# MBA - I YEAR

## *DKR18* : RESEARCH METHODOLOGY

### SYLLABUS

**Unit I**

Research – Meaning, Scope and Significance – Type of Research – Research process – Characteristics of good research – Scientific method – Problems in research – identifying research problem – Objectivity in research.

**Unit II**

Hypothesis – Meaning – Sources – Types – Case study – Features of good design measurement – Meaning, need, errors in measurement, tests of sound measurement, techniques of measurement. Scaling techniques – meaning, types of scales, scale construction techniques – Sampling design – meaning. Concepts, steps in Sampling – Criteria for good sample design – Types of sample designs, probability and non-probability sample.

**Unit III**

Data Collection – Types of data – Sources – Tools for data collection, methods of data collection, constructing questionnaire – Pilot study – Case study – Data processing coding – Editing and tabulation of data – Data analysis.

**Unit IV**

Test of significance – Assumptions about parametric and nonparametric tests. Parametric tests – chi – square, t – Test, F Test, Z Test. Introduction to ANOVA, One way, Two way and three way classification.

**Unit V**

Interpretation – meaning, Techniques of interpretation, Report writing – significance and steps – layout of report – types of reports – oral presentation – executive summary – mechanics of writing research report – Precautions for writing report – norms for using tables, chart and diagrams – Appendix – norms of using Index and Bibliography.

**References** :


1. Rao K.V. Research Method for Management and Commerce – Sterling.
2. Kothari C.R. – Research Methodology.
3. Wilkinson Bhadarkar – Methodology and Techniques of Social Research.
4. Anderson et.al. – Assignment and Thesis writing.

**Unit - I**

*Research - Meaning, Scope and Significance - Type of Research - Research process - Characteristics of good research - Scientific method - Problems in research - identifying research problem - Objectivity in research.*

## 1.1 MEANING OF RESEARCH

Research in common parlance refers to a search for knowledge. Once can also define research as a scientific and systematic search for pertinent information on a specific topic. In fact, research is an art of scientific investigation.

The Advanced Learner's Dictionary of Current English lays down the meaning of research as "a careful investigation or inquiry specially through search for new facts in any branch of knowledge."

Redman and Mory define research as a "systematized effort to gain new knowledge." Some people consider research as a movement, a movement from the known to the unknown. It is actually a voyage of discovery. We all possess the vital instinct of inquisitiveness for, when the unknown confronts us, we wonder and our inquisitiveness makes us probe and attain full and fuller understanding of the unknown. This inquisitiveness is the mother of all knowledge and the method, which man employs for obtaining the knowledge of whatever the unknown, can be termed as research.

Research is an academic activity and as such the term should be used in a technical sense. According to Clifford Woody research comprises defining and redefining problems, formulating hypothesis or suggested solutions; collecting, organising and evaluating data; making deductions and reaching conclusions; and at last carefully testing the conclusions to determine whether they fit the formulating hypothesis. D. Slesinger and M. Stephenson in the Encyclopaedia of Social Sciences define research as "the manipulation of things, concepts or symbols for the purpose of generalising to extend, correct or verify knowledge, whether that knowledge aids in construction of theory or in the practice of an art." Research is, thus, an original contribution to the existing stock of knowledge making for its advancement. It is the persuit of truth with the help of study, observation, comparison and experiment. In short, the search for knowledge through objective and systematic method of finding solution to a problem is research. The systematic approach concerning generalisation and the formulation of a theory is also research. As such the term 'research' refers to the systematic method consisting of enunciating the problem, formulating a hypothesis, collecting the facts or data, analyzing the facts and reaching certain conclusions either in the form of solutions(s) towards the concerned problem or in certain generalisations for some theoretical formulation.

## 1.2 SCOPE AND SIGNIFICANCE OF RESEARCH

"All progress is born of inquiry. Doubt is often better than overconfidence, for it leads to inquiry, and inquiry leads to invention" is a famous Hudson Maxim in context of which the significance of research can well be understood. Increased amounts of research make progress possible. Research inculcates scientific and inductive thinking and it promotes the development of logical habits of thinking and organisation.

The role of research in several fields of applied economics, whether related to business or to the economy as a whole, has greatly increased in modern times. The increasingly complex nature of business and government has focused attention on the use of research in solving operational problems. Research, as an aid to economic policy, has gained added importance, both for government and business.

Research provides the basis for nearly all government policies in our economic system. For instance, government's budgets rest in part on an analysis of the needs and desires of the people and on the availability of revenues to meet these needs. The cost of needs has to be equated to probable revenues and this is a field where research is most needed. Through research we can devise alternative policies and can as well examine the consequences of each of these alternatives. Decision-making may not be a part of research, but research certainly facilitates the decisions of the policy maker. Government has also to chalk out programmes for dealing with all facets of the country's existence and most of these will be related directly or indirectly to economic conditions. The plight of cultivators, the problems of big and small business and industry, working conditions, trade union activities, the problems of distribution, even the size and nature of defence services are matters requiring research. Thus, research is considered necessary with regard to the allocation of nation's resources. Another area in government, where research is necessary, is collecting information on the economic and social structure of the nation. Such information indicates what is happening in the economy and what changes are taking place. Collecting such statistical information is by no means a routine task, but it involves a variety of research problems. These day nearly all governments maintain large staff of research technicians or experts to carry on this work. Thus, in the context of government, research as a tool to economic policy has three distinct phases of operation, viz., (i) investigation of economic structure through continual compilation of facts; (ii) diagnosis of events that are taking place and the analysis of the forces underlying them; and (iii) the prognosis, i.e., the prediction of future developments.

Research has its special significance in solving various operational and planning problems of business and industry. Operations research and market research, along with motivational research, are considered crucial and their results assist, in more than one way, in taking business decisions. Market research is the investigation of the structure and development of a market for the purpose of formulating efficient policies for purchasing, production and sales. Operations research refers to the application of mathematical, logical and analytical techniques to the solution of business problems of cost minimisation or of profit maximisation or what can be termed as optimisation problems. Motivational research of determining why people behave as they do is mainly concerned with market characteristics. In other words, it is concerned with the determination of motivations underlying the consumer (market) behaviour. All these are of great help to people in business and industry who are responsible for taking business decisions. Research with regard to demand and market factors has great utility in business. Given knowledge of future demand, it is generally not difficult for a firm, or for an industry to adjust its supply schedule within the limits of its projected capacity. Market analysis has become an integral tool of business policy these days. Business budgeting, which ultimately results in a projected profit and loss account, is based mainly on sales estimates which in turn depends on business research. Once sales forecasting is done, efficient production and investment programmes can be set up around which are grouped the purchasing and financing plans. Research, thus, replaces intuitive business decisions by more logical and scientific decisions.

Research is equally important for social scientists in studying social relationships and in seeking answers to various social problems. It provides the intellectual satisfaction of knowing a few things just for the sake of knowledge and also has practical utility for the social scientist to know for the sake of being able to do something better or in a more efficient manner. Research in social sciences is concerned both with knowledge for its own sake and with knowledge for what it can contribute to practical concerns. "This double emphasis is perhaps especially appropriate in the case of social science. On the one hand, its responsibility as a science is to develop a body of principles that make possible the understanding and prediction of the whole range of human interactions. On the other hand, because of its social orientation, it is increasingly being looked to for practical guidance in solving immediate problems of human relations."

In addition to what has been stated above, the significance of research can also be understood keeping in view the following points:

(a) To those students who are to write a master's or Ph.D. thesis, research may mean a careerism or a way to attain a high position in the social structure;
(b) To professionals in research methodology, research may mean a source of livelihood;
(c) To philosophers and thinkers, research may mean the outlet for new ideas and insights;
(d) To literary men and women, research may mean the development of new styles and creative work;
(e) To analysts and intellectuals, research may mean the generalisations of new theories.

Thus, research is the fountain of knowledge for the sake of knowledge and an important source of providing guidelines for solving different business, governmental and social problems. It is a sort of formal training which enables one to understand the new developments in one's field in a better way.

## 1.3 TYPES OF RESEARCH

The basic types of research are as follows:

**(i)** **Descriptive vs. Analytical**: Descriptive research includes surveys and fact-finding enquiries of different kinds. The major purpose of descriptive research is description of the state of affairs as it exists at present. In social science and business research we quite often use the term Ex post facto research for descriptive research studies. The main characteristic of this method is that the researcher has no control over the variables; he can only report what has happened or what is happening. Most ex post facto research projects are used for descriptive studies in which the researcher seeks to measure such items as, for example, frequency of shopping, preferences of people, or similar data. Ex post facto studies also include attempts by researchers to discover causes even when they cannot control the variables. The methods of research utilized in descriptive research are survey methods of all kinds, including comparative and correlational methods. In analytical research, on the other hand, the researcher has to use facts or information already available, and analyze these to make a critical evaluation of the material.

**(ii)** **Applied vs. Fundamental**: Research can either be applied (or action) research or fundamental (to basic or pure) research. Applied research aims at finding a solution for an immediate problem facing a society or an industrial/business organisation, whereas fundamental research is mainly concerned with generalisations and with the

formulation of a theory. "Gathering knowledge for knowledge's sake is termed 'pure' or 'basic' research." Research concerning some natural phenomenon or relating to pure mathematics are examples of fundamental research. Similarly, research studies, concerning human behaviour carried on with a view to make generalisations about human behaviour, are also examples of fundamental research, but research aimed at certain conclusions (say, a solution) facing a concrete social or business problem is an example of applied research. Research to identify social, economic or political trends that may affect a particular institution or the copy research (research to find out whether certain communications will be read and understood) or the marketing research or evaluation research are examples of applied research. Thus, the central aim of applied research is to discover a solution for some pressing practical problem, whereas basic research is directed towards finding information that has a broad base of applications and thus, adds to the already existing organized body of scientific knowledge.

**(iii) Quantitative vs. Qualitative:** Quantitative research is based on the measurement of quantity or amount. It is applicable to phenomena that can be expressed in terms of quantity. Qualitative research, on the other hand, is concerned with qualitative phenomenon, i.e., phenomena relating to or involving quality or kind. For instance, when we are interested in investigating the reasons for human behaviour (i.e., why people think or do certain things), we quite often talk of 'Motivation Research', an important type of qualitative research. This type of research aims at discovering the underlying motives and desires, using in depth interviews for the purpose. Other techniques of such research are word association tests, sentence completion tests, story completion tests and similar other projective techniques. Attitude or opinion research i.e., research designed to find out how people feel or what they think about a particular subject or institution is also qualitative research. Qualitative research is specially important in the behavioural sciences where the aim is to discover the underlying motives of human behaviour. Through such research we can analyse the various factors which motivate people to behave in a particular manner or which make people like or dislike a particular thing. It may be stated, however, that to apply qualitative research in practice is relatively a difficult job and therefore, while doing such research, one should seek guidance from experimental psychologists.

(iv) **Conceptual vs. Empirical:** Conceptual research is that related to some abstract idea(s) or theory. It is generally used by philosophers and thinkers to develop new concepts or to reinterpret existing ones. On the other hand, empirical research relies on experience or observation alone, often without due regard for system and theory. It is data-based research, coming up with conclusions which are capable of being verified by observation or experiment. We can also call it as experimental type of research. In such a research it is necessary to get at facts firsthand, at their source, and actively to go about doing certain things to stimulate the production of desired information. In such a research, the researcher must first provide himself with a working hypothesis or guess as to the probable results. He then works to get enough facts (data) to prove or disprove his hypothesis. He then sets up experimental designs which he thinks will manipulate the persons or the materials concerned so as to bring forth the desired information. Such research is thus characterised by the experimenter's control over the variables under study and his deliberate manipulation of one of them to study its effects. Empirical research is appropriate when proof is sought that certain variables affect other variables in some way. Evidence gathered through experiments or empirical studies is today considered to be the most powerful support possible for a given hypothesis.

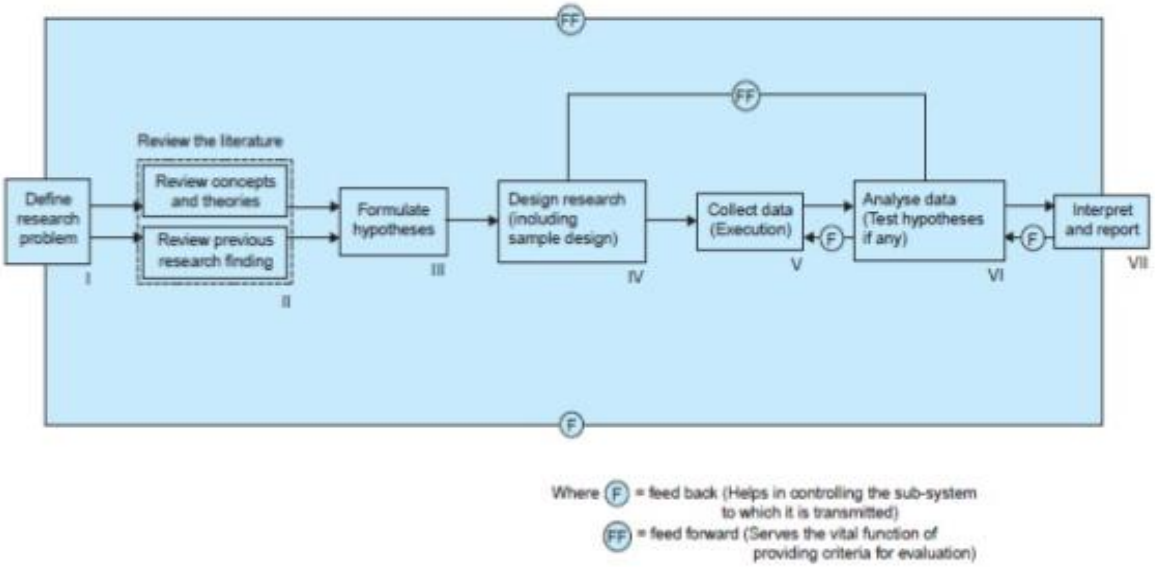
(v) **Some Other Types of Research:** All other types of research are variations of one or more of the above stated approaches, based on either the purpose of research, or the time required to accomplish research, on the environment in which research is done, or on the basis of some other similar factor. Form the point of view of time, we can think of research either as one-time research or longitudinal research. In the former case the research is confined to a single time-period, whereas in the latter case the research is carried on over several time-periods. Research can be field-setting research or laboratory research or simulation research, depending upon the environment in which it is to be carried out. Research can as well be understood as clinical or diagnostic research. Such research follows case-study methods or indepth approaches to reach the basic causal relations. Such studies usually go deep into the causes of things or events that interest us, using very small samples and very deep probing data gathering devices. The research may be exploratory or it may be formalized. The objective of exploratory research is the development of hypotheses rather than their testing, whereas formalized research studies are those with substantial structure and

with specific hypotheses to be tested. Historical research is that which utilizes historical sources like documents, remains, etc. to study events or ideas of the past, including the philosophy of persons and groups at any remote point of time. Research can also be classified as conclusion-oriented and decision-oriented. While doing conclusion oriented research, a researcher is free to pick up a problem, redesign the enquiry as he proceeds and is prepared to conceptualize as he wishes. Decision-oriented research is always for the need of a decision maker and the researcher in this case is not free to embark upon research according to his own inclination. Operations research is an example of decision oriented research since it is a scientific method of providing executive departments with a quantitative basis for decisions regarding operations under their control.

## 1.4 RESEARCH PROCESS

Before embarking on the details of research methodology and techniques, it seems appropriate to present a brief overview of the research process. Research process consists of series of actions or steps necessary to effectively carry out research and the desired sequencing of these steps.

**Research process chart**




The chart indicates that the research process consists of a number of closely related activities, as shown through I to VII. But such activities overlap continuously rather than following a strictly prescribed sequence. At times, the first step determines the nature of the

last step to be undertaken. If subsequent procedures have not been taken into account in the early stages, serious difficulties may arise which may even prevent the completion of the study. One should remember that the various steps involved in a research process are not mutually exclusive; nor they are separate and distinct. They do not necessarily follow each other in any specific order and the researcher has to be constantly anticipating at each step in the research process the requirements of the subsequent steps. However, the following order concerning various steps provides a useful procedural guideline regarding the research process:

1. Formulating the research problem;
2. Extensive literature survey;
3. Developing the hypothesis;
4. Preparing the research design;
5. Determining sample design;
6. Collecting the data;
7. Execution of the project;
8. Analysis of data;
9. Hypothesis testing;
10. Generalisations and interpretation, and
11. Preparation of the report or presentation of the results, i.e., formal write-up of conclusions reached.

A brief description of the above stated steps will be helpful.

**1. Formulating the research problem:** There are two types of research problems, viz., those which relate to states of nature and those which relate to relationships between variables. At the very outset the researcher must single out the problem he wants to study, i.e., he must decide the general area of interest or aspect of a subject-matter that he would like to inquire into. Initially the problem may be stated in a broad general way and then the ambiguities, if any, relating to the problem be resolved. Then, the feasibility of a particular solution has to be considered before a working formulation of the problem can be set up. The formulation of a general topic into a specific research problem, thus, constitutes the first step in a scientific enquiry. Essentially two steps are involved in formulating the research problem, viz., understanding the problem thoroughly, and rephrasing the same into meaningful terms from an analytical point of view.

The best way of understanding the problem is to discuss it with one's own colleagues or with those having some expertise in the matter. In an academic institution the researcher can seek the help from a guide who is usually an experienced man and has several research problems in mind. Often, the guide puts forth the problem in general terms and it is up to the researcher to narrow it down and phrase the problem in operational terms. In private business units or in governmental organisations, the problem is usually earmarked by the administrative agencies with whom the researcher can discuss as to how the problem originally came about and what considerations are involved in its possible solutions.

The researcher must at the same time examine all available literature to get himself acquainted with the selected problem. He may review two types of literature—the conceptual literature concerning the concepts and theories, and the empirical literature consisting of studies made earlier which are similar to the one proposed. The basic outcome of this review will be the knowledge as to what data and other materials are available for operational purposes which will enable the researcher to specify his own research problem in a meaningful context. After this the researcher rephrases the problem into analytical or operational terms i.e., to put the problem in as specific terms as possible. This task of formulating, or defining, a research problem is a step of greatest importance in the entire research process. The problem to be investigated must be defined unambiguously for that will help discriminating relevant data from irrelevant ones. Care must, however, be taken to verify the objectivity and validity of the background facts concerning the problem. Professor W.A. Neiswanger correctly states that the statement of the objective is of basic importance because it determines the data which are to be collected, the characteristics of the data which are relevant, relations which are to be explored, the choice of techniques to be used in these explorations and the form of the final report. If there are certain pertinent terms, the same should be clearly defined along with the task of formulating the problem. In fact, formulation of the problem often follows a sequential pattern where a number of formulations are set up, each formulation more specific than the preceeding one, each one phrased in more analytical terms, and each more realistic in terms of the available data and resources.

**2. Extensive literature survey:** Once the problem is formulated, a brief summary of it should be written down. It is compulsory for a research worker writing a thesis for a Ph.D. degree to write a synopsis of the topic and submit it to the necessary Committee or the Research Board for approval. At this juncture the researcher should undertake extensive literature survey connected with the problem. For this purpose, the abstracting and indexing

journals and published or unpublished bibliographies are the first place to go to. Academic journals, conference proceedings, government reports, books etc., must be tapped depending on the nature of the problem. In this process, it should be remembered that one source will lead to another. The earlier studies, if any, which are similar to the study in hand should be carefully studied. A good library will be a great help to the researcher at this stage.

**3. Development of working hypotheses:** After extensive literature survey, researcher should state in clear terms the working hypothesis or hypotheses. Working hypothesis is tentative assumption made in order to draw out and test its logical or empirical consequences. As such the manner in which research hypotheses are developed is particularly important since they provide the focal point for research. They also affect the manner in which tests must be conducted in the analysis of data and indirectly the quality of data which is required for the analysis. In most types of research, the development of working hypothesis plays an important role. Hypothesis should be very specific and limited to the piece of research in hand because it has to be tested. The role of the hypothesis is to guide the researcher by delimiting the area of research and to keep him on the right track. It sharpens his thinking and focuses attention on the more important facets of the problem. It also indicates the type of data required and the type of methods of data analysis to be used.

How does one go about developing working hypotheses? The answer is by using the following approach:

(a) Discussions with colleagues and experts about the problem, its origin and the objectives in seeking a solution;

(b) Examination of data and records, if available, concerning the problem for possible trends, peculiarities and other clues;

(c) Review of similar studies in the area or of the studies on similar problems; and

(d) Exploratory personal investigation which involves original field interviews on a limited scale with interested parties and individuals with a view to secure greater insight into the practical aspects of the problem.

Thus, working hypotheses arise as a result of a-priori thinking about the subject, examination of the available data and material including related studies and the counsel of experts and interested parties. Working hypotheses are more useful when stated in precise and clearly defined terms. It may as well be remembered that occasionally we may encounter a problem where we do not need working hypotheses, specially in the case of exploratory or formulative researches which do not aim at testing the hypothesis. But as a general rule,

specification of working hypotheses in another basic step of the research process in most research problems.

**4. Preparing the research design:** The research problem having been formulated in clear cut terms, the researcher will be required to prepare a research design, i.e., he will have to state the conceptual structure within which research would be conducted. The preparation of such a design facilitates research to be as efficient as possible yielding maximal information. In other words, the function of research design is to provide for the collection of relevant evidence with minimal expenditure of effort, time and money. But how all these can be achieved depends mainly on the research purpose.

Research purposes may be grouped into four categories, viz.,

(i) Exploration,

(ii) Description,

(iii) Diagnosis, and

(iv) Experimentation.

A flexible research design which provides opportunity for considering many different aspects of a problem is considered appropriate if the purpose of the research study is that of exploration. But when the purpose happens to be an accurate description of a situation or of an association between variables, the suitable design will be one that minimises bias and maximises the reliability of the data collected and analysed.

There are several research designs, such as, experimental and non-experimental hypothesis testing. Experimental designs can be either informal designs (such as before-and-after without control, after-only with control, before-and-after with control) or formal designs (such as completely randomized design, randomized block design, Latin square design, simple and complex factorial designs), out of which the researcher must select one for his own project.

The preparation of the research design, appropriate for a particular research problem, involves usually the consideration of the following:

(i) the means of obtaining the information;

(ii) the availability and skills of the researcher and his staff (if any);

(iii) explanation of the way in which selected means of obtaining information will be organized and the reasoning leading to the selection;

(iv) the time available for research; and

(v) the cost factor relating to research, i.e., the finance available for the purpose.

**5. Determining sample design:** All the items under consideration in any field of inquiry constitute a 'universe' or 'population'. A complete enumeration of all the items in the 'population' is known as a census inquiry. It can be presumed that in such an inquiry when all the items are covered no element of chance is left and highest accuracy is obtained. But in practice this may not be true. Even the slightest element of bias in such an inquiry will get larger and larger as the number of observations increases. Moreover, there is no way of checking the element of bias or its extent except through a resurvey or use of sample checks. Besides, this type of inquiry involves a great deal of time, money and energy. Not only this, census inquiry is not possible in practice under many circumstances. For instance, blood testing is done only on sample basis. Hence, quite often we select only a few items from the universe for our study purposes. The items so selected constitute what is technically called a sample.

The researcher must decide the way of selecting a sample or what is popularly known as the sample design. In other words, a sample design is a definite plan determined before any data are actually collected for obtaining a sample from a given population. Thus, the plan to select 12 of a city's 200 drugstores in a certain way constitutes a sample design. Samples can be either probability samples or non-probability samples. With probability samples each element has a known probability of being included in the sample but the non-probability samples do not allow the researcher to determine this probability. Probability samples are those based on simple random sampling, systematic sampling, stratified sampling, cluster/area sampling whereas non-probability samples are those based on convenience sampling, judgement sampling and quota sampling techniques. A brief mention of the important sample designs is as follows:

**(i) Deliberate sampling:** Deliberate sampling is also known as purposive or non-probability sampling. This sampling method involves purposive or deliberate selection of particular units of the universe for constituting a sample which represents the universe. When population elements are selected for inclusion in the sample based on the ease of access, it can be called convenience sampling. If a researcher wishes to secure data from, say, gasoline buyers, he may select a fixed number of petrol stations and may conduct interviews at these stations. This would be an example of convenience sample of gasoline buyers. At times such a procedure may give very biased results particularly when the population is not homogeneous. On the other hand, in judgement sampling the researcher's judgement is used for selecting items which he considers as representative of the population. For example, a

judgement sample of college students might be taken to secure reactions to a new method of teaching. Judgement sampling is used quite frequently in qualitative research where the desire happens to be to develop hypotheses rather than to generalise to larger populations.

**(ii) Simple random sampling**: This type of sampling is also known as chance sampling or probability sampling where each and every item in the population has an equal chance of inclusion in the sample and each one of the possible samples, in case of finite universe, has the same probability of being selected. For example, if we have to select a sample of 300 items from a universe of 15,000 items, then we can put the names or numbers of all the 15,000 items on slips of paper and conduct a lottery. Using the random number tables is another method of random sampling. To select the sample, each item is assigned a number from 1 to 15,000. Then, 300 five digit random numbers are selected from the table. To do this we select some random starting point and then a systematic pattern is used in proceeding through the table. We might start in the 4th row, second column and proceed down the column to the bottom of the table and then move to the top of the next column to the right. When a number exceeds the limit of the numbers in the frame, in our case over 15,000, it is simply passed over and the next number selected that does fall within the relevant range. Since the numbers were placed in the table in a completely random fashion, the resulting sample is random. This procedure gives each item an equal probability of being selected. In case of infinite population, the selection of each item in a random sample is controlled by the same probability and that successive selections are independent of one another.

**(iii) Systematic sampling:** In some instances the most practical way of sampling is to select every 15th name on a list, every 10th house on one side of a street and so on. Sampling of this type is known as systematic sampling. An element of randomness is usually introduced into this kind of sampling by using random numbers to pick up the unit with which to start. This procedure is useful when sampling frame is available in the form of a list. In such a design the selection process starts by picking some random point in the list and then every nth element is selected until the desired number is secured.

(**iv) Stratified sampling:** If the population from which a sample is to be drawn does not constitute a homogeneous group, then stratified sampling technique is applied so as to obtain a representative sample. In this technique, the population is stratified into a number of non overlapping sub populations or strata and sample items are selected from each stratum. If the items selected from each stratum is based on simple random sampling the entire

procedure, first stratification and then simple random sampling, is known as stratified random sampling.

**(v) Quota sampling:** In stratified sampling the cost of taking random samples from individual strata is often so expensive that interviewers are simply given quota to be filled from different strata, the actual selection of items for sample being left to the interviewer's judgement. This is called quota sampling. The size of the quota for each stratum is generally proportionate to the size of that stratum in the population. Quota sampling is thus an important form of non-probability sampling. Quota samples generally happen to be judgement samples rather than random samples.

**(vi) Cluster sampling and area sampling:** Cluster sampling involves grouping the population and then selecting the groups or the clusters rather than individual elements for inclusion in the sample. Suppose some departmental store wishes to sample its credit card holders. It has issued its cards to 15,000 customers. The sample size is to be kept say 450. For cluster sampling this list of 15,000 card holders could be formed into 100 clusters of 150 card holders each. Three clusters might then be selected for the sample randomly. The sample size must often be larger than the simple random sample to ensure the same level of accuracy because is cluster sampling procedural potential for order bias and other sources of error is usually accentuated. The clustering approach can, however, make the sampling procedure relatively easier and increase the efficiency of field work, specially in the case of personal interviews. Area sampling is quite close to cluster sampling and is often talked about when the total geographical area of interest happens to be big one. Under area sampling we first divide the total area into a number of smaller non-overlapping areas, generally called geographical clusters, then a number of these smaller areas are randomly selected, and all units in these small areas are included in the sample. Area sampling is specially helpful where we do not have the list of the population concerned. It also makes the field interviewing more efficient since interviewer can do many interviews at each location.

**(vii) Multi-stage sampling**: This is a further development of the idea of cluster sampling. This technique is meant for big inquiries extending to a considerably large geographical area like an entire country. Under multi-stage sampling the first stage may be to select large primary sampling units such as states, then districts, then towns and finally certain families within towns. If the technique of random-sampling is applied at all stages, the sampling procedure is described as multi-stage random sampling.

**(viii) Sequential sampling:** This is somewhat a complex sample design where the ultimate size of the sample is not fixed in advance but is determined according to mathematical decisions on the basis of information yielded as survey progresses. This design is usually adopted under acceptance sampling plan in the context of statistical quality control.

In practice, several of the methods of sampling described above may well be used in the same study in which case it can be called mixed sampling. It may be pointed out here that normally one should resort to random sampling so that bias can be eliminated and sampling error can be estimated. But purposive sampling is considered desirable when the universe happens to be small and a known characteristic of it is to be studied intensively. Also, there are conditions under which sample designs other than random sampling may be considered better for reasons like convenience and low costs. The sample design to be used must be decided by the researcher taking into consideration the nature of the inquiry and other related factors.

