehension and remembering.

(iv) Facility of comparisons is another main objectives of tabulation. Comparisons within a table and with other tables may be made.

(v) Ease in handling of totals, analysis, interpretation, etc.

#### Construction of Tables

A table is constructed depending on the type of information to be presented and the requirements of statistical analysis. The following are the essential features of a table:

(i) **Title:** It should have a clear and relevant title, which describes the contents of the table. The title should be brief and self explanatory.

(ii) **Stubs and captions:** It should have clear headings and sub headings. Column headings are called captions and row headings are called stubs. The stubs are usually wider than the captions.

(iii) **Unit:** It should indicate all the units used.

(iv) **Body:** The body of the table should contain all information arranged according to description.

(v) **Headnote:** The headnote or prefatory note, placed just below the title, in a less prominent type, gives some additional explanation about the table. Sometimes, the headnote consists of the unit of measurement.

(vi) **Footnotes:** A footnote at the bottom of the table may clarify some omissions of special features.

(vii) **Source:** A source note gives information about the source used, if any.

(viii) **Arrangement of data:** Data may be arranged according to requirements in chronological, alphabetical, geographical, or any other order.

(ix) **Emphasis:** The items to be emphasized may be put in different print or marked suitably.

(x) **Other details:** Percentages, ratios, etc. should be shown in separate columns. Thick and thin lines should be drawn at proper places.

A table should be easy to read and should contain only the relevant details. If the aim of clarification is not achieved, the table should be redesigned.

## Types of Tables

Depending on the nature of the data and other requirements, tables may be divided into various types. They are given below:

(i) **General Tables or Reference Tables:** These contain detailed information for general use and reference, e.g., tables published by government agencies.

(ii) **Specific Purpose or Derivative Tables:** They are usually summarized from general tables and are useful for comparison and analytical purposes. Averages, percentages, etc., are incorporated along with information in these tables.

(iii) **Simple and Complex Tables:** A table showing only one characteristic is a simple table. The tables that show two or more characteristics or groups of items are termed as complex tables (see Tables 6.3 and 6.4).

***Table 6.3*** *Simple Table*

**Cinema Attendance among Adult Male Factory Workers in Bombay March 1972**

| *Frequency* | *Number of Workers* |
|---|---|
| Less than once a month | 3780 |
| 1 to 4 times a month | 1652 |
| More than 4 times a month | 926 |

Table 6.4 is the result of a survey on the cinema-going habits of adult factory workers.

***Table 6.4*** *Complex Table*

**Cinema Attendance among Adult Male Factory Workers in Bombay March 1972**

It is obvious that the tabular form of classification of data is a great improvement over the narrative form.

Frequently, table construction involves deciding which attribute should be taken as primary and which as secondary. For the previous table, we can also consider that whether it would be improved further if 'under 30' and '30 and over' had been the main

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column headings and 'single' and 'married' the sub headings. The modifications depend on the purpose of the table. If the activities of age groups are to be compared, it is best left as it stands. But if a comparison between men of different marital status is required, the change would be an improvement.

### Advantages of Tabulating of Data

The following are the advantages of tabulating data:

(i) Tabulated data can be more easily understood and grasped than untabulated data.

(ii) A table facilitates comparisons between subdivisions and with other tables.

(iii) It enables the required figures to be located easily.

(iv) It reveals patterns within the figures, which otherwise might not have been obvious, e.g., from the previous table, we can conclude that regular and frequent cinema attendance is mainly confined to younger age group.

(v) It makes the summation of items and the detection of errors and omissions, easier.

(vi) It obviates repetition of explanatory phrases and headings and hence takes less space.

## 4.4.2 Graphs

In a graph, the independent variable should always be placed on the horizontal or *x*-axis and the dependent variable on the vertical or *y*-axis.

### Line Graphs

Here, the points are plotted on paper (or graph paper) and joined by straight lines. Generally, continuous variables are plotted by the line graph.

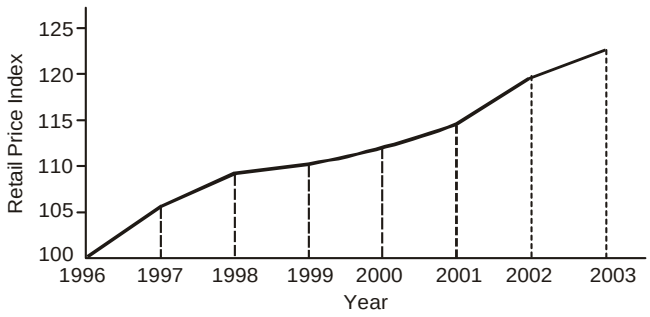
**Example 6.1:** The monthly averages of Retail Price Index from 1996 to 2003 (Jan. 1996 = 100) were as follows:

[redacted]

Draw a diagram to display these figures.

**Solution:** Here, years are plotted along the horizontal line and the retail price index along the vertical line.

Erect perpendiculars to horizontal line from the points marked as retail price index for the years 1997, 1998, ..., 2003 and cut off these ordinates according to the given data and thus various points will be plotted on the paper. Join these points by straight lines.



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## Frequency Polygon

A frequency polygon is a line chart of frequency distribution in which, either the values of discrete variables or midpoints of class intervals are plotted against the frequencies and these plotted points are joined together bystraight lines. Since the frequencies generally do not start at zero or end at zero, this diagram as such would not touch the horizontal axis. However, since the area under the entire curve is the same as that of a histogram which is 100 per cent of the data presented, the curve can be enclosed so that the starting point is joined with a fictitious preceding point whose value is zero. This ensures that the start of the curve is at horizontal axis and the last point is joined with a fictitious succeeding point whose value is also zero, so that the curve ends at the horizontal axis. This enclosed diagram is known as the frequency polygon.

We can construct the frequency polygon from the table presented for the ages of 30 workers as shown in Figure 6.2.

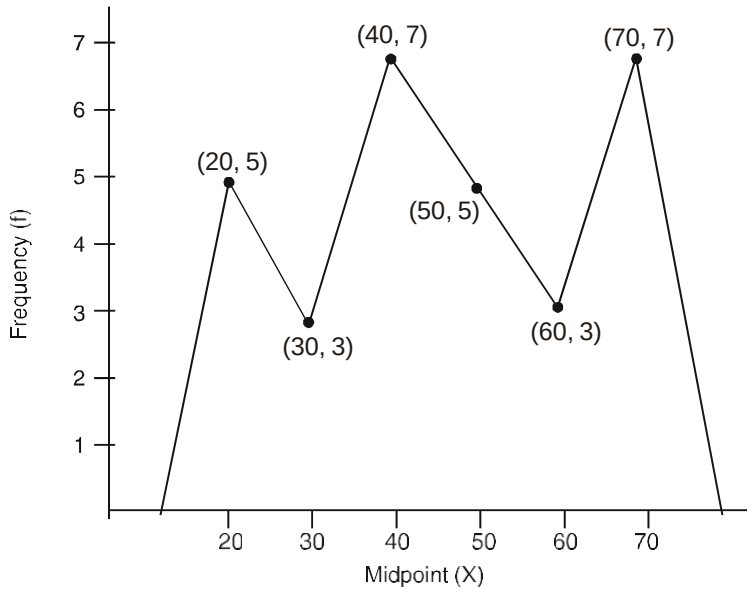


***Fig. 6.2*** *Frequency Polygon*

## Relative Frequencies

In a frequency distribution, if the frequency in each class interval is converted into a proportion, dividing it by the total frequency, we get a series of proportions called *relative frequencies*. A distribution presented with relative frequencies rather than actual frequencies is called a *relative frequency* distribution. The sum of all relative frequencies in a distribution is 1.

## Ogive Curves

Cumulative frequency curve or ogive is the graphic representation of a cumulative frequency distribution. Ogives are of two types. One of these is less than and the other one is greater than ogive. Both these ogives are constructed based upon the following table of our example of 30 workers.

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(i) **Less than Ogive:** In this case, the less than cumulative frequencies are plotted against the upper boundaries of their respective class intervals. Less than Ogive is shown in Figure 6.3.


***Fig. 6.3*** *Less than Ogive*

(ii) **Greater or More than Ogive.** In this case, the greater than cumulative frequencies are plotted against the lower boundaries of their respective class intervals. Greater than ogive is shown in Figure 6.4.

These ogives can be used for comparison purposes. Several ogives can be drawn on the same grid, preferably with different colours for easier visualization and differentiation.

Although, diagrams and graphs are powerful and effective media for presenting statistical data, they can only represent a limited amount of information and they are not of much help when intensive analysis of data is required.

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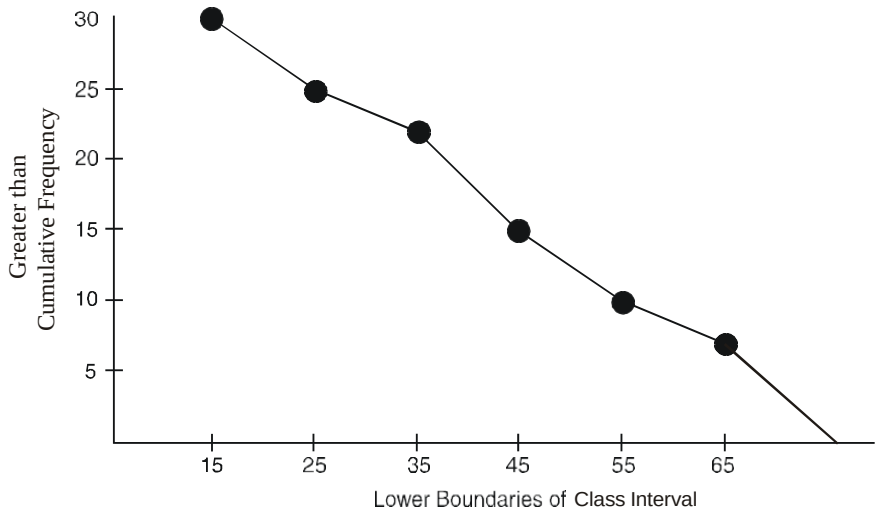


***Fig. 6.4*** *Greater than Ogive*

## Histograms

A histogram is the graphical description of data and is constructed from a frequency table. It displays the distribution method of a data set and is used for statistical as well as mathematical calculations.

The word histogram is derived from the Greek word 'histos' which means 'anything set upright' and 'gramma' which means 'drawing, record, writing'. It is considered as the most important basic tool of statistical quality control process.

In this type of representation, the given data is plotted in the form of a series of rectangles. Class intervals are marked along the *X*-axis and the frequencies along the *Y*-axis according to a suitable scale. Unlike the bar chart, which is one dimensional, meaning that only the length of the bar is important and not the width, a histogram is two-dimensional in which both the length and the width are important. A histogram is constructed from a frequency distribution of a grouped data, where the height of the rectangle is proportional to the respective frequency and the width represents the class interval. Each rectangle is joined with the other and any blank spaces between the rectangles would mean that the category is empty and there are no values in that class interval.

As an example, let us construct a histogram for our example of ages of 30 workers. For convenience sake, we will present the frequencydistribution along with the midpoint of each interval, where the midpoint is simply the average of the values of the lower and the upper boundary of each class interval. The frequency distribution is shown in Table 6.5.

***Table 6.5*** *Frequency Distribution Table*

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The histogram of this data would be shown in Figure 6.5.