**6. Collecting the data:** In dealing with any real life problem it is often found that data at hand are inadequate, and hence, it becomes necessary to collect data that are appropriate. There are several ways of collecting the appropriate data which differ considerably in context of money costs, time and other resources at the disposal of the researcher. Primary data can be collected either through experiment or through survey. If the researcher conducts an experiment, he observes some quantitative measurements, or the data, with the help of which he examines the truth contained in his hypothesis. But in the case of a survey, data can be collected by any one or more of the following ways:

**(i) By observation:** This method implies the collection of information by way of investigator's own observation, without interviewing the respondents. The information obtained relates to what is currently happening and is not complicated by either the past behaviour or future intentions or attitudes of respondents. This method is no doubt an expensive method and the information provided by this method is also very limited. As such this method is not suitable in inquiries where large samples are concerned.

**(ii) Through personal interview**: The investigator follows a rigid procedure and seeks answers to a set of pre-conceived questions through personal interviews. This method of collecting data is usually carried out in a structured way where output depends upon the ability of the interviewer to a large extent.

**(iii)Through telephone interviews:** This method of collecting information involves contacting the respondents on telephone itself. This is not a very widely used method

but it plays an important role in industrial surveys in developed regions, particularly, when the survey has to be accomplished in a very limited time.

**(iv) By mailing of questionnaires:** The researcher and the respondents do come in contact with each other if this method of survey is adopted. Questionnaires are mailed to the respondents with a request to return after completing the same. It is the most extensively used method in various economic and business surveys. Before applying this method, usually a Pilot Study for testing the questionnaire is conduced which reveals the weaknesses, if any, of the questionnaire. Questionnaire to be used must be prepared very carefully so that it may prove to be effective in collecting the relevant information.

**(v) Through schedules**: Under this method the enumerators are appointed and given training. They are provided with schedules containing relevant questions. These enumerators go to respondents with these schedules. Data are collected by filling up the schedules by enumerators on the basis of replies given by respondents. Much depends upon the capability of enumerators so far as this method is concerned. Some occasional field checks on the work of the enumerators may ensure sincere work

The researcher should select one of these methods of collecting the data taking into consideration the nature of investigation, objective and scope of the inquiry, financial resources, available time and the desired degree of accuracy. Though he should pay attention to all these factors but much depends upon the ability and experience of the researcher. In this context Dr A.L Bowley very aptly remarks that in collection of statistical data commonsense is the chief requisite and experiences the chief teacher.

**7. Execution of the project:** Execution of the project is a very important step in the research process. If the execution of the project proceeds on correct lines, the data to be collected would be adequate and dependable. The researcher should see that the project is executed in a systematic manner and in time. If the survey is to be conducted by means of structured questionnaires, data can be readily machine-processed. In such a situation, questions as well as the possible answers may be coded. If the data are to be collected through interviewers, arrangements should be made for proper selection and training of the interviewers. The training may be given with the help of instruction manuals which explain clearly the job of the interviewers at each step. Occasional field checks should be made to ensure that the interviewers are doing their assigned job sincerely and efficiently. A careful watch should be

kept for unanticipated factors in order to keep the survey as much realistic as possible. This, in other words, means that steps should be taken to ensure that the survey is under statistical control so that the collected information is in accordance with the pre-defined standard of accuracy. If some of the respondents do not cooperate, some suitable methods should be designed to tackle this problem. One method of dealing with the non-response problem is to make a list of the non-respondents and take a small sub-sample of them, and then with the help of experts vigorous efforts can be made for securing response.

**8. Analysis of data:** After the data have been collected, the researcher turns to the task of analyzing them. The analysis of data requires a number of closely related operations such as establishment of categories, the application of these categories to raw data through coding, tabulation and then drawing statistical inferences. The unwieldy data should necessarily be condensed into a few manageable groups and tables for further analysis. Thus, researcher should classify the raw data into some purposeful and usable categories. Coding operation is usually done at this stage through which the categories of data are transformed into symbols that may be tabulated and counted. Editing is the procedure that improves the quality of the data for coding. With coding the stage is ready for tabulation. Tabulation is a part of the technical procedure wherein the classified data are put in the form of tables. The mechanical devices can be made use of at this juncture. A great deal of data, specially in large inquiries, is tabulated by computers. Computers not only save time but also make it possible to study large number of variables affecting a problem simultaneously.

Analysis work after tabulation is generally based on the computation of various percentages, coefficients, etc., by applying various well defined statistical formulae. In the process of analysis, relationships or differences supporting or conflicting with original or new hypotheses should be subjected to tests of significance to determine with what validity data can be said to indicate any conclusion(s). For instance, if there are two samples of weekly wages, each sample being drawn from factories in different parts of the same city, giving two different mean values, then our problem may be whether the two mean values are significantly different or the difference is just a matter of chance. Through the use of statistical tests we can establish whether such a difference is a real one or is the result of random fluctuations. If the difference happens to be real, the inference will be that the two samples come from different universes and if the difference is due to chance, the conclusion would be that the two samples belong to the same universe. Similarly, the technique of

analysis of variance can help us in analysing whether three or more varieties of seeds grown on certain fields yield significantly different results or not. In brief, the researcher can analyse the collected data with the help of various statistical measures.

**9. Hypothesis-testing:** After analysing the data as stated above, the researcher is in a position to test the hypotheses, if any, he had formulated earlier. Do the facts support the hypotheses or they happen to be contrary? This is the usual question which should be answered while testing hypotheses. Various tests, such as Chi square test, t-test, F-test, have been developed by statisticians for the purpose. The hypotheses may be tested through the use of one or more of such tests, depending upon the nature and object of research inquiry. Hypothesis-testing will result in either accepting the hypothesis or in rejecting it. If the researcher had no hypotheses to start with, generalisations established on the basis of data may be stated as hypotheses to be tested by subsequent researches in times to come.

**10. Generalisations and interpretation:** If a hypothesis is tested and upheld several times, it may be possible for the researcher to arrive at generalisation, i.e., to build a theory. As a matter of fact, the real value of research lies in its ability to arrive at certain generalisations. If the researcher had no hypothesis to start with, he might seek to explain his findings on the basis of some theory. It is known as interpretation. The process of interpretation may quite often trigger off new questions which in turn may lead to further researches.

**11. Preparation of the report or the thesis:** Finally, the researcher has to prepare the report of what has been done by him. Writing of report must be done with great care keeping in view the following:

1. The layout of the report should be as follows: (i) the preliminary pages; (ii) the main text, and (iii) the end matter. In its preliminary pages the report should carry title and date followed by acknowledgements and foreword. Then there should be a table of contents followed by a list of tables and list of graphs and charts, if any, given in the report.

The main text of the report should have the following parts:

**(a) Introduction**: It should contain a clear statement of the objective of the research and an explanation of the methodology adopted in accomplishing the research. The scope of th study along with various limitations should as well be stated in this part.

**(b) Summary of findings**: After introduction there would appear a statement of findings and recommendations in non-technical language. If the findings are extensive, they should be summarised.

**(c) Main report**: The main body of the report should be presented in logical sequence and broken-down into readily identifiable sections.

**(d) Conclusion**: Towards the end of the main text, researcher should again put down the results of his research clearly and precisely. In fact, it is the final summing up.

At the end of the report, appendices should be enlisted in respect of all technical data. Bibliography, i.e., list of books, journals, reports, etc., consulted, should also be given in the end. Index should also be given specially in a published research report.

1. Report should be written in a concise and objective style in simple language avoiding vague expressions such as 'it seems,' 'there may be', and the like.
2. Charts and illustrations in the main report should be used only if they present the information more clearly and forcibly.
3. Calculated 'confidence limits' must be mentioned and the various constraint experienced in conducting research operations may as well be stated.

## 1.5 CHARACTERISTICS OF GOOD RESEARCH

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

1. The purpose of the research should be clearly defined and common concepts be used.
2. The research procedure used should be described in sufficient detail to permit another researcher to repeat the research for further advancement, keeping the continuity of what has already been attained.
3. The procedural design of the research should be carefully planned to yield results that are as objective as possible.
4. The researcher should report with complete frankness, flaws in procedural design and estimate their effects upon the findings.
5. The analysis of data should be sufficiently adequate to reveal its significance and the methods of analysis used should be appropriate. The validity and reliability of the data should be checked carefully.

6. Conclusions should be confined to those justified by the data of the research and limited to those for which the data provide an adequate basis.
7. Greater confidence in research is warranted if the researcher is experienced, has a good reputation in research and is a person of integrity.

In other words, we can state the qualities of a good research as under:

1. **Good research is systematic**: It means that research is structured with specified steps to be taken in a specified sequence in accordance with the well defined set of rules. Systematic characteristic of the research does not rule out creative thinking but it certainly does reject the use of guessing and intuition in arriving at conclusions.
2. **Good research is logical**: This implies that research is guided by the rules of logical reasoning and the logical process of induction and deduction are of great value in carrying out research. Induction is the process of reasoning from a part to the whole whereas deduction is the process of reasoning from some premise to a conclusion which follows from that very premise. In fact, logical reasoning makes research more meaningful in the context of decision making.
3. **Good research is empirical:** It implies that research is related basically to one or more aspects of a real situation and deals with concrete data that provides a basis for external validity to research results.
4. **Good research is replicable:** This characteristic allows research results to be verified by replicating the study and thereby building a sound basis for decisions.

## 1.6 RESEARCH AND SCIENTIFIC METHOD

For a clear perception of the term research, one should know the meaning of scientific method. The two terms, research and scientific method, are closely related. Research, as we have already stated, can be termed as "an inquiry into the nature of, the reasons for, and the consequences of any particular set of circumstances, whether these circumstances are experimentally controlled or recorded just as they occur. Further, research implies the researcher is interested in more than particular results; he is interested in the repeatability of the results and in their extension to more complicated and general situations." On the other hand, the philosophy common to all research methods and techniques, although they may vary considerably from one science to another, is usually given the name of scientific method. In this context, Karl Pearson writes, "The scientific method is one and same in the branches (of science) and that method is the method of all logically trained minds … the

unity of all sciences consists alone in its methods, not its material; the man who classifies facts of any kind whatever, who sees their mutual relation and describes their sequences, is applying the Scientific Method and is a man of science." Scientific method is the pursuit of truth as determined by logical considerations. The ideal of science is to achieve a systematic interrelation of facts. Scientific method attempts to achieve "this ideal by experimentation, observation, logical arguments from accepted postulates and a combination of these three in varying proportions." In scientific method, logic aids in formulating propositions explicitly and accurately so that their possible alternatives become clear. Further, logic develops the consequences of such alternatives, and when these are compared with observable phenomena, it becomes possible for the researcher or the scientist to state which alternative is most in harmony with the observed facts. All this is done through experimentation and survey investigations which constitute the integral parts of scientific method.

Experimentation is done to test hypotheses and to discover new relationships. If any, among variables. But the conclusions drawn on the basis of experimental data are generally criticized for either faulty assumptions, poorly designed experiments, badly executed experiments or faulty interpretations. As such the researcher must pay all possible attention while developing the experimental design and must state only probable inferences. The purpose of survey investigations may also be to provide scientifically gathered information to work as a basis for the researchers for their conclusions.

The scientific method is, thus, based on certain basic postulates which can be stated as under:

1. It relies on empirical evidence;
2. It utilizes relevant concepts;
3. It is committed to only objective considerations;
4. It presupposes ethical neutrality, i.e., it aims at nothing but making only adequate and correct statements about population objects;
5. It results into probabilistic predictions;
6. Its methodology is made known to all concerned for critical scrutiny are for use in testing the conclusions through replication;
7. It aims at formulating most general axioms or what can be termed as scientific theories.

Thus, "the scientific method encourages a rigorous, impersonal mode of procedure dictated by the demands of logic and objective procedure." Accordingly, scientific method implies an objective, logical and systematic method, i.e., a method free from personal bias or prejudice, a method to ascertain demonstrable qualities of a phenomenon capable of being verified, a method wherein the researcher is guided by the rules of logical reasoning, a method wherein the investigation proceeds in an orderly manner and a method that implies internal consistency.

## 1.7 RESEARCH PROBLEM

In research process, the first and foremost step happens to be that of selecting and properly defining a research problem.* A researcher must find the problem and formulate it so that it becomes susceptible to research. Like a medical doctor, a researcher must examine all the symptoms (presented to him or observed by him) concerning a problem before he can diagnose correctly. To define a problem correctly, a researcher must know: what a problem is?

**What is a research problem?**

A research problem, in general, refers to some difficulty which a researcher experiences in the context of either a theoretical or practical situation and wants to obtain a solution for the same. Usually we say that a research problem does exist if the following conditions are met with:

I. There must be an individual (or a group or an organisation), let us call it 'I,' to whom the problem can be attributed. The individual or the organisation, as the case may be, occupies an environment, say 'N', which is defined by values of the uncontrolled variables, Yj.

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

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

IV. The courses of action available must provides some chance of obtaining the objective but they cannot provide the same chance, otherwise the choice would not matter. Thus, if

P (Oj / I, Cj, N) represents the probability that an outcome Oj will occur, if I select Cj in N, then $P(O_1 / I , C_1, N) \neq P(O_1 / I , C2 , Ng$ . In simple words, we can say that the choices must have unequal efficiencies for the desired outcomes.

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

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

a) There must be an individual or a group which has some difficulty or the problem.
b) There must be some objective(s) to be attained at. If one wants nothing, one cannot have a problem.
c) There must be alternative means (or the courses of action) for obtaining the objective(s) one wishes to attain. This means that there must be at least two means available to a researcher for if he has no choice of means, he cannot have a problem.
d) There must remain some doubt in the mind of a researcher with regard to the selection of alternatives. This means that research must answer the question concerning the relative efficiency of the possible alternatives.
e) There must be some environment(s) to which the difficulty pertains.

Thus, a research problem is one which requires a researcher to find out the best solution for the given problem, i.e., to find out by which course of action the objective can be attained optimally in the context of a given environment. There are several factors which may result in making the problem complicated. For instance, the environment may change affecting the efficiencies of the courses of action or the values of the outcomes; the number of alternative courses of action may be very large; persons not involved in making the decision may be affected by it and react to it favourably or unfavourably, and similar other factors. All such elements (or at least the important ones) may be thought of in context of a research problem.

**Selecting or identifying the Research Problem**

The research problem undertaken for study must be carefully selected. The task is a difficult one, although it may not appear to be so. Help may be taken from a research guide in

this connection. Nevertheless, every researcher must find out his own salvation for research problems cannot be borrowed. A problem must spring from the researcher's mind like a plant springing from its own seed. If our eyes need glasses, it is not the optician alone who decides about the number of the lens we require. We have to see ourselves and enable him to prescribe for us the right number by cooperating with him. Thus, a research guide can at the most only help a researcher choose a subject. However, the following points may be observed by a researcher in selecting a research problem or a subject for research:

1. Subject which is overdone should not be normally chosen, for it will be a difficult task to throw any new light in such a case.
2. Controversial subject should not become the choice of an average researcher.
3. Too narrow or too vague problems should be avoided.
4. The subject selected for research should be familiar and feasible so that the related research material or sources of research are within one's reach. Even then it is quite difficult to supply definitive ideas concerning how a researcher should obtain ideas for his research. For this purpose, a researcher should contact an expert or a professor in the University who is already engaged in research. He may as well read articles published in current literature available on the subject and may think how the techniques and ideas discussed therein might be applied to the solution of other problems. He may discuss with others what he has in mind concerning a problem. In this way he should make all possible efforts in selecting a problem.
5. The importance of the subject, the qualifications and the training of a researcher, the costs involved, the time factor are few other criteria that must also be considered in selecting a problem. In other words, before the final selection of a problem is done, a researcher must ask himself the following questions:
    a) Whether he is well equipped in terms of his background to carry out the research?
    b) Whether the study falls within the budget he can afford?
    c) Whether the necessary cooperation can be obtained from those who must participate in research as subjects?

    If the answers to all these questions are in the affirmative, one may become sure so far as the practicability of the study is concerned.
6. The selection of a problem must be preceded by a preliminary study. This may not be necessary when the problem requires the conduct of a research closely similar to one that has already been done. But when the field of inquiry is relatively new and does

not have available a set of well developed techniques, a brief feasibility study must always be undertaken.

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

## 1.8 OBJECTIVITY IN RESEARCH

**Meaning:**

Objectivity is sine qua non of the scientific method. It means the willingness and ability to examine evidence dispassionately. It is the first condition of research. Objectivity means basing conclusion on facts without any bias and value judgment. The conclusion should be independent of one's personal beliefs, likes, dislikes and hopes. Both the data and the inference drawn from their analysis must be free from bias and prejudices.

Research, as stressed by Myrdal, has an inbuilt, self-cleaning, or self-healing capacity. Facts kick, and do so even-though with some delay when data are first assembled under categories that correspond to the biased approach applied but are inadequate to reality.

**Factors Affecting Objectivity:**

It is very difficult to achieve objectivity in social science research. This difficulty arises out of the adverse influences of (1) personal prejudices and bias, (2) value judgment, (3) ethical dilemma and (4) complexity of social phenomena.

Personal prejudices and biases emanate from habits of thought, temperamental weaknesses, skeptical attitude, wishful thinking, vested interest etc. "prejudice and biases are like fantasies-to believe what is comforting to believe". These make on to believe something without considering evidence.

Value related problem arises from the social context within which research occurs. A researcher's attitudes towards socio-economic issues are influenced by his values. His judgment is coloured by the 'ism' – capitalism or communism or socialism, etc., to which he belongs and the writer/philosopher who inspired him. Even great social scientists project their values and views in their theories. The proletarian interpretation of Karl Marx, Bertrand Russel's power interpretation of social order, Freud's sex interpretation of society, Fabian socialism of George Bernard Shaw and Gandhiji's philosophy of limiting wants and trusteeship are illustrations. To quote Gunnar Myrdal, "value premises are needed even in

the theoretical stage of establishing knowledge about facts and factual relations. A view is impossible except from a viewpoint. A disinterested social science has never existed and can never come to exist—for logical reasons, valuations are always implied in our search for truth.

Personal preconceptions may not only have a distorting effect on the data but are also highly insidious, because they are so "subtle, so implicit, so deeply noted that it is difficult for us to discern them in ourselves, or when they are called to our attention, to avoid rationalizing them, instead of examining them objectively. Ethical dilemmas arises out of the researchers's relations with other participants in the research process. There are four types of interpersonal relations that pose potential ethical dilemmas: (1) relations with those sponsoring the research, (2) relations with those permitting access to sources of data, (3) relations with the investigators connected with the project, and (4) relations with research subjects themselves.

Social phenomena are too complex for easy comprehension, and too vast to provide precise verifiable knowledge. A physical scientist is confined to the four walls of a laboratory, and he can conduct controlled experimentation. On the other hand, laboratory of social scientists is as vast as the entire society and it is not amenable for controllers' experimentation.

Although strict objectivity is next to impossibility, it is possible for a reflective researcher of social life to attain a reasonable level of objectivity consistent with logical and systematic thinking.

**Achieving Reasonable Objectivity in Social Science Research:**

The following approaches and measures may contribute to some degree of objectivity.

1. **Patience and Self-control:** A researcher must have utmost patience and self-control. He should not be overwhelmed by personal likes and undisciplined imagination and wishful thinking. He must discipline himself to avoid prejudging the phenomenon under study.
2. **Open mind:** A researcher often succumbs to the habit of thinking and personal notions that leads him to presuppose that certain facts are "truths". He must have an open mind to subject his research process and interpretations to the critical review of other scientists. Only by such interaction. Can corrections be made.
3. **Use of standardized concepts:** The concepts should be precisely defined and used consistently so as to avoid misconceptions and confusion.

4. **Use of quantitative method:** Appropriate statistical and mathematical techniques of analysis may be used, as they are free from subjective bias.
5. **Co-operative research:** Group research will be more objective than an individual research. Group interaction will reduce the influence of personal bias.
6. **Use of random sampling:** In drawing a sample of units of study, random sampling technique may be used, as it is free from personal prejudices.

# UNIT II

## 2.1 HYPOTHESIS

### Introduction

The formulation of hypotheses or propositions as to the possible answers to the research question is an important step in the process of formulation of the research problem. Keen observation, creative thinking, hunch, wit, imagination, vision, insight and sound judgment are of greater importance in setting up reasonable hypotheses. A thorough knowledge about the phenomenon and related fields is of great value in its process. The formulation of hypotheses plays an important part in the growth of knowledge in every science.

### Meaning of Hypothesis

Hypothesis is a tentative proposition formulated for empirical testing. It is a declarative statement combining concepts. It is a tentative answer to a research question. It is tentative, because its veracity can be evaluated only after it has been tested empirically. Lundberg defines hypothesis as "a tentative generalization, that validity of which remains to be tested" Goods and Hatt define it as "a proposition which can be put to a test to determine its validity".

### Hypothesis –Necessary or Not

It the formulation of useful hypotheses always necessary and possible? It is true that hypotheses are useful and they guide the research process in the proper direction. But can hypotheses may not arise. Similarly, in exploratory studies, initially it may not be possible to set up any worthwhile hypotheses. In fact, the very purpose of such exploratory studies may be to formulate meaningful hypotheses for further formal studies. But strictly speaking, the mere fact-finding and the exploratory studies cannot be considered to be typical research studies. In all analytical and experimental studies, hypotheses should be set up in order to give a proper direction to them.

## 2.2 SOURCES OF HYPOTHESES

Hypotheses can be derived from various sources:

1. **Theory:** This is one of the main sources of hypotheses. It gives direction to research by stating what is known. Logical deduction from theory leads to new hypotheses. For example, profit/wealth maximization is considered as the goal of private enterprises.

From this assumption, various hypotheses are derived. "The rate of return on capital employed is an index of business success"; "The optimum capital structure is that combination of debt and equity which leads to the maximum value of the firm." "Higher the earning per share, more favourable is the financial leverage."

2. **Observation:** Hypotheses can be derived from observation. From the observation of price behaviour in a market, for example, the relationship between the price and demand for an article is hypothesized.
3. **Analogies** are another source of useful hypotheses. Julian Huxley has pointed out that casual observations in nature or in the framework of another science may be a fertile source of hypotheses. For example, the hypothesis that "similar human types or activities may be found in similar geophysical regions" came from plant ecology.
4. **Intuition and personal experience** may also contribute to the formulation of hypotheses. Personal life and experiences of persons determine their perception and conception. These may, in turn, direct a person to certain hypotheses more quickly. The story of Newton and the falling apple, the flash of wisdom to Buddha under a Banyan tree illustrate this individual accidental process.
5. **Findings of studies:** Hypotheses may be developed out of the findings of other studies in order to replicate and test.
6. **State of knowledge:** An important source of hypotheses is the state of knowledge in any particular science. Where formal theories exist, hypotheses can be deduced. If the hypotheses are rejected, theories would be modified. Where formal theories are scarce, hypotheses are generated from conceptual frameworks. In either case, the hypotheses are related to the conceptual-theoretical level.
7. **Culture:** Another source of hypotheses is the culture on which the researcher was nurtured. Western culture has induced the emergence of sociology as an academic discipline. Over the past decade, a large part of the hypotheses on American society examined by researchers we connected with violence. This interest is related to the considerable increase in the level of violence in America. In India insocio-economic and leadership studies, hypotheses based on caste and economic status are common, because Indian economic system is riddled with inequalities and privileges.
8. **Continuity of research:** The continuity of research in a field itself constituted an important source of hypotheses. The rejection of some hypotheses leads to the

formulation of new ones capable of explaining dependent variables in subsequent researches on the same subject.

## 2.3 TYPE OF HYPOTHESES

Hypotheses are classified in several ways. With reference to their function, hypotheses are of two types: (a) Descriptive Hypotheses and (b) Relational Hypotheses. Another approach is to classify them into: (c) Working Hypotheses, (d) Null Hypotheses and (e) Statistical Hypotheses. Third approach is to divide them on the basis of the level of abstraction. Three broad levels may be distinguished: (i) simple description, (ii) logical derivation, and (iii) abstraction. Accordingly there are three types of hypotheses: (f) common-sense hypotheses, (g) complex hypotheses and (h) analytical hypotheses.

**Descriptive hypotheses :** these are propositions that describe the characteristics (such as size, form or distribution) of a variable. The variable may be an object, person, organization, situation or event. Some examples are:

"The rate of unemployment among arts graduates is higher than that of commerce graduates".

"Public enterprises are more amenable for centralized planning"

"The Educational system is not oriented to human resource needs of a country"

**Relational hypotheses: +**These are propositions, which describe the relationship between two variables. The relationship suggested may be positive or negative correlation or causal relationship. Some examples are:

"Families with higher incomes spend more for recreation".

"Participative management promotes motivation among executives"

"The lower the rate of job turnover in a work group, the higher the work productivity"

"Upper-class people have fewer children than lower-class people"

"Labour productivity decreases as working duration increases"

Causal hypotheses state that the existence of, or a change in, one variable causes or leads to an effect on another variable. The first variable is called the independent variable, and the latter the dependent variable. When dealing with causal relationships between variables the researcher must consider the direction in which such relationships flow, I,e., which is cause and which is effect.

**Working hypotheses:** while planning the study of problem, hypotheses are formed. Initially then may not be very specific. In such cases, they are referred to as "Working Hypotheses" which are subject to modification as the investigation proceeds.

**Null hypotheses:** These are hypothical statement denying what are explicitly indicated in working hypotheses. They do not, nor were ever intended to exist in reality. They state that no difference exists between the parameter and the statistic being compared to it. For example, even though there is relationship between a family's income level and expenditure on recreation, a null hypothesis may state: "There is no relationship between families' income level and expenditure on recreation." Null hypotheses are formulated for testing statistical significance, since, this form is a convenient approach to statistical analysis. As the test would nullify the null hypotheses, they are so called.

There is some justification for using null hypotheses. They conform to the qualities of detachment and objectivity to be possessed by a researcher. The attempts to test hypotheses which he assumes to be true, it would appear as if he is not behaving objectively. This problem does not arise when he uses null hypotheses.

Moreover, null hypotheses are more exact. It is easier to reject the contrary of an hypothesis than to confirm it with complete certainty. Hence, the concept of null hypotheses is found to be very useful.

**Statistical hypotheses:** These are statements about a statistical population. These are derived from a sample. These are quantitative in nature in that they are numerically measurable, e.g., "Group A is older than Group B."

Statistical hypotheses may be hypotheses of difference or hypotheses of association. The latter specify the relations between variables. This association is measured by the co-efficient of correlation. E.g., if the co-efficient of correlation between bonus and productivity is +1.0, then there is a perfect positive correlation between the bonus and productivity.

As Abraham Kaplan has pointed out, "all inductive inference is based on samples … All hypotheses might be said to be statistical hypotheses in a broad sense: statistics has the task of assessing the weight of evidence for a particular hypothesis contained in a given set of data."

**Common sense hypotheses:** These represent the common sense ideas. They state the existence of empirical uniformities perceived through dy to day observations. Many empirical

uniformities may be observed in business establishments. The social background of workers. And the behaviour patterns of specific groups like students, e.g., "shop-assistants in small shops lack motivation."

"Soldiers from upper-class are less adjusted in the army than lower class men"; "Fresh students conform to the conventions set up by seniors."

Common sense statements are often a confused mixture of clichés and moral judgments. Scientists have a large-scale job in transforming and testing them. This requires three tasks: "first, the removal of value judgement; second the clarification of terms: and third, the application of validity tests." 'What everybody knows' is not known until it has been tested'. The simple level hypotheses that seek empirical generalization play an important role in the growth of a science.

**Complex hypotheses:** These aim at testing the existence of logically derived relationships between empirical uniformities. For example, in the ea4ly stage Human ecology described empirical uniformities in the distribution of land values, industrial concentrations, types of business and other phenomena. Further study and logical analysis of these and other related findings led to the formulation of complex hypotheses such as "The concentric growth circles characterize a city", "Members of minority groups suffer from oppression psychosis", etc. Such hypotheses are purposeful **distributions** of empirical exactness. Because of their removal from empirical reality, these constructs are termed as 'ideal types. 'The function of such hypotheses is to create tools and problems for further research in otherwise very complex areas of investigation."

**Analytical hypotheses:** These are concerned with the relationship of analytic variables. These hypotheses occur at the highest level of abstraction. These specify relationship between changes in one property and changes in another. For example, the study of human fertility might show empirical regularities by wealth, education, region, and religion. If these were raised to the level of ideal type formulation, one result might be the hypotheses: "There are two high-fertility population segments in India, viz., low-income urban Muslims and low-income rural low caste Hindus." At a still higher level of abstraction, the effects of region, education, and religion on fertility might be held constant. This would allow a better measurement of the relation between the variables of wealth and fertility.

This level of hypothesizing is the most sophisticated mode of formulation and contributes to the development of 'brilliant' abstract theories.

## 2.4 MEASUREMENT IN RESEARCH

### Meaning and need of measurement

In our daily life we are said to measure when we use some yardstick to determine weight, height, or some other feature of a physical object. We also measure when we judge how well we like a song, a painting or the personalities of our friends. We, thus, measure physical objects as well as abstract concepts. Measurement is a relatively complex and demanding task, specially so when it concerns qualitative or abstract phenomena. By measurement we mean the process of assigning numbers to objects or observations, the level of measurement being a function of the rules under which the numbers are assigned.