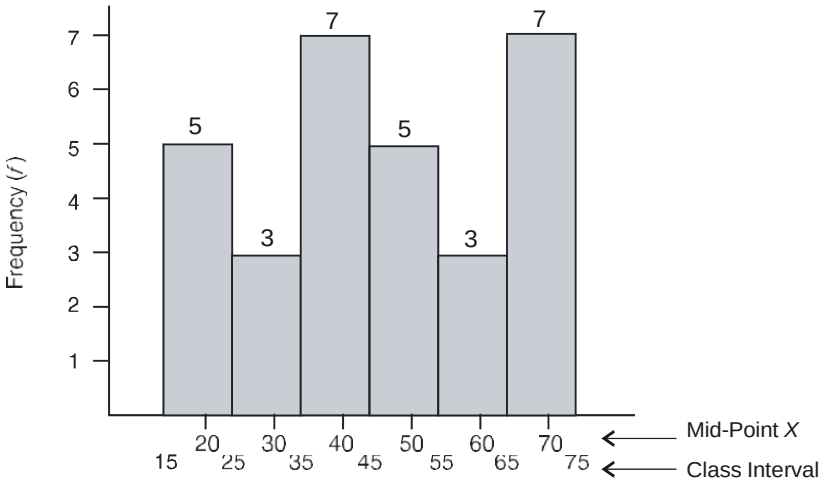



***Fig. 6.5*** *Histogram*

### 4.4.3 Diagrams

The data we collect can often be more easily understood for interpretation if it is presented graphically or pictorially. Diagrams and graphs give visual indications of magnitudes, groupings, trends and patterns in the data. These important features are more simply presented in the form of graphs. Also, diagrams facilitate comparisons between two or more sets of data.

The diagrams should be clear and easy to read and understand. Too much information should not be shown in the same diagram; otherwise, it may become cumbersome and confusing. Each diagram should include a brief and self explanatory title dealing with the subject matter. The scale of the presentation should be chosen in such a way that the resulting diagram is of appropriate size. The intervals on the vertical as well as the horizontal axis should be of equal size; otherwise, distortions would occur.

Diagrams are more suitable to illustrate the data which is discrete, while continuous data is better represented by graphs. The following are the diagrammatic and the graphic representation methods that are commonly used.

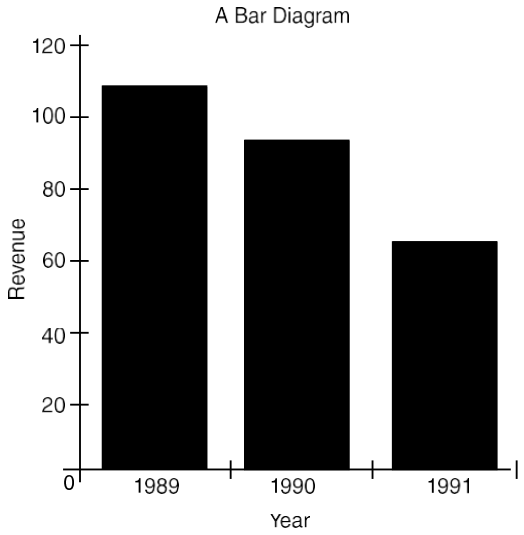
#### One-Dimensional Diagrams

Bars are simply vertical lines where the lengths of the bars are proportional to their corresponding numerical values. The width of the bar is unimportant but all bars should have the same width so as not to confuse the reader of the diagram. Additionally, the bars should be equally spaced.

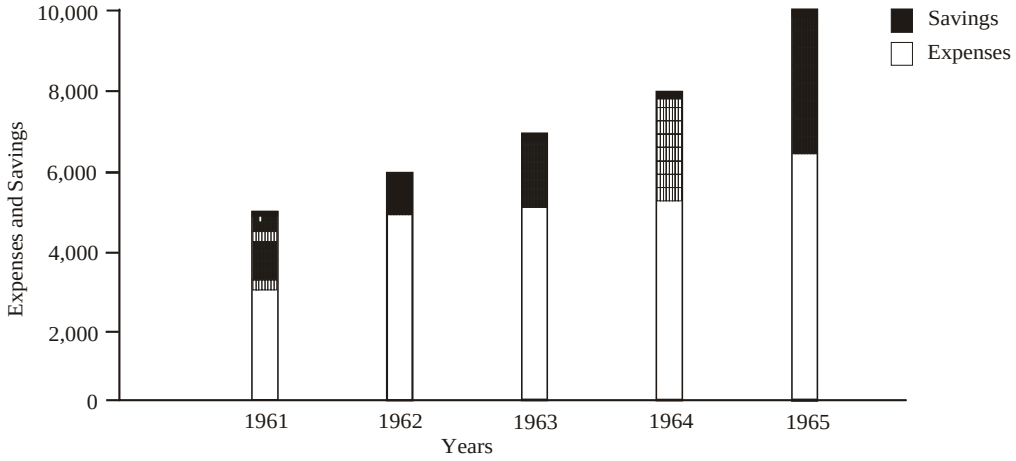
**Example 6.2:** Suppose that the following were the gross revenues (in $100,000.00) for a company *XYZ* for the years 1989, 1990 and 1991.

Construct a bar diagram for this data.

**Solution:** The bar diagram for this data can be constructed as follows with the revenues represented on the vertical axis and the years represented on the horizontal axis.




When each figure is made up of two or more component figures, the bars may be subdivided into components. Too many components should not be shown.




***Component Bar Chart Showing Expenses and Savings of Mr X***

The following shows the Annual Income, Expenses and Savings of Mr X:

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The bars drawn can be further subdivided into components depending upon the type of information to be shown in the diagram (see Figure 6.3 and Table 6.4). This will be clear by the following example in which we present three components in a bar.

### Multiple Bar Charts

The multiple bar charts for showing expenses and savings of Mr X is shown in Figure 6.6.

Here, the interrelated component parts are shown in adjoining bars, coloured or marked differently, thus allowing comparison between different parts.

These charts can be used if the overall total is not required. Some charts given earlier show totals also.

### Two-Dimensional Diagrams

Two dimensional diagrams take two components of data for representation. These are also called area diagrams as it considers two dimensions. The types are rectangles, squares and pie. It can be best explained with the help of the following squares diagram example:

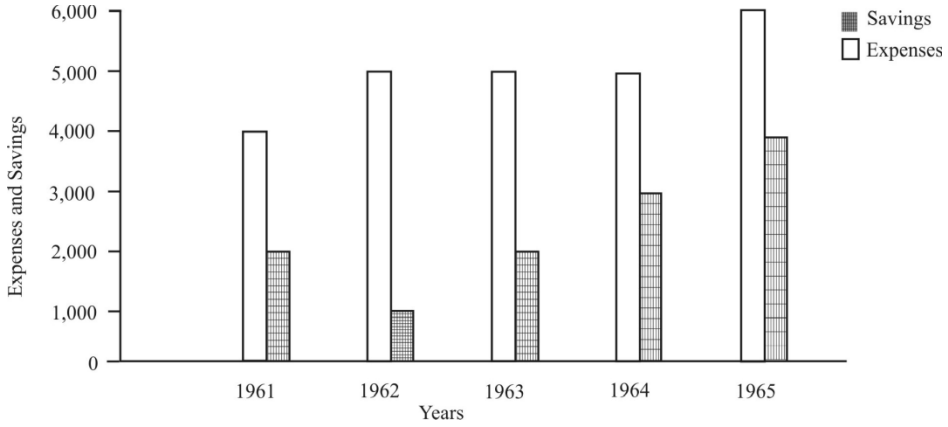


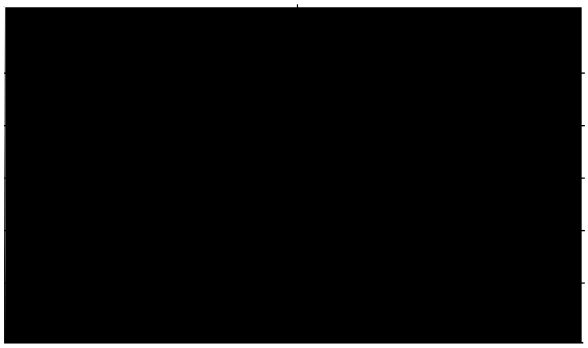

***Fig. 6.6*** *Multiple Bar Chart showing Expenses and Savings of Mr X*

**Squares:** The square diagram is easy and simple to draw. Take the square root of the values of various given items that are to be shown in the diagrams and then select a suitable scale to draw the squares.

### Pie Diagrams

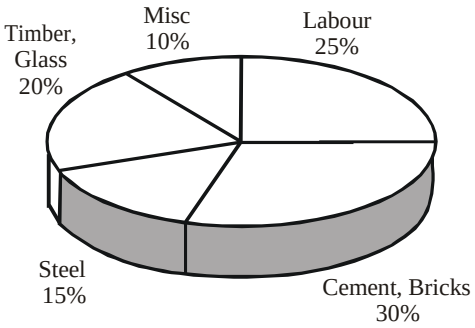
This type of diagram enables us to show the partitioning of a total into its component parts. The diagram is in the form of a circle and is also called a pie because the entire diagram looks like a pie and the components resemble slices cut from it. The size of the slice represents the proportion of the component out of the whole.

**Example 6.3:** The following figures relate to the cost of the construction of a house. The various components of cost that go into it are represented as percentages of the total cost.



Construct a pie chart for the above data.

**Solution:** The pie chart for this data is presented as follows:




Pie charts are very useful for comparison purposes, especially when there are only a few components. If there are too many components, it may become confusing to differentiate the relative values in the pie.

### Three-Dimensional Diagrams

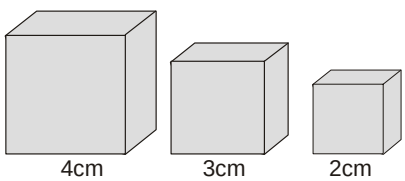
Three dimensional diagrams are also termed as volume diagram and consist of cubes, cylinders, spheres, etc. In these diagrams, three dimensions namely length, width and height are taken into account. Cubes are used to represent where side of a cube is drawn in proportion to the cube root of the magnitude of data.

**Example 6.4:** Represent the following data using volume diagram.

| *Category* | *Number of Students* |
|---|---|
| Under graduate | 64000 |
| Post graduate | 27000 |
| Professionals | 8000 |

**Solution:** The sides of cubes are calculated as follows:

| *Category* | *Number of Students* | *Cube Root* | *Side of Cube* |
|---|---|---|---|
| Undergraduate | 64000 | 40 | 4 cm |
| Postgraduate | 27000 | 30 | 3 cm |
| Professional | 8000 | 20 | 2 cm |




**Check Your Progress**

7. What is a frequency polygon?
8. How is data represented in histograms?

## NOTES

## 4.5 SUMMARY

NOTES

- Data processing involves the analysis and manipulation of the collected data by performing various functions. The functions that can be performed on data are: editing, coding, tabulation and classification.
- Editing of data involves the testing of data collection instruments in order to ensure maximum accuracy.
- Coding of data can be defined as representing the data symbolically using some predefined rules.
- Classification of data involves arrangement of data in groups or classes on the basis of some common characteristics.
- Tabulation means placing the data collected and results from research in a tabular form.
- Analysis of data is the process of transforming data for the purpose of extracting useful information, which in turn facilitates the discovery of some useful conclusions.
- The various types of analyses are: multiple regression analysis, multiple discriminant analysis and canonical correlation analysis.
- Analysis on the basis of the variance that exists in the data can be: univariate analysis, bivariate analysis and multivariate analysis.
- Data interpretation refers to the identification of trends in different variables. The researcher uses statistics for this purpose. The level of measurement used can be nominal, ordinal, interval or ratio.
- Data in raw form can be cumbersome to deal with. It must be presented in a suitable and summarized form without any loss of relevant information so that it can be efficiently used for decision-making. The common forms of representation of data are: graphs, tables, diagrams, etc.
- Tabulation is a systematic arrangement of data in columns and rows. The analysis of the data is done so by arranging the columns and rows to facilitate analysis and comparisons. A table is constructed depending on the type of information to be presented and the requirements of the statistical analysis.
- Diagrams and graphs give visual indications of magnitudes, groupings, trends and patterns in the data. These important features are more simply presented in the form of graphs. Also, diagrams facilitate comparisons between two or more sets of data.
- While arithmetic mean is the most commonly used measure of central tendency, mode and median are more suitable measures under certain set of conditions and for certain types of data.
- Arithmetic mean is commonly known as the mean. Even though average, in general, means measure of central tendency, when we use the word average in our daily routine, we always mean the arithmetic average.
- Median is that value of a variable which divides the series in such a manner that the number of items below it is equal to the number of items above it.

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- The mode of a distribution is the value at the point around which the items tend to be most heavily concentrated. It is the most frequent or the most common value, provided that a sufficiently large number of items are available, to give a smooth distribution.
- Some measures than other measures of central tendency are often employed when summarizing or describing a set of data where it is necessary to divide the data into equal parts. The quartiles divide the data into four equal parts, the deciles divide the total ordered data into ten equal parts and the percentile divide the data into 100 equal parts.
- A measure of dispersion, or simplydispersion maybe defined as statistics signifying the extent of the scatteredness of items around a measure of central tendency. These can be in the form of mean deviation, quartile deviation or standard deviation.

## 4.6 KEY TERMS

- **Data processing:** It refers to the analysis and manipulation of the collected data by performing various functions.
- **Coding of data:** It is defined as representing the data symbolically using some predefined rules.
- **Analysis of data:** It is the process of transforming data for the purpose of extracting useful information, which in turn facilitates the discovery of some useful conclusions.
- **Mean:** It refers to the arithmetic average and measure of central location.
- **Mode:** It is a form of average that can be defined as the most frequently occurring value in the data.
- **Median:** It refers to a measure of central tendency that appears in the centre of an ordered data.
- **Standard deviation:** The square root of the average of the squared deviations from their mean of a set of observations.

## 4.7 ANSWERS TO 'CHECK YOUR PROGRESS'

1. The functions that can be performed on data are: editing, coding, tabulation and classification.
2. Coding decisions are usually taken at the designing state of the questionnaire.
3. Class intervals refer to a range of values of a variable. This interval is used to calibrate the scale of a variable in order to tabulate the frequency distribution of a sample.
4. The following are the different methods used in hand tabulation: direct tally method, list and tally method and card sort method.
5. Bivariate analysis is a type of analysis that examines the relationship between two variables. It tries to find the extent of association that exists among these variables.
6. The ordinal scale of measurement is used to calculate and derive data pertaining to the median, percentage, rank order, correlations and percentile.

7. A frequency polygon is a line chart of frequency distribution in which, either the values of discrete variables or midpoints of class intervals are plotted against the frequencies and these plotted points are joined tighter by straight lines.
8. In histograms, the given data is plotted in the form of a series of rectangles. Class intervals are marked along the X-axis and the frequencies along the Y-axis according to a suitable scale.
9. The following are the characteristics of mean: the sum of the deviation of individual values of X from the mean will always add up to zero, it is very sensitive to extreme values, and the sum of the squares of the deviations about the mean is minimum.
10. When there is an even number of cases, there is no actual middle item and the median is taken to be the average of the values of the items lying on either side of (N+1)/2, where N is the total number of items.
11. The four important methods of estimating mode of a series are: (i) locating the most frequently repeated value in the array; (ii) estimating the mode by interpolation; (iii) locating the mode by graphic method; and (iv) estimating the mode from the mean and the median.
12. Range is the crudest measure of dispersion. It is the difference between the highest and lowest values in the series.
13. The median deviation is preferred over mean because it has the important property that the average deviation from it is the least.

## 4.8 QUESTIONS AND EXERCISES

### Short-Answer Questions

1. Distinguish between the terms data classification according to attributes and class intervals.
2. State any three advantages of tabulation.
3. What is an Ogive curve?
4. Differentiate between a mean and a mode.
5. Write three characteristics of mean.
6. What is the importance of arithmetic mean in statistics?
7. Define quartiles, deciles and percentiles with suitable examples.
8. What is geometric mean? How is it calculated?
9. Write the definition and formula of quartile deviation.
10. How will you calculate the mean deviation of a given data?
11. Explain standard deviation. Why is it used in statistical evaluation of data?

### Long-Answer Questions

1. Briefly describe the process and significance of coding of data.
2. Enumerate and elaborate on the methods of tabulation.
3. Elaborate on any three ways of representation of the collected data.
4. Discuss the various types of diagrams used for data representation.

NOTES

5. Explain the term descriptive statistics with the help of examples.
6. Discuss the various measures of central tendency.
7. Discuss the significance of diagrammatic representation of data.
8. Explain the common techniques of diagrammatic representation.
9. The following table gives the heights (in inches) of 100 boys of a class. Calculate mean, mode and median of the height.

| *Height (inches)* | *No. of Students* |
|---|---|
| 60–62 | 5 |
| 62–64 | 18 |
| 64–66 | 42 |
| 66–68 | 20 |
| 68–70 | 8 |
| 70–72 | 7 |
| | 100 |

**Solution:** 65.58

10. The daily profits in rupees of 100 shops are distributed as follows. Draw a histogram of the data and then find the modal value. Check this value by direct calculation.

| *Profits per shop* | *Number of shops* |
|---|---|
| 0–100 | 12 |
| 100–200 | 18 |
| 200–300 | 27 |
| 300–400 | 20 |
| 400–500 | 17 |
| 500–600 | 6 |

Since class 200–300 has the highest frequency, i.e., 27, mode lies in this class.

Mode = 256.25

## 4.9 FURTHER READING

Chandan, J. S. 1998. *Statistics for Business and Economics*. New Delhi: Vikas Publishing House.

Gupta, S. C. 2006. *Fundamentals of Statistics*. New Delhi: Himalaya Publishing House.

Gupta, S. P., 2005. *Statistical Methods*. New Delhi: Sultan Chand and Sons.

Hooda, R. P. 2002. *Statistics for Business and Economics*. New Delhi: Macmillan India.

Kothari, C. R., 1984. *Quantitative Techniques*. New Delhi: Vikas Publishing House.

Monga, G. S. 2000. *Mathematics and Statistics for Economics*. New Delhi: Vikas Publishing House.

# UNIT 7 REPORT WRITING

**Structure**



NOTES

## INTRODUCTION

The final unit will discuss the writing of research reports. A research study is a tedious task and calls for exhaustive investigation on the part of the researcher. This quite often leads to accumulation of bulk data obtained from the research study. Even if the concerned study results in brilliant hypotheses or a generalized theory, it is the responsibility of the researcher to format this bulk study into an easy-to-understand pattern or format. This is where a research report comes in.

One cannot overemphasize the significance of a well-documented and structured research report. This step is often taken as extremely rudimentary and is, thus, ignored. However, just like all the other steps in the research process, this requires careful and sequential progression. The unit will discuss in detail the formation and presentation of the research study. The format and the steps might be moderately adjusted and altered based on the reader's requirement. Thus, it might be for an academic and theoretical purpose or might need to be clearly spelt and linked with the business manager's decision dilemma.

## UNIT OBJECTIVES

After going through this unit, you will be able to:

- Discuss the importance of report writing
- Describe the types of research reports
- Explain the report preparation and presentation
- Identify the components of report
- Assess the formulation of report writing and guidelines

NOTES

# NEED FOR EFFECTIVE DOCUMENTATION

On completion of the research study and after obtaining the research results, the real skill of the researcher lies in terms of analysing and interpreting the findings and linking them with the propositions formulated in the form of research hypotheses at the beginning of the study. The statistical or qualitative summary of results would be little more than numbers or conclusions unless one is able to present the documented version of the research endeavour.

## Importance of Report Writing

Depending on the business researcher's orientation, the intention might be different and would be reflected in the form of the presentation but the significance is critical to both. Essentially, this is so because of the following reasons:

- The research report fulfills the historical task of serving as a concrete proof of the study that was undertaken. This serves the purpose of providing a framework for any work that can be conducted in the same or related areas.
- It is the complete detailed report of the research study undertaken by the researcher, thus it needs to be presented in a comprehensive and objective manner. This is a one-way communication of the researcher's study and analysis to the reader/manager, and thus needs to be all-inclusive and yet neutral in its reporting.
- For academic purposes, the recorded document presents a knowledge base on the topic under study and for the business manager seeking help in taking more informed decisions, the report provides the necessary guidance for taking appropriate action.
- As the report documents all the steps followed and the analysis carried out, it also serves to authenticate the quality of the work carried out and establishes the strength of the findings obtained.

Thus, effective recording and communicating of the results of the study becomes an extremely critical step of the research process. Based on the nature of the research study and the researcher's orientation, the report can take different forms.

## Types of Research Reports

The form and structure of the research report might change according to the purpose for which it has been designed. Based on the size of the report, it is possible to divide the report into the following types:

### Brief Reports

These kinds of reports are not formally structured and are generally short, sometimes not running more than four to five pages. The information provided is of a limited scope and is prepared either for immediate consumption or as a prelude to the formal structured report that would subsequently follow. These reports could be designed in several ways.

- ***Working papers*** or ***basic reports*** are written for the purpose of collating the process carried out in terms of scope and framework of the study, the methodology followed and instrument designed. The results and findings would also be recorded

here. However, the interpretation of the findings and study background might be missing, as the focus is more on the present study rather than past literature. These reports are significant as they serve as a reference point when writing the final report or when the researcher wants to revisit the detailed steps followed in collecting the study-related information.

- ***Survey reports*** might or might not have an academic orientation. The focus here is to present findings in an easy-to-comprehend format that includes figures and tables. The reader can then study the patterns in the findings to arrive at appropriate conclusions, essential for resolving the research problem. The advantage of these reports is that they are simple and easy to understand and present the findings in a clear and usable format.

### Detailed Reports

These are more formal and pedantic in their structure and are essentially either academic, technical or business reports. Sometimes, the researcher may prepare both kinds—for an academic as well as for a business purpose. The language, presentation and format of the two kinds of reports would be vastly different as they would need to be prepared for the understanding of the reader's capabilities and intentions.

### Technical Reports

These are major documents and would include all elements of the basic report, as well as the interpretations and conclusions, as related to the obtained results. This would have a complete problem background and any additional past data/records that are essential for comprehending and interpreting the present study output. All sources of data, sampling plan, data collection instrument(s), data analysis outputs would be formally and sequentially documented.

### Business Reports

These reports would not have the technical rigour and details of the technical report and would be in the language and include conclusions as understood and required by the business manager. The tables, figures and numbers of the first report would now be pictorially shown as bars and graphs and the reporting tone would be more in business terms rather than in conceptual or theoretical terms. If needed, the tabular data might be attached in the appendix.

## COMPONENTS OF REPORT

Whatever the type of report, the reporting and dissemination of the study and its findings require a structured format and by and large, the process is standardized. As stated above, the major difference amongst the types of reports is that all the elements that essentially constitute a research report would be present only in a detailed technical report.

The entire research project needs to be recorded either as a single written report or into several reports, depending on the need of the readers. The researcher would need to assist the business manager in deciphering the report, executing the findings, and in case of need, to revise the report to suit the specific actionable requirements of the manager.