It is easy to assign numbers in respect of properties of some objects, but it is relatively difficult in respect of others. For instance, measuring such things as social conformity, intelligence, or marital adjustment is much less obvious and requires much closer attention than measuring physical weight, biological age or a person's financial assets. In other words, properties like weight, height, etc., can be measured directly with some standard unit of measurement, but it is not that easy to measure properties like motivation to succeed, ability to stand stress and the like. We can expect high accuracy in measuring the length of pipe with a yard stick, but if the concept is abstract and the measurement tools are not standardized, we are less confident about the accuracy of the results of measurement.

Technically speaking, measurement is a process of mapping aspects of a domain onto other aspects of a range according to some rule of correspondence. In measuring, we devise some form of scale in the range (in terms of set theory, range may refer to some set) and then transform or map the properties of objects from the domain (in terms of set theory, domain may refer to some other set) onto this scale. For example, in case we are to find the male to female attendance ratio while conducting a study of persons who attend some show, then we may tabulate those who come to the show according to sex. In terms of set theory, this process is one of mapping the observed physical properties of those coming to the show (the domain) on to a sex classification (the range). The rule of correspondence is: If the object in the domain appears to be male, assign to "0" and if female assign to "1". Similarly, we can record a person's marital status as 1, 2, 3 or 4, depending on whether the person is single, married, widowed or divorced. We can as well record "Yes or No" answers to a question as "0" and "1" (or as 1 and 2 or perhaps as 59 and 60). In this artificial or nominal way, categorical data (qualitative or descriptive) can be made into numerical data and if we thus code the various categories, we refer to the numbers we record as nominal data. Nominal

data are numerical in name only, because they do not share any of the properties of the numbers we deal in ordinary arithmetic. For instance if we record marital status as 1, 2, 3, or 4 as stated above, we cannot write $4 > 2$ or $3 < 4$ and we cannot write $3 – 1 = 4 – 2$, $1 + 3 = 4$ or $4 / 2 = 2$.

In those situations when we cannot do anything except set up inequalities, we refer to the data as ordinal data. For instance, if one mineral can scratch another, it receives a higher hardness number and on Mohs' scale the numbers from 1 to 10 are assigned respectively to talc, gypsum, calcite, fluorite, apatite, feldspar, quartz, topaz, sapphire and diamond. With these numbers we can write $5 > 2$ or $6 < 9$ as apatite is harder than gypsum and feldspar is softer than sapphire, but we cannot write for example $10 – 9 = 5 – 4$, because the difference in hardness between diamond and sapphire is actually much greater than that between apatite and fluorite. It would also be meaningless to say that topaz is twice as hard as fluorite simply because their respective hardness numbers on Mohs' scale are 8 and 4. The greater than symbol (i.e., >) in connection with ordinal data may be used to designate "happier than" "preferred to" and so on.

When in addition to setting up inequalities we can also form differences, we refer to the data as interval data. Suppose we are given the following temperature readings (in degrees Fahrenheit): 58°, 63°, 70°, 95°, 110°, 126° and 135°. In this case, we can write $100° > 70°$ or $95° < 135°$ which simply means that 110° is warmer than 70° and that 95° is cooler than 135°. We can also write for example $95° – 70° = 135° – 110°$, since equal temperature differences are equal in the sense that the same amount of heat is required to raise the temperature of an object from 70° to 95° or from 110° to 135°. On the other hand, it would not mean much if we said that 126° is twice as hot as 63°, even though $126° / 63° = 2$. To show the reason, we have only to change to the centigrade scale, where the first temperature becomes $5/9 (126 – 32) = 52°$, the second temperature becomes $5/9 (63 – 32) = 17°$ and the first figure is now more than three times the second. This difficulty arises from the fact that Fahrenheit and Centigrade scales both have artificial origins (zeros) i.e., the number 0 of neither scale is indicative of the absence of whatever quantity we are trying to measure.

When in addition to setting up inequalities and forming differences we can also form quotients (i.e., when we can perform all the customary operations of mathematics), we refer to such data as ratio data. In this sense, ratio data includes all the usual measurement (or determinations) of length, height, money amounts, weight, volume, area, pressures etc.

## 2.5 TYPES OF MEASUREMENT SCALES

From what has been stated above, we can write that scales of measurement can be considered in terms of their mathematical properties. The most widely used classification of measurement scales are: (a) nominal scale; (b) ordinal scale; (c) interval scale; and (d) ratio scale.

**(a) Nominal scale:** Nominal scale is simply a system of assigning number symbols to events in order to label them. The usual example of this is the assignment of numbers of basketball players in order to identify them. Such numbers cannot be considered to be associated with an ordered scale for their order is of no consequence; the numbers are just convenient labels for the particular class of events and as such have no quantitative value. Nominal scales provide convenient ways of keeping track of people, objects and events. One cannot do much with the numbers involved. For example, one cannot usefully average the numbers on the back of a group of football players and come up with a meaningful value. Neither can one usefully compare the numbers assigned to one group with the numbers assigned to another. The counting of members in each group is the only possible arithmetic operation when a nominal scale is employed. Accordingly, we are restricted to use mode as the measure of central tendency. There is no generally used measure of dispersion for nominal scales. Chi-square test is the most common test of statistical significance that can be utilized, and for the measures of correlation, the contingency coefficient can be worked out.

Nominal scale is the least powerful level of measurement. It indicates no order or distance relationship and has no arithmetic origin. A nominal scale simply describes differences between things by assigning them to categories. Nominal data are, thus, counted data. The scale wastes any information that we may have about varying degrees of attitude, skills, understandings, etc. In spite of all this, nominal scales are still very useful and are widely used in surveys and other ex-post-facto research when data are being classified by major sub-groups of the population.

**(b) Ordinal scale:** The lowest level of the ordered scale that is commonly used is the ordinal scale. The ordinal scale places events in order, but there is no attempt to make the intervals of the scale equal in terms of some rule. Rank orders represent ordinal scales and are frequently used in research relating to qualitative phenomena. A student's rank in his graduation class involves the use of an ordinal scale. One has to be very careful in making statement about scores based on ordinal scales. For instance, if Ram's position in his class is 10 and Mohan's

position is 40, it cannot be said that Ram's position is four times as good as that of Mohan. The statement would make no sense at all. Ordinal scales only permit the ranking of items from highest to lowest. Ordinal measures have no absolute values, and the real differences between adjacent ranks may not be equal. All that can be said is that one person is higher or lower on the scale than another, but more precise comparisons cannot be made.

Thus, the use of an ordinal scale implies a statement of 'greater than' or 'less than' (an equality statement is also acceptable) without our being able to state how much greater or less. The real difference between ranks 1 and 2 may be more or less than the difference between ranks 5 and 6. Since the numbers of this scale have only a rank meaning, the appropriate measure of central tendency is the median. A percentile or quartile measure is used for measuring dispersion. Correlations are restricted to various rank order methods. Measures of statistical significance are restricted to the non-parametric methods.

**(c) Interval scale:** In the case of interval scale, the intervals are adjusted in terms of some rule that has been established as a basis for making the units equal. The units are equal only in so far as one accepts the assumptions on which the rule is based. Interval scales can have an arbitrary zero, but it is not possible to determine for them what may be called an absolute zero or the unique origin. The primary limitation of the interval scale is the lack of a true zero; it does not have the capacity to measure the complete absence of a trait or characteristic. The Fahrenheit scale is an example of an interval scale and shows similarities in what one can and cannot do with it. One can say that an increase in temperature from 30° to 40° involves the same increase in temperature as an increase from 60° to 70°, but one cannot say that the temperature of 60° is twice as warm as the temperature of 30° because both numbers are dependent on the fact that the zero on the scale is set arbitrarily at the temperature of the freezing point of water. The ratio of the two temperatures, 30° and 60°, means nothing because zero is an arbitrary point.

Interval scales provide more powerful measurement than ordinal scales for interval scale also incorporates the concept of equality of interval. As such more powerful statistical measures can be used with interval scales. Mean is the appropriate measure of central tendency, while standard deviation is the most widely used measure of dispersion. Product moment correlation techniques are appropriate and the generally used tests for statistical significance are the 't' test and 'F' test.

**(d) Ratio scale:** Ratio scales have an absolute or true zero of measurement. The term 'absolute zero' is not as precise as it was once believed to be. We can conceive of an absolute zero of length and similarly we can conceive of an absolute zero of time. For example, the zero point on a centimeter scale indicates the complete absence of length or height. But an absolute zero of temperature is theoretically unobtainable and it remains a concept existing only in the scientist's mind. The number of minor traffic-rule violations and the number of incorrect letters in a page of type script represent scores on ratio scales. Both these scales have absolute zeros and as such all minor traffic violations and all typing errors can be assumed to be equal in significance. With ratio scales involved one can make statements like "Jyoti's" typing performance was twice as good as that of "Reetu." The ratio involved does have significance and facilitates a kind of comparison which is not possible in case of an interval scale.

Ratio scale represents the actual amounts of variables. Measures of physical dimensions such as weight, height, distance, etc. are examples. Generally, all statistical techniques are usable with ratio scales and all manipulations that one can carry out with real numbers can also be carried out with ratio scale values. Multiplication and division can be used with this scale but not with other scales mentioned above. Geometric and harmonic means can be used as measures of central tendency and coefficients of variation may also be calculated.

Thus, proceeding from the nominal scale (the least precise type of scale) to ratio scale (the most precise), relevant information is obtained increasingly. If the nature of the variables permits, the researcher should use the scale that provides the most precise description. Researchers in physical sciences have the advantage to describe variables in ratio scale form but the behavioural sciences are generally limited to describe variables in interval scale form, a less precise type of measurement.

## 2.6 ERRORS IN MEASUREMENT

Measurement should be precise and unambiguous in an ideal research study. This objective, however, is often not met with in entirety. As such the researcher must be aware about the sources of error in measurement. The following are the possible sources of error in measurement.

**(a) Respondent:** At times the respondent may be reluctant to express strong negative feelings or it is just possible that he may have very little knowledge but may not admit his ignorance. All this reluctance is likely to result in an interview of 'guesses.' Transient factors

like fatigue, boredom, anxiety, etc. may limit the ability of the respondent to respond accurately and fully.

**(b) Situation:** Situational factors may also come in the way of correct measurement. Any condition which places a strain on interview can have serious effects on the interviewer-respondent rapport. For instance, if someone else is present, he can distort responses by joining in or merely by being present. If the respondent feels that anonymity is not assured, he may be reluctant to express certain feelings.

**(c) Measurer:** The interviewer can distort responses by rewording or reordering questions. His behaviour, style and looks may encourage or discourage certain replies from respondents. Careless mechanical processing may distort the findings. Errors may also creep in because of incorrect coding, faulty tabulation and/or statistical calculations, particularly in the data-analysis stage.

**(d) Instrument:** Error may arise because of the defective measuring instrument. The use of complex words, beyond the comprehension of the respondent, ambiguous meanings, poor printing, inadequate space for replies, response choice omissions, etc. are a few things that make the measuring instrument defective and may result in measurement errors. Another type of instrument deficiency is the poor sampling of the universe of items of concern.

Researcher must know that correct measurement depends on successfully meeting all of the problems listed above. He must, to the extent possible, try to eliminate, neutralize or otherwise deal with all the possible sources of error so that the final results may not be contaminated.

## 2.7 TESTS OF SOUND MEASUREMENT

Sound measurement must meet the tests of validity, reliability and practicality. In fact, these are the three major considerations one should use in evaluating a measurement tool. "Validity refers to the extent to which a test measures what we actually wish to measure. Reliability has to do with the accuracy and precision of a measurement procedure ... Practicality is concerned with a wide range of factors of economy, convenience, and interpretability..."1 We briefly take up the relevant details concerning these tests of sound measurement.

### 1. Test of Validity

Validity is the most critical criterion and indicates the degree to which an instrument measures what it is supposed to measure. Validity can also be thought of as utility. In other

words, validity is the extent to which differences found with a measuring instrument reflect true differences among those being tested. But the question arises: how can one determine validity without direct confirming knowledge? The answer may be that we seek other relevant evidence that confirms the answers we have found with our measuring tool. What is relevant, evidence often depends upon the nature of the research problem and the judgement of the researcher. But one can certainly consider three types of validity in this connection:

(i) Content validity;

(ii) Criterion-related validity and

(iii) Construct validity.

**(i) Content validity** is the extent to which a measuring instrument provides adequate coverage of the topic under study. If the instrument contains a representative sample of the universe, the content validity is good. Its determination is primarily judgemental and intuitive. It can also be determined by using a panel of persons who shall judge how well the measuring instrument meets the standards, but there is no numerical way to express it.

**(ii) Criterion-related validity** relates to our ability to predict some outcome or estimate the existence of some current condition. This form of validity reflects the success of measures used for some empirical estimating purpose. The concerned criterion must possess the following qualities:

**Relevance:** (A criterion is relevant if it is defined in terms we judge to be the proper measure.) Freedom from bias: (Freedom from bias is attained when the criterion gives each subject an equal opportunity to score well.)

**Reliability:** (A reliable criterion is stable or reproducible.)

**Availability:** (The information specified by the criterion must be available.)

In fact, a Criterion-related validity is a broad term that actually refers to (i) Predictive validity and (ii) Concurrent validity. The former refers to the usefulness of a test in predicting some future performance whereas the latter refers to the usefulness of a test in closely relating to other measures of known validity. Criterion-related validity is expressed as the coefficient of correlation between test scores and some measure of future performance or between test scores and scores on another measure of known validity.

**(iii) Construct validity** is the most complex and abstract. A measure is said to possess construct validity to the degree that it confirms to predicted correlations with other theoretical propositions. Construct validity is the degree to which scores on a test can be accounted for by the explanatory constructs of a sound theory. For determining construct validity, we associate a set of other propositions with the results received from using our measurement instrument. If measurements on our devised scale correlate in a predicted way with these other propositions, we can conclude that there is some construct validity.

If the above stated criteria and tests are met with, we may state that our measuring instrument is valid and will result in correct measurement; otherwise we shall have to look for more information and/or resort to exercise of judgement.

**2. Test of Reliability**

The test of reliability is another important test of sound measurement. A measuring instrument is reliable if it provides consistent results. Reliable measuring instrument does contribute to validity, but a reliable instrument need not be a valid instrument. For instance, a scale that consistently overweighs objects by five kgs., is a reliable scale, but it does not give a valid measure of weight. But the other way is not true i.e., a valid instrument is always reliable. Accordingly reliability is not as valuable as validity, but it is easier to assess reliability in comparison to validity. If the quality of reliability is satisfied by an instrument, then while using it we can be confident that the transient and situational factors are not interfering.

Two aspects of reliability viz., stability and equivalence deserve special mention. The stability aspect is concerned with securing consistent results with repeated measurements of the same person and with the same instrument. We usually determine the degree of stability by comparing the results of repeated measurements. The equivalence aspect considers how much error may get introduced by different investigators or different samples of the items being studied. A good way to test for the equivalence of measurements by two investigators is to compare their observations of the same events. Reliability can be improved in the following two ways:

I. By standardising the conditions under which the measurement takes place i.e., we must ensure that external sources of variation such as boredom, fatigue, etc., are minimised to the extent possible. That will improve stability aspect.

II. By carefully designed directions for measurement with no variation from group to group, by using trained and motivated persons to conduct the research and also by broadening the sample of items used. This will improve equivalence aspect.

**3. Test of Practicality**

The practicality characteristic of a measuring instrument can be judged in terms of economy, convenience and interpretability. From the operational point of view, the measuring instrument ought to be practical i.e., it should be economical, convenient and interpretable. Economy consideration suggests that some trade-off is needed between the ideal research project and that which the budget can afford. The length of measuring instrument is an important area where economic pressures are quickly felt. Although more items give greater reliability as stated earlier, but in the interest of limiting the interview or observation time, we have to take only few items for our study purpose. Similarly, data-collection methods to be used are also dependent at times upon economic factors. Convenience test suggests that the measuring instrument should be easy to administer. For this purpose one should give due attention to the proper layout of the measuring instrument. For instance, a questionnaire, with clear instructions (illustrated by examples), is certainly more effective and easier to complete than one which lacks these features. Interpretability consideration is specially important when persons other than the designers of the test are to interpret the results. The measuring instrument, in order to be interpretable, must be supplemented by (a) detailed instructions for administering the test; (b) scoring keys; (c) evidence about the reliability and (d) guides for using the test and for interpreting results.

## 2.8 TECHNIQUE OF DEVELOPING MEASUREMENT TOOLS

The technique of developing measurement tools involves a four-stage process, consisting of the following:

a) Concept development;
b) Specification of concept dimensions;
c) Selection of indicators; and
d) Formation of index.

The first and foremost step is that of concept development which means that the researcher should arrive at an understanding of the major concepts pertaining to his study. This step of concept development is more apparent in theoretical studies than in the more pragmatic research, where the fundamental concepts are often already established.

The second step requires the researcher to specify the dimensions of the concepts that he developed in the first stage. This task may either be accomplished by deduction i.e., by adopting a more or less intuitive approach or by empirical correlation of the individual dimensions with the total concept and/or the other concepts. For instance, one may think of several dimensions such as product reputation, customer treatment, corporate leadership, concern for individuals, sense of social responsibility and so forth when one is thinking about the image of a certain company.

Once the dimensions of a concept have been specified, the researcher must develop indicators for measuring each concept element. Indicators are specific questions, scales, or other devices by which respondent's knowledge, opinion, expectation, etc., are measured. As there is seldom a perfect measure of a concept, the researcher should consider several alternatives for the purpose. The use of more than one indicator gives stability to the scores and it also improves their validity.

The last step is that of combining the various indicators into an index, i.e., formation of an index. When we have several dimensions of a concept or different measurements of a dimension, we may need to combine them into a single index. One simple way for getting an overall index is to provide scale values to the responses and then sum up the corresponding scores. Such an overall index would provide a better measurement tool than a single indicator because of the fact that an "individual indicator has only a probability relation to what we really want to know."2 This way we must obtain an overall index for the various concepts concerning the research study.

## 2.9 SCALING TECHNIQUES

### Introduction

In research we quite often face measurement problem (since we want a valid measurement but may not obtain it), specially when the concepts to be measured are complex and abstract and we do not possess the standardised measurement tools. Alternatively, we can say that while measuring attitudes and opinions, we face the problem of their valid measurement. Similar problem may be faced by a researcher, of course in a lesser degree, while measuring physical or institutional concepts. As such we should study some procedures which may enable us to measure abstract concepts more accurately. This brings us to the study of scaling techniques.

**Meaning of Scaling**

Scaling describes the procedures of assigning numbers to various degrees of opinion, attitude and other concepts. This can be done in two ways viz., (i) making a judgement about some characteristic of an individual and then placing him directly on a scale that has been defined in terms of that characteristic and (ii) constructing questionnaires in such a way that the score of individual's responses assigns him a place on a scale. It may be stated here that a scale is a continuum, consisting of the highest point (in terms of some characteristic e.g., preference, favourableness, etc.) and the lowest point along with several intermediate points between these two extreme points. These scale-point positions are so related to each other that when the first point happens to be the highest point, the second point indicates a higher degree in terms of a given characteristic as compared to the third point and the third point indicates a higher degree as compared to the fourth and so on. Numbers for measuring the distinctions of degree in the attitudes/opinions are, thus, assigned to individuals corresponding to their scale-positions. All this is better understood when we talk about scaling technique(s). Hence the term 'scaling' is applied to the procedures for attempting to determine quantitative measures of subjective abstract concepts. Scaling has been defined as a "procedure for the assignment of numbers (or other symbols) to a property of objects in order to impart some of the characteristics of numbers to the properties in question."

**Scale construction techniques**

Following are the five main techniques by which scales can be developed.

**(i) Arbitrary approach:** It is an approach where scale is developed on ad hoc basis. This is the most widely used approach. It is presumed that such scales measure the concepts for which they have been designed, although there is little evidence to support such an assumption.

**(ii) Consensus approach:** Here a panel of judges evaluate the items chosen for inclusion in the instrument in terms of whether they are relevant to the topic area and unambiguous in implication.

**(iii) Item analysis approach:** Under it a number of individual items are developed into a test which is given to a group of respondents. After administering the test, the total scores are calculated for everyone. Individual items are then analysed to determine which items discriminate between persons or objects with high total scores and those with low scores.

**(iv) Cumulative scales** are chosen on the basis of their conforming to some ranking of items with ascending and descending discriminating power. For instance, in such a scale the

endorsement of an item representing an extreme position should also result in the endorsement of all items indicating a less extreme position.

**(v) Factor scales** may be constructed on the basis of inter correlations of items which indicate that a common factor accounts for the relationship between items. This relationship is typically measured through factor analysis method.

## 2.10 TYPES OF SCALES

We now take up some of the important scaling techniques often used in the context of research specially in context of social or business research.

**Rating scales:** The rating scale involves qualitative description of a limited number of aspects of a thing or of traits of a person. When we use rating scales (or categorical scales), we judge an object in absolute terms against some specified criteria i.e., we judge properties of objects without reference to other similar objects. These ratings may be in such forms as "like-dislike", "above average, average, below average", or other classifications with more categories such as "like very much-like somewhat-neutral-dislike somewhat-dislike very much"; "excellent-good-average-below average-poor", "always-often-occasionally-rarely never", and so on. There is no specific rule whether to use a two-points scale, three-points scale or scale with still more points. In practice, three to seven points scales are generally used for the simple reason that more points on a scale provide an opportunity for greater sensitivity of measurement.

Rating scale may be either a graphic rating scale or an itemized rating scale.

**(i) The graphic rating scale** is quite simple and is commonly used in practice. Under it the various points are usually put along the line to form a continuum and the rater indicates his rating by simply making a mark (such as ü) at the appropriate point on a line that runs from one extreme to the other. Scale-points with brief descriptions may be indicated along the line, their function being to assist the rater in performing his job. The following is an example of five-points graphic rating scale when we wish to ascertain people's liking or disliking any product:

**How do you like the product? (Please check)**

| **Like very** much | **Like some** what | **Neutral** | **Dislike some** what | **Dislike very** much |
|---|---|---|---|---|

Fig.2.1

This type of scale has several limitations. The respondents may check at almost any position along the line which fact may increase the difficulty of analysis. The meanings of the terms like "very much" and "somewhat" may depend upon respondent's frame of reference so much so that the statement might be challenged in terms of its equivalency. Several other rating scale variants (e.g., boxes replacing line) may also be used.

**(ii) The itemized rating scale** (also known as numerical scale) presents a series of statements from which a respondent selects one as best reflecting his evaluation. These statements are ordered progressively in terms of more or less of some property. An example of itemized scale can be given to illustrate it. Suppose we wish to inquire as to how well does a worker get along with his fellow workers? In such a situation we may ask the respondent to select one, to express his opinion, from the following:

- He is almost always involved in some friction with a fellow worker.
- He is often at odds with one or more of his fellow workers.
- He sometimes gets involved in friction.
- He infrequently becomes involved in friction with others.
- He almost never gets involved in friction with fellow workers.

The chief merit of this type of scale is that it provides more information and meaning to the rater, and thereby increases reliability. This form is relatively difficult to develop and the statements may not say exactly what the respondent would like to express.

Rating scales have certain good points. The results obtained from their use compare favourably with alternative methods. They require less time, are interesting to use and have a wide range of applications. Besides, they may also be used with a large number of properties or variables. But their value for measurement purposes depends upon the assumption that the respondents can and do make good judgements. If the respondents are not very careful while rating, errors may occur. Three types of errors are common viz., the error of leniency, the error of central tendency and the error of hallo effect. The error of leniency occurs when

certain respondents are either easy raters or hard raters. When raters are reluctant to give extreme judgements, the result is the error of central tendency. The error of hallo effect or the systematic bias occurs when the rater carries over a generalised impression of the subject from one rating to another. This sort of error takes place when we conclude for example, that a particular report is good because we like its form or that someone is intelligent because he agrees with us or has a pleasing personality. In other words, hallo effect is likely to appear when the rater is asked to rate many factors, on a number of which he has no evidence for judgement.

**Ranking scales:** Under ranking scales (or comparative scales) we make relative judgements against other similar objects. The respondents under this method directly compare two or more objects and make choices among them. There are two generally used approaches of ranking scales viz.

**(a) Method of paired comparisons:** Under it the respondent can express his attitude by making a choice between two objects, say between a new flavour of soft drink and an established brand of drink. But when there are more than two stimuli to judge, the number of judgements required in a paired comparison is given by the formula:

$$N = \frac{n(n-1)}{2}$$

Where N = number of judgements

n = number of stimuli or objects to be judged.

For instance, if there are ten suggestions for bargaining proposals available to a workers union, there are 45 paired comparisons that can be made with them. When N happens to be a big figure, there is the risk of respondents giving ill considered answers or they may even refuse to answer. We can reduce the number of comparisons per respondent either by presenting to each one of them only a sample of stimuli or by choosing a few objects which cover the range of attractiveness at about equal intervals and then comparing all other stimuli to these few standard objects. Thus, paired-comparison data may be treated in several ways. If there is substantial consistency, we will find that if X is preferred to Y, and Y to Z, then X will consistently be preferred to Z. If this is true, we may take the total number of preferences among the comparisons as the score for that stimulus.

It should be remembered that paired comparison provides ordinal data, but the same may be converted into an interval scale by the method of the Law of Comparative Judgement developed by L.L. Thurstone. This technique involves the conversion of frequencies of

preferences into a table of proportions which are then transformed into Z matrix by referring to the table of area under the normal curve. J.P. Guilford in his book "Psychometric Methods" has given a procedure which is relatively easier. The method is known as the Composite Standard Method and can be illustrated as under:

Suppose there are four proposals which some union bargaining committee is considering. The committee wants to know how the union membership ranks these proposals. For this purpose a sample of 100 members might express the views as shown in the following table:

Table 2.1: Response Patterns of 100 Members. Paired Comparisons of 4 Suggestions for Union Bargaining Proposal Priorities

| | | Suggestion | | |
|---|---|---|---|---|
| | A | B | C | D |
| A | – | 65 * | 32 | 20 |
| B | 40 | – | 38 | 42 |
| C | 45 | 50 | – | 70 |
| D | 80 | 20 | 98 | – |
| TOTAL: | 165 | 135 | 168 | 132 |

*Read as 65 members preferred suggestion B to suggestion A.

| Rank order | 2 | 3 | 1 | 4 |
|---|---|---|---|---|
| $M_p$ | 0.5375 | 0.4625 | 0.5450 | 0.4550 |
| $Z_j$ | 0.09 | (–).09 | 0.11 | (–).11 |
| $R_j$ | 0.20 | 0.02 | 0.22 | 0.00 |

Comparing the total number of preferences for each of the four proposals, we find that C is the most popular, followed by A, B and D respectively in popularity. The rank order shown in the above table explains all this.

By following the composite standard method, we can develop an interval scale from the paired comparison ordinal data given in the above table for which purpose we have to adopt the following steps in order:

Using the data in the above table, we work out the column mean with the help of the formula given below:

$$M_P = \frac{C + .5\,(N)}{nN} = \frac{165 + .5(100)}{4(100)} = \mathbf{.5375}$$

where

$M_p$ = the mean proportion of the columns

C = the total number of choices for a given suggestion

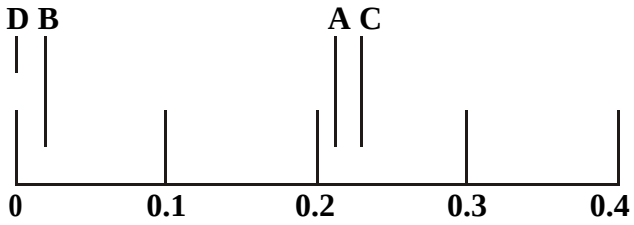
n = number of stimuli (proposals in the given problem)

N = number of items in the sample.

The column means have been shown in the Mp row in the above table.

(ii) The Z values for the Mp are secured from the table giving the area under the normal curve. When the Mp value is less than .5, the Z value is negative and for all Mp values higher than .5, the Z values are positive.* These Z values are shown in Zj row in the above table.

(iii) As the Zj values represent an interval scale, zero is an arbitrary value. Hence we can eliminate negative scale values by giving the value of zero to the lowest scale value (this being (–).11 in our example which we shall take equal to zero) and then adding the absolute value of this lowest scale value to all other scale items. This scale has been shown in Rj row in the above table. Graphically we can show this interval scale that we have derived from the paired-comparison data using the composite standard method as follows:




(* To use Normal curve area table for this sort of transformation, we must subtract 0.5 from all Mp values which exceed .5 to secure the values with which to enter the normal curve area table for which Z values can be obtained. For all Mp values of less than . 5 we must subtract all such values from 0.5 to secure the values with which to enter the normal curve area table for which Z values can be obtained but the Z values in this situation will be with negative sign.)