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**Check Your Progress**

1. State one extremely critical step of the research process.
2. Why is the purpose for writing working papers?

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As presented in Figure 7.1, most research reports include the following sections:

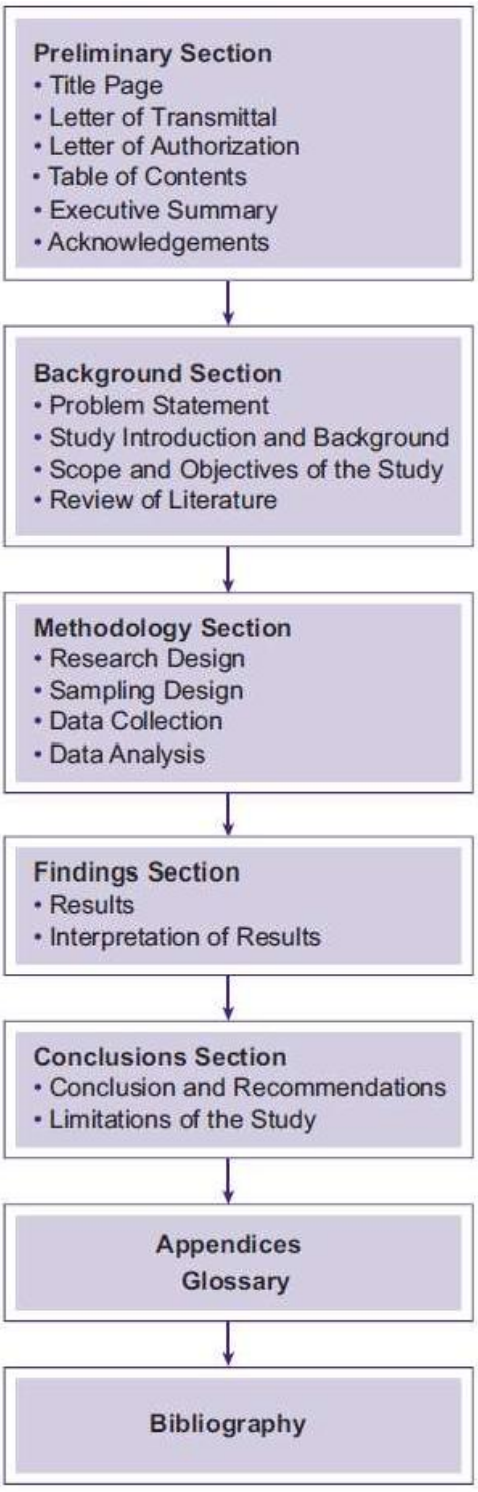


***Fig. 7.1*** *The Process of Report Formulation and Writing*

## 1. Preliminary Pages

This section mainly consists of identification information for the study conducted. It has the following individual elements:

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**Title page:** This includes classification data about:

- The target audience, or the intended reader of the report.
- The report author(s), including their name, affiliation and address.
- The title of the study presented in a manner to clearly indicate the study variables; the relationship or status of the variables studied and the population to which the results apply. The title should be crisp and indicative of the nature of the project, as illustrated in the following examples.
  - o Comparative analysis of BPO workers and schoolteachers with reference to their work–life balance
  - o Segmentation analysis of luxury apartment buyers in the National Capital Region (NCR).
  - o An assessment of behavioural factors impacting consumer financial investment decisions.

**Letter of transmittal:** This is the letter that goes alongside the formalized copy of the final report. It broadly refers to the purpose behind the study. The tone in this note can be slightly informal and indicative of the rapport between the client-reader and the researcher. A sample letter of transmittal is presented in Exhibit 7.1. The letter broadly refers to three issues: It indicates the term of the study or objectives; next it goes on to broadly give an indication of the process carried out to conduct the study and the implications of the findings. The conclusions are generally indicative of the researcher's interest/learning from the study and in some cases may be laying the foundation for future research opportunities.

**Letter of authorization:** Sometimes the letter of authorization may be redundant as indications of the formal approval for conducting the study might be included in the letter of transmittal. The author of this letter is the business manager or corporate representative who formally gives the permission for executing the project. The tone of this letter, unlike the above document, is very precise and formal, leaving no room for speculation or interpretation.

**Exhibit 7.1 Sample Letter of Transmittal**

| | | | |
|---|---|---|---|
| **To:** | Mr Prem Parashar | **From:** | Nayan Navre |
| **Company:** | Just Bondas Corporation (JBC) | **Company:** | Jigyasa Associates |
| **Location:** | Mumbai 116879 | **Location:** | Sabarmati Dham, Mumbai |
| **Telephone:** | 48786767; 4876768 | **Telephone:** | 41765888 |
| **Fax:** | 48786799 | **Fax:** | 41765899 |

**Addendums: Highlight of findings (pages: 20)**

15 January 2011

Dear Prem,

Please find the enclosed document which covers a summary of the findings of the November- December 2010 study of the new product offering and its acceptibility. I would be sending three hard copies of the same tomorrow.

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Once the core group has discussed the direction of the expected results I would request you to kindly get back with your comments/queries/suggestions, so that they can be incorporated in the preparation of the final report document.

The major findings of the study were that the response of the non-vegetarians consuming the new *keema bonda pav* at Just Bondas was positive. As you can observe, however, the introduction of the non-vegetarian *bonda* has not been well received by the regular customers who visit the outlets for their regular *alloo bonda*. These findings, though on a small respondent base, are significant as they could be an indication of a deflecting loyal customer base.

Best regards,

Nayan

As explained, this letter is not critical to submission, in case reference to the same has been made in the transmittal letter. However, in case it is to be included in the report, it is advisable to reproduce the exact prototype of the original letter.

**Table of contents:** All reports should have a section that clearly indicates the division of the report based on the formal areas of the study as indicated in the research structure. The major divisions and subdivisions of the study, along with their starting page numbers, should be presented. The subheadings and the smaller sections of a topic need not be indicated here as then the presentation of the content seems cluttered.

Once the major sections of the report are listed, the list of tables come next, followed by the list of figures and graphs, exhibits (if any) and finally the list of appendices.

**Executive summary:** This is the last and the most critical element of the preliminary section. The summary of the entire report, starting from the scope and objectives of the study to the methodology employed and the results obtained, have to be presented in a brief and concise manner. In case the research requirement was to provide recommended changes based on the findings, it is advisable to provide short pointers here. Interestingly, it has been observed that in most instances the business managers read only the executive summary in its complete detail and most often just glance through the rest of the report. Thus, it becomes extremely critical to present a Gestaltan view of the entire report in a suitable condensed form.

The executive summary essentially can be divided into four or five sections. It begins with the study background, scope and objectives of the study, followed by the execution, including the sample details and methodology of the study. Next comes the findings and results obtained. The fourth section covers the conclusions which are more or less based on the opinion of the researcher. Finally, as stated earlier, in case the study objectives necessitates implications, the last section would include recommendations and suggestions.

**Acknowledgements:** A small note acknowledging the contribution of the respondents, the corporates and the experts who provided inputs for accomplishing the study is to be included here.

Though the executive summary comes before the main body of the report, it is always prepared after the entire report has been finalized and is ready in its final form. The length of this section is one or two pages only and the researcher needs to effectively present the most significant parts of the study in a succinct form. It has been observed that the executive summary is a standalone document that is often circulated independently to the interested managers who might be directly or indirectly related to the study.

## 2. Main Text

This is the most significant and academically robust part of the report. The sections of this division follow the essential pattern of a typical research study.

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**Problem definition:** This section begins with the formal definition of the research problem. The problem statement is the research intention and is more or less similar to what was stated earlier as the title of the research study.

**Study background:** Study background presents details of the preliminary conceptualization of the management decision problem and all the groundwork done in terms of secondary data analysis, industry experts' perspectives and any other earlier reporting of similar approaches undertaken. Thus, essentially, the section begins by presenting the decision-makers' problem and then moves on to a description of the theoretical and contemporary market data that laid the foundation that guided the research.

In case the study is an academic research, there is a separate section devoted to the review of related literature, which presents a detailed reporting of work done on the same or related topic of interest.

**Study scope and objectives:** The logical arguments then conclude in the form of definite statements related to the purpose of the study. A clear definition of the scope and objective of the study is presented usually after the study background; in case the study is causal in nature, the formulated hypotheses are presented here as well.

**Methodology of research:** This section would not be sequentially placed here, for short reports or for a business report. In such reports, a short description of the methodology followed would be documented in the appendix. However, for a technical and academic report, this is a significant and primary contribution of the research study. The section would essentially have five to six sections specifying the details of how the research was conducted. These would essentially be:

- *Research framework or design:* The variables and concepts being investigated are clearly defined, with a clear reference to the relationship being studied. The justification for using a particular design has to be presented in a sequential and step-wise manner enlisting the experimental and control conditions, in case of a causal study. The researcher must take care to keep the technical details of the execution in the appendix and present the execution details in simple language, in the main body.
- *Sampling design:* The entire sampling plan in terms of the population being studied, along with the reasons for collecting the study-related information from the given group is given here. The execution details, in terms of sample size calculations, sampling frame considered and field work details can be recorded in the appendix rather than in the main body of the report. However, the sample profile and identification details are included in the main section. As stated earlier, the report needs to be reader-friendly, and too much technical information might not be required by the decision-maker.
- *Data collection methods:* In this section, the researcher should clearly list the information needed for the study as drawn from the study objectives stated earlier. The secondary data sources considered and the primary instrument designed for the specific study are discussed here. However, the final draft of the measuring instrument can be included in the appendix, which includes the execution details in terms of how the information was collected; how the open ended or opinion-

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based questions were handled; and how irregularities were handled and accounted for in the study. These and similar information enable a clear insight into the standardization of procedures maintained.

- *Data analysis:* Here, the researcher again needs to revisit the research objectives and the study design in order to justify the analytical tools and techniques used in the study. The assumptions and constraints of the analysis need to be explained here in simple, non-technical terms. There is no need to give a detailed description of the statistical calculations here.
- *Study results and findings:* This is the most critical chapter of the report and requires special care; it is probably also one of the longest chapters in the document. The researcher could, thus, consider either breaking this into subchapters or at least clear subheadings.

Researchers commonly divide the chapter on the basis of the data collection plan, i.e., there is a section on interview analysis, another one on focus group discussion and the third referring to the questionnaire analysis. This, however, does not serve any purpose as the results would then seem repetitive and disjointed. Instead, the result should be organized according to the information areas on which the data was collected or on the basis of the research objectives. There are also times when the data would be presented for the whole sample and then will be split and presented for the sub-population studied. For example, in the study on work-life balance, the findings were presented for the whole sample and then at the micro level for the BPO sector and separately for the school teacher segment. For each group, first the sample profile in terms of the demographic details of age, education, income (individual and family), years of experience, marital status, family size and other details was presented. Next, the descriptive data was made available on the seven sub-scales studied—and lastly—the predictive data–based on a multiple regression analysis with work-life balance as the dependent variable and the seven variables as independent, was presented. There was only one open-ended question related to the individual's suggestion as to what support was required from one's place of work to achieve work-life balance. This was presented last in the form of a bar chart showing variability in the responses given. Again as advised earlier, it is essential to present the findings in the form of simplified tables, graphs and figures, with the same being explained in simple text subsequently.

## Interpretations of Results and Suggested Recommendations

The section study results and findings, i.e., the main report, presents a bird's eye view of the information as it exists in a summarized and numerical form. This kind of information might become difficult to understand and convert into actionable steps, thus the real skill of the researcher lies in simplifying the data in a reader-friendly language. Here, it is recommended that this section should be more analytical and opinion based. The results could be supported by the data that was presented earlier, for example, industry forecasts or the expert opinion. In case the report had an earlier section on literature review, the researcher could demonstrate the similarity of findings with past studies done on the topic. For example, in a study conducted on analysing the antecedents of turnover intention, the results obtained were explained as follows:

The results of the logit regression indicate that organizational commitment, age and martial status are significant at 5 per cent and 10 per cent levels respectively. The results indicate that as organizational commitment increases, the log of odd ratios in the favour of high turnover intention reduces, which is very logical. This is in accordance with the results obtained by Mobley, et al. (1978), Cotton and Tuttle (1986), Igbaria and Greenhaus (1992), Ahuja, et al. (2007). Thus, when employees feel committed to an organization, they are more likely to stay with the organization.

NOTES

Sometimes, the research results obtained may not be in the direction as found by earlier researchers. Here, the skill of the researcher in justifying the obtained direction is based on his/her individual opinion and expertise in the area of study. For example, in the same study on turnover intentions, contrary findings were explained as follows:

> ...the results indicate that the log of odd ratios in favour of high turnover intention is more in the case of older respondents; this is contrary to the findings of Zeffane and Gul (1995) and Finegold, et al. (2002). However, this has to be understood in the light of the profession, as in India, most people take the BPO sector as a stop-gap career and use the time at the BPO employment as an opportunity to enhance their academic qualification and then move on, which is also one of the reasons why this sector is a young sector.

Subsequent to the subsection on the interpretation of results, sometimes, the study requirement might be to formulate indicative recommendations to the decision-makers as well. Thus, in case the report includes recommendations, they should be realistic, workable and topically related to the industry studied. For example, to the business manager of organic food products, the following recommendation was made to build awareness amongst potential customers about the benefits of organic products:

**Organic food study: An illustration:** The power of the print media in promoting a high-involvement product is unsurpassed. Thus, articles byleading nutritionists and doctors (88 per cent of consumers are influenced by others in consuming health alternatives) on any aspect of organic food would work well. The organic players need to take care that they do not advertise only their product offerings and price alone but they also need to educate the consumer on the health benefits of the products in their advertisements.

The article/advertisement could be placed in the Sunday supplements of newspapers so that people would read them at leisure. The major decision-makers for groceries are women thus magazines like Femina, Health and Savvy would be likely choices (the magazines suggested are English fortnightlies and have a reader profile similar to our sample profile). This is also because the product is a premium and niche product and thus requires selective exposure.

## Limitations of the Study

The last in this section is a brief discussion of the problems encountered during the study and the constraints in terms of time, financial or human resources. There could also have been constraints in obtaining the required information, either because the data about the topic of interest has not been collected or because it is not readily available to all. These clear revelations about the drawbacks are thus kept in mind by the reader when analysing the results and the implications of the study.

## 3. End Text

The final section of the report provides all the supportive material in the study. Some of the common details presented in this section are as follows:

NOTES

**Appendices:** The appendix section follows the main body of the report and essentially consists of two kinds of information:

1. Secondary information like long articles or in case the study uses/is based on/ refers to some technical information that needs to be understood by the reader. Or long tables or articles or legal or policy documents.
2. Primary data that can be compressed and presented in the main body of the report. This includes: Original questionnaire, discussion guides, formula used for the study, sample details, original data, long tables and graphs which can be described in statement form in the text.

**Bibliography:** This is an important part of the final section as it provides the complete details of the information sources and papers cited in a standardized format. It is recommended to follow the publication manuals from the American Psychological Association (APA) or the Harvard method of citation for preparing this section. In fact, with the advancement in computer technology the latest version of Microsoft office Word 2007 can automatically generate a bibliography based on any of these formats, based on the source information provided in the document.

The reporting content of the bibliography could also be in terms of:

- **Selected bibliography:** Selective references are cited in terms of relevance and reader requirement. Thus, the books or journals, that are technical and not really needed to understand the study outcomes are not reported.
- **Complete bibliography:** All the items that have been referred to, even when not cited in the text, are given here.
- **Annotated bibliography:** Along with the complete details of the cited work, some brief information about the nature of information sought from the article is given. This could run into three or four lines or a brief paragraph.

At this juncture we would like to refer to another method of citation that an author might wish to use during report writing. This could be in the form of a footnote. To explain the difference we would first like to explain what a typical footnote is:

**Footnote:** A typical footnote, as the name indicates, is part of the main report and comes at the bottom of a page or at the end of the main text. This could refer to a source that the author has referred to or it may be an explanation of a particular concept referred to in the text.

The referencing protocol of a footnote and bibliography is different. In a footnote, one gives the first name of the person first and the surname next. However, this order is reversed in the bibliography. Here we start first with the surname and then the first name. In a bibliography, we generally mention the page numbers of the article or the total pages in the book. However, in a footnote, the specific page from which the information is cited is mentioned. A bibliography is generally arranged alphabetically depending on the author's name, but in the footnote the reporting is based on the sequence in which they occur in the text.

**Glossary of terms:** In case there are specific terms and technical jargon used in the report, the researcher should consider putting a glossary in the form of a word list of terms used in the study. This section is usually the last section of the report.

## REPORT WRITING: REPORT FORMULATION

NOTES

An important point to remember in report writing is that the document compiled is meant for specific readers. Thus, one needs to design the same according to the needs of the reader. Listed below are some features of a good research study that should be kept in mind while documenting and preparing the report.

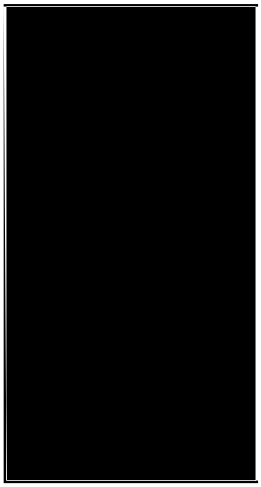
**Clear report mandate:** While writing the research problem statement and study background, the writer needs to be focused, precise and very explicit in terms of the problem under study, the background that provided the impetus to conduct the research and the study domain. This is prepared on the assumption that the writer at no point in time needs to be physically present in order to clarify the research mandate. One cannot make an assumption that the reader has earlier insights into the problem situation. The writer needs to be absolutely clear on the need for lucidity of thought and dissemination of this knowledge to the reader.

**Clearly designed methodology:** Any research study has its unique orientation and scope and thus has a specific and customized research design, sampling and data collection plan. The writer, thus, needs to be explicit in terms of the logical justification for having used the study methods and techniques. However, as stated earlier, the language should be non-technical and reader friendly and any technical explanations or details must be provided in the appendix. In researches, that are not completely transparent on the set of procedures, one cannot be absolutely confident of the findings and resulting conclusions.

**Clear representation of findings:** The sample size for each analysis, any special conditions or data treatment must be clearly mentioned either as a footnote or as an endnote, so that the reader takes this into account while interpreting and understanding the study results. The sample base is very important in justifying a trend or taking a strategic decision; for example, if amongst a sample of bachelors we say that 100 per cent young bachelors want to buy grocery online or on the telephone and the recommended strategy is to suggest this as the delivery channel, one might be making an error if the size of the bachelors was four out of a total sample of 100 grocery buyers considered. Thus, complete honesty and transparency in stating the treatment and editing of missing or contrary data is extremely critical.

**Representativeness of study finding:** A good research report is also explicit in terms of extent and scope of the results obtained, and in terms of the applicability of findings. This is also dependent on whether the assumptions and preconditions made for formulating the conclusions and recommendations of the study have been explicitly stated.

In order to ensure that one has been able to achieve the above stated objective, the reader must ensure a standardization of procedures in writing the document as well as follow standard protocols for preparing graphs and tables. In the following section we will briefly discuss some simple rules that the researcher can use as guidelines for this.



## Guidelines for Effective Documentation

NOTES

The following are certain guidelines that are needed for effective documentation.

**Command over the medium:** Even though one may have done an extremely rigorous and significant research study, the fundamental test still remains as to how the learning has been disseminated. Regardless of how effective the graphs and figures are in showcasing the findings, the verbal description and explanation—in terms of why it was done, how it was done, and what was the outcome, still remain the acid test.

Thus, a correct and effective language of communication is critical in putting ideas and objectives in the vernacular of the reader/decision-maker. The writer may, thus, be advised to read professionally written reports and, if necessary, seek assistance from those proficient in preparing business reports.

**Phrasing protocol:** There is a debate about whether or not one makes use of personal pronoun while reporting. To understand this, one needs to revisit the responsibility of the researcher, which is to present the findings of his/her study, with complete objectivity and precision. The use of personal pronoun such as 'I think…..' or 'in my opinion…..' lends a subjectivity and personalization of judgement. Thus, the tone of the reporting should be neutral. For example:

'Given the nature of the forecasted growth and the opinion of the respondents, it is likely that the……'

Whenever the writer is reproducing the verbatim information from another document or comment of an expert or published source, it must be in inverted commas or italics and the author or source should be duly acknowledged.

For example:

Sarah Churchman, Head of Diversity, PricewaterhouseCoopers, states 'At PricewaterhouseCoopers we firmly believe that promoting work–life balance is a 'business-critical' issue and not simply the 'right thing to do'. Profitable growth and sustainable business depends on attracting and retaining top talent and we know, from our own research and experience that work–life policies are an essential ingredient of successful recruitment and retention strategies.'

The writer should avoid long sentences and break up the information in clear chunks, so that the reader can process it with ease. Similar is the case in structuring of the chapters or sections of the report that can be logically broken down into smaller sections that are comprehensive and complete and yet maintain a strong but logical link with the flow of reporting.

With the onset of the use of abbreviated communications in SMS and emails, most people tend to use shortened form as 'cd.' for could and 'u' for you, etc. Also the use of colloquial language and slangs must be avoided, as this is a formal document and one must maintain the sanctity of the formal documentation required in a research report.

**Simplicity of approach:** Along with grammatically and structurally correct language, care must be taken to avoid technical jargon as far as possible. The business manager, might have been a business student who had prepared a research report in his academic pursuits but now understands simple common terms and does not have the time or inclination to juggle the dictionary and the report together. In case it is imperative to use certain terminology, then, as stated earlier, the definition of these terms can be provided in the glossary of terms at the end of the report.

NOTES

Sometimes the writer may prepare different research reports for the same study to suit the need of diverse readers, for example, the business report needs to be crisp and simple with definable and workable recommendations. On the other hand, an academic report could discuss extensively the literature review section, as well as the statistical analysis and interpretation.

**Report formatting and presentation:** In terms of paper quality, page margins and font style and size, a professional standard should be maintained. The font style must be uniform throughout the report. The topics, subtopics, headings and subheadings must be construed in the same manner throughout the report. Sometimes certain academic reports have a mandated format for presentation which the writers need to follow, in which case there is no choice in presentation.

However, when this is not clear, it is advisable that the writer creates his/her own formatting rules and saves it on a notepad so that they can be implemented in a standardized and professional manner.

The researcher can provide data relief and variation by adequately supplementing the text with graphs and figures. Pictorial representations are simple to comprehend and also break the monotony and fatigue of reading. They should be used effectively whenever possible in the report.

## Guidelines for Presenting Tabular Data

We have discussed this topic in detail in the previous unit. In this section, we will recall some of the concepts again along with some new information.

Most research studies involve some form of numerical data, and even though one can discuss this in text, it is best represented in tabular form. The advantage of doing this is that statistical tables present the data in a concise and numeral form, which makes quantitative analysis and comparisons easier. Tables formulated could be general tables following a statistical format for a particular kind of analysis. These are best put in the appendix, as they are complex and detailed in nature. The other kind is simple summary tables, which only contain limited information and yet, are, essentially critical to the report text.

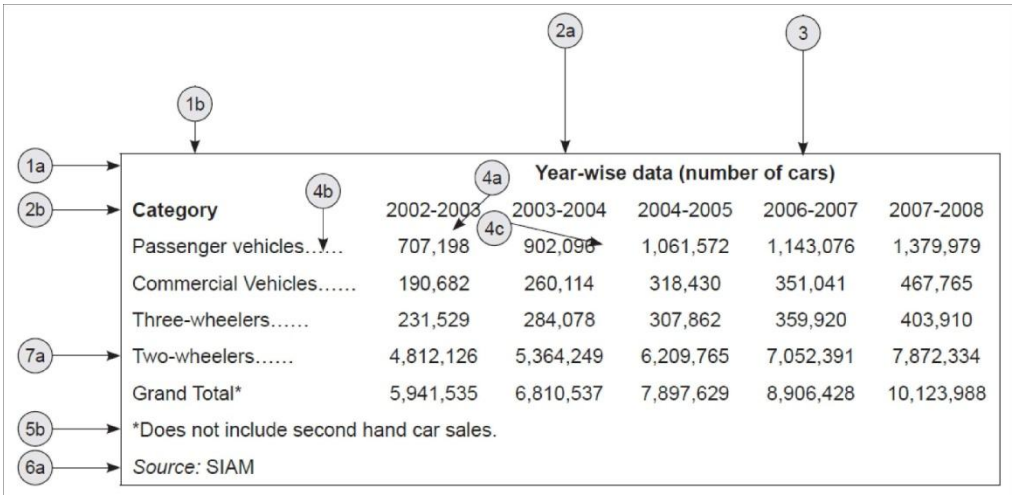
The mechanics of creating a summary table are very simple and are illustrated below with an example (Table 7.1). The illustration has been labelled with numbers which relate to the relevant section.