**(b) Method of rank order:** Under this method of comparative scaling, the respondents are asked to rank their choices. This method is easier and faster than the method of paired comparisons stated above. For example, with 10 items it takes 45 pair comparisons to complete the task, whereas the method of rank order simply requires ranking of 10 items only. The problem of transitivity (such as A prefers to B, B to C, but C prefers to A) is also not there in case we adopt method of rank order. Moreover, a complete ranking at times is not

needed in which case the respondents may be asked to rank only their first, say, four choices while the number of overall items involved may be more than four, say, it may be 15 or 20 or more. To secure a simple ranking of all items involved we simply total rank values received by each item. There are methods through which we can as well develop an interval scale of these data. But then there are limitations of this method. The first one is that data obtained through this method are ordinal data and hence rank ordering is an ordinal scale with all its limitations. Then there may be the problem of respondents becoming careless in assigning ranks particularly when there are many (usually more than 10) items.

## 2.11 SCALE CONSTRUCTION TECHNIQUES

In social science studies, while measuring attitudes of the people we generally follow the technique of preparing the opinionnaire (or attitude scale) in such a way that the score of the individual responses assigns him a place on a scale. Under this approach, the respondent expresses his agreement or disagreement with a number of statements relevant to the issue. While developing such statements, the researcher must note the following two points:

i. That the statements must elicit responses which are psychologically related to the attitude being measured;
ii. That the statements need be such that they discriminate not merely between extremes of attitude but also among individuals who differ slightly.

Researchers must as well be aware that inferring attitude from what has been recorded in opinionnaires has several limitations. People may conceal their attitudes and express socially acceptable opinions. They may not really know how they feel about a social issue. People may be unaware of their attitude about an abstract situation; until confronted with a real situation, they may be unable to predict their reaction. Even behaviour itself is at times not a true indication of attitude. For instance, when politicians kiss babies, their behaviour may not be a true expression of affection toward infants. Thus, there is no sure method of measuring attitude; we only try to measure the expressed opinion and then draw inferences from it about people's real feelings or attitudes.

With all these limitations in mind, psychologists and sociologists have developed several scale construction techniques for the purpose. The researcher should know these techniques so as to develop an appropriate scale for his own study. Some of the important approaches, along with the corresponding scales developed under each approach to measure attitude are as follows:

**Table 2.2: Different Scales for Measuring Attitudes of People**

| Name of the scale construction approach | Name of the scale developed |
|---|---|
| 1. Arbitrary approach | Arbitrary scales |
| 2. Consensus scale approach | Differential scales (such as Thurstone Differential scale) |
| 3. Item analysis approach | Summated scales (such as Likert Scale) |
| 4. Cumulative scale approach | Cumulative scales (such as Guttman's Scalogram) |
| 5. Factor analysis approach | Factor scales (such as Osgood's Semantic Differential, Multi-dimensional Scaling, etc.) |

**Arbitrary Scales**

Arbitrary scales are developed on ad hoc basis and are designed largely through the researcher's own subjective selection of items. The researcher first collects few statements or items which he believes are unambiguous and appropriate to a given topic. Some of these are selected for inclusion in the measuring instrument and then people are asked to check in a list the statements with which they agree.

The chief merit of such scales is that they can be developed very easily, quickly and with relatively less expense. They can also be designed to be highly specific and adequate. Because of these benefits, such scales are widely used in practice.

At the same time there are some limitations of these scales. The most important one is that we do not have objective evidence that such scales measure the concepts for which they have been developed. We have simply to rely on researcher's insight and competence.

**Differential Scales (or Thurstone-type Scales)**

The name of L.L. Thurstone is associated with differential scales which have been developed using consensus scale approach. Under such an approach the selection of items is made by a panel of judges who evaluate the items in terms of whether they are relevant to the topic area and unambiguous in implication. The detailed procedure is as under:

(a) The researcher gathers a large number of statements, usually twenty or more, that express various points of view toward a group, institution, idea, or practice (i.e., statements belonging to the topic area).

(b) These statements are then submitted to a panel of judges, each of whom arranges them in eleven groups or piles ranging from one extreme to another in position. Each of the judges is requested to place generally in the first pile the statements which he thinks are most

unfavourable to the issue, in the second pile to place those statements which he thinks are next most unfavourable and he goes on doing so in this manner till in the eleventh pile he puts the statements which he considers to be the most favourable.

(c) This sorting by each judge yields a composite position for each of the items. In case of marked disagreement between the judges in assigning a position to an item, that item is discarded.

(d) For items that are retained, each is given its median scale value between one and eleven as established by the panel. In other words, the scale value of any one statement is computed as the 'median' position to which it is assigned by the group of judges.

(e) A final selection of statements is then made. For this purpose a sample of statements, whose median scores are spread evenly from one extreme to the other is taken. The statements so selected, constitute the final scale to be administered to respondents. The position of each statement on the scale is the same as determined by the judges.

After developing the scale as stated above, the respondents are asked during the administration of the scale to check the statements with which they agree. The median value of the statements that they check is worked out and this establishes their score or quantifies their opinion. It may be noted that in the actual instrument the statements are arranged in random order of scale value. If the values are valid and if the opinionnaire deals with only one attitude dimension, the typical respondent will choose one or several contiguous items (in terms of scale values) to reflect his views. However, at times divergence may occur when a statement appears to tap a different attitude dimension.

The Thurstone method has been widely used for developing differential scales which are utilized to measure attitudes towards varied issues like war, religion, etc. Such scales are considered most appropriate and reliable when used for measuring a single attitude. But an important deterrent to their use is the cost and effort required to develop them. Another weakness of such scales is that the values assigned to various statements by the judges may reflect their own attitudes. The method is not completely objective; it involves ultimately subjective decision process. Critics of this method also opine that some other scale designs give more information about the respondent's attitude in comparison to differential scales.

**Summated Scales (or Likert-type Scales)**

Summated scales (or Likert-type scales) are developed by utilizing the item analysis approach wherein a particular item is evaluated on the basis of how well it discriminates

between those persons whose total score is high and those whose score is low. Those items or statements that best meet this sort of discrimination test are included in the final instrument.

Thus, summated scales consist of a number of statements which express either a favourable or unfavourable attitude towards the given object to which the respondent is asked to react. The respondent indicates his agreement or disagreement with each statement in the instrument. Each response is given a numerical score, indicating its favourableness or unfavourableness, and the scores are totaled to measure the respondent's attitude. In other words, the overall score represents the respondent's position on the continuum of favourable-unfavourableness towards an issue.

Most frequently used summated scales in the study of social attitudes follow the pattern devised by Likert. For this reason they are often referred to as Likert-type scales. In a Likert scale, the respondent is asked to respond to each of the statements in terms of several degrees, usually five degrees (but at times 3 or 7 may also be used) of agreement or disagreement. For example, when asked to express opinion whether one considers his job quite pleasant, the respondent may respond in any one of the following ways: (i) strongly agree, (ii) agree, (iii) undecided, (iv) disagree, (v) strongly disagree.

We find that these five points constitute the scale. At one extreme of the scale there is strong agreement with the given statement and at the other, strong disagreement, and between them lie intermediate points. We may illustrate this as under:

| Strongly agree | Agree | Undecided | Disagree | Strongly disagree |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |

Fig. 2.3

Each point on the scale carries a score. Response indicating the least favourable degree of job satisfaction is given the least score (say 1) and the most favourable is given the highest score (say 5). These score—values are normally not printed on the instrument but are shown here just to indicate the scoring pattern. The Likert scaling technique, thus, assigns a scale value to each of the five responses. The same thing is done in respect of each and every statement in the instrument. This way the instrument yields a total score for each respondent, which would then measure the respondent's favourableness toward the given point of view. If the instrument consists of, say 30 statements, the following score values would be revealing.

- $30 \times 5 = 150$ Most favourable response possible
- $30 \times 3 = 90$ A neutral attitude
- $30 \times 1 = 30$ Most unfavourable attitude.

The scores for any individual would fall between 30 and 150. If the score happens to be above 90, it shows favourable opinion to the given point of view, a score of below 90 would mean unfavourable opinion and a score of exactly 90 would be suggestive of a neutral attitude.

**Procedure:** The procedure for developing a Likert-type scale is as follows:

i. As a first step, the researcher collects a large number of statements which are relevant to the attitude being studied and each of the statements expresses definite favourableness or unfavourableness to a particular point of view or the attitude and that the number of favourable and unfavourable statements is approximately equal.

ii. After the statements have been gathered, a trial test should be administered to a number of subjects. In other words, a small group of people, from those who are going to be studied finally, are asked to indicate their response to each statement by checking one of the categories of agreement or disagreement using a five point scale as stated above.

iii. The response to various statements are scored in such a way that a response indicative of the most favourable attitude is given the highest score of 5 and that with the most unfavourable attitude is given the lowest score, say, of 1.

iv. Then the total score of each respondent is obtained by adding his scores that he received for separate statements.

v. The next step is to array these total scores and find out those statements which have a high discriminatory power. For this purpose, the researcher may select some part of the highest and the lowest total scores, say the top 25 per cent and the bottom 25 per cent. These two extreme groups are interpreted to represent the most favourable and the least favourable attitudes and are used as criterion groups by which to evaluate individual statements. This way we determine which statements consistently correlate with low favourability and which with high favourability.

vi. Only those statements that correlate with the total test should be retained in the final instrument and all others must be discarded from it.

**Advantages:** The Likert-type scale has several advantages. Mention may be made of the important ones.

a) It is relatively easy to construct the Likert-type scale in comparison to Thurstone-type scale because Likert-type scale can be performed without a panel of judges.
b) Likert-type scale is considered more reliable because under it respondents answer each statement included in the instrument. As such it also provides more information and data than does the Thurstone-type scale.
c) Each statement, included in the Likert-type scale, is given an empirical test for discriminating ability and as such, unlike Thurstone-type scale, the Likert-type scale permits the use of statements that are not manifestly related (to have a direct relationship) to the attitude being studied.
d) Likert-type scale can easily be used in respondent-centred and stimulus-centred studies i.e., through it we can study how responses differ between people and how responses differ between stimuli.
e) Likert-type scale takes much less time to construct, it is frequently used by the students of opinion research. Moreover, it has been reported in various research studies that there is high degree of correlation between Likert-type scale and Thurstone-type scale.

**Cumulative scales:** Cumulative scales or Louis Guttman's scalogram analysis, like other scales, consist of series of statements to which a respondent expresses his agreement or disagreement. The special feature of this type of scale is that statements in it form a cumulative series. This, in other words, means that the statements are related to one another in such a way that an individual, who replies favourably to say item No. 3, also replies favourably to items No. 2 and 1, and one who replies favourably to item No. 4 also replies favourably to items No. 3, 2 and 1, and so on. This being so an individual whose attitude is at a certain point in a cumulative scale will answer favourably all the items on one side of this point, and answer unfavourably all the items on the other side of this point. The individual's score is worked out by counting the number of points concerning the number of statements he answers favourably. If one knows this total score, one can estimate as to how a respondent has answered individual statements constituting cumulative scales. The major scale of this type of cumulative scales is the Guttman's scalogram. We attempt a brief description of the same below.

The technique developed by Louis Guttman is known as scalogram analysis, or at times simply 'scale analysis'. Scalogram analysis refers to the procedure for determining whether a set of items forms a unidimensional scale. A scale is said to be unidimensional if the responses fall into a pattern in which endorsement of the item reflecting the extreme position results also in endorsing all items which are less extreme. Under this technique, the respondents are asked to indicate in respect of each item whether they agree or disagree with it, and if these items form a unidimensional scale, the response pattern will be as under:

**Response Pattern in Scalogram Analysis**

| Item Number | | | | Respondent Score |
|---|---|---|---|---|
| 4 | 3 | 2 | 1 | |
| X | X | X | X | 4 |
| – | X | X | X | 3 |
| – | – | X | X | 2 |
| – | – | – | X | 1 |
| – | – | – | – | 0 |

X = Agree – = Disagree

A score of 4 means that the respondent is in agreement with all the statements which is indicative

of the most favourable attitude. But a score of 3 would mean that the respondent is not agreeable to item 4, but he agrees with all others. In the same way one can interpret other values of the respondents' scores. This pattern reveals that the universe of content is scalable.

**Procedure:** The procedure for developing a scalogram can be outlined as under:

a) The universe of content must be defined first of all. In other words, we must lay down in clear terms the issue we want to deal within our study.

b) The next step is to develop a number of items relating the issue and to eliminate by inspection the items that are ambiguous, irrelevant or those that happen to be too extreme items.

c) The third step consists in pre-testing the items to determine whether the issue at hand is scalable (The pretest, as suggested by Guttman, should include 12 or more items, while the final scale may have only 4 to 6 items. Similarly, the number of respondents in a pretest may be small, say 20 or 25 but final scale should involve relatively more respondents, say 100 or more).

In a pretest the respondents are asked to record their opinions on all selected items using a Likert-type 5-point scale, ranging from 'strongly agree' to 'strongly disagree'. The strongest favourable response is scored as 5, whereas the strongest unfavourable response as 1. The total score can thus range, if there are 15 items in all, from 75 for most favourable to 15 for the least favourable.

Respondent opinionnaires are then arrayed according to total score for analysis and evaluation. If the responses of an item form a cumulative scale, its response category scores should decrease in an orderly fashion as indicated in the above table. Failure to show the said decreasing pattern means that there is overlapping which shows that the item concerned is not a good cumulative scale item i.e., the item has more than one meaning. Sometimes the overlapping in category responses can be reduced by combining categories. After analysing the pretest results, a few items, say 5 items, may be chosen.

d) The next step is again to total the scores for the various opinionnaires, and to rearray them to reflect any shift in order, resulting from reducing the items, say, from 15 in pretest to, say, 5 for the final scale. The final pretest results may be tabulated in the form of a table given in Table 2.4.

The Final Pretest Results in a Scalogram Analysis*

| Scale type | | | Item | | | Errors | Number of | Number of |
|---|---|---|---|---|---|---|---|---|
| | 5 | 12 | 3 | 10 | 7 | per case | cases | errors |
| 5 (perfect) | X | X | X | X | X | 0 | 7 | 0 |
| 4 (perfect) | – | X | X | X | X | 0 | 3 | 0 |
| (nonscale) | – | X | – | X | X | 1 | 1 | 1 |
| (nonscale) | – | X | X | – | X | 1 | 2 | 2 |
| 3 (perfect) | – | – | X | X | X | 0 | 5 | 0 |
| 2 (perfect) | – | – | – | X | X | 0 | 2 | 0 |
| 1 (perfect) | – | – | – | – | X | 0 | 1 | 0 |
| (nonscale) | – | – | X | – | – | 2 | 1 | 2 |
| (nonscale) | – | – | X | – | – | 2 | 1 | 2 |
| 0 (perfect) | – | – | – | – | – | 0 | 2 | 0 |
| | | | n = 5 | | | | N = 25 | e = 7 |

* (Figures in the table are arbitrary and have been used to explain the tabulation process only.)

The table shows that five items (numbering 5, 12, 3, 10 and 7) have been selected for the final scale. The number of respondents is 25 whose responses to various items have been tabulated along with the number of errors. Perfect scale types are those in which the respondent's answers fit the pattern that would be reproduced by using the person's total score as a guide. Non-scale types are those in which the category pattern differs from that expected from the respondent's total score i.e., non-scale cases have deviations from unidimensionality or errors. Whether the items (or series of statements) selected for final scale may be regarded a perfect cumulative (or a unidimensional scale), we have to examine on the basis of the coefficient of reproducibility. Guttman has set 0.9 as the level of minimum reproducibility in order to say that the scale meets the test of unidimensionality. He has given the following formula for measuring the level of reproducibility:

Guttman's Coefficient of Reproducibility **= 1 – e / nr(N)**

where e = number of errors

n = number of items

N = number of cases

For the above table figures,

Coefficient of Reproducibility = 1 – 7/5(25) = .94

This shows that items number 5, 12, 3, 10 and 7 in this order constitute the cumulative or unidimensional scale, and with this we can reproduce the responses to each item, knowing only the total score of the respondent concerned. Scalogram, analysis, like any other scaling technique, has several advantages as well as limitations. One advantage is that it assures that only a single dimension of attitude is being measured. Researcher's subjective judgement is not allowed to creep in the development of scale since the scale is determined by the replies of respondents. Then, we require only a small number of items that make such a scale easy to administer. Scalogram analysis can appropriately be used for personal, telephone or mail surveys. The main difficulty in using this scaling technique is that in practice perfect cumulative or unidimensional scales are very rarely found and we have only to use its approximation testing it through coefficient of reproducibility or examining it on the basis of some other criteria. This method is not a frequently used method for the simple reason that its development procedure is tedious and complex. Such scales hardly constitute a reliable basis for assessing attitudes of persons towards complex objects for predicting the behavioural responses of individuals towards such objects. Conceptually, this analysis is a bit more difficult in comparison to other scaling methods.

**Factor Scales**

Factor scales are developed through factor analysis or on the basis of intercorrelations of items which indicate that a common factor accounts for the relationships between items. Factor scales are particularly "useful in uncovering latent attitude dimensions and approach scaling through the concept of multiple-dimension attribute space."5 More specifically the two problems viz., how to deal appropriately with the universe of content which is multi-dimensional and how to uncover underlying (latent) dimensions which have not been identified, are dealt with through factor scales. An important factor scale based on factor analysis is Semantic Differential (S.D.) and the other one is Multidimensional Scaling. We give below a brief account of these factor scales.

Semantic differential scale: Semantic differential scale or the S.D. scale developed by Charles E. Osgood, G.J. Suci and P.H. Tannenbaum (1957), is an attempt to measure the psychological meanings of an object to an individual. This scale is based on the presumption that an object can have different dimensions of connotative meanings which can be located in multidimensional property space, or what can be called the semantic space in the context of S.D. scale. This scaling consists of a set of bipolar rating scales, usually of 7 points, by which one or more respondents rate one or more concepts on each scale item. For instance, the S.D. scale items for analysing candidates for leadership position may be shown as under:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Successful** | | | | | | | **Unsuccessful** |
| **Severe** | | | | | | | **Lenient** |
| **Heavy** | | | | | | | **Light** |
| **Hot** | | | | | | | **Cold** |
| **Progressive** | | | | | | | **Regressive** |
| **Strong** | | | | | | | **Weak** |
| **Active** | | | | | | | **Passive** |
| **Fast** | | | | | | | **Slow** |
| **True** | | | | | | | **False** |
| **Sociable** | | | | | | | **Unsociable** |
| | **3** | **2** | **1** | **0** | **–1** | **–2** | **–3** |

Fig. 2.4

Candidates for leadership position (along with the concept—the 'ideal' candidate) may be compared and we may score them from +3 to –3 on the basis of the above stated scales. (The letters, E, P, A showing the relevant factor viz., evaluation, potency and activity respectively, written along the left side are not written in actual scale. Similarly the numeric values shown are also not written in actual scale.)

Osgood and others did produce a list of some adjective pairs for attitude research purposes and concluded that semantic space is multidimensional rather than unidimensional. They made sincere efforts and ultimately found that three factors, viz., evaluation, potency and activity, contributed most to meaningful judgements by respondents. The evaluation dimension generally accounts for 1/2 and 3/4 of the extractable variance and the other two factors account for the balance.

**Multidimensional scaling:** Multidimensional scaling (MDS) is relatively more complicated scaling device, but with this sort of scaling one can scale objects, individuals or both with a minimum of information. Multidimensional scaling (or MDS) can be characterized as a set of procedures for portraying perceptual or affective dimensions of substantive interest. It "provides useful methodology for portraying subjective judgements of diverse kinds."7 MDS is used when all the variables (whether metric or non-metric) in a study are to be analyzed simultaneously and all such variables happen to be independent. The underlying assumption in MDS is that people (respondents) "perceive a set of objects as being more or less similar to one another on a number of dimensions (usually uncorrelated with one another) instead of only one."8 Through MDS techniques one can represent geometrically the locations and interrelationships among a set of points. In fact, these techniques attempt to locate the points, given the information about a set of interpoint distances, in space of one or more dimensions such as to best summarise the information contained in the interpoint distances. The distances in the solution space then optimally reflect the distances contained in the input data. For instance, if objects, say X and Y, are thought of by the respondent as being most similar as compared to all other possible pairs of objects, MDS techniques will position objects X and Y in such a way that the distance between them in multidimensional space is shorter than that between any two other objects.

Two approaches, viz., the metric approach and the non-metric approach, are usually talked about in the context of MDS, while attempting to construct a space containing m points such that m(m – 1)/2 interpoint distances reflect the input data. The metric approach to

MDS treats the input data as interval scale data and solves applying statistical methods for the additive constant which minimises the dimensionality of the solution space. This approach utilises all the information in the data in obtaining a solution. The data (i.e., the metric similarities of the objects) are often obtained on a bipolar similarity scale on which pairs of objects are rated one at a time. If the data reflect exact distances between real objects in an r-dimensional space, their solution will reproduce the set of interpoint distances. But as the true and real data are rarely available, we require random and systematic procedures for obtaining a solution. Generally, the judged similarities among a set of objects are statistically transformed into distances by placing those objects in a multidimensional space of some dimensionality.

The non-metric approach first gathers the non-metric similarities by asking respondents to rank order all possible pairs that can be obtained from a set of objects. Such non-metric data is then transformed into some arbitrary metric space and then the solution is obtained by reducing the dimensionality. In other words, this non-metric approach seeks "a representation of points in a space of minimum dimensionality such that the rank order of the interpoint distances in the solution space maximally corresponds to that of the data. This is achieved by requiring only that the distances in the solution be monotone with the input data." The non-metric approach has come into prominence during the sixties with the coming into existence of high speed computers to generate metric solutions for ordinal input data.

The significance of MDS lies in the fact that it enables the researcher to study "the perceptual structure of a set of stimuli and the cognitive processes underlying the development of this structure. Psychologists, for example, employ multidimensional scaling techniques in an effort to scale psychophysical stimuli and to determine appropriate labels for the dimensions along which these stimuli vary."10 The MDS techniques, infact, do away with the need in the data collection process to specify the attribute(s) along which the several brands, say of a particular product, may be compared as ultimately the MDS analysis itself reveals such attribute(s) that presumably underlie the expressed relative similarities among objects. Thus, MDS is an important tool in attitude measurement and the techniques falling under MDS promise "a great advance from a series of unidimensional measurements (e.g., a distribution of intensities of feeling towards single attribute such as colour, taste or a preference ranking with indeterminate intervals), to a perceptual mapping in multidimensional space of objects ... company images, advertisement brands, etc."

In spite of all the merits stated above, the MDS is not widely used because of the computation complications involved under it. Many of its methods are quite laborious in terms of both the collection of data and the subsequent analyses. However, some progress has been achieved (due to the pioneering efforts of Paul Green and his associates) during the last few years in the use of non-metric MDS in the context of market research problems. The techniques have been specifically applied in "finding out the perceptual dimensions, and the spacing of stimuli along these dimensions, that people, use in making judgements about the relative similarity of pairs of Stimuli." But, "in the long run, the worth of MDS will be determined by the extent to which it advances the behavioral sciences."

## 2.12 SAMPLING DESIGN

### Meaning

Research objectives are generally translated into research questions that enable the researchers to identify the information needs. Once the information needs are specified, the sources of collecting the information are sought. Some of the information may be collected through secondary sources (published material). Whereas the rest may be obtained through primary sources. The primary methods of collecting information could be the observation method, personal interview with questionnaire, and their analysis plays a vital role in finding answers to research questions. Survey respondents should be selected using the appropriate procedures, otherwise the researchers may not be able to get the right information to solve the problem under investigation. The process of selecting the right individuals, objects or events for the study is known as sampling. Sampling involves the study of a small number of individuals, objects chosen from a large group.

### Sampling Concepts

Before we get into the details of various issues pertaining to sampling, it would be appropriate to discuss some of the sampling concepts.

**Population :** Population refers to any group of people or object that form the subject of study in a particular survey and are similar in one or more ways. For example, the number of full-time MBA students, the population size would be 200. We may be interested in understanding their perceptions about business education. If there are 200 class IV employees would form the population of interest. If a TV manufacturing company produces 150 TVs per week and we are interested in estimation the proportion of defective TVs produced per week, all the 150 TVs would form our population. If, in an organization there are 1000

engineers, out of which 350 are mechanical engineers and we are interested in examining the proportion of mechanical engineers who intend to leave the organization within six months, all the 350 how the patients in a hospital are looked after, then all the patients of the hospital would fall under the category of population.

**Element:** An element comprises a single member of the population. Out of the 350 mechanical engineers mentioned above, each mechanical engineer would form an element of the population. In the example of MBA students whose perception about the management education is of interest to us, each of the 200 MBA students will be an element of the population. This means that there will be 200 elements of the population.

**Sampling frame:** Sampling frame comprises all the elements of a population with proper identification that is available to us for selection at any stage of sampling. For example, the list of registered voters in a constituency could form a sampling frame; the telephone directory; the number of students registered with university; the attendance sheet of a particular class and the payroll of an organization are examples of sampling frames. When the population size is very large, it becomes virtually impossible to form a sampling frame. We know that there is a large number of consumers of soft drinks and, therefore, it becomes very difficult to for the sampling frame for the same.

**Sample:** It is a subset of the population. It comprises only some element of the population. If out of the 350 mechanical engineers employed in an organization, 30 members would constitute the sample.

**Sampling unit:** A sampling unit is a single member of the sample. If a sample of 50 students is taken from a population of 200 MBA students in a business school, then each of the 50 students is a sampling unit. Another example could be that if a sample of 50 patients is taken from a hospital to understand their perception about the services of the hospital, each of 50 patients is a sampling unit.

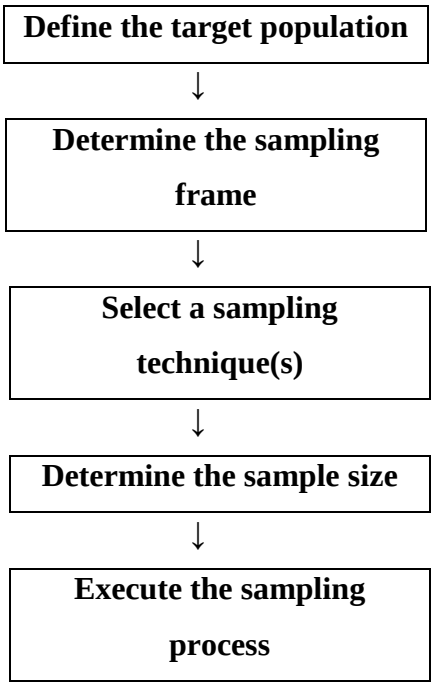
**Sampling:** It is process of selection an adequate number of elements from the population so that the study of the sample will not only help in understanding the characteristics of t population but will also enable us to generalize the results. We will see later that there are

two types of sampling designs-probability sampling design and non-probability sampling design.

**Census (or complete enumeration):** An examination of each and every element of the population is called census or complete enumeration. Census is an alternative to sampling.

## 2.13 STEPS IN SAMPLING DESIGN

The sampling design process includes five steps that shown sequentially in figure 2.5 these steps are closely interrelated and relevant to all aspects of the management research project, from problem definition to the presentation of the results. Therefore, sample design decision should be integrated with all other decisions in a research project.




### Define the target population

Sampling design begins by specifying the target population. The target population is the collection of elements or objects that possess the information sought by the researcher and about which inferences are to be made. The target population must be defined precisely. Imprecise definition of the target population will result in research that is ineffective at best and misleading at worst. Defining the target population involves translating the problem definition into a precise statement of who should and should not be included in the sample.

The target population should be defined in terms of elements. Sampling units, extent and tie. An element is the object about which of from which the information is desired. In

survey research, the element, that is available for selection at some stage of t sampling process. Suppose that Revlon wanted to assess consumer response to a new line of lipsticks and wanted to sample females over 18 years of age. It may be possible to sample females over 18 directly, in which case a sampling unit would be the same as an element. Alternatively, the sampling unit might be households. In the latter case, households would be sampled and all females over 18 in each selected household would be interviewed. Here, the sampling unit and the population element are different. Extent refers to the geographical boundaries, and the time factor is the time period under consideration. The opening duck stamps example showed an appropriate definition of a population. We use the department store project to provide another illustration.

**Determine the Sampling Frame**

**A sampling frame** is a representation of the elements of the target population. It consists of a list or set of directions for identifying the target population. Examples of a sampling frame include the telephone book, an association directory listing the firms in an industry, a mailing list purchased from a commercial organization, a city directory, or a map. If a list cannot be compiled, then at least some directions for identifying the target population should be specified, such as random digit dialing procedures in telephone surveys. In the opening duck stamp example, the sampling frame consisted of a computer program for randomly and efficiently generating telephone numbers, excluding nonworking and non household numbers.

**Select a Sampling Technique**

Selecting a sampling technique involves several decisions of a broader nature. The researcher must decide whether to use a Bayesian or traditional sampling approach, to sample with or without replacement, and to use non-probability or probability sampling.

**Bayesian approach**

A selection method in which the elements are selected sequentially. The Bayesian approach explicitly incorporates prior information about population parameters as well as the costs and probabilities associated with making wrong decisions.

**Sampling with replacement**

A sampling technique in which an element can a included in the sample more than once.

**Sampling without replacement**

A sampling technique in which an element cannot be included in the sample more than once.

The most important decision about the choice of sampling technique is whether to use probability or nonprobability sampling. Givens it importance, the issues involved in this decision are discussed in great detail in this chapter.

If the sampling unity is different from the element, it is necessary to specify precisely how the elements within the sampling unit should be selected. In in-home personal interviews and telephone interviews, merely specifying the address or the telephone number may not be sufficient. For example, should the person answering the doorbell or the telephone be interviewed, or someone else in the household? Often, more than one person in a household may qualify. For example, both the male and female heads of household may be eligible to participate in a study examining family leisure-time activities. When a probability sampling technique is being employed, a random selection must be made from all the eligible persons in each household. A simple procedure for random selection is the next birthday method. the interviewer asks which of the eligible persons in the household has the next birthday and includes that persons in the sample, as in the opening duck stamps example.

**Determine the Sample Size**

Sample size refers to the number of elements to be included in the study. Determining the sample size is complex and involves several qualitative and quantitative consideration.

Important qualitative factors that should be considered in determining the simple size include (1) the importance of the decision, (2) the nature of the research, (3) the number of variables, (4) the nature of the analysis, (5) sample sizes used in similar studies, (6) incidence rates, (7) completion rates, and (8) resource constraints.

In general, for more important decisions, more information is necessary and the information should be obtained more precisely. This calls for larger samples, but as the sample size increases, each unit of information is obtained at greater cost. The degree of precision may be measured in terms of the standard deviation of the mean. The degree of precision may be measured in terms of the standard deviation of the mean. The standard

deviation of the mean is inversely proportional to the square root of the sample size. The larger the sample, the smaller the gain in precision by increasing the sample size by one unit.

The nature of the research also has an impact of nth sample size. For exploratory research designs, such as those using qualitative research, the sample size is typically small. For conclusive research, such as descriptive surveys, larger samples are required. Likewise, if data are being collected on a large number of variables, larger samples are required. The cumulative effects of sample error across variables are reduced in a large sample.

**Execute the Sampling Process**

Execution of the sampling process requires a detailed specification of how the sampling design decisions with respect to the population. Sampling frame, sampling unit, an operational definition of a household is needed. Procedures should be specified for vacant housing units and for callbacks in case no one is at home. Detailed information must be provided for all sampling design decision.

**Criteria for good sample design**

Whether the result obtained from a sample survey would be accurate or not depends upon the quality of the sample. The characteristics of a good sample are described below.

1. **Representativeness:** A sample must be representative of the population. Probability sampling technique yield representative sample. In measurement terms, the sample must be valid. The validity of a sample depends upon its accuracy and precision.
2. **Accuracy:** Accuracy is defined as the degree to which bias is absent from the sample. An accurate (unbiased) sample is one which exactly represents the population. It is free from any influence that causes any difference between sample value and population value (say, average).
3. **Precision:** The sample must yield precise estimate. Precision is measured by the standard error or standard deviation of the sample estimate. The smaller the standard error or estimate, the higher is the precision of the sample.
4. **Size:** A good sample must be adequate in size in order to be reliable. The sample should be of such size that the inferences drawn from the sample are accurate to the given level of confidence.

## 2.14 TYPES OF SAMPLE DESIGNS

Sampling design refers to the process of selecting samples from a population. There are two types of sampling designs.

1. Probability or Random sampling
2. Non-probability or Non-random sampling

Probability sampling is of following types:

1. Simple random sampling
2. Stratified random sampling
3. Systematic random sampling
4. Cluster sampling

Non-probability sampling may be classified into:

1. Convenience or accidental sampling
2. Purposive (or Judgement) sampling
3. Quota sampling
4. Snow-ball sampling

**Probability Vs. Non-Probability Sampling**

Probability sampling is based on the theory of probability. It is also known as random sampling. It provides a known non-zero chance of selection for each population element.

Its characteristics are:

1. In probability sampling every population has a chance of being selected.
2. Such chance is a known probability. For instance, if a sampling frame is a list of 100 students of a specific course of study, in a simple random sample, each student has $1/100^{th}$ chance of being selected.
3. Probability sampling yields a representative sample, and hence the findings of the sample survey are generalisable to the population.
4. The closeness of a sample to the population can be determined by estimating sampling bias or error. Through randomization, the danger of unknown sampling bias can be minimized. Hence, probability sampling is preferable to non-probability sampling.

Probability sampling should be used when generalization is the objective of study, and a greater degree of accuracy of estimation of population parameters is required. Cost and

time required for probability sampling may be large. Hence, the benefit derived from it should justify the cost.

**Non-probability sampling** or non-random sampling is not based on the theory of probability. This sampling does not provide a chance of selection to each population element. The only merits of this type of sampling are simplicity, convenience an d low cost.

Its merits are:

1. It does not ensure a selection chance to each population unit.
2. The selection probability is unknown.
3. A non-probability sample may not be a representative one.
4. Non-probability sampling plan does not perform inferential function, i.e., the population parameters cannot be estimated from the sample values.
5. It suffers from sampling bias which will distort results.

Therefore, non-random is not a desirable method. Yet there are some practical reasons for using it. Those reasons are:

1. When there is no other feasible alternative due to non-availability of a list of population, non-availability of some population elements for collection of data, etc;
2. When the study does not aim at generalizing the findings to the population, but simply at feeling the range of conditions, or nature of the phenomenon;
3. When the cost required for probability sampling may be too large, and the benefit expected from it is not commensurate with such costs; and
4. When probability sampling requires more time, but the time constraints and the time limit for completing the study do not permit it.

## 1. PROBABILITY SAMPLING METHODS

### Random Sampling Procedures

The importance of randomness in sampling needs no emphasis. It is a means for securing a representative sample. How can a random sample be drawn? The layman tends to think that random sampling means picking out units "at random", i.e., in a haphazard or hit-and-miss way. Experience shows that the human being is an extremely poor instrument for the conduct of a random selection. To ensure true randomness the method of selection must be independent of human judgement. There are three basic procedures.

**1. The lottery method:** This is the simplest and most familiar procedure of random sampling. If a sample of 10 students is to be drawn out of a list of 50 students in a section,

take 50 equal size chips or slips of paper; number them from 1 to 50 each bearing only one number. Roll each slip. Put the rolled slips in a global container and thoroughly shuffle or mix them. Take 10 chips from the container one after another. Each time before drawing a chip, mix the chips in the container thoroughly. The units bearing the numbers of chips drawn constitute the random sample.

In the above sampling procedure, there are two alternatives. After a number is selected by draw, it may be replaced and consequently it has a chance of being selected again. Such a method is known as sampling with replacement. This is usually referred to as unrestricted random sampling. Alternatively, the selected number is set aside, and so in the subsequent draws, it does not get chance of being selected again. This type of sampling is known as sampling without replacement. This is a form of restricted sampling.

Sampling with replacement guarantees each element an equal and independent chance of being selected in each draw. However an element previously drawn and replaced in the vessel has a chance of being drawn again. But the common procedure is not to count it again as an item of the sample. For, it is absurd to ask a respondent to fill in a questionnaire twice.

Lottery method is useful for drawing a small sample from a small population. But it would be time consuming and tedious if the population is very large.

(4) The sampling error in this sampling is greater than that in order probability samples of the same size, because it is less precise than other methods.

(5) The size of the sample required to ensure its representativeness is usually larger under this type of sampling than under other random sampling techniques.

(6) A simple random design may be expensive in time and money.

These problems have led to the development of alternative superior random sampling designs like stratified random sampling, systematic sampling, etc.

**Stratified Random Sampling**

This is an improved type of random or probability sampling. In this method, the population is sub-divided into homogeneous groups or strata, and from each stratum, random sample is drawn. For example, university students may be dividend on the basis of discipline, and each discipline group may again be divided into juniors and seniors; and the employees of a business undertaking may be divided into managers and non-managers and each of those two groups may be sub-divided into salary-grade-wise strata.

Accordingly stratified random sampling may be classified into (a) Proportionate stratified sampling and (b) Disproportionate stratified sampling.

**Proportionate Stratified Sampling**

This sampling involves drawing a sample from each stratum in proportion to the latter's share in the total population. For example, if the final year MBA students of the Management Faculty of a university consist of the following specialization groups:

| Specialization stream | No. of students | Proportion of each stream |
|---|---|---|
| Production | 40 | 0.4 |
| Finance | 20 | 0.2 |
| Marketing | 30 | 0.3 |
| Rural Development | 10 | 0.1 |
| | 100 | 1.0 |

The researcher wants to drawn an overall sample of 30.Then the strata sample sizes would be:

| Strata | Sample size |
|---|---|
| Production | 30 × 0.4 = 12 |
| Finance | 30 × 0.2 = 6 |
| Marketing | 30 × 0.3 = 9 |
| Rural Development | 30 × 0.1 = 3 |
| | 30 |

Thus, proportionate sampling gives proper representation to each stratum and its statistical efficiency is generally higher. This method is, therefore, very popular.

**Disproportionate Stratified Random Sampling**

This method does not give proportionate representation to strata. It necessarily involves giving overrepresentation to some strata and under representation to others. There may be several disproportionate schemes. All strata may be given equal weight, even though their shares in the total population vary. Alternatively some substrata may be given greater weight and others lesser weight. When is such disproportionate weighing preferable?

The desirability of disproportionate sampling is usually determined by three factors, viz., (a) the sizes of strata, (b) internal variances among strata, and (c) sampling costs.

The guideline suggested by Cochran is:

In a given stratum, take a larger sample if

(a) the stratum is larger,

(b) the stratum is more variable internally, and

(c) sampling is cheaper in the stratum.

If the elements of a stratum are more mixed or variable, then it would be sensible to take a larger sample from it in order to make it representative of the stratum. Similarly, if the cost per sampling unit is expected to be greater in some strata than in others, one could increase the cost effectiveness by taking a less proportionate sample in the costlier strata.

**Usage:** This method of disproportionate sampling is not widely used. However, it is appropriate to use it under the following circumstances:

(1) When the population contains some small but important sub-groups.

(2) When certain sub-groups are quite heterogeneous, while others are homogeneous; and

(3) When it is expected that there will be appreciable differences in the response rates of the sub-groups in the population. But the above differences should be several-fold to make disproportionate sampling worthwhile.

Disproportionate sampling cannot be used for population with unknown proportions of characteristics, because correct sizes of strata samples cannot be determined.

**Systematic Sampling or Fixed Interval Method**

**Meaning and process:** This method of sampling is an alternative to random sampling. It consists of taking every $k^{th}$ item in the population after a random start with an item from 1 to k. For example, suppose it is desired to select a sample of 20 students, from a list of 300 students, divide the population total of 300 by 20, the quotient is 15. (if there is any fraction in the quotient ignore the fraction and take the integer or whole number). Select a number at random between 1 and 15, using lottery method or a table of random numbers. Suppose the selected number is 9. Then the students numbered 9, 24 (9+15), 39 (24+15), 54 (39+15), 69,84 … are selected as the sample.

As the interval between sample units is fixed, this method is also known as fixed interval method.

**Applications:** Systematic selection can be applied to various populations such as students in a class, houses in a street, telephone directory, customers of a bank, assembly line output in a factory, members of an association, and so on.

**Cluster Sampling**

Where the population elements are scattered over a wider area and a list of population elements is not readily available, the use of simple or stratified random sampling method would be too expensive and time-consuming. In such cases cluster sampling is usually adopted.

**Meaning:** cluster sampling means random selection of sampling units consisting of population elements. Each such sampling unit is a cluster of population elements. Then from each selected sampling unit, a sample of population elements is drawn by either simple random selection or stratified random selection.

Suppose a researcher wants to select a random sample of 1,000 households out of 40,000 estimated households in a city for a survey. A direct sample of individual households would be difficult to select, because a list of households does not exist and would be too costly to prepare. Instead, he can select a random sample of a few blocks/wards. The number of blocks to be selected depends upon the average number of estimated households per block. Suppose the average number of households per block is 200, then 5 blocks comprise the sample. Since the number of households per block varies, the actual sample size depends on the block which happen to be selected. Alternatively he can draw a sample of more blocks and from each sample blocks a certain number of households may be selected by systematic sampling.

Some illustrations of clusters are:

| Population | Elements | Cluster or Sampling units |
|---|---|---|
| 1. City | Households | Blocks |
| 2. City | Individuals | Households |
| 3. Affiliating University | Students | Affiliated collages |
| 4. Rural areas | Households | Villages |
| 5. Industrial areas | Industrial unit | Industrial estates |

**Features:** What makes a desirable cluster depends on the survey's situation and resources. The individual elements are determined by the survey objectives. For example, for an opinion poll, the individual person is a population element, but for a socio-economic survey of households or a consumer behavior survey, a household may be population element or unit of study. The cluster may be an institution or a geographical area or any other appropriate group depending on the nature of survey.

The number of elements in a cluster is called the cluster size. The clusters in most populations are of unequal size, e.g., dwellings in blocks, persons in household, employees in sections, farm households in villages, etc. Clusters of equal size are often the result of planned conditions such as manufacturing, e.g., matches in match boxes, soap cakes in cases. They rarely exist in nature or society.

**Cluster sampling vs. stratified sampling:** How does cluster sampling compare with stratified sampling? There are certain differences between them.

**Cluster sampling process:** The process of cluster sampling involves the following steps:

| Cluster Sampling | Stratified Sampling |
|---|---|
| 1. The sampling unit is a cluster or a group consisting of population elements. | The population elements itself is the sampling unit. |
| 2. The population is divided into many clusters or sub-groups, each with a few elements. | The population is divided into a few sub-groups or strata, each with many elements. |
| 3. Clustering is done on the basis of geographical areas or administrative divisions. (district/taluka) farm size etc., | Stratification is done on the bass of variables under study, e.g., educational status, product line, of organizational unit. (e.g., department/sections) |
| 4. We try to secure heterogeneity with sub-groups and homogeneity between sub-groups. | We aim at securing homogeneity within sub-groups and heterogeneity between sub-groups. |
| 5. We make a random selection of sub-groups or clusters. | We make a random selection of elements from each sub-group. |
| 6. The resulting sample may give a lower degree of representativeness for a given sample size. | It yields a higher degree of representative sample for the same sample size. |
| 7. The sampling error may be great. | The sampling error will be less. |
| 8. The cost per element is lower. | The cost per elements is higher. |

1. **Identify clusters:** What can be appropriate clusters for a population? This depends on the nature of the study and the distribution of the population relating to it. The appropriate clusters may be area units (e.g., districts, talukas, villages, blocks of a city) or organizations/organizational units (e.g., schools, colleges, factories, sections in a school or departments in a factory).
2. **Examine the nature of clusters:** How homogeneous are the cluster? Clusters should not be homogeneous in internal characteristics. A sample drawn from such clusters

cannot fully represent the overall population. Hence clusters should be constructed in a way as to increase intra-cluster variance. For example, contiguous villages/city blocks that contain different income/social groups may be combined into one cluster Should the clusters be of equal or unequal size? "The theory of clustering is that the means of sample clusters are unbiased estimates of the population mean. This is generally true when clusters are equal. But natural clusters often vary. The effects of unequal size may be reduced by 1) combining small clusters and splitting large clusters or 2) stratifying clusters by size and selecting clusters from each stratum.

3. **Determine the number of stages:** Shall we use single-stage or multistage clusters? This depends primarily on the geographical area of the study, the scale of the study, there size of the population and the consideration of costs. Depending on these factors, the following alternatives are possible:
   **(a) Single-stage sampling:** Select clusters on a random basis and study all elements in each of the sample clusters.
   **(b) Two-stage sampling:** Select clusters and then select element from each selected cluster.
   **(c) Multi-stage sampling:** Extent the above method to more stages.

**Area Sampling:**

This is an important form of cluster sampling. In larger field surveys, clusters consisting of specific geographical areas like districts, talukas, villages or blocks in a city are randomly drawn. As the geographical areas are selected as sampling units in such cases, their sampling is called area sampling. It is not a separate method of sampling, but forms part of cluster sampling. It is not a separate method of sampling, but forms part of cluster sampling.

In a country like India where a state (previously known as a province) is divided into districts, districts into talukas and talukas into towns and villages, areas sampling is done on the basis of these administrative units in multi-stages.

Illustration: where they are covered by a study is a city, to draw a random sample of households, the following procedure may be adopted:

(1) Take a map of the concerned city and lay over it a transparent sheet with a grid system of lines

(2) The grid system divides the city into squares of equal size, say 100 areas.

(3) Leave the squares occupied by non-residential business and public buildings, parks etc.,- say 30 squares.

(4) Number the remaining squares in a serial order 1,2,3,4,5,….. 70 in a serpentine manner.

(5) Estimate the average number of households in each square on the basis of house counts in a few squares. Say the average number of households is 80.

(6) If the required sample of households is, say 640, determine the number of squares to be selected by dividing this total by 80, i.e., 8 squares.

(7) Select eight squares out of 80 on a simple random basis using a table of random numbers; or by adopting systematic random sampling method, i.e., every $10^{th}$ (80/8=10) square with a random start.

(8) Study all households in each of the sample eight squares. The total sample would be 8 × 80 =640 or a little less or more.

Where different socio-economic class of households are found to be concentrated in specific areas of the city, it is desirable to stratify the areas on an identifiable basis, then

- ❖ Draw a random sample of proportionate number of areas from each strata.
- ❖ Prepare a list of households in each of the selected areas.
- ❖ Select randomly a proportionate number of households in each of these lists.

Alternatively divide each of the selected area into smaller area of almost equal size called segments and select randomly a proportionate number of segments in each sample area and survey all households in each of the selected segments.

Area sampling invariably involves multi-stage sampling and sub-sampling.

**Multi-Stage Sampling**

In this method, sampling is carried out in two or more stages. The population is regarded as being composed of a number of first stag sampling units. Each of them is made up of a number of second stage units and so forth. That is, at each stage, a sampling unit is a cluster of the sampling units of the subsequent stage. First, a sample of the first stage sampling units is drawn. The procedure continues down to the final sampling units or population elements. Appropriate random sampling method is adopted at each stage.

**Usage:** multi-stage sampling is appropriate where the population is scattered over a wider geographical area and no frame or list is available for sampling. It is also useful when a survey has to be made within a limited time and cost budget.

**Advantages:** The crucial advantages of multi-stage sampling are:

1. It results in concentration of fieldwork in compact small areas and consequently in a saving of time, labour and money.
2. It is more convenient, efficient and flexible than single-stage sampling.
3. It obviates the necessity of having a sampling frame covering the entire population.

**Disadvantages:** The major disadvantage of the multi-stage sampling is that the procedure of estimating sampling error and cost advantages is complicated. It is difficult for a non-satisfaction follow this estimation procedure.

**Sub-Sampling:**

Sub-sampling is a part of a multi-stage sampling process. In multi-stage sampling, the sampling in second and subsequent stage frames is called sub-sampling. Suppose that from a population of 40,000 households in 800 streets of a city, we want to select a sample of about 400 households. We can select a sample of 400 individual households (elements) or a sample of 8 streets (cluster). The sample of 400 elements would be scattered over the city, but the cluster sample would be confined to 8 streets. Clustering reduces survey costs, but increases the sampling error. Sub-sampling balances these two conflicting effects of clustering. In the above case, first a sample of say 80 streets may be drawn and from each of the selected street a 10% sub sample of households may be drawn. In each of the above stages, an appropriate probability sampling-simple random/stratified random sampling /systematic random sampling-may be adopted.

## 2. NON-PROBABILITY SAMPLING METHODS

**Introduction**

As explained earlier, non-probability sampling does not adopt the theory of probability and it does not give a representative sample of the population. The primary methods of non-probability sampling are:

- ❖ Convenience sampling (or Accidental sampling)
- ❖ Purposive (or Judgment) sampling
- ❖ Quota sampling
- ❖ Snow-ball sampling

**Convenience or Accidental Sampling**

This is non-probability sampling. It means selecting sample units in a just ‘hit and miss’ fashion, e.g., interviewing people whom we happen t meet. This sampling also means

selecting whatever sampling units are conveniently available, e.g., a teacher may select students in his class.

This method is also known as accidental sampling because t respondents whom the researcher meets accidently are included in the sample.

**Usefulness:** Though convenience sampling has no status, it may be used for simple purpose such as testing ideas or gaining ideas or rough impression about a subject of interest. It lays a groundwork for a subsequent probability sampling. Sometimes it may have to be necessarily used. For example, when a population cannot be defined or a list of population is not available, there is no other alternative than to use convenient sampling.

**Advantages:**

1. Convenience sampling is the cheapest and simplest.
2. It does not require a list of population.
3. It does not require any statistical expertise.

**Disadvantage:**

1. Convenience sampling is highly biased, because of the researcher's subjectivity, and so it does not yield a representative sample.
2. It is the least reliable sampling method. there is no way of estimation the representativeness of the sample.
3. The findings cannot be generalized.

**Purposive or Judgement Sampling**

This method means deliberate selection of sample units that conform to some pre-determined criteria. This is also known as Judgement sampling. This involves selection of cases which we judge as the most appropriate ones for the given study. It is based on the judgement of the researcher or some expert. It does not aim at securing a cross section of a population.

T chance that a particular case be selected for the sample depends on the subjective judgement of the researcher. For example, a researcher may deliberately choose industrial undertakings in which quality circles are believed to be functioning successfully and undertaking in which quality circles are believed to be a total failure.

**Application:** The method is appropriate when what is important is the typicality and specific relevance of the sampling unit to the study and not their overall representativeness to the population.

**Advantage:** The advantages of purposive or judgement sampling are:

1. It is less costly and more convenient.
2. It guarantees inclusion of relevant elements in the sample. Probability sampling plans cannot give such guarantee.

**Disadvantage:** the demerits of judgement sampling are:

1. This does not ensure the representativeness of sample.
2. This is less efficient for generalizing when compared with random sampling.
3. This method requires more prior extensive information about the population one studies. Without such information, it is not possible to adjudge the suitability of the sample items to be selected.
4. This method does not lend itself for using inferential statistics, because, this sampling does not satisfy the underlying assumption of randomness.

**Quota Sampling**

This is a form of convenient sampling involving selection of quota groups of accessible sampling units by traits such as sex, age, social class, etc., when the population is known to consist of various categories by sex, age, religion, social class etc., in specific proportions, each investigator may given an assignment of quota groups specified by the per-determined trait in specific proportions. He can then select accessible persons, belonging to those quota groups in the area assigned to him.

"Quota Sampling is therefore a method of stratified sampling in which selection within strata is non-random. It is this Non-random element that constitutes its greatest weakness".

Quotas are stratified by such variables as sex, age, social class and religion. It is easy to classify accessible respondents under sex, age and religion, but it is very difficult to classify then into social categories, since social class usually involves a combination of factors such as occupation income and caste and the interviewer's subjective judgement and bias play some role in the social class classification of respondents.

A model of assignment given to an interviewer is shown below:

**Assignment of Quota**

| **Sex** | | **Age** | | **Social Class** | |
|---|---|---|---|---|---|
| Male | 11 | 20-40 | 5 | Higher | 3 |
| Female | 09 | 41-50 | 8 | Middle | 10 |
| | | 51-60 | 4 | Lower | 7 |
| | | 61 & above | 3 | | |
| Total | 20 | Total | 20 | Total | 20 |

**Application:** Quota sampling is used in studies like marketing surveys, opinion polls and leadership surveys which do not aim at precision, but to get quickly some crude results.

**Merits:** The major advantages of quota sampling are:

1. It is considerably less costly than probability sampling.
2. It is takes less time.
3. There is no need for a list of population. Thus, quota sampling is a suitable method of sampling a population for which no suitable frame is available.
4. Field work can easily be organized. Strict supervision need not be required.

**Shortcoming:** The method of quota sampling suffers from certain major shortcomings.

1. It may not yield a precise representative sample, and it is impossible to estimate sampling error. The findings, therefore, are not generalizable to any significant extent.
2. Interviewers may tent to choose the most accessible person; they may ignore slums or areas difficult to reach. Thus, they may fail to secure a representative sample within their quota groups.
3. Strict control of field work is difficult.
4. It difficult or sampling on more than three variable dimensions. This is because the number of categories to be selected is a multiplication of the number of values in each variable. For instances, if we want sample proportion at number of persons by sex, social status and age and these variables consist of two, tree and three categories respectively, we have to select $2 \times 3 \times 3 = 18$ categories of respondents.

5. The quota of sampling is subject to a higher degree of classification error, because the investigators are likely to base their classification of respondents' social status and economic status mostly on their impression about them.

**Snowball Sampling**

This is the colourful name for a technique of building up a list or a sample of a special population by using an initial setoff its members as information. For example, if a researcher wants to study the problem faced by Indians through some source like Indian embassy. Then he can ask each one of the to supply names of other Indians known to them, and continue this procedure until he gets an exhaustive list from which he can draw a sample or make a census survey.

This sampling technique may also be used in socio-metric studies. For example, the members of a social group may be asked to name the persons with whom they have social contacts, each one of the persons so named may also be asked to do so, and so on. The researcher may thus get a constellation of associates and analyse it.

**Advantages:** The advantages of snowball sampling are:

1. It is very useful in studying social groups, informal group in a formal organization, and diffusion of information among professionals of various kinds.
2. It is useful for smaller populations for which no frames are readily available.

**Disadvantages:**

1. The major disadvantages of snowball sampling is that it does not allow the use of probability statistical methods. Elements included are dependent on the subjective choice of the original selected respondents.
2. It is difficult to apply this method when the population is large.
3. It does not ensure the inclusion of all elements in the list.

**Unit III**

*Data Collection – Types of data – Sources – Tools for data collection, methods of data collection, constructing questionnaire – Pilot study – Case study – Data processing coding – Editing and tabulation of data – Data analysis.*

## 3.1 MEANING AND IMPORTANCE OF DATA

### Meaning of Data

The search for answers to research questions is called collection of data. Data are facts, and other relevant materials, past and present, serving as bases for study and analyses. Some example of data are:

- The types of Loans secured by borrowers (for a credit survey)
- The items of raw materials required for a product line (Materials management)
- The quantity of each material required for a unit of output.
- The sex, age, social class, religion, income level of respondents in a consumer behavior study.
- The opinions of eligible couples on birth control devices (Family Planning Survey)
- The capital expenditure proposals considered by a firm during year (Financial Management)
- The marks obtained by students of a class in a test on a particular subject (Performances of students)
- The opinions of people on voting in a general election (Opinion Poll)
- The types of news read by newspaper readers (Readership Survey)
- The aspirations of management trainees (The emerging Managers in Indian enterprises)
- The types and frequency of breakdowns occurred in particular brand of scooter (Post-purchase Behaviour Survey) and so on.

### Importance of data

The data serve as the bases or raw materials for analysis. Without an analysis of factual data, no specific inferences can be drawn on the questions under study. Inferences based on imagination or guess work cannot provide correct answers to research questions. The relevance, adequacy and reliability of data determine the quality of the findings of a study.

Data form the basis for testing the hypotheses formulated in a study. Data also provide the facts and figures required for constructing measurement scales and tables, which are analysed with statistical techniques. Inferences on the results of statistical analysis and tests of significance provide the answers to research questions. Thus, the scientific process of measurements, analysis, testing and inferences depends on the availability of relevant data and their accuracy. Hence, the importance data for nay research study.

## 3.2 TYPES OF DATA

There are two types of data Primary Data and Secondary Data.

1. **Primary Data:** Raw data or primary data is a term for data collected at source. This type of information is obtained directly from first hand sources by means of surveys, observations and experimentation and not subjected to any processing or manipulation and also called primary data.
2. **Secondary Data:** It refers to the data collected by someone other than the user i.e. the data is already available and anlysed by someone else. Common sources of secondary data include various published or unpublished data, books, magazines, newspaper, trade journals etc.

## 3.3 SOURCES OF DATA

The sources of data may be classified into (a) primary sources and (b) secondary sources.

**Primary Sources**

Primary sources are original sources from which he researcher directly collects data that have not been previously collected, e.g., collection of data directly by the researcher on brand awareness, brand preference, brand loyalty and other aspects of consumer behavior from a sample of consumers by interviewing them. Primary data are first-hand information collected through various methods such as observation, interviewing, mailing etc.

**Secondary Sources**

These are sources containing data which have been collected and compiled for another purpose. The secondary sources consists of readily available compendia and already compiled statistical statements and reports whose data may be used by researches for their studies, e.g., census reports, annual, reports and financial statements of companies, Statistical statements, Reports of Government Departments, Annual Reports on currency and finance published by the Reserve Bank of India, Statistical Statements relating to Cooperatives and Regional Rural Banks, published by the NABARD, Reports of the National Sample Survey

Organization, Reports of trade associations, publications of international organizations such as UNO, IMF, World Bank, ILO, WHO, etc., Trade and Financial Journals, newspapers, etc.,

Secondary sources consists of not only published records and reports, but also unpublished records. The latter category includes various records and registers maintained by firms and organizations, e.g., accounting and financial records, personnel records, personnel records, register of members, minutes of meetings, inventory records, etc.

**Features of Secondary Sources:** Though secondary sources are diverse and consist of all sorts of materials, they have certain common characteristics.

First, they are readymade and readily available, and do not require the trouble of constructing tools and administering them.