**Table identification details:** The table must have a title (1a) and an identification number (1b). The table title should be short and usually would not include any verbs or articles. It only refers to the population or parameter being studied. The title should be briefly yet clearly descriptive of the information provided. The numbering of tables is usually in a series and generally one makes use of Arabic numbers to identify them.

**Data arrays:** The arrangement of data in a table is usually done in an ascending manner. This could either be in terms of time, as shown in Table 7.1 (column-wise) or according to sectors or categories (row-wise) or locations, e.g., north, south, east, west and central. Sometimes, when the data is voluminous, it is recommended that one goes alphabetically, e.g., country or state data. Sometimes there may be subcategories to the main categories, for example, under the total sales data—a column-wise component of the revenue statement—there could be subcategories of department store, chemists and druggists, mass merchandisers and others. Then these have to be displayed under the sales data head, after giving a tab command as follows:

NOTES

***Table 7.1*** *Automobile Domestic Sales Trends*




Total sales

Mass market

Department store

Drug stores

Others (including paan beedi outlets)

**Measurement unit:** The unit in which the parameter or information is presented should be clearly mentioned.

**Spaces, Leaders and Rulings (SLR):** For limited data, the table need not be divided using grid lines or rulings. Simple white spaces add to the clarity of information presented and processed. In case the number of parameters are too many and the data seems to be bulky to be simply separated by space, it is advisable to use vertical ruling. Horizontal lines are drawn to separate the headings from the main data, as can be seen in Table 7.1. When there are a number of subheadings as in the sales data example, one may consider using leaders (…….) to assist the eye movement in absorbing and processing the information.

**Total sales**

Mass market……

Department store……

Drug stores……

Others (including *paan beedi* outlets)……

**Assumptions, details and comments:** Any clarification or assumption made, or a special definition required to understand the data, or formula used to arrive at a particular figure, e.g., total market sale or total market size can be given after the main tabled data in the form of footnotes.

**Data sources:** In case the information documented and tabled is secondary in nature, complete reference of the source must be cited after the footnote, if any.

**Special mention:** In case some figure or information is significant and the reader should pay special attention to it, the number or figure can be bold or can be highlighted to increase focus.

## Guidelines for Visual Representations: Graphs

NOTES

Similar to the summarized and succinct data in the form of tables, the data can also be presented through visual representations in the form of graphs. As we have seen the previous unit, the visual representation of the findings in the form of lines or boxes and bars relative to a number line is easy to comprehend and interpret. There are some standard rules and procedures available to the researcher for this; also there are computer programs like MS Excel and SPSS, where the numbered data can be converted with ease into graphical form.

**Line and curve graphs:** Usually, when the objective is to demonstrate trends and some sort of pattern in the data, a line chart is the best option available to the researcher as the line is able to clearly portray any change in pattern during a particular time period. On the same chart, it is also possible to show patterns of growth of different sectors or industries in the same time period or to compare the change in the studied variable across different organizations or brands in the same industry. Certain points to be kept in mind while formulating line charts include:

- The time units or the causal variable being studied are to be put on the X-axis, or the horizontal axis.
- If the intention is to compare different series on the same chart, the lines should be of different colours or forms (Figure 7.2).
- Too many lines are not advisable on the same chart as then the data becomes too cluttered; an ideal number would be five or less than five lines on the chart.

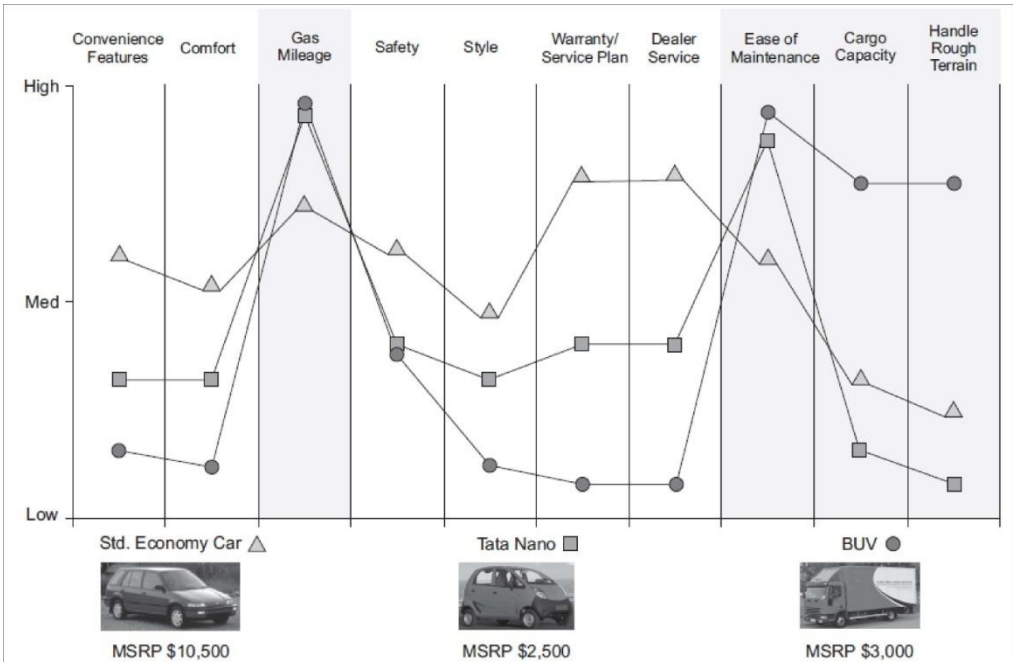



***Fig. 7.2*** *Comparative Analysis of Vehicles (including Nano) on Features Desired by*

***Source:*** vytrak.com

- The researcher also must take care to formulate the zero baseline in the chart as otherwise, the data would seem to be misleading. For example, in Figure 7.3(a), in case the zero baseline is (as shown in the chart) the expected change in the number of hearing aids units to be sold over the time period 2002–03 to 2007–08,

it can be accurately perceived. However, in Figure 7.3(b), where the zero is at 1,50,000 units, the rate of growth can be misjudged to be more swift.

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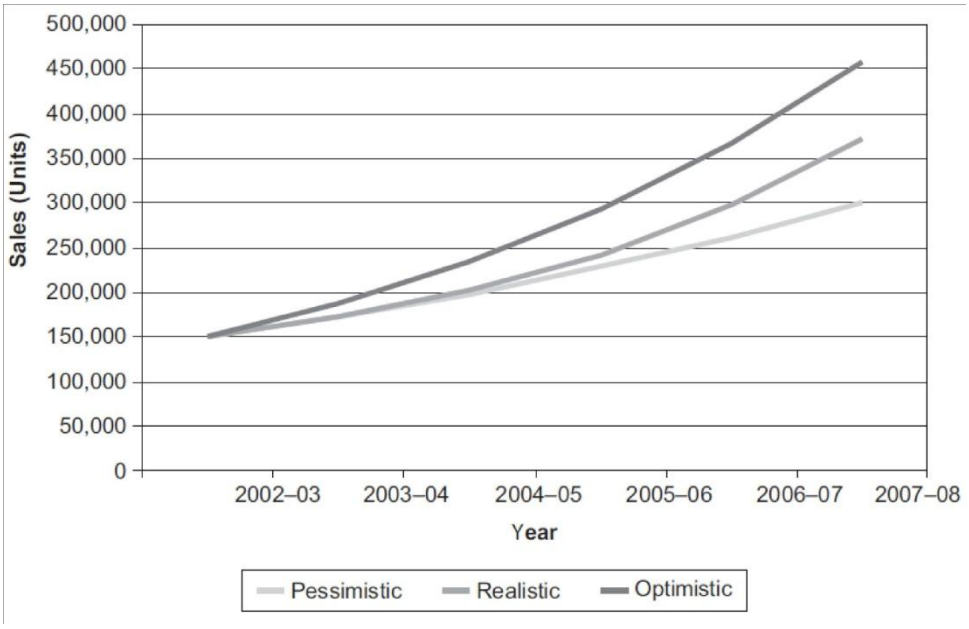


***Fig. 7.3(a)*** *Expected Growth in the Number of Hearing Aids Units to be Sold in North India (Three Perspectives)*

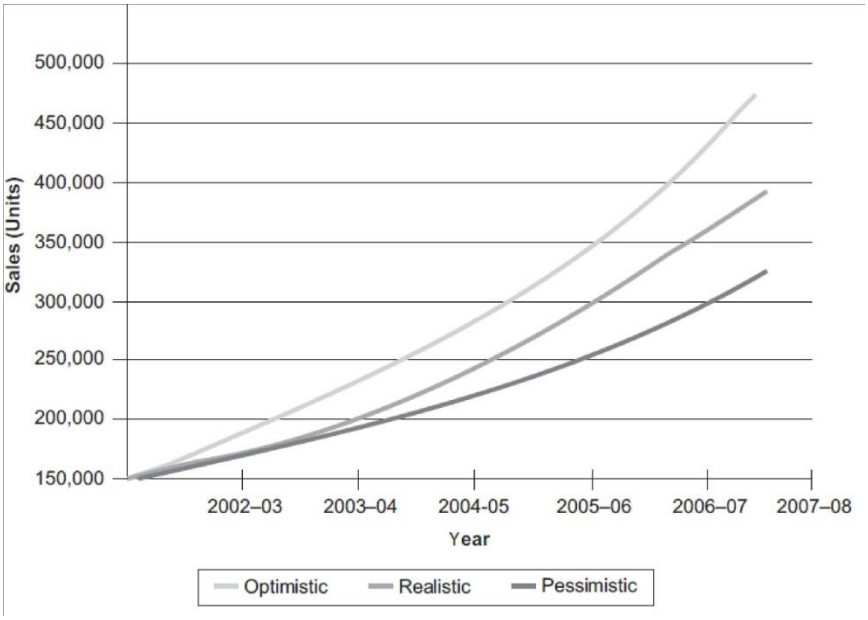


***Fig. 7.3(b)*** *Expected Growth in the Number of Hearing Aids Units to be Sold in North India (Three Perspectives)*

**Area or stratum charts:** Area charts are like the line charts, usually used to demonstrate changes in a pattern over a period of time. However, here there are multiple lines that are essentially components of the original composite data. What is done is that the change in each of the components is individually shown on the same chart and each of them is stacked one on top of the other. The areas between the various lines indicate the scale or volume of the relevant factors/categories (Figure 7.4).

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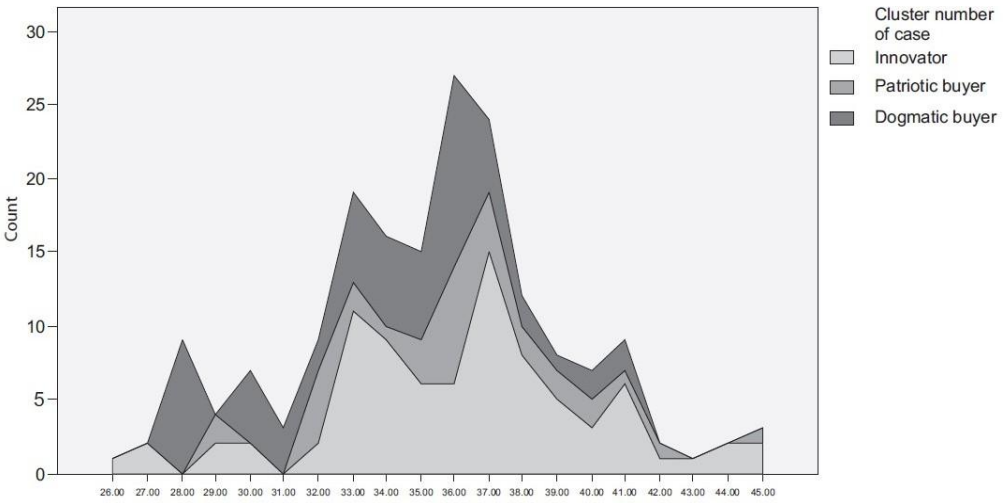


***Fig. 7.4*** *Perception of Nano by Three Psychographic Segments of Two-wheeler Owners*

**Pie charts:** Another way of demonstrating the area or stratum or sectional representation is through the pie charts. The critical difference between a line and pie chart is that the pie chart cannot show changes over time. It simply shows the cross-section of a single time period**.** The sections or slices of the pie indicate the ratio of that section to the total area of the parameter being displayed. There are certain rules that the researcher should keep in mind while creating pie charts.