Second, they consist of data over which a researcher has no original control over collection and classification. Both the form and the content of secondary sources are not limit the research value of secondary sources.

Finally, secondary sources are not limited in time and space. That is, the researcher using them need not have been present when and where they we gathered.

## 3.4 TOOLS FOR DATA COLLECTION

The various methods of data gathering involve the use of appropriate recording forms. These are called tools or instruments of data collection. They consist of-

Observation schedule or observationnaire
Interview guide
Interview schedule
Mailed questionnaire
Rating scale
Check list
Opinionnaire
Document schedule/data sheet
Schedule for institutions
Inventories

Each of the above tools is used for a specific method of data gathering: observation schedule for observation method, interview schedule and interview guide for interviewing, questionnaire and option air for mail survey, and so on.

**Function**

The tools of data collection translate the research objectives into specific questions/items, the responses to which will provide the data required to achieve the research objectives. In order to achieve this purpose, each question/item must convey to the respondent the idea or group of ideas required by the research objectives, and each item must obtain a response which can be analyzed for fulfilling the research objective.

Information gathered through the tools provide descriptions of characteristics of individuals institutions or other phenomena under study. The characteristics may help to explain differences in behavioural pattern and performance of objects under study.

Information gathered through the tools serve another purpose also. It is useful for measuring the various variables pertaining to the study. The variables and their interrelationships are analysed for testing the hypothesis or for exploring the content areas set by the research objectives.

A brief description of the various tools of data collection is given below.

**Observation Schedule or Observationnaire**

The is a form on which observations of a object or a phenomenon are recorded. The items to be observed are determined with reference to the nature and objectives of the study. They are grouped into appropriate categories and listed in the schedule in the order inn which the observer would observe them.

The items are structured with possible alternatives. Space is provided against each unit observation for encircling or checking, or recording, as the case may be.

Provision is made for the correct identification of each case observed and of the observer.

The schedule should be so constructed as to make it possible to record the observations easily and correctly, and to tabulate and analyzed effectively.

The schedule must be so devised as to provide the required verifiable and quantifiable data and to avoid selective bias and misinterpretation of observed items. The units of observation must be simple, and meticulously worded so as to facilitate precise and uniform recording.

**Interview Guide**

This is used for non-directive and depth interviews. It does not contain a complete list of items on which information has to be elicited from a respondent; it just contains only the broad topics or areas to be covered in the interview.

Interview guide serves as a suggestive reference or prompter during interview. It aids in focusing attention on salient points relating to the study and in securing comparable data in different interview by the same or different interviewers.

There is considerable flexibility as to the manner, order and language in which the interviewer asks the questions. If the interviewer has to refer the guide very often, it would defeat its own purpose. The interviewer cannot listen closely and analytically if his attention rests on the guide. He may fail to respond to the use and implications of the interviewee's remarks.

**Interview Schedule and Mailed Questionnaire**

Both these tools are widely used in surveys. Both are complete list of questions on which information is elicited from the respondents. The basic difference between them lies in recording responses. While a schedule is filled out by the interviewer, a questionnaire is completed by the respondent.

Name of the Organization:

Date of Observations:

Name of observer:

1. Purpose for which the room is used:
   Chief Executive's room_____
   Section head's room _____
   Open Office _____
   Other (specify) _____
2. Dimensions of room (in meter and centimeter):
   (a) Floor space: length _____ width _____
   Total square meter _____
   (b) Height of ceiling _____
3. Windows:
   (a) Number of windows
   (b) Measurement of each window: Height _____ Width _____
   (c) Window doors: Wooden _____ Glass: Clear _____ Tinted _____
   (d) Panes: single _____ Double _____
   (e) Frames: Wood _____ Metal _____
4. Lighting: Fluorescent _____ Incandescent _____
   Direct _____ Indirect _____

5. Temperature control: Cooling

   Central cooling system for building _____

   Room cooler _____ None _____

   Temperature at time of observation_____

6. Floor covering: Wood _____ Carpet (Wall to Wall)

   Carpet partial_____

   Linoleum _____ Other (specify) _____

   None _____

**Check List**

This is the simplest of all the devices. It consists of a prepared list of items pertinent to an object or a particular task. The presence or absence of each item may be indicated by checking 'yes' or 'no' the object, act or task. A check list contains terms which the respondent understands and which more briefly and succinctly express his views than answers to open-ended question. It is a crude device, but careful pre-test can make it less so. It is at best when used to test specific hypothesis. It may be used as an independent tool or as a part of a schedule/questionnaire.

Its main drawback is that items may be responded in different ways. They may try to create a favourable impression of themselves by checking those qualities that they regard as socially desirable.

Given below is a check list taken from a questionnaire designed for university lady students check (=========)

| | Very important | important | indifferent | Undesirable |
|---|---|---|---|---|
| 1. Good looks | | | | |
| 2. Fair complexion | | | | |
| 3. Kindness | | | | |
| 4. Economic status | | | | |
| 5. Higher education | | | | |
| 6. Dependability | | | | |
| 7. Family background | | | | |
| 8. Sense of humour | | | | |
| 9. Ambition | | | | |
| 10. Moral character | | | | |
| 11. Domesticity | | | | |

| | | | | |
|---|---|---|---|---|
| 12. Intelligence<br>13. Good health<br>14. physique | | | | |

A check list given under "question Construction" in topic 8.2 is another example.

**Opinionnaire**

This is a list of questions or statements pertaining to an issues or program. It is used for studying the opinions of people. It is commonly used in opinion polls. People are asked to express their responses to the listed questions or reactions to the listed statements.

**Documents Schedule/Data Sheet**

This is a list of items of information to be obtained from documents, records and other materials. In order to secure measurable data, the items included in the schedule are limited to those that can be uniformly secured from a large number of case histories or other records. For example, a study of annual returns and financial statements filed by joint-stock companies with the register of joint-capital employed, net worth, volume of business, income and expenditure, gross profit, net profit before tax and net profit after tax.

**Schedule for Institutions**

This is used for survey of organizations like business enterprises, educational institutions, social or cultural organizations and the like. It will include various categories of data relating to their profile, functions and performance. These data are gathered from their records, annual reports and financial statements.

**Inventories**

"An inventory is essentially a list that the respondent is asked to mark or check in a particular way". Some example of inventories are

1. **Lists of interest:** the respondents are asked to check those things that interest them a lot.
2. **List of personality traits:** people are asked to check which of these apply to them.
3. **List of spare-time activities:** one has to check the activity engaged most often.
4. **Perceived effects of T.V:**(Stimulation of Activities): The respondents may be asked to check 'true' or 'untrue' the following items:
   (a) I have copied the way the people dress on TV.
   (b) I have made things after they have been shown on TV.
   (c) I have purchased a particular brand after seeing its advertisement on TV.
   (d) I have gone to an art gallery after seeing it on TV. And so on.

**Uses:** Inventories can be constructed with various purposes in mind or to test particular hypothesis. They invariably form part of a questionnaire/schedule.

## 3.5 METHODS OF PRIMARY DATA COLLECTION

There are various methods of data collection. A 'Method' is different from a 'Tool'. While a method refers to the way or mode of gathering data, a tool is an instrument used for the method. For example, a schedule is used for interviewing. The important methods are (a) observation, (b) interviewing, (c) mail survey, (d) experimentation, (e) simulation, and (f) projective technique.

### OBSERVATION

### Meaning and Importance

Observation means viewing or seeing. We go on observing something or other while we are awake. Most of such observations are just casual and have no specific purpose. But observation in a method of data collection is different from such casual viewing.

Observation may be defined as a systematic viewing of a specific phenomenon in its proper setting for the specific purpose of gathering data for a particular study. Observation as a method includes both 'seeing' and 'hearing'. It is accompanied by perceiving as well.

Observation is a classical method of scientific enquiry. The body of knowledge of various natural and physical sciences such as biology, physiology, astronomy, plant ecology etc. has been built upon centuries of systematic observation.

Observation also plays a major role in formulating and testing hypotheses in social sciences. Behavioural scientists observe interactions in small groups; anthropologists observe simple societies, and small communities; political scientists observe the behavior of political leaders and political institutions. Ina sense, as the Webs have pointed out, all social research begins and ends with observation. A researcher silently watching a city council or a trade union committee or quality circle or a departmental meeting or a conference of politicians or others picks up hints that help him to formulate new hypothesis. He can test them through further observation and study.

Observation becomes scientific, when it (a) serves a formulated research purpose, (b) is planned deliberately, (c) is recorded systematically, and (d) is subjected to checks and controls on validity and reliability. Validity refers to the extent to which the recorded observations accurately reflect the construct they are intended to measure. Validity is assessed by examining how well the observations agree with alternative measures of the same construct. Reliability entails consistency and freedom from measurement error. This is

usually assessed in terms of (a) the extent to which two or more independent observers agree in their ratings of the same event; and (b) the repeatability of observations over time by means of test-reset comparisons.

**Types of observation**

Observation may be classified in different ways. With reference to investigator's role, it may be classified into (a) participant observation, and (b) non-participant observation. In terms of mode of observation, it may be classified into (c) direct observation and (d) indirect observation. With reference to the rigor of the system adopted, observation is classified into (e) controlled observation, and (f) uncontrolled observation.

**Participant observation:** In this observation, the observer is a part of the phenomenon or group which is observed and he acts as both an observer and a participant. For example, a study of tribal customs by an anthropologist by taking part in tribal activities like folk dance. The persons who are observed should not be aware of the researcher's purpose. Then only their behavior will be 'natural'. The concealment of research objective and researcher's identity is justified on the ground that it makes it possible to study certain aspects of the group's culture which are not revealed to outsiders.

**Advantages:** The advantages of participant observation are:

(1) The observer can understand the emotional reactions of the observed group, and get a deeper insight of their experiences.

(2) The observer will be able to record context which gives meaning to the observed behavior and heard statements.

**Disadvantages:** Participant observation suffers from some demerits.

1. The participant observer narrows his range of observation. For example, if there is a hierarchy of power in the group/community under study, he comes to occupy one position within it, and thus other avenues of information are closed to him.
2. To the extent that the participant observer participates emotionally, the objectivity is lost.
3. Another limitation of this method is the dual demand made on the observer. Recording can interfere with participation, and participation can interfere with observation. Recording on the spot is not possible and it has to be postponed until the observer is alone. Such time lag results in some inaccuracy in recording.

Because of the above limitations, participant observation is generally restricted to those cases where non-participant observation is not practical, e.g., a study of the functioning of a mobile library or mobile bank or tribal community etc.

**Non-participant observation:** In this method, the observer stands apart and dose not participate in the phenomenon observed. Naturally, there is no emotional involvement on the part of the observer. This method calls for skill in recording observations in an unnoticed manner.

**Direct observation:** This means observation of an event personally by the observer by the observer when it takes place. This method is flexible and allows the observer to see and record subtle aspects of events and behavior as they occur. He is also free to shift places, change the focus of the observation. A limitation of this method is that the observer's perception circuit may not be able to cover all relevant events when the latter move quickly, resulting in the incompleteness of the observation.

**Indirect observation:** This does not involve the physical presence of the observer, and the recording is done by mechanical, photographic or electronic devices, e.g., recording customer and employee movements by a special motion picture camera mounted in a department of a large of a large store. This method is less flexible then direct observation, but it is less biasing and less erratic in recording accuracy. It also provides a permanent record for an analysis of different aspects of the event.

**Controlled observation:** This involves standardization of observational techniques and exercise of maximum control over extrinsic and intrinsic variables by adopting experimental design and systematically recording observations.

Controlled observation is carried out either in the laboratory or in the field. In is typified by clear and explicit decisions on what, how and when to observe. It is primarily used for inferring causality, and testing causal hypothesis.

**Uncontrolled observation:** This does not involve control over extrinsic and intrinsic variables. It is primarily used for descriptive research. Participant observation is a typical uncontrolled one.

**EXPERIMENTATION**

**Meaning**

Experimentation is a research process used to study the causal relationships between variables. It aims at studying the effect of an independent variable on a dependent, by keeping the other independent variable constant through some type of control. For example, a social scientist may use experimentation for studying the effect of a family planning publicity on people's awareness of family planning techniques.

Various kinds of designs such as “after-only design”, “before-after-design”’ etc. are used for experimentation.

**Why Experiment?**

Experimentation requires special efforts. It is often extremely difficult to design, and it is also a time consuming process process. Why should then one take such trouble? Why not simply observe/survey the phenomenon? The fundamental weakness of any non-experimental study is its inability to specify causes and effect. It can show only correlations between variables, but correlation alone never prove causation. The experiment is the only method which can show the effect of an independent variable on dependent variable. In experimentation, the researcher canmanipulate the independent variable and measure its effect on the dependent variable. For example, the effect of various types of promotional strategies on the sale of a given product can be studied by using different advertising media media such as T.V., radio and Newspapers.

Moreover, experiment provides “the opportunity to very the treatment (experimental variable) in a systematic manner, thus allowing for the isolation and precise specification of important differences.”3

**Planning and Conducting Experiments**

It is easy to conceive ideas, but difficult to translate the ideas into a workable, credible, meaningful set of experimental operations. This to a great extent depends upon the researcher’s knowledge, imagination and intelligence. Yet the general procedure in experimentation may be outlined.

First, determine the hypothesis to be tested and the independent and dependent variables involved in it.

Second, operationalize the variables by identifying their measurable dimensions

Third, select the type of experimental plan. The types of experimental design based on types of control may be classified into: (1) one group plan, using the same group as experimental and control group and measuring it before and after experimental treatment; (2) matched groups plan, consisting of two identical groups, one to be used as control group and another as experimental group, with (a) Post-test only measurement or (b) pretest-post-test measurements.

Fourth, choose the setting. The setting may be field or laboratory (See subsequent paragraphs for detailed discussion on these types of experiments).

Fifth, make the experimental conditions as nearly the same as the expected real life conditions. This is essential in order to make the findings reliable.

Sixth, make a record of per-experimental conditions.

Seventh, introduce appropriate methods for controlling extraneous variables that are not

These methods are:

1. **Removing the variable:** An extraneous variable may be eliminated completely. For example, observer distraction may be eliminated by separating the observer by a one-way glass partition. Some variables may be eliminated by selecting cases with uniform characteristics, e.g., using only male subjects removing sex as a variable.
2. **Matching cases:** Selecting control and experimental groups with identical characteristics. By this all variables are kept constant.
3. **Balancing cases:** This means assigning subjects to experimental and control groups in such as way that the means and the variances of the groups are as nearly equal as possible.
4. **Randomization:** This involves pure chance selection and assignment of subjects to experimental and control groups. This method eliminates systematic bias and minimizes the effect of extraneous variables.
5. **Analysis of covariance:** This is a statistical method of eliminating initial differences on several variables between the experimental and control groups. Pretest mean scores are used as covariates.

Eighth, apply the experimental treatment and record observations and measurements using appropriate measurement devices. If feasible, repeat the tests several times in order to insure the accuracy of results.

Ninth, analyse the results, using appropriate statistical devices.

Last, interpret the results, giving consideration to all possible extraneous conditions. No possible cause should be overlooked, as unforeseen conditions might influence the results.

**Applications**

The applications of experimental method are discussed under “Laboratory Experiment”, and “field Experiment” below.

**Laboratory Experiment**

An experiment can Conducted either in a laboratory or in a real-life setting.

A laboratory experiment is an investigation conducted in a setting created specifically for the purpose. The researcher manipulates an independent variables constant.

**Purpose:** The purpose of laboratory experiments are: (1) to discover causal relations under uncontaminated conditions, reduce the discovered relations to functional form y = f(x) and make predictions on the basis of the functions; (2) to test the predictions derived from theory and other researches; and (3) to refine theories.

**Applications or uses:** This method is useful not only in physical sciences research, but also in social sciences research. Even though experimentation on a social science problem has special difficulties, it can be used for a variety of studies such as voting behavior, Leadership style, Learning process, effectiveness of advertising media, effect of package on sales, influence schemes on labour productivity and so on.

**Field Experiment**

This is an experiment conducted in a real life situation in which the experimenter manipulates an independent variable in order to test a hypothesis. Compared with laboratory experiment, a field experiment incorporates less control. As it is difficult to foresee and control extraneous factors in a field experiment, its result is subject to large uncontrolled variation.

**Application or Uses:** This method is well suited to both testing of theory and finding solutions to practical social problems. It has been used for studying a variety of social action programmes such as, improving the quality of work life in assembly-lines,, post offices and insurance companies and banks; the learning process in educational institutions and training centers changing group productivity; changing organization culture; changing superior-subordinate relationship in organization; overcoming resistance to change through participative approach; changing attitude through social contract; changing food habits; improving the effectiveness of mass education; testing new products in markets; determining best procedures or techniques for tasks; and so on.

“Anyone who wishes to take effective social action in any setting can improve upon the uncontrolled, try out of new methods by the application of more scientific experimental procedures. Through careful measurements, better theorizing, the use of control groups, and other aspects of improved experimental design, the practical problems of social action can be

solved with greater certainty, with greater accuracy, and sometimes with greater efficiency than through common-sense trial-and-error methods."

The field experiment will be more successful if preceded by a field study which gives a more thorough knowledge of the setting and thus enables the experimenter to manipulate and control his variables more effectively.

**SIMULATION**

**Meaning**

Simulation is one of the forms of observational methods. It is a process of conducting experiments on a symbolic model representing a phenomenon. Abelson defines simulation as "the exercise of a flexible limitation of process and outcomes for the purpose of explaining the underlying mechanisms involved." It is a symbolic abstraction simplification and substitution for some referent system. In other words, simulation is a theoretical money of the elements, relations and processes which symbolize some referent system, e.g., the flow of money in the economic system may be simulated in an operating model consisting of a set of pipes through which liquid moves. Simulation is thus a technique of performing sampling experiments on the model of the systems. The experiments are done on the model instead of on the real system, because the latter would be too inconvenient and expensive.

**The process Simulation**

First, the process or system to be simulated is identified.

Second, the purpose of this simulation is decided. It may be to "clarify" or "explain" the process

Third, on the basis of the available information on the process or system- its components and the set of conditions assumed to operate in the between the components- a mathematical model is developed.

Fourth, several sets of input data to be used are collected. Inputs may be samples of actual of actual data or synthetic data on the general characteristics of real input data.

Fifth, the type of simulation- computer simulation or man simulation or man-computer simulation-to be used is determined.

Lastly, the simulation is operated with the various sets of input data, and results are analysed to determine the best solution.

## INTERVIEWING

### Definition

Interviewing is one of the prominent methods of data collection. It may be defined as a two-way systematic conversation between an investigator and an informant, initiated for obtaining information relevant to a specific study. It involves not only conversation, but also leaning from the respondent's gestures, facial expressions and pauses, and his environment.

Interviewing requires face-to-face contact or contact over telephone3 and calls for interviewing skills, It is done by using a structured schedule or an unstructured guide.

### Types of Interviews

The interviews may be classified into: (a) structured or directive interview, (b) unstructured or non- directive interview, (c) focused interview, and (d) clinical interview and (d) depth interview

### Directive Interview Structured,

This is an interview made with a detailed standardized schedule. The same questions are put to all the respondents and in the same order. Each question is asked in the same way in each interview, promoting measurement reliability. This type of interview is used for large-scale formalized surveys.

**Advantages:** This is interview has certain has certain advantages. First, data from one interview to the next one are easily comparable. Second, recording and coding data do not pose any problem, and greater precision is achieved.. Lastly, attention is not diverted to extraneous, irrelevant and time-consuming conversation.

**Limitation:** However, this type of interview suffers from some limitation. First, it tends to love the spontaneity of natural conversation. Second, the way in which the interview is structured may be such that the respondent" views are minimized and the investigator's own biases regarding the problem under study are inadvertently introduced. Lastly, the scope for exploration is limited.

### Unstructured or Non-directive Interview

This is the least structured one. The interviewer encourages the respondent to talk freely about a given topic with a minimum of prompting or guidance.

In this type of interview, a detailed pre-planned schedule is not used. Only a broad interview guide is used. The interviewer avoids channeling the interview directions. Instead, he develops a very permissive atmosphere. Question are not ordered in a particular way.

This interviewing is more useful in case studies rather than in surveys. It is particularly useful in exploratory research where the lines of investigation are not clearly defined. It is also useful for gathering information on sensitive topics such as divorce, social discrimination, class conflict, generation gap, drug-addition etc. It provides opportunity to explore the various aspect of the problem in an unrestricted manner.

**Advantages:** This type of interview has certain special advantages. It can closely approximate the spontaneity of a natural conversation. It is less prone to interviewer's bias. It provides greater opportunity to explore the problem in an unrestricted manner

**Limitations:** Though the unstructured interview is a potent research instrument, it is not free from limitations.

One of its major limitations is that the data obtained from one interview is not comparable to the data from the next. Hence, it is not suitable for surveys.

Time may be wasted in unproductive conversations. By not focusing on or another facet of a problem, the investigator may run the risk of being led up blind alley.

As there is no particular order or sequence in this interview, the classification of responses and coding may require more time.

This type of informal interviewing calls for greater skill than the formal survey interview.

**Focused Interview**

This is a semi-structured interview where the investigator attempts to focus the discussion on the actual effects of a given experience to which the respondents have been exposed. It takes place with the respondents known to have involved in a particular experience, e.g., seeing a particular film, viewing a particular programme on T.V., involved in a train/bus accident, etc. The situation is analysed prior to the interview. An interview guide specifying topics relating to the research hypothesis is used. The interview is focused on the subjective experiences of the respondent, i.e., his attitudes, and emotional responses regarding the situation under study.13

The focused interview permits the interviewer to obtain details of personal reactions, specific emotions and the like.

**Merits:** This type of interview is free from the inflexibility of formal methods, yet gives the interview a set form and insures adequate coverage of all the relevant topics.

The respondent is asked for certain information, yet he has plenty of opportunity to present his views.

The interviewer is also free to choose the sequence of questions and determine the extent of probing

**Clinical Interview**

This is similar to the focused interview but with a subtle difference. While the focused interview is concerned with the effects of a specific experience, clinical interview is concerned with broad underlying feelings or with the course of the individual's life experiences.

The 'Personal history 'interview used in social case work, prison administration, psychiatric clinics and in individual life history research is the most common type of clinical interview. The specific aspects of the individual's life history to be covered by the interview are determined with reference to the purpose of the study and the respondent is encouraged to talk freely about them.

**Depth Interview**

This is an intensive and searching interview aiming at studying the respondent's opinion, emotions or convictions on the basis of an interview guide. This requires much more training inter-personal skills than structured interviewing. This deliberately aims to elicit unconscious as well as extremely personal feeling and emotions.

This is generally a lengthy procedure designed to encourage free expression of affectively charged information. It requires probing.

The interviewer should totally avoid advising or showing disagreement. Of course, he should use encouraging expressions like "uh-huh" or "I see" to motivate the respondent to continue narration. Sometimes the depth interviewer has to face the problem of affection, i.e., the respondent may hide expressing affective feelings. The interviewer should handle such situation with great care.

**Telephone Interviewing**

Telephone interviewing is a non-personal method of data collection. It may be used as a major method or supplementary method.

**Uses:** It will be useful in the following situation:

1. When the universe is composed of those person whose names are listed in telephone directions, e.g., business houses, executives, doctors, other professionals.
2. When the study requires responses to five of six simple question, e.g., Radio or Television programme survey.

3. When the survey must be conducted in a very short period of time, provided the units of study are listed in telephone directory.
4. When the subject is interesting or important to respondents, e.g., A survey relating to trade conducted by a trade association or a chamber of commerce, a survey relating to a profession conducted by the concerned professional association.
5. When the respondents are widely scattered and when there are many call backs to make.

**Evaluation Advantages:** The advantage of telephone interview are:

1. The survey can be completed at very low cost, because telephone survey does not involve travel time and cost and all calls can be made from a single location.
2. Information can be collected in a short period of time. 5 to 10 interviews can be conducted per hour.
3. Quality of response is good, because interviewer bias is reduced as there is no face-to-face contact between the interviewer and the respondent.
4. This method of interviewing is less demanding upon the interviewer.
5. It does not involve field work.
6. Individuals who could not be reached or who might not care to be interviewed personally can be contacted easily.

**Group Interview**

**Meaning and Nature:** A group interview may be defined as a method of collecting primary data in which a number of individuals with a common interest interact with each other. In a personal interview, the flow of information is multi-dimensional.

The group may consist of about six to eight individuals with a common interest. The interviewer acts as the discussion leader. Free discussion is encouraged on some aspect of the subject under study. The discussion leader stimulates the group members to interact with each other.

The desired information may be obtained through self-administered questionnaires or interview, with the discussion serving as a guide ensure consider consideration of the areas of concern. In particular, the interviewers look for evidence of common elements of attitudes, beliefs, intentions and opinions among individuals in the group. At the same time, he must be aware that a single comment by a member can provide important insight.

Sample for group interview can be obtained through schools, clubs and other organized groups.

**Uses:** The group interview technique can be employed by researchers in studying people's reactions on public amenities, public health projects, welfare schemes, etc., it is a popular method in marketing research to evaluate new product or service concepts, brand names, packages, promotional strategies and attitudes. When an organization needs a great variety of information inasmuch detail as possible at a relatively low cost and in a short period of time, the group interview technique is more useful. In can be used to generate primary data in the exploratory phase of a project.

**Evaluation: Advantages:** The advantages of this technique are:

1. The respondents comment freely and in detail.
2. The method is highly flexible. The flexibility helps the research work with new concepts or topics which have not been previously investigated.
3. Visual aids can be used.
4. A group can be interviewed in the tie required for one personal interview.
5. The client can watch the interview unobserved.
6. Respondents are more articulate in a group than in the individual interview.
7. The technique eliminates the physical limitations inherent in individual interviews.

**PANEL METHOD**

**Meaning**

The panel method is a method of data collection, by which data is collected from the same sample respondents at intervals either by mail of by personal interview. This is used for longitudinal studies on economic conditions, expenditure pattern, consumer behavior, recreational pattern, effectiveness of advertising, voting behavior, and so on. The period over which the panel members are contacted for information may spread over several months or years. The time interval at which they are contacted repeatedly may be 10 or 15 days, or two months depending on the nature of the study and the memory span of the respondents.

**Characteristics**

The basic characteristic of the panel method is successive collection of data on the same items from the same persons over a period of time.

The type of information to be collected should be such facts that con be accurately and completely furnished by the respondent without any reservation.

The number of item should be as few as possible so that they could be furnished within a few minutes, especially when mail survey is adopted. The average amount of time that panel member has to spend each time for reporting can be determined in a pilot study.

The panel method requires carefully selected and well-trained field workers and effective supervision over their work.

**Need for Panel Study**

When sample respondents – particularly households or individuals-are contacted once only, they may not be able to recall exactly what have occurred during a longer time period, say a year because their memory span is short. Therefore they will not be able t give correct information on such facts as cash inflow, source-wise income, expenditure pattern, purchases, savings, recreation pattern and so on. But when they are contacted successively at short intervals of 10 or 15 days, they would to able to give accurate information on happenings between two successive contacts, as the time span is short and well within the memory span. In this way, data are collected repeatedly at intervals, and computations for the required period like a year can be easily made and the data so collected will be more reliable.

**Types of Panels**

The panel may be static or dynamic. A static or continuous panel is one in which the membership remains the same throughout e life of the panel, except for the members who drop out. The dropout are not replaced.

The static panel is appropriate when the purpose is to study changes in a given group of persons over a period of time. The main drawbacks of the static panel are:

1. Due to dropouts, it ceases to be representative of the original universe after a time.
2. The size of the reporting panel may become too small for satisfactory results.

In a dynamic panel, to keep the panel representative of the current population in the area covered by the universe, replacement are found for the members who drop out. A dynamic panel may also be a rotating one, in which members are systematically replaced at specified time intervals.

The dynamic panel is most useful when it is important to keep the panel representative of the population at all times. The main problem connected with its use is the cost and difficulty of recruiting new members to replace the dropouts.

**MAIL SURVEY**

**Definition**

The mail survey is another method of collecting method of collecting primary data. This method involves sending questionnaires to the respondents with a request to complete them and return them by post. This can be used in the case of educated respondents only. The mail questionnaires should be simple so that the respondents can easily understand the questions and answer them. It should preferably contain mostly closed-end and multiple-choice questions so that it could be completed within a few minutes.

The distinctive feature of the mail survey is that the questionnaire is self-administered by the respondents themselves and the responses are recorded by them, and not by the investigator as in the case of personal interview method. it does not involve face-to-face conversation between the investigator and the respondent. Communication is carried out only in writing and this requires more cooperation from the respondents than does verbal communication.

**Procedure**

The researcher should prepare a mailing list of the selected respondents by collecting the addresses from the telephone directory of the association or organization to which the belong.

A covering letter should accompany a copy of the questionnaire. It is a copy of a respondent the purpose of the study and the importance of his cooperation to e success of the project. Anonymity may be assured.

**A Covering Letter used for a Study on 'Corporate Planning'**

The sponsor's identity may be revealed. However when such information may bias the results, It is not desirable to reveal it. In the later case, a disguised organization name may be used.

A self-addressed stamped envelope should be enclosed in the covering letter.