- The complete data must be shown as a 100 per cent area of the subject being graphed.
- It is a good idea to have the percentages displayed within or above the pie rather than in the legend as then it is easier to understand the magnitude of the section in comparison to the total. For example, Figure 7.5 shows the brand-wise sales in units for the existing brands of hearing aids in the North Indian market.

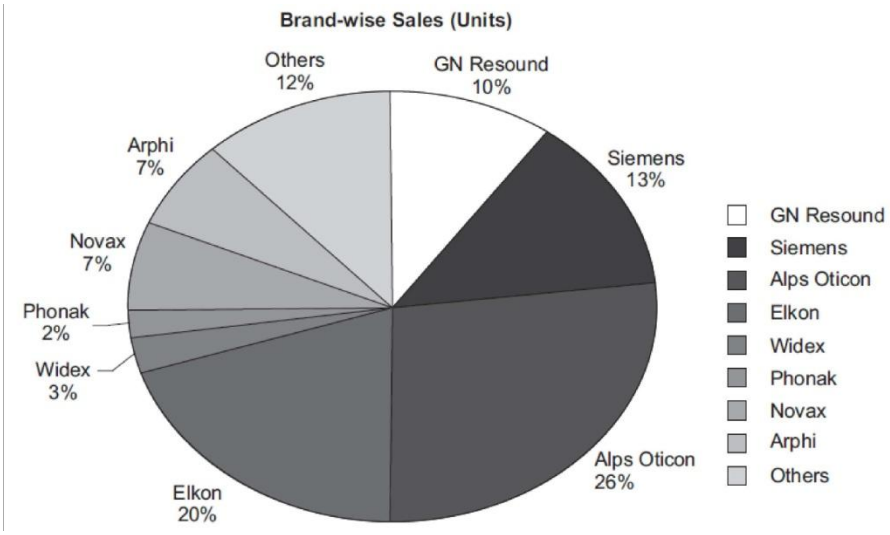


***Fig. 7.5*** *Brand-wise Sales (units) of Hearing Aids in the North Indian Market (2002–03)*

NOTES

- Showing changes over time is difficult through a pie chart, as stated earlier. However, the change in the components at different time periods could be demonstrated as in Figure 7.6, showing share of the car market in India in 2009 and the expected market composition of 2015.

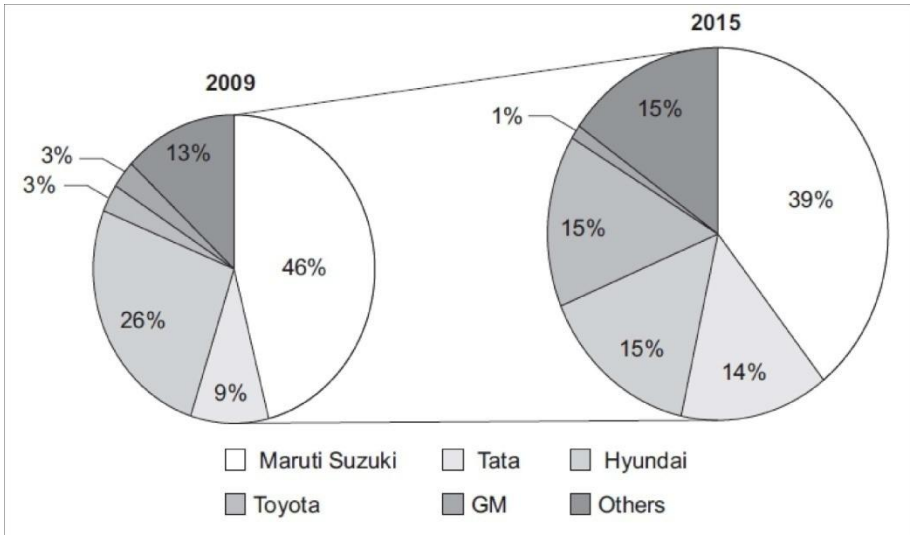


***Fig. 7.6*** *Current Structure of the Indian Car Market (2009) and the Forecasted Structure for 2015*

**Bar charts and histograms:** A very useful representation of quantum or magnitude of different objects on the same parameter are bar diagrams. The comparative position of objects becomes very clear. The usual practice is to formulate vertical bars; however, it is possible to use horizontal bars as well if none of the variable is time related [Figure 7.7(a)]. Horizontal bars are especially useful when one is showing both positive and negative patterns on the same graph [Figure 7.7(b)]. These are called bilateral bar charts and are especially useful to highlight the objects or sectors showing a varied pattern on the studied parameter. It is possible to generate bar graphs with relative ease with computer programs today and the distance between the bars can be extremely precise as compared to those created by hand.

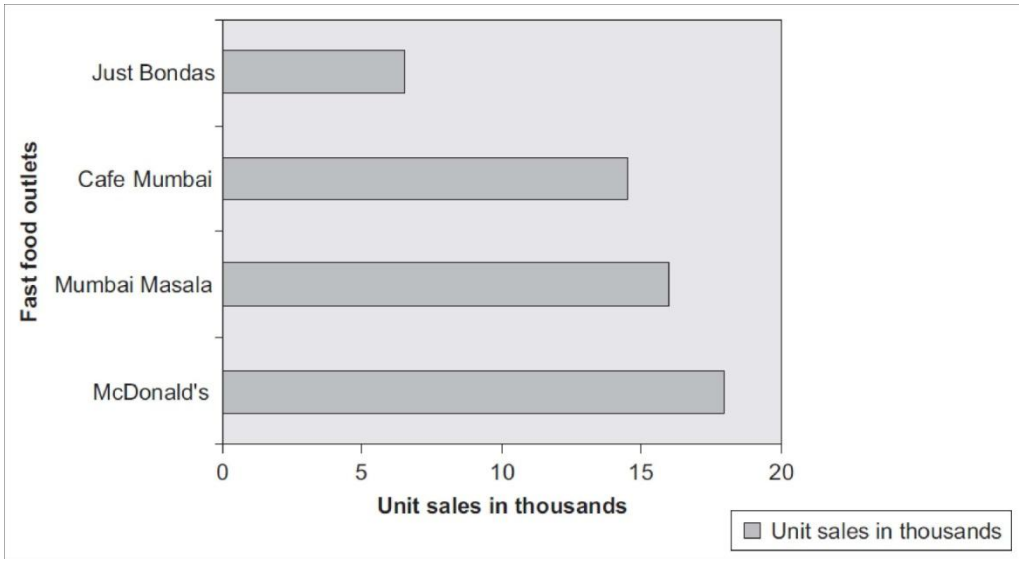


***Fig. 7.7(a)*** *Bar Chart Per day, Unit Sales (Thousands) at Fast Food Outlets in Mumbai*

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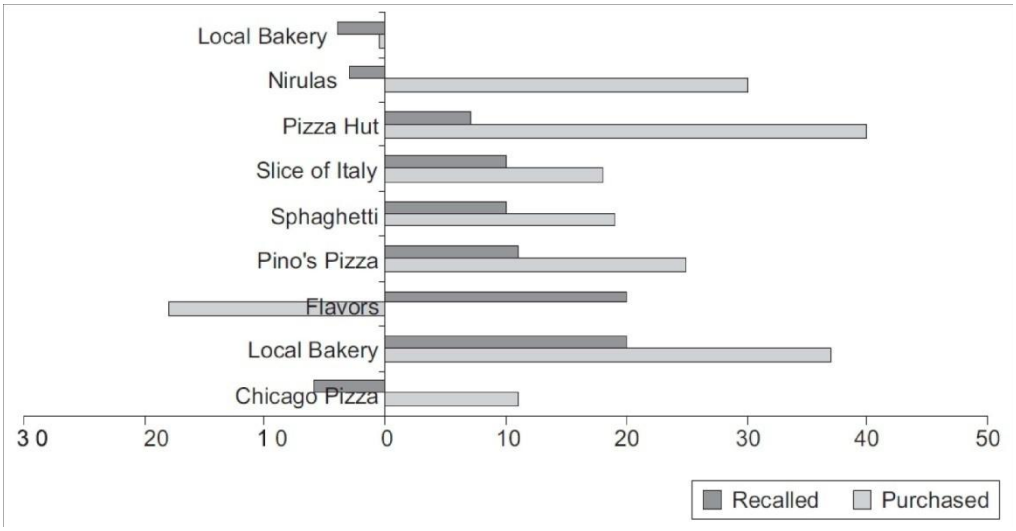


***Fig. 7.7(b)*** *Bilateral Bar Chart—the Brand Recall and Brand Purchase Response for Pizza Joints in the NCR*

Another variation of the bar chart is the histogram (Figure 7.8) here the bars are vertical and the height of each bar reflects the relative or cumulative frequency of that particular variable.

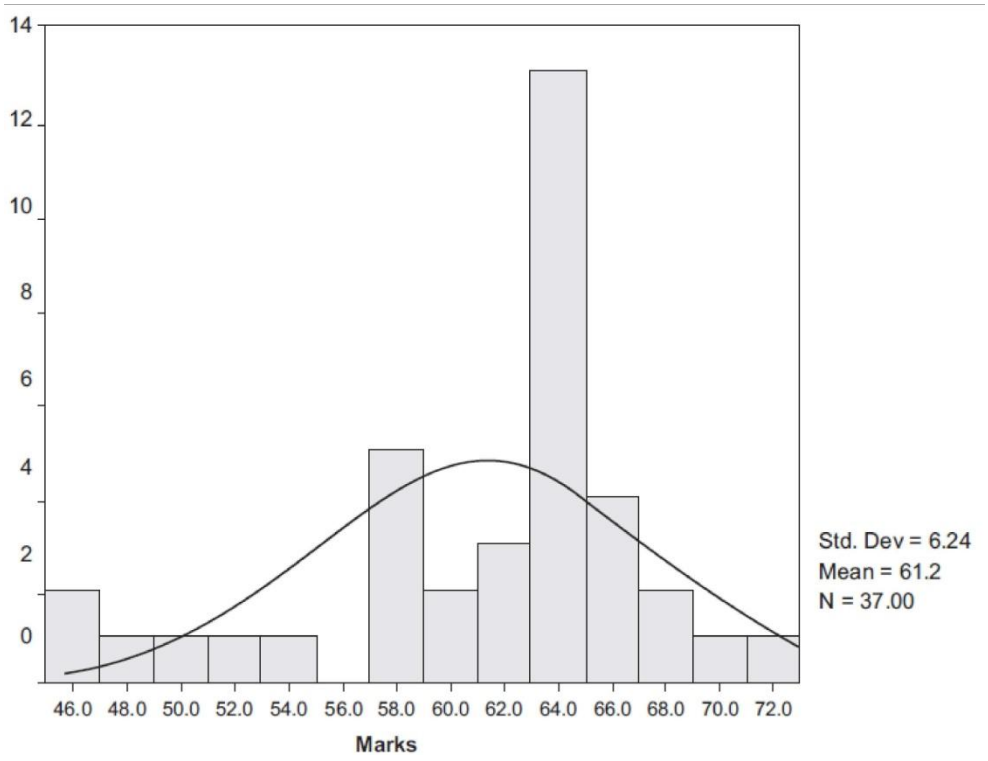


***Fig. 7.8*** *Histogram (With Normal Curve) Displaying Marks in a Course on Research Methods for Management*

**Pictogram:** A pictogram shows graphical representation of data. Pictograms are most often used in popular and general read such as in magazines and newspapers, as they are eye-catching and easy to comprehend by one and all. They are not a very accurate or scientific representation of the actual data and, thus, should be used with caution in an

academic or technical report. Examples of pictograph are given in Figures 7.9(a) and 7.9(b).

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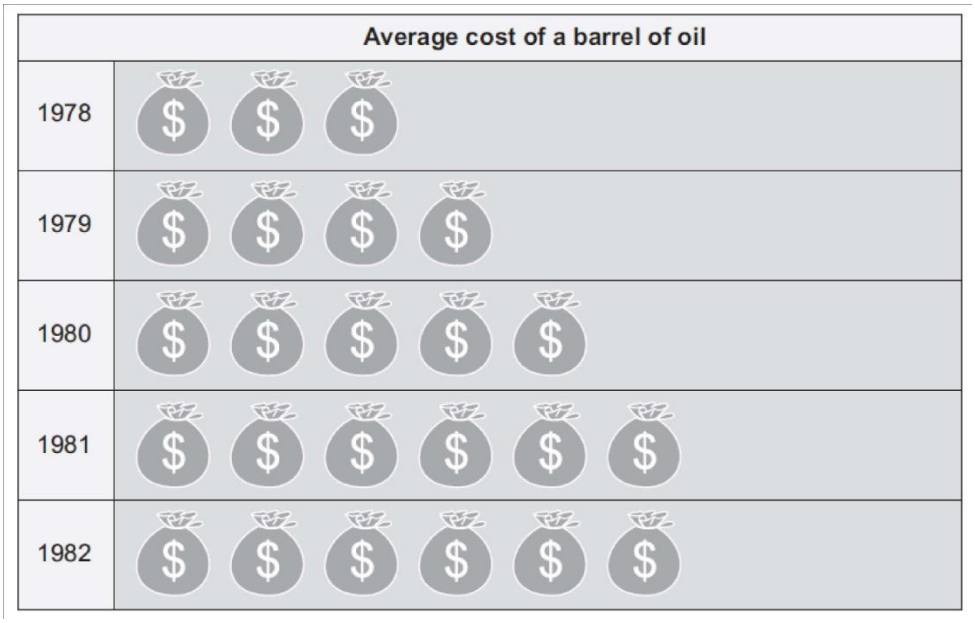


***Fig. 7.9(a)*** *Pictogram Displaying Change in the Cost of Oil Vver a Five-Year Block (1978–1982)*

***Source:*** tutorvista.com

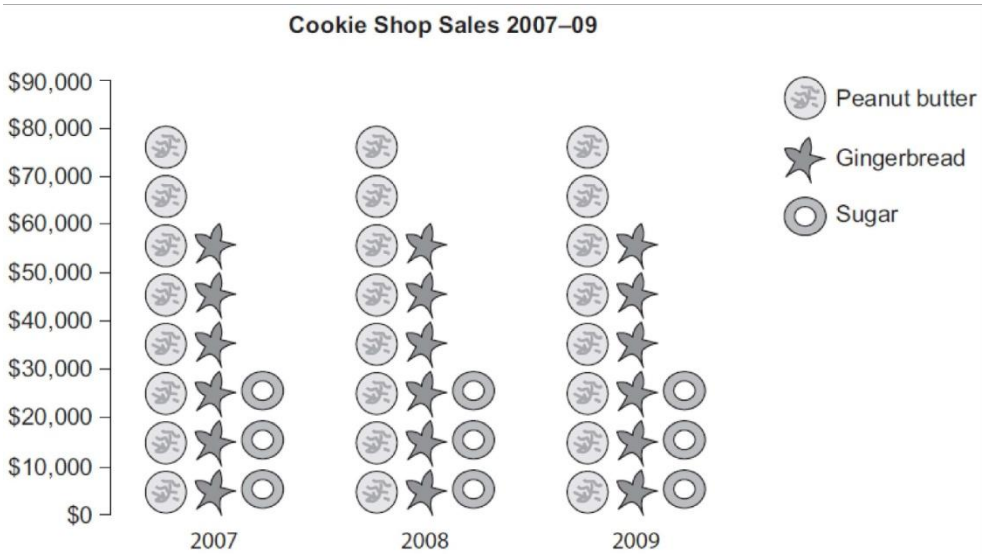


***Fig. 7.9(b)*** *Pictogram Displaying Sales for Cookie Shop over Three Years (2007–09)*

***Source:*** 4spreadsheets.pbworks.com

**Geographic representation:** Geographic or regional maps related to countries, states, districts, territories can be used as a base to show occurrence of the studied variable in various regions or to show comparative analysis about major brands or industries or minerals. In case of comparative data, the researcher must provide the legend in the displayed map, for example any map of the location may be given.

## Research Briefings: Oral Presentation

NOTES

Once the final draft of the research report is prepared and documented, the last stage is sharing the findings and research implications with the client or interested audience. This is usually done orally and with the support of visual aids. The presentation that the researcher might be making could be detailed for his team members or for an academic audience. However, in case the presentation is for the client or for a business audience, brevity and focus of the presentation is critical. A thumb rule for this is not to go beyond 20 minutes with more time for question and answers and interactive discussion on the findings.

Regardless of the audience for the presentation, the most critical aspect of the presentation is two-fold:

(a) Who is the listener? What does he/she seek from the presentation?

(b) What is the core of the briefing—is it background, or methodology, key findings or decision directions that the findings are indicating?

Once the researcher is clear on this, he needs to need to focus on three key aspects:

**Study background:** This should be essentially 10–15 per cent of the entire presentation. It should explain the impetus behind the study as briefly and with suitable emphasis as possible.

**Study findings:** The major conclusions of the study need to be shared in simple words and with appropriate supportive visuals or material. The researcher must be able to demonstrate clearly the link between the study objectives and the findings.

**Study implications:** In case this was agreed upon between the researcher and the client or was specified as a study objective by the researcher, this section would be the last section of the presentation. The link between what was found and what is suggested must be clear to the audience. The researcher may vary the discussion time between the earlier section and this as 45 per cent each or 30–70 or 70–30, depending on the study objective, i.e., more findings or more implication oriented. As supportive material the researcher can make use of:

**Handouts:** These could be in the form of the primary questionnaire designed for the study or company brochures and other related secondary material. They should be distributed to the audience when the presenter is referring to them.

**Slides:** These are created today with the help of computer programmes. There are endless possibilities enhancing the material be presented and for engaging the listener. The designing and creation of the material requires considerable skill and care to ensure that the presentation style should be the supportive aid for an effective delivery and not a showcase of the computer graphics that the researcher is well versed with. Too much clutter and a random mix of text and graphics should be avoided. Animation of the data in synchronization with the vocal delivery makes the presentation more forceful.

**Chalkboards and flipcharts:** These are additional visual aids that could be kept as standby for the question-and-answer session when an idea might have to be highlighted or demonstrated in the response of some query raised by the listeners. However, use of these means during an active presentation should be avoided as they necessitate the presenter to be engaged with the medium at the cost of losing contact with the listener.

NOTES

**Video and audio tapes:** Again, these are supportive materials that can be used to emphasize a point.

The world has become smaller as a consequence of technological innovations that make dissemination of knowledge seem like child's play. Thus, the significance of communication and presentation of this learning cannot be overemphasized.

## SUMMARY

- On completion of the research study and after obtaining the research results, the real skill of the researcher lies in terms of analysing and interpreting the findings and linking them with the propositions formulated in the form of research hypotheses at the beginning of the study.
- The following is the significance of report: it fulfills the historical task of serving as a concrete proof, it ideally presents a comprehensive and objective study of the research problem, it presents a knowledge based on the topic under study, it documents all the steps followed and the analysis carried out.
- Research can be divided into brief reports, detailed reports, technical reports, and business reports.
- Whatever the type of report, the reporting and dissemination of the study and its findings require a structured format and by and large, the process is standardized.
- The following are the steps involved in the report formulation and presentation: a preliminary section with rudimentary parts, the background section with the scope, objectives, background etc; the methodology section and the conclusions.
- The preliminary pages include the letter of transmittal, letter of authorization, table of contents, executive summary and acknowledgements.
- The main text of the report includes problem definition, study background, study scope and objectives and the methodology of research.
- The end text of the report includes appendices, bibliography, footnote and glossary of terms.
- The features of a good research study: clear report mandate, clearly designed methodology, clear representation of findings, representativeness of study finding, etc.
- Guidelines for effective documentation include pointers related to command over the medium, phrasing protocol, simplicity of approach and report formatting and presentation.
- Guidelines for presenting tabular data includes discussion related to the table identification details, data arrays, measurement unit, space, leaders and rulings, assumptions, details and comments, data sources and special mention. There are also certain guidelines related to graphic representation and the use of different graphs.
- Once the final draft of the research report is prepared and documented, the last stage is sharing the findings and research implications with the client or interested audience. This is usually done orally with the support of visual aids.

## KEY TERMS

NOTES

- **Preliminary pages:** It is the initial section of the report which should carry a 'title' and a 'date,' followed by the acknowledgements in the form of Preface or Foreword.
- **Main text:** It is the main text of the report which comprises of the complete outline of the research report with all the details.
- **Letter of transmittal:** It is the letter that goes alongside the formalized copy of the final report containing the purpose behind the study.
- **Executive summary:** It includes the summary of the report starting from the scope and objectives of the study to the methodology employed and the results obtained in a brief and concise manner.

## ANSWERS TO 'CHECK YOUR PROGRESS'

1. Effective recording and communicating of the results of the study is the extremely critical step of the research process.
2. Working papers or basic reports are written for the purpose of collating the process carried out in terms of scope and framework of the study, the methodology followed and instrument designed.
3. The following are the three issues addressed by the letter of transmittal: it indicates the term of the study or objectives, next it goes on to broadly give an indication of the process carried out to conduct the study and the implications of the findings.
4. An executive summary is the summary of the entire report, starting from the scope and objectives of the study to the methodology employed and the results obtained, have to be presented in a brief and concise manner.
5. The following sections specify the methodology of research: research framework, sampling design, data collection methods, data analysis and study results and findings.
6. Some examples of the primary data which are included in the appendices are: original questionnaire, discussion guides, formula used for the study, sample details, original data, and long tables and graphs which can be described in statement form in the text.
7. The research problem statement is prepared on the assumption that the writer at no point in time needs to be physically present in order to clarify the research mandate.
8. The advantage of presenting information in a tabular form is that the statistical tables present the data in a concise and numeral form, which makes quantitative analysis and comparisons easier.
9. The critical difference between a line and pie chart is that the pie chart cannot show changes over time. It simply shows the cross-section of a single time period. The sections or slices of the pie indicate the ratio of that section to the total area of the parameter being displayed.

10. The thumb rule to be followed to ensure the brevity and focus of the presentation is for the presentation to not go beyond 20 minutes with more time for question and answers and interactive discussion on the findings.

NOTES

## QUESTIONS AND EXERCISES

### Short-Answer Questions

1. What is the significance of report writing?
2. List the classification of data included in the title page of a report.
3. Briefly explain the different types of graphs and their uses.
4. Explain the research briefings for oral presentation.
5. What is the difference between geographic representations and pictograms?

### Long-Answer Questions

1. Explain the different types of report.
2. What are the guidelines for effective report writing? Illustrate with suitable examples.
3. Discuss the concept of methodology of report mentioned in the main text of the report.
4. Critically examine the interpretations of results and suggested recommendations
5. Discuss the features of the report writing.
6. 'Visual representations of results are best understood by a reader; thus special care must be taken for this formulation.' Examine the truth of this statement by giving suitable examples.

## FURTHER READING

Kothari, C.R. 2009. *Research Methodology: Methods and Techniques*. New Delhi: New Age International Pvt. Ltd. Publishers.

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Krishnaswami, O R. 2013. *Methodology of Research in Social Sciences*. New Delhi: Himalaya Publishing.

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