After a few days from the data of mailing the questionnaires to the respondents, the researcher can expect the return of completed ones from them. The progress in return may be watched and at the appropriate stage follow-up efforts can be made.

**Alternative Modes of Sending Questionnaires**

There are some alternative methods of distributing questionnaires to the respondents. They are: (1) personal delivery, (2) attaching questionnaire to a product, (3) advertising questionnaire in a newspaper of magazine, and (4) news stand inserts.

**Personal delivery:** the researcher or his assistant may deliver the questionnaires to the potential respondents with a request to complete them at their convenience. After a day or two he can collect the completed questionnaires from the. Often referred to as the self-administered questionnaire method, it combines the advantages of the personal interview and the mail survey.

Alternatively, the questionnaire may be delivered in person and the completed questionnaires may be returned by mail by the respondents.

**Attaching questionnaire to a product:** A firm test-marketing a product may attach a questionnaire to a product and request the buyer to complete it and mail it back to the firm. The respondent is usually rewarded by a gift or a discount coupon.

**Advertising the questionnaire:** The questionnaire with the instructions for completion may be advertised on a page of a magazine or in a section of newspapers. The potential respondent completes it tears it out and mails it to the advertiser. For example, the committee on Banks Customer Service used this method for collecting information from the customers of commercial banks in India. This method may be useful for large-scale on topics of common interest.

News-stand inserts: This method involves inserting the covering letter, questionnaire and self-addressed reply-paid envelope into a random sample of newsstand copies of a newspaper or magazine.

**Improving the Response Rate in a Mail Survey**

The response rate in mail surveys is generally very low., More so in developing countries like India. Certain techniques have to be adopted to increase the response rate. They are:

1. Quality printing: The questionnaire may be neatly printed in quality light coloured paper so as to attract the attention of the respondent.
2. Covering letter: The covering letter should be couched in a pleasant style so as to attract and hold the interest of the respondent. It must anticipate objections and answer them briefly. It is desirable to address the respondent by name.

3. Advance information: Advance information can be provided to potential respondents by a telephone call or advance notice in the newsletter of t concerned organization or by a letter. Such preliminary contact with potential respondents is more successful than follow. Up effort.
4. Incentives: Money, stapes for collection and other incentives are also used to induce respondents to complete and return mail questionnaires.
5. Follow-up-contact: In the case of respondents belonging to an organization, they may be approached through someone in that organization known to the researcher.
6. Larger sample size: A larger sample may be drawn than the estimated sample size. For example, if the required sample size is 1000, a sample of 1500 may be drawn. This may help the researcher t secure in effective sample size closer to the required size.

**PROJECTIVE TECHNIQUES**

The direct methods of data collection, viz., personal interview, telephone interview and mail survey rely on respondents" own report of their behaviour, beliefs, attitudes, etc. But respondents may be unwilling to discuss controversial issues or to reveal intimate information about themselves or may be reluctant to express their true views fearing that they are generally disapproved. In order to overcome these limitations, indirect methods have been developed. Projective techniques are such indirect methods. They become popular during 1950s as a part of motivation research.

**Meaning**

Projective techniques involve presentation of ambiguous stimuli to the respondents for interpretation. In doing so, the respondents reveal their inner characteristics. The stimuli may be a picture, a photograph, an ink blot or an incomplete sentence.

The basic assumption of projective techniques is that a person projects his own thoughts, ideas and attributes when he perceives and responds to ambiguous or unstructured stimulus materials. Thus, a person's unconscious operations of the mind are brought to a conscious level in a disguised and projected from, and person projects his inner characteristics.

**Functions**

Projective techniques can help to overcome some of the following psychological barriers:

1. **The barrier of unawareness:** People are often unaware of their motives and attitudes. For example, a lonely woman may keep cats as some kind of substitute for children, but also might be unaware of such need.
2. **The barrier irrationality:** Our society places a high premium on sensible, rational and logical behavior. Most of us tend to rationalize. We invent logical reasons for actions whose origins are far from rational.
3. **The barrier of inadmissibility:** We find it difficult to admit our failure to meet social norms or expectations.
4. **The barrier of self-incrimination:** It concerns those aspects of behavior and feeling that might lower the respondent's self-esteem such as communal prejudice, superstition, etc.
5. **The barrier of politeness:** People often prefer not to say negative or critical views. They tend to say "all right" for everything.

Whenever the pilot study shows the existence of the above barriers with respect to the problem under study, then the use of projective technique should be considered.

**Approaches**

The commonly used approaches are:

1. **Association:** "Say-the-first-thing comes into your mind" approach is based on the assumption the a fast response to a stimulus word, picture or question will be less "guarded" and therefore more "revealing of underlying attitudes and motives.
2. **Fantasy:** The respondent is asked to guess or tell a story or discuss a picture in imaginary terms. In doing this he is likely to reveal his own attitudes and experiences
3. **Ambiguous stimuli:** Whenever a subject is asked to respond to a relatively ambiguous stimulus, he will reveal something about himself when making his response.
4. **Conceptualizing:** The way a respondent names, orders or groups thing may reflect his attitudes.

All these approaches rely on spontaneity or interpretation, and on ambiguity in the stimulus. They should be as non-directive as possible so as not to bias the responses. They also require a certain amount of interpretation on the part of the researcher. This influence may vary from observer to observer. Thus, projective methods lack objectivity and the reliability and validity are rather shaky Yet they yield best results when interpreted by tainted psychologists, in terms of some pre-established psychological conceptualization. In fact, projective tests serve

as a major tool for understanding human personality, and for measuring achievement motivation as well. “If we have to penetrate deeper, below the lever of conscious awareness or being the individual’s social façade, then indirect projective techniques have to be used.”18

**Types of Projective Techniques**

Projective Techniques may be divided into three broad categories: (a) visual projective techniques, (b) verbal projective techniques, and (c) Expressive techniques.

(a) Visual Projective techniques involve use of visual (pictorial) stimuli. They include (1) Rorschach Tests., (2) Thematic Apperception Test (TAT), (3) Rosenzweigh Test, (4) Picture Frustration Test, and (5) Holtzman Inkblot Test (HIT).

(b) Verbal Techniques involve use of words both for stimulus and for response. They consist of (1) Word Association Test, (2) Sentence Completion test and (3) Story Completion Test.

(c) Expressive Techniques: The Subject to from some sort of product out of the given material.

But the emphasis is on the manner in which he does the work and not on end product. “The subject expresses his needs, emotions and motives through working with, manipulating and interacting with materials, including other persons, in a manner or style that uniquely expresses his personality,”19

The principal expressive methods are (1) play, (2) drawing, (3) finger painting, and (4) role playing

**Rorschach test:** This was first developed by a Swiss scientist Herman Rorschach and was used for diagnostic of the personality as a whole. This test uses association approach. It consists of ten cards. On each card is printed an ink blot the subject is asked to tell what he sees-what the blot represents.

This test studies the imagination of an individual. It is also as a supplementary test to study mental qualities of an individual. This test requires very high skill on the part of its administrator.

**Thematic Apperception Test (TAT):** This test was first developed by Murray and his associates at the Howard Psychological Clinic. In contrast to ink-blot techniques, the TAT presents highly structured stimuli and requires more complex and meaningfully organized verbal responses.

The TAT material consists of 19 cards containing vague pictures in black and white and one black cart. The subject is shown each cart and is asked to make up a story to fit each picture, telling what let up the event shown in the picture, what is happening at the moment and what the outcome would be. In the case of the black card, the subject is asked to imagine some picture on the cart, describe it and then tell a story about it.

The content of the story is analyzed, the themes developed by the subject, the way in which each cart is perceived, the roles ascribed to the characters, emotional tones expressed, speed of responses, length of stories, etc., are considered. On the basis of qualitative schemes and rating scales relating to them, the interpretation is made.

The TAT is used extensively in personality research, attitude surveys, executive appraisal, etc.

**Rosenzweigh test of Cartoon test:** This was first developed by Rosenzweigh. The test consists of a series of cartons. In each cartoon are portrayed two characters; one is represented as saying something which is stated in a speech balloon over the character; the other character is provided with an empty speech balloon. The respondents can be classified according to the attitudes, frame of reference and role perceptions that they reflect.

The cartoon characters should be so developed as to represent the situation pertinent to the subject matter under investigation. It is important to maintain the neutrality of cartoon characters, because it helps the respondent to identify with a character.

The administration of cartoon test requires trained investigator and the interpretation must be done with the assistance of trained psychologists.

Picture frustration test: This is an adaptation of Rozenzweig test. It consists of 24 sets of cartoon pictures in pair. In each pair there is a picture depicting a frustrating situation accompanied by verbal remarks. A blank space is provided for the respondent to write what the frustrated person would reply.

The responses are classified with reference to the direction of aggression and type of aggression. The direction of aggression is scored as extra punitive (aggression turned out wart), intropunitive (turned inwards), and impunities (turned off to evade situation or gloss over it). The type of aggression includes obstacle dominance, emphasizing frustrating object, ego defense, focusing attention on the constructive solution of the frustrating problem. In scoring this test, the percentage of responses falling into each of these categories is compared with the corresponding normative percentage.

The P.F., being highly structured and relatively objective in its scoring procedure, lends itself better to statistical analysis than many other projective techniques. It is used for research on a variety of problems such as attitude towards minority group, consumer response to product, reactions of disabled towards their disability etc.

This test calls for a thorough knowledge of psychology and skill in interviewing.

**Holtzman Inkblot Test (HIT):**This test, developed by W.H.Holtzman, is a modification of the Rorschach test. This test consists of 45 inkblot cards based on colour, movement, shading and other factors. Only one response per card is obtained from the respondent and his responses are interpreted at three levels of form appropriateness. Form responses are interpreted for knowing the accuracy or inaccuracy of respondent's percepts: shading and colour for ascertaining his affectional and emotional needs; and movement responses for assessing the dynamic aspects of his life.

**Word association test:** This is the oldest and simplest test. The interviewer administering the test reads a list of 25 to 100 words, one at a time. Emotionally-tinged words are mixed up with neutral words. The respondent is asked to respond with the first matching word that comes to his mind, in two or three seconds. As he reads the words, the interviewer records the response and the time taken by the respondent to react to each word.

A word which provokes and immediate response is more likely to be noticed and remembered than that which provokes a slow response. Speediness of response also indicates attitude strength or intensity.

If the respondent takes more than three seconds to respond with a matching word then it is called 'hesitation.' Hesitation indicates his emotional involvement in finding a suitable word. In some cases, the respondent may "block" or give on answer, because the test word or what it symbolizes to him is highly charged with emotion. A high hesitation rate and low response rate to a word indicate that the respondent is concerned about what the word means to him.

The list of words should be selected carefully so that the researcher can uncover the patterns of responses, motives and attitudes of individuals.,

The 'word association' test is easy to administer and dose not need highly trained interviewers. However the interpretation requires someone trained in psychology.

This technique is frequently used in marketing research to find out the appropriate words to be used for advertising.

**Sentence completion test:** This is an extension of word association test. It is administered and interpreted in the same manner. The respondent is exposed to the first parts of incomplete sentences and asked to complete them. The completion of sentences requires the respondent to take a position or express his attitudes.

The objective of the test is to provoke spontaneous response from the respondent and the first answer reveals his attitudes or motives.

**Story completion test:** This test is an extended version of the sentence completion test. The interviewers provides the respondent with the beginning of a story and asks him to complete. It is assumed that in completing the story, the respondent will reveal his own attitudes and other characteristics.

This test is of great help in identifying and devaluating specific psychogenic needs that cannot be uncovered by simple projective techniques.

Highly trained interviewers are required to administer this test and the assistance of psychoanalyst is needed for interpretation of data. The data obtained are qualitative and cannot be analysed by quantitative methods.

**Play technique:** This is used often in studying children's attitudes through manipulation of dolls. A set of dolls representing a miniature life situation is given to children who are allowed to play with them freely. The manner in which the children organize dolls would indicate their attitude towards the subject under study.

**Finger painting:** This is a rich expressive method. A set of a special type of paint is given to the respondent who is told to draw what he likes with the paints, using his fingers and hands. Variables can be measured by counting number of certain kinds of manipulative and approach behaviour. Alper, Blans and Adams' study20 is an excellent example. Sixteen aspects of finger painting were measured: time to begin painting, use of whole hand, finger tip approach, washing-up behaviour, and so on. Significant differences were found between middle-class and working-class children in most of the tasks.

**Role playing:** is the acting-out of assigned specific roles for a brief period by two or more individuals. This is used in behavioural research. An observation system may be used to measure the variables under study. Group processes, interpersonal interaction, authoritarianism, prejudice and other variable can be studied.

## SOCIOMETRY

### Definition

Sociometry is "a method for discovering, describing and evaluating social status, structure, and development through measuring the extent of acceptance or rejection between individuals in groups'22. Franz defines sociometry as "a method used for the discovery and manipulation of social configurations by measuring the attractions and repulsions between individuals in a group."23 It is a means for studying the choice, communication and interaction patens of individuals in a group. It is concerned with attractions and repulsions between individuals in a group. In this method, a person is asked to choose one or more persons according to specified criteria, in order to find out the person or persons with whom he will like to associate.

Helen Jennings describes sociometry "as a means of presenting simply and graphically the entire structure of relations existing at a given time among members of a given group. The major lines of communication, or the pattern of attraction and rejection in full scope, are made readily comprehensive at a glance."

### Sociometry Test

The basic technique in sociometry is the "sociomteric test." This is a test under which each member of a group is asked to choose from all other members those with whom he prefers to associate in a specific situation. The situation must be a real one to the group under study, e.g., 'group study.' 'play,' 'class room seating' for students of a public school.

A specific number of choices, say two or three to be allowed is determined with reference to the size of the group, and different levels of preferences are designated for reach choice.

Suppose we desire to find out the likings and disliking of persons in a work group consisting of 8 persons. Each person is asked to select 3 persons in order or preference with whom he will like to work on a group assignment.

## CONTENT ANALYSIS

### Meaning

Content analysis is a research technique for making inferences by objectively and systematically identifying specified characteristics of contents of documents. This is a method of data collection and analysis. This is used for gathering data from archival records, documents, newspapers, diaries, letters, minutes of meetings and the like. The content of the written materials serves as a basis of inference. The analysis is made objectively and

systematically. Objectivity refers to making analysis on the basis of explicit rules which enable different researchers to obtain the same results from the same documents. Systematic analysis refers to making inclusion or exclusion of content according to consistently applied criteria of selection; only materials relevant to research's hypothesis are examined.30

Content analysis, as a method of studying communications was developed in the United States as a branch of social psychology known as 'Communications research.'31

Content analysis can be applicable to available materials such as letter, diaries, newspaper articles and editorials, etc. and to materials like stories or essays especially produced for a particular research problem.

**Procedure**

Significant content analysis begins with some systematic problem which requires specific data from content analysis. The researcher must conceptualize the variables that are relevant to his problem.

The procedure of content analysis involves certain steps.

The first step is to define the universe of content that is to be analysed, e.g., the editorials of newspapers on the subject-matter of the problem (say 'sati') under study; the publications of an author; the issues of a newspaper for a given period. If the volume of materials to be examined is too large, a representative sample of documents may be selected for analysis.

The second step is to specify the content characteristic to be measured. On the basis of these characteristics, the universe is divided into categories.

Before discussing the general procedures for categorization, it is necessary to specify the major units of analysis or recording units and to differentiate recording units from context units. The recording unit is the smallest element of content in which the appearance of a reference is counted. The context unit is a larger body of the content that may be examined in characterizing a recording unit. For example, the recording unit may be a single term; but in order to note whether the term is treated favourably or unfavourably, one has to consider the entire sentence in which the term appears. The sentence is the context unit.

### 3.6 CONSTRUCTING QUESTIONNAIRE

**Introduction:**

Nowadays questionnaire is widely used for data collection in social research. It is a reasonably fair tool for gathering data from large, diverse, varied and scattered social groups.

The questionnaire is the media of communication between the investigator and the respondents. According to Bogardus, a questionnaire is a list of questions sent to a number of persons for their answers and which obtains standardized results that can be tabulated and treated statistically. The Dictionary of Statistical Terms defines it as a "group of or sequence of questions designed to elicit information upon a subject or sequence of subjects from information." A questionnaire should be designed or drafted with utmost care and caution so that all the relevant and essential information for the enquiry may be collected without any difficulty, ambiguity and vagueness. Drafting of a good questionnaire is a highly specialized job and requires great care skill, wisdom, efficiency and experience. No hard and fast rule can be laid down for designing or framing a questionnaire. However, in this connection, the following general points may be borne in mind:

**1. Size Of The Questionnaire Should Be Small:**

A researcher should try his best to keep the number of questions as small as possible, keeping in view the nature, objectives and scope of the enquiry. Respondent's time should not be wasted by asking irrelevant and unimportant questions. A large number of questions would involve more work for the investigator and thus result in delay on his part in collecting and submitting the information. A large number of unnecessary questions may annoy the respondent and he may refuse to cooperate. A reasonable questionnaire should contain from 15 to 25 questions at large. If a still larger number of questions are a must in any enquiry, then the questionnaire should be divided into various sections or parts.

**2. The Questions Should Be Clear:**

The questions should be easy, brief, unambiguous, non-offending, courteous in tone, corroborative in nature and to the point, so that much scope of guessing is left on the part of the respondents.

**3. The Questions Should Be Arranged In A Logical Sequence:**

Logical arrangement of questions reduces lot of unnecessary work on the part of the researcher because it not only facilitates the tabulation work but also does not leave any chance for omissions or commissions. For example, to find if a person owns a television, the logical order of questions would be: Do you own a television? When did you buy it? What is its make? How much did it cost you? Is its performance satisfactory? Have you ever got it serviced?

**4. Questions Should Be Simple To Understand:**

The vague words like good, bad, efficient, sufficient, prosperity, rarely, frequently, reasonable, poor, rich etc., should not be used since these may be interpreted differently by different persons and as such might give unreliable and misleading information. Similarly the use of words having double meaning like price, assets, capital income etc., should also be avoided.

**5. Questions Should Be Comprehensive & Easily Answerable:**

Questions should be designed in such a way that they are readily comprehensible and easy to answer for the respondents. They should not be tedious nor should they tax the respondents' memory. At the same time questions involving mathematical calculations like percentages, ratios etc., should not be asked.

**6. Questions of Personal & Sensitive Nature Should Not Be Asked:**

There are some questions which disturb the respondents and he/she may be shy or irritated by hearing such questions. Therefore, every effort should be made to avoid such questions. For example, 'do you cook yourself or your wife cooks?' 'Or do you drink?' Such questions will certainly irk the respondents and thus be avoided at any cost. If unavoidable then highest amount of politeness should be used.

**7. Types of Questions:**

Under this head, the questions in the questionnaire may be classified as follows:

**(a) Shut Questions:**

Shut questions are those where possible answers are suggested by the framers of the questionnaire and the respondent is required to tick one of them. Shut questions can further be subdivided into the following forms:

**i) Simple Alternate Questions:**

In this type of questions the respondent has to choose from the two clear cut alternatives like 'Yes' or 'No', 'Right or Wrong' etc. Such questions are also called as dichotomous questions. This technique can be applied with elegance to situations where two clear cut alternatives exist.

**(ii) Multiple Choice Questions:**

Many a times it becomes difficult to define a clear cut alternative and accordingly in such a situation additional answers between Yes and No, like Do not know, No opinion, Occasionally, Casually, Seldom etc., are added. For example, in order to find if a person smokes or drinks, the following multiple choice answers may be used:

Do you smoke?

(a) Yes regularly [ ] (b) No never [ ]

(c) Occasionally [ ] (d) Seldom [ ]

Multiple choice questions are very easy and convenient for the respondents to answer. Such questions save time and also facilitate tabulation. This method should be used if only a selected few alternative answers exist to a particular question.

**8. Leading Questions Should Be Avoided:**

Questions like 'why do you use a particular type of car, say Maruti car' should preferably be framed into two questions-

(i) which car do you use? (ii) why do you prefer it?

It gives smooth ride [ ]

It gives more mileage [ ]

It is cheaper [ ]

It is maintenance free [ ]

**9. Cross Checks:**

The questionnaire should be so designed as to provide internal checks on the accuracy of the information supplied by the respondents by including some connected questions at least with respect to matters which are fundamental to the enquiry.

**10. Pre Testing the Questionnaire:**

It would be practical in every sense to try out the questionnaire on a small scale before using it for the given enquiry on a large scale. This has been found extremely useful in practice. The given questionnaire can be improved or modified in the light of the drawbacks, shortcomings and problems faced by the investigator in the pre test.

**11 A Covering Letter:**

A covering letter from the organizers of the enquiry should be enclosed along with the questionnaire for the purposes regarding definitions, units, concepts used in the questionnaire, for taking the respondent's confidence, self addressed envelop in case of mailed questionnaire, mention about award or incentives for the quick response, a promise to send a copy of the survey report etc.

## 3.7 PILOT STUDIES AND PRE-TESTS

**Pilot Study:**

**The need for pilot study:** it is difficult to plan a major study or project without adequate knowledge of its subject matter, the population it is to cover, their level of

knowledge and understanding and the like. What are the issues involved? What are the concepts associated with the subject matter? How can they be operationalized? What method of study is appropriate? How long the study will take? How much money it will cost? These and other related questions call for a good deal of knowledge of the subject matter of the study and its dimensions. In order to gain such pre-knowledge of the subject matter of an extensive study, a preliminary investigation is conducted. This is called a pilot study.

**Meaning:** a pilot study is a "small scale replica" of the main study. It is the rehearsal of the main study. It covers the entire process of research: preparation of a broad plan of the study, construction of tools, collection of data, processing and analysis of data and report-writing.

**Functions of a Pilot Study**

A pilot study fulfills one or more of the following purposes:

1. It provides a better knowledge of the problem under study and its dimensions.
2. It provides guidance on conceptualization – identification and operationalization of concepts relating to the study.
3. It assists in discovering the nature of relationship between variables and in formulating hypothesis.
4. It shows the nature of the population to be surveyed and the variability within it. This is of importance in determining an efficient sample design.
5. A pilot study shows whether the available sampling frame from which sampling is to be drawn is adequate, complete, accurate, up to date and convenient.
6. It provides data on the relative suitability of alternative methods of collection of data-observation, mailing, interviewing – their relative cost accuracy and response rates to make a sensible choice.
7. It shows the adequacy of the tool for data collection.
8. It also helps in discovering mechanical problems relating to interviews/mailing.
9. It assists in developing better approaches to target population – as regards introduction, rapport etc.,
10. It provides information for structuring questions with alternative answer.
11. It helps the researcher to develop an appropriate plan of analysis.
12. It enables the researcher to identify field problems to be encountered and suggests remedial approaches.

13. It provides information for estimating the probable cost and duration of the main study and of it various stages.
14. Above all, it helps the researcher to determine whether or not a more substantial study is warranted. In the light of the results of the pilot study, the researcher will be able to take a pragmatic view on the main study's potentialities and feasibility.

**Size and Design of Pilot Study**

The size, scope and design of he pilot study is a matter of convenience, time and money. It should be large enough to fulfill the above functions and the sample should be of a comparable structure to that of the main study. It should be designed so as to ensure a testing of alternative methods of data collection, ordering the questions, wording and the like. It should succeed in disclosing the significant difficulties to be guarded against.

In the light of the outcome of the pilot study, if its found that the main study is worth undertaking, then it is adequately designed on the basis of the results of the pilot study and the lesson drawn from its experience.

**Pre-test**

**Meaning:** while a pilot study is a full-fledged miniature study of a problem, pre-test is a trial test of a specific aspect of the study such as method of data collection instrument-interview schedule, mailed questionnaire of measurement scale.

**Need for Pre-testing**

An instrument of data collection is designed with reference to the data requirements of the study. But it cannot be perfected purely on the basis of a critical scrutiny by the designer and other researchers. It should be empirically tested. As emphatically pointed by good and Hatt, "no amount of thinking, no matter how logical the mind or brilliant the insight, is likely to take the place of careful empirical checking. Hence pre-testing of a draft instrument is indispensable. Pre-testing means trial administration of the instrument to a sample of respondents before finalizing it.

**Purposes of Pre-testing**

pre-testing has several purposes: (1) to test whether the instrument would elicit responses required to achieve the research objectives, (2) to test whether the content of the instrument is relevant and adequate, (3) to test whether wording of questions is clear and suited to the understanding of the respondents, (4) to test the other qualitative aspects of the instrument like question structure and question sequence, and (5) to develop appropriate procedure for administering the instrument with reference to field conditions.

**Pre-test Procedure**

A broad guideline is suggested below for pre-testing of an instrument. The first testing of a draft instrument con be done among one's colleagues in order to find out its shortconings. After this "in-house" testing, it should be revised and tested in the field. The instrument may be administered to 15 or 20 sample respondents drawn from the universe relating to the planned survey. They may be interview or copies of the instrument mailed to them, depending on the method selected for data collection. Test mailings are useful, but it is quicker to use a substitute procedure. That is, copies of the draft questionnaires may be handed over to a few respondents with a request to complete them. The researcher may meet them later and request them to comment on question clarity and other aspects of the questionnaire. This appeal for advice may elicit their cooperation, and the researcher can got constructive suggestions for revising the questionnaire. Whatever be the mode of pre-testing, it is important to conduct the field test under actual field conditions.

The pre-test responses should be carefully examined and analysed in order to identify the weaknesses of the instrument. The researcher should look for signs or indicators of weaknesses. As pointed by goode and Hatt, the signs may include: (1) lack of order in the answer which may be caused by a poor conceptualization; (2) "all-or-none" responses, i.e., questions eliciting mere stereotyped responses; (3) a high proportion of "don't know" or "don't understand" answer which indicate that the questions are improperly drawn or vague or a bad sampling design has been used; (4) a great number of qualifications or irrelevant comments, indicating the inadequate listing of alternative answers; (5) a high proportion of refusals to answer indicating out of context of the question or poor transition from one subject area to another; (6) inconsistencies in answers, (7) problem of space and the like.

Necessary corrections, deletions, additions and changes in question wording and sequences should be made to eliminate the imperfections discovered.

Often, several pre-testing with different sets of new respondents are required until a workable instrument is achieved. The importance of 'rest-revise' retest cycle' needs no emphasis. Any failure to take this step will lead to poor research results. Testing is the hallmark of a scientific research.

## 3.8 PROCESSING AND ANALYZING DATA

### Introduction

Processing of data is the most important step in research. Lot of statistical treatment is done on the data. After such analysis, an interpretation of the statistics is made to draw inferences about the population.

### Meaning of procession and analysis of data

The data collected needs to be processed and analyzed. processing of data implies editing, coding, classification, tabulation, charting and diagrammatic presentation of data. The analysis of the data means computing appropriate statistical measures such as measures of central tendency, measures of dispersion, measures of association, computing test statistics and drawing inferences from all the above.

### Importance of data processing and analysis

To distil the essence of information from the mass of data, processing and analysis of data are essential. Data processing and analysis are the culmination of the long process of research design, survey and data collection. From the mass of data meaning must be churned out. This needs editing I the first place to do away with unnecessary and irrelevant data. Thus some data reduction is effected. Furth reduction of data is done through coding which replaces similar ones by a standard code. After coding, classification is done which groups data according to common features found or established. This is another data reduction purpose. Tabulation then follows which involves presenting classified data in the form of tables. Each table provides a summary data on an issues or related issues. A table present essential data on a particular topic and helps to mke sense out of the figures.

All these are certain aspect of data processing. The purpose is to figure out the essential fact from a vast mass of data. This facilitates analysis.

Analysis involves computing (i) descriptive statistics or parameters like measures of central tendency, (ii) associative statistics such as correlation and regression, (iii) test statistics such as Z values, ‘t’ values, ‘F’ values, chi-square values, ‘U’ values, and so on, and (iv) finding out clusters, principal components, etc. Without these analyses, no inference, no conclusion and no recommendation can be offered.

So, description, association, hypotheses testing and inference are possible only when the basics of processing and relevant analyses are done. The overall understanding of the problems, issues, phenomenon and events studies is facilitated by data processing. Description, implantation and prediction of phenomena, problems and issues studied are

facilitated only by processing and analysis. A major part of the main body of any research work has its bases in processing and analysis-hence the importance of data processing and analysis.

**Processing of data**

Data processing is concerned with editing, coding, classifying, tabulating, charting and diagramming data. The essence of data processing is data reduction. Data reduction involves winnowing out the irrelevant from the relevant data and giving it shape.

**Editing**

Editing is the first step in data processing. Editing is the process of examining the data collected in questionnaires/schedules to detect errors and omissions and to see that they are corrected and the schedules are ready for tabulation. When the whole data collection is over, a final and a thorough check is made. Milred B. Parten in his book points out that the editor is responsible for seeing that the data is (1) as accurate as possible, (2) consistent with other facts secured, (3) uniformly entered, (4) as complete as possible, (5) acceptable for tabulation and arranged to facilitate coding tabulation.

The editor must not destroy data, or make the original data illegible. He must do the editing work in a different ink, and all changes must be initialed and dated.

There are different types of editing: editing for quality, editing for tabulation, field editing and central editing.

**Editing for quality** asks the following questions: Are the data forms complete? Is the data free of bias, are the recordings free of errors? Are the inconsistencies in responses within limits, is there evidence to show the dishonesty of the enumerators or the interviewers? Is there any wanton manipulation of data?

**Editing for tabulation** makes certain accepted modifications to the data or even rejects certain pieces of data, in order to facilitate tabulation. For instance, extremely high or low-value data items may be ignored or bracketed with suitable class intervals.

**Field editing** is done by the enumerator. The schedule filled up by the enumerator or the respondent might have some abbreviated or illegible writings, etc. these are rectified by the enumerator. This should be done soon after the enumeration or interview, before the loss of memory. The field editing should not result in providing guesswork data to fill up omissions.

**Central editing** is done by the researcher after getting all schedules or questionnaires or forms from the enumerators or respondents. Obvious errors can be corrected. For missed

data or information, the editor may substitute data or information by reviewing information provided by other similarly placed respondents. A definite inappropriate answer is removed and 'No Answer' is entered when reasonable attempts to get the appropriate answer fail to produce results.

**Coding**

Coding is necessary for efficient analysis and through it, the several replies may be reduced to a small number of classes which contain the critical information required for analysis. Coding decisions should usually be 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 as on can straightaway enter from the original questionnaires. But in the case of hand-coding, some standard method may be used. One such standard method is to code in the margin with a coloured pencil. The other method can be to transcribe the data from the questionnaire to a coding sheet. Whatever method is adopted, one should see that coding errors are altogether eliminated or reduced to the minimum level.

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

The study of the responses is the first step in coding. In the case of processing-coded questions, coding begins at the preparation of the interview schedules. Secondly, the coding frame the indicators used for coding is developed by listing the possible answers to each question and assigning code numbers or symbols to each of them. The coding frame is an outline of what is coded and how it is to be coded. That is, a coding frame is a set of explicit rules and conventions that are used to base classification of variable observations into values which are transformed into numbers. Thirdly, after preparing the sample frame, the gradual process of fitting the answers to the questions must begin. Lastly, transcription is undertaken, i.e., transferring of the information from the schedules to a separate sheet called transcription sheet. A transcription sheet is a large summary sheet which contains the answer/codes of all

the respondents. Transcription may not be necessary when only simple tables are required and the number of respondents is few.

**Classification**

Classification or categorization is the process of grouping the statistical data under various understandable homogeneous groups for the purpose of convenient interpretation. A uniformity of attributes is the basic criterion for classification, and the grouping of data is made according to similarity. Classification becomes necessary when there is a data is made according to similarity. Classification becomes necessary when there is a diversity in the data collected for meaningless presentation and analysis. However, it is meaningless in respect of homogeneous data. A good classification should have the characteristics of clarity, homogeneity, equality of scale, purposefulness and accuracy.

**Objectives of Classification**

(a) The complex scattered and haphazard data is organized into concise, logical and intelligible form.

(b) It is possible to make the characteristics of similarities and dissimilarities clear.

(c) Comparative studies are possible.

(d) Understanding of the significance is made easier, thereby saving a good deal of human energy.

(e) Underlying unity amongst different items is made clear and expressed.

(f) Data is so arranged that analysis and generalization becomes possible.

**Types of classification:** Classification is of two types, viz., quantitative classification, which is on the basis of variables or quantity and qualitative classification (classification according to attributes). The former is the way of grouping the variables, (say quantifying the variables) in cohesive groups, while the latter groups the data on the basis of attributes or qualities. Again, it may be multiple classification. The former is the way of making many (more than two) group on the basis of some quality or attributes, while the latter is the classification into two groups on the basis of some quality or attributes, while the latter is the classification into two groups on the basis of presence or absence of a certain quality. Grouping the workers of a factory under various income (class intervals) groups, comes under multiple classification and making two groups into skilled workers and unskilled workers is the dichotomous classification. The tabular form of such classification is known as statistical series, which may be inclusive or exclusive.

**Tabulation**

Tabulation is the process of summarizing raw data and displaying it in compact form for further analysis. Therefore, preparing tables is a very important step. Tabulation may be by hand, mechanical, or electronic. The choice is made largely on the basis of the size and type of study, alternative costs, time pressures, and the availability of computers, and computer programmes. If the number of questionnaires is small and their length short, hand tabulation is quite satisfactory.

A table may be divided into: (i) Frequency tables, (ii) Response tables, (iii) Contingency tables, (iv) Uni-variate tables, (v) Bi-variate tables, (vi) Statistical tables and (vii) Time series tables.

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

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

(i) **Title of table:** The table should be first given a brief, simple and clear title which may express the basis of classification

**(ii) Columns and rows:** Each table should be prepared in an adequate number of columns and rows.

**(iii) Captions and stubs:** The columns and rows should be given siple and clear captions and stubs.

**(iv) Ruling:** columns and rows should be divided by means of thin or thick rulings.

**(v) Arrangement of items:** Comparable figures should be arranged side by side.

**(vi) Deviations:** These should be arranged in the column near the original data so that their presence may be easily noted.

**(vii) Size of columns:** This should be according to the requirement.

**(viii) Arrangements of items:** This should be according to the problem.

**(ix) Special emphasis:** This can be done by writing important detain bold or special letters.

**(x) Unit of measurement:** The unit should be noted below the lines.

**(xi) Approximation:** This should also be noted below the title**.**

**(xii) Footnotes:** These may be given below the table.

**(xiii) Total:** totals of each column and grand total should be in one line.

**(xiv) Source:** source of data must be given. For primary data, write primary data.

It is always necessary to present fact in a tabular for if they can be presented more simply in the body of the text. Tabular presentation enables the reader to follow it more quickly than textual presentation. A table should not merely repeat information covered in the text. The same information should not, of course, be presented in tabular form and graphical form. Smaller and simpler tables may be presented in the text, while the large and complex tables may be placed at the end of the chapter or report.

**Diagrams**

Diagrams are charts and graphs used to present data. These facilitate in catching the attention of the reader. They help in presenting the data more effectively. Creative presentation of the data is possible. Interpretation can be effectively done.

**Unit IV**

*Test of significance – Assumptions about parametric and nonparametric tests. Parametric tests – chi – square, t – Test, F Test, Z Test. Introduction to ANOVA, One way, Two way and three way classification.*

## 4.1 TESTS OF SIGNIFICANCE

An important aspects of the sampling theory is to study the tests of significance, which will enable us to decide, on the basis of the results of the samples, whether

- the deviation between the observed sample statistic and the hypothetical parameter value or
- the deviation between two samples statistics is significant or might be attributed due to chance or the fluctuations of the sampling.

If n is large, all the distributions like, Binomial, Poisson, Chi-square, t distribution, F distribution can be approximated by a normal curve.

### Hypothesis

A hypothesis is some statement about a population parameter. The hypothesis is tested on the basis of the outcome of a random sample.

### Null Hypothesis

In any testing of hypothesis problem we are faced with a pair of hypothesis such that one and only one of them is always true. One of this pair is called null hypothesis, and the other one is called alternative hypothesis.

The Null hypothesis is represented as $H_0$ and the alternative hypothesis is represented by $H_1$,

If the population mean is represented by $\mu$.

$H_0 : \mu < 50;\ H_1,\ \mu > 50$

End of the testing if we conclude that $H_0$ is to be rejected, then $H_1$ should be accepted.

### Type -1 and Type - II Errors

In testing the hypothesis if we wrongly reject $H_0$, when in reality $H_0$ is true, the error is called a Type I error. Similarly, if we wrongly accept $H_0$ when $H_0$ is false, the error is called a Type II error.

We should not commit both the errors and should be reduced to the minimum they can be completely eliminated when the full population is examined. The probability of Type I error would be kept down to lower limits.

**The Significance Level**

In testing of hypothesis, Type I error is assumed to be more serious than Type II error and so the probability of Type I error needs to be explicitly controlled. This is done through the significance level of which the test is conducted. The significance level sets a limit to the probability of Type I errors and test procedures are designed so as to get the lowest probability of Type II error subject to the significance level. The probability of Type I error is denoted by a and probability of Type II error is denoted by p. Most of the test are conducted at $\alpha = 0.1$, $\alpha = 0.05$, $\alpha = 0.01$, by convection as well as by convenience. Generally, we use to test at 5% level.

**Hypothesis Testing Procedure**

**Step 1:** State the null and the alternative hypothesis.

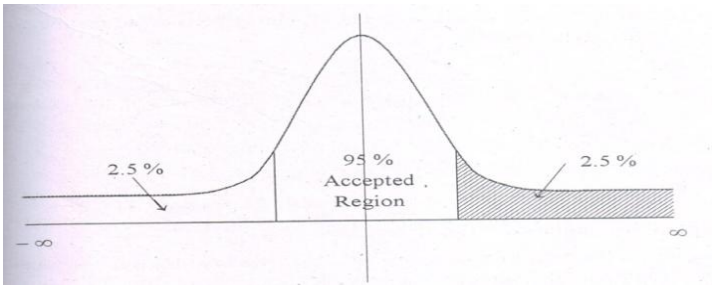
**Step 2 :** Choose the test statistic.

**Step 3 :** Specify a level of significance of a.

**Step 4 :** Define the critical region in terms of the test statistic.

**Step 5:** Compare the observed value of the test statistic with the cut-off value to accept or reject the null hypothesis.

**Level of Significance and Critical Region**




In testing a hypothesis, the maximum probability with which we are willing to risk a Type I error is called the level of significance of the test. Generally, we take either 5% or 1% level of significance, that is there are about 5 cases in 100 that we would reject the hypothesis when it should be accepted. That is we are about 95% confident that we have made that the right decision similarly for 1% level of significance.

From the above fig. the test statistic ***Z = t - E (t) / S .E of t*** of a sample statistic lies between -1.96 and 1.96, we are 95% confident that the hypothesis is true.

**(i.e) P[-1.96 $\leq$ Z $\leq$ 1.96 ] = 0.95**

If for a random sample the test statistic Z lies outside the range -1.96 to 1.96 i.e., if | Z | > 1.96, we say that event will happen with probability of only 0.05. If the given hypothesis were true. In this case we say that Z-score differed significantly from the value expected under the hypothesis and hence the hypothesis us to be rejected at ,5% level of significance. The total shaded are 0.5 represents the probability of our $H_Q$ being wrong in rejecting the hypothesis. 0.05 is the probability of making Type -1 error. Thus if | Z | > 1.96 the hypothesis is rejected at a 5% level significance.

*(i.,e.)|Z| > 1.96 constitutes critical region or region of rejection of the hypothesis or the region of significance*. Thus the critical region is the area under the sampling distribution in which the test statistic value has to fall for the null hypothesis to be rejected. The set of Z scores inside the range -1.96 to 1.96 is called the region of the acceptance of the hypothesis.

**Decision Rule**

1. Reject the null hypothesis at 5% level of significance if the test statistic
   | Z | > 1.96.
   Accept the null hypothesis at 5% level of significance if | Z | $\leq$ 1.96.
2. Reject the null hypothesis at 1% level of significance if | Z | > 2.58.
   Accept the null hypothesis at 1% level of significance of | Z | $\leq$ 2,58.

**One - Tailed and Two - Tailed Test**

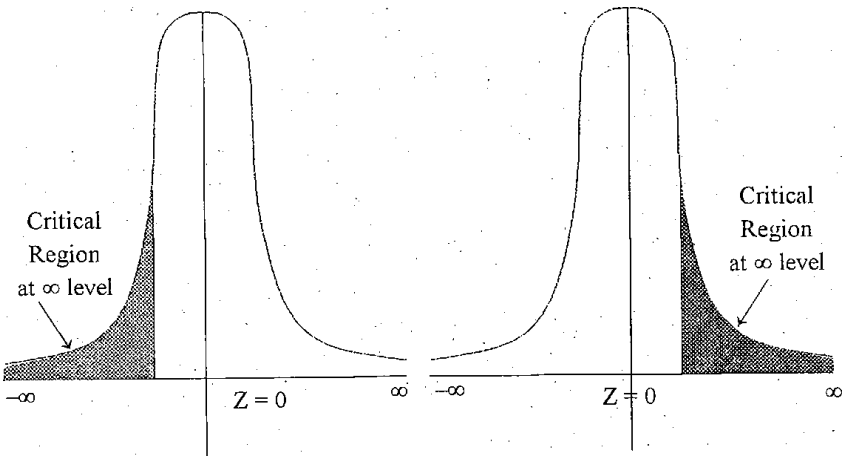
In testing whether the population mean $\mu = \mu_0$, we have $H_0 : \mu = \mu_0$ against the alternative hypothesis $H_1$ given by

$\mathbf{H_1} : \mu > \mu_0$ (right-tailed) or $\mu < \mu_0$ (left-tailed).

In the right-tailed test $\mathbf{H_1} : \mu > \mu_0$, the critical region $Z > Z_\alpha$ lies entirely in the right tail of the sampling distribution of sample mean x with area equal to the level of significance $\alpha$ . Similarly, in the left-tailed $H_1 : \mu < \mu_0$, the critical region $[Z < -Z_\alpha]$ lies entirely in the left of the sampling distribution of x with area equal to the level of significance $\alpha$.

If the alternative hypothesis $H_1$ in a test be two-tailed (both right and left tailed).

Right-tailed test Left-tailed test;




(i.e) $H_1 : \mu \neq \mu_0$ ($\mu > \mu_0$ or $\mu < \mu_0$) then the test is called two-tailed test and in such a case the critical region lies in both right and left tailed of the sampling distribution of the test statistic, with, total area equal to the level of the significance. We apply two-tailed or one-tailed according as $H_1$ is two-tailed or one-tailed.

**Critical Values of Z**

| Level of the significance (a) | 1% | 5% | 10% |
|---|---|---|---|
| Critical values of two-tailed tests | $\|Z_\alpha\| = 2.58$, | $\|Z_\alpha\| = 1.96$ | $\|Z_\alpha\| = 1.645$ |
| Critical values of right-tailed tests | $Z_\alpha = 2.33$ | $Z_\alpha = 1.645$ | $Z_\alpha = 1.28$ |
| Critical values of left-tailed tests | $Z_\alpha = -2.33$ | $Z_\alpha = -1.645$ | $Z_\alpha = -1.28$ |

## 4.2 ASSUMPTIONS ABOUT PARAMETRIC AND NONPARAMETRIC TESTS

**Parametric (distribution) tests** refer to statistical analysis tests that are generally appropriate to use when the data being examined is interval or ratio and is based on a large population sample and/or produces an identifiable Gaussian function or bell-shaped curve indicating a normality of distribution.

**Non-parametric (distribution free) tests** refer to statistical analyses tests which are less powerful than parametric tests but generally appropriate to use when the data being examined is ordinal or nominal and is based on a small population sample or does not have a clear Gaussian function.

If you understand those definitions then you understand the difference between parametric and non-parametric. If parametric assumptions are met you use a parametric test. If they're not met you use a non-parametric test. If assumptions are partially met, then it's a

judgement call. In general, try and avoid non-parametric when possible (because it's less powerful).

**Parametric Assumptions**

Listed below are the most frequently encountered assumptions for parametric tests. Statistical procedures are available for testing these assumptions. The Kolmogorov-Smirnov Test is used to determine how likely it is that a sample came from a population that is normally distributed. The Levene test is used to test the assumption of equal variances. If we violate test assumptions, the statistic chosen cannot be applied. In this circumstance we have two options: 1) we can use a data transformation or 2) we can choose a nonparametric statistic. If data transformations are selected, the transformation must correct the violated assumption. If successful, the transformation is applied and the parametric statistic is used for data analysis.

| |
|---|
| **1. Interval or ratio scale of measurement (approximately interval)** |
| **2. Random sampling from a defined population** |
| **3. Samples are independent/dependent (varies by statistic)** |
| **4. Characteristic is normally distributed in the population** |
| **5. Population variances are equal (if two or more groups/variables in the design)** |

**Non - Parametric Assumptions**

A nonparametric test is a hypothesis test that does not require the population's distribution to be characterized by certain parameters. For example, many hypothesis tests rely on the assumption that the population follows a normal distribution with parameters μ and σ. Nonparametric tests do not have this assumption, so they are useful when your data are strongly non-normal and resistant to transformation.

However, nonparametric tests are not completely free of assumptions about your data. For instance, nonparametric tests require the data to be an independent random sample.

### 4.1 Parametric and non parametric tests

| | Parametric | Non-parametric |
|---|---|---|
| Distribution | Normal/Gaussian | Any |
| Assumed variance | Homogeneous | Any |
| Type of data | Ratio or Interval | Ordinal or Nominal |
| Data set relationships | Independent | Any |
| Measure of central tendency | Mean | Median |
| Correlation test | Pearson | Spearman |
| Independent measures, 2 groups | Independent-measures t-test | Mann-Whitney test |
| Independent measures, >2 groups | One-way, independent-measures ANOVA | Kruskal-Wallis test |
| Repeated measures, 2 conditions | Matched-pair t-test | Wilcoxon test |
| Repeated measures, >2 conditions | One-way, repeated measures ANOVA | Friedman's test |

### 4.3 CHI SQUARE TEST

Chi square test is applied in statistics to test the goodness of fit to. verify the distribution of observed data with assumed theoretical distribution. Therefore, it is a measure to study the divergence of actual and expected frequencies. It has great use in statistics, specially in sampling studies, where we expect a doubted coincidence between actual and expected frequencies, and the extend to which the difference can be ignored, because of fluctuations in sampling. If there is no difference between the actual and expected frequencies, $\chi^2$ is zero. Thus, the Chi square test describes the discrepancy between theory and observation.

**Characteristics of $\chi^2$ test**

- Test is based on events of frequencies,- where as in theoretical distribution, the test is based on mean and standard deviation.
- To draw inferences, this test is applied, specially testing the hypothesis but not useful for estimation.
- The test can be used between the entire set of observed and expected frequencies.
- For every increase in the number of degree of freedom, a new $\chi^2$ distribution is formed.

- It is a general purpose test and as such is highly useful in research.

**Assumptions**

1. All the observations must be independent.
2. All the events must be mutually exclusive.
3. There must be large observations.
4. For comparison purposes, the data must be in original units.

**Degree of Freedom**

When we compare the computed value of $\chi^2$ with the table value the degree of freedom is evident. The degree of freedom means the number of classes to which values can be assigned at will, without violating restrictions. For e.g., we choose any four numbers, whose total is 50. Here we have a choice to select any three numbers, say 10, 15, 20 and the fourth number is 5, [50 - (10 + 15 + 20)]. Thus our choice of freedom is reduced by one, on the condition that the total be 50. Therefore the restriction placed on the freedom is one and degree of freedom is three. As the restrictions increase, the freedom is reduced. Thus,

V – n - K

V : (nu) = Degree of freedom

K : Number of independent constraints

n : Number of frequency classes.

For a contingency table, 2><2, table, the degree of freedom is

V = (C-l) (r-l)

=: (2-1) (2-1)

= 1.

**Uses**

$\chi$2 test of goodness of fit. Through the test we can find out the deviations between the observed values and expected values. Here we are not concerned with the parameters but concerned with the form of distribution. Karl pearson has developed a method to test the difference between the theoretical value (hypothesis) and the observed value. The test is done by comparing the computed value with the table value of $\chi^2$ for the desired degree of freedom. A greek letter $\chi^2$ is used to describe the magnitude of difference between the fact and theory.

The $\chi^2$ may be defined as

$$\chi 2 = \sum \left\{ \frac{(O-E)^2}{E} \right\}$$

O = observed frequencies

E = Expected frequencies.

Steps

- A hypothesis is established along with the significance level.
- Compute deviations between observed value and expected value (O-E).
- Square the deviations calculated $(O-E)^2$.
- Divide the $(O-E)^2$ by its expected frequency.
- Add all the values obtained in step 4.
- Find the value of $\chi^2$, from $\chi^2$ table at certain level of significance, usually 5% level.

If the calculated value of $\chi^2$ is greater than the tabled value of $\chi^2$, at certain level of significance, we reject the hypothesis. If the computed value of $\chi^2$ value is zero then, the observed value and expected values completely coincide. If the computed value of $\chi^2$ is less than the table value, at a certain degree of level of significance, it is said to be non-significant. This implies that the discrepancy, between the observed and expected frequencies in simple sampling.

**$\chi^2$ as a test of independence**

$\chi^2$ test can be used to find out whether one or more attributes are associated or not. For example, coaching class and successful candidate, marriage and failure, etc; we can find out whether they are related or independent we take a hypothesis that the attributes are independent. If the calculated value of $x^2$ is less than the tabled value at a certain level of significance, the hypothesis is correct and vice versa.

$$\chi 2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

$$\text{Expected value} = \frac{\text{Row Total (R.T) x Column Total (C.T)}}{\text{Grand Total (G.T)}}$$

**Example 1: A certain drug was administered to 500 people out of a total of 800 included in the sample to test its efficiency against typhoid. The result are given below.**

| | **Typhoid** | **No. Typhoid** | **Total** |
|---|---|---|---|
| Drug | 200 | 300 | 500 |
| No Drug | 280 | 20 | 300 |
| Total | 480 | 320 | 800 |

On the basis of these data, can it be concluded that the drug is effective in preventing typhoid (Given for V = 1, $\chi^2$ 0.05 = 3.84).

**Solution :**

Let the hypothesis be "The drug is not effective in preventing typhoid".

"The table of expected frequencies are:

| | | |
|---|---|---|
| 480 X 500 / 800 =300 | 320 X 500 / 800 = 200 | 500 |
| 480 X 300 / 800 = 180 | 320 X 300 / 800 = 120 | 300 |
| 480 | 320 | 800 |

N.B Alternatively, after finding out the first value, the remaining can be obtained in the following manner.

| O | E | (O-E) | $(O-E)^2$ | $(O-E)^2$ E |
|---|---|---|---|---|
| 200 | 300 | -100 | 10000 | 33.33 |
| 280 | 180 | + 100 | 10000 | 55.56 |
| 300 | 200 | +100 | 10000 | 50.00 |
| 20 | 120 | -100 | 10000 | 83.33 |
| 800 | 800 | $\chi 2 = \sum \frac{(O_i - E_i)^2}{E_i}$ = 222.22 | | |

V = (r-l) (C-l.)

= (2-1) (2-1)

= 1 x 1

= 1.

d.f= l, $\chi^2_{0.05}$ = 3.84.

Calculated value of $\chi^2$ = 222.22, Table value of $\chi^2$ = 3.84 (from table) The calculated value of $\chi^2$ is much greater than the table value. Therefore the hypothesis the drug is not effective is rejected. Hence we conclude that the drug is effective in preventing typhoid:

**Example 2: In an experiment on immunization of cattle from tuberculosis the following results were obtained.**

| | Affected | Not Affected |
|---|---|---|
| **Inoculated** | **12** | **26** |
| **Not inoculated** | **16** | **6** |

Calculate $\chi^2$ and discuss the effect of vaccine in controlling susceptibility to tuberculosis (5% value of $\chi^2$ for one degree of freedom = 3.84).

**Solution :**

Let us take the hypothesis that the vaccine is not effective in controlling susceptibility to tuberculosis. Applying $\chi^2$ test.

Expectation of (AB) $= \frac{R.Tx\ C.T}{GT}$

$= \frac{38x28}{60} = 17.7$

The table of expected frequencies is given below.

| | | |
|---|---|---|
| 17.7 | 20.3 | 38 |
| 10.3 | 11.7 | 22 |
| 28 | 32 | 60 |

Using yates correction and then apply $\chi^2$ text.

| 0 | E | (O-E) | $(O-E)^2$ | $(O-E)^2/E$ |
|---|---|---|---|---|
| 12 | 17.7 | -5.7 | 32.49 | 1.84 |
| 16 | 10.3 | 5.7 | 32.49 | 3.15 |
| 26 | 20,3 | 5.7 | 32.49 | 1.60 |
| 6 | 11.7 | -5.7 | 32.49 | 2.78 |
| | | | | 9.37 |

$\chi 2 = \sum \frac{(O-E)^2}{E} = 9.37$

Calculated value of $x^2 = 9.37$, Table value of $x^2 = 3.84$

Since the calculated value of $x^2$ is greater than the table value, the hypothesis is not true. Therefore, we conclude that vaccine is effective in controlling susceptibility to tuberculosis.

**Example : 3** 1000 families were selected at random in a city to test the belief that high income families usually send their children to public schools and the low income families often send their children to government schools. The following results were obtained

| | School | | |
|---|---|---|---|
| Income | Public | Govt. | Total |
| Low | 370 | 430 | 800 |
| High | 130 | 70 | 200 |
| Total | 500 | 500 | 1000 |

Test whether income and type of schooling are independent.

**Solution :**

Let us take the hypothesis that the income and type of schooling are independent.

Expectation of (AB) $= \frac{R.Tx\ C.T}{GT}$

$= \frac{300x800}{1000} = 400$

The table of expected frequencies is given below.

| | | |
|---|---|---|
| 400 | 400 | 800 |
| 100 | 100 | 200 |
| 500 | 500 | 1000 |

Applying $\chi^2$

| 0 | E | (O-E) | $(O-E)^2$ E |
|---|---|---|---|
| 370 | 400 | 900 | 2.25 |
| 130 | 100 ' | 900 | 9.00 |
| 430 . | 400 | 900 | 2.25 |
| 70. | 100 | 900 | 9.00 |
| | | | 22.50 |

$\chi 2 = \sum \frac{(O-E)^2}{E} = 22.5$

Calculated value of $\chi^2 = 22.5$

The calculated value of $\chi^2$ is more than the table value ($V = 1, \chi^2_{0.05} = 3.84$). The hypothesis is rejected. Hence income and type of schooling are not independent.

### 4.4 'T' TEST

A t-test is any statistical hypothesis test in which the test statistic follows a Student's t-distribution under the null hypothesis. It can be used to determine if two sets of data are significantly different from each other.

A t-test is most commonly applied when the test statistic would follow a normal distribution if the value of a scaling term in the test statistic were known. When the scaling term is unknown and is replaced by an estimate based on the data, the test statistics (under certain conditions) follow a Student's t distribution.

**Types of t-tests**

A t-test is a hypothesis test of the mean of one or two normally distributed populations. Several types of t-tests exist for different situations, but they all use a test statistic that follows a t-distribution under the null hypothesis:

| Test | Purpose | Example |
|---|---|---|
| 1sample t-test | Tests whether the mean of a single population is equal to a target value | Is the mean height of female college students greater than 5.5 feet? |
| 2 sample t-test | Tests whether the difference between the means of two independent populations is equal to a target value | Does the mean height of female college students significantly differ from the mean height of male college students? |
| paired t-test | Tests whether the mean of the differences between dependent or paired observations is equal to a target value | If you measure the weight of male college students before and after each subject takes a weight-loss pill, is the mean weight loss significant enough to conclude that the pill works? |

**STUDENT'S 't' TEST FOR SINGLE MEAN**

Suppose we want to test

- If a random sample $x_i$ of size n has been drawn from a normal population with a specified mean $\mu_0$.
- If the sample mean differs significantly from the hypothetical value $\mu_0$ of the population mean.

$$t = \frac{\bar{x} - \mu}{\frac{S}{\sqrt{n}}} \; (or) \; t = \frac{\bar{x} - \mu}{\frac{S.D}{\sqrt{n-1}}}$$

where

$\bar{x}$ → Sample mean

**μ** → Population mean

S → Standard deviation

n → Number of observation

n -1 → is degree of freedom

**Example 1**: **A machinist is making engine parts with axle diameter of 0.700 inch. A random sample of 10 parts shows a mean diameter of 0.742 inch with S.D of 0.040 inch. Compute the statistic you would use to test whether the work is meeting the specification.**

**Solution**

**Null Hypothesis $H_0$:**

$\mu = 0.700$

**Alternative Hypothesis $H_1$:**

$\mu \neq 0.700$

$n = 10$

$\bar{x} = 0.742$

$S.D = 0.040$

$$t = \frac{\bar{x} - \mu}{\frac{S.D}{\sqrt{n-1}}}$$

$$= \frac{0.742 - 0.700}{\frac{0.040}{\sqrt{10-1}}}$$

$$= \frac{0.042}{\frac{0.04}{\sqrt{9}}}$$

$$= \frac{0.042x3}{0.040}$$

$$= 3.15$$

Table value of t at 5% with degree of freedom 9.

$t_{0.05} = 2.26$

**Result:**

Calculated value > Table value => Reject $H_0$.

' 3.15 > 2.26 => Reject $H_0$.

**Example : 2 The mean weekly sales of soap bars in departmental stores was 146.3 bars per store. After an advertising campaign the mean weekly sales in 22 stores for a typical week increased to 153.7 and showed a S.D of 17.2 was the advertising campaign successful.**

**Null Hypothesis $H_0$ :**

$\mu = 146.3$

**Alternative Hypothesis $H_1$ :**

$\mu \neq 146.3$

n = 22

$\bar{x} = 153.7$

S.D = 17

$$t = \frac{\bar{x} - \mu}{\frac{SD}{\sqrt{n-1}}}$$

$$= \frac{153.7 - 146.3}{\frac{17.2}{\sqrt{22-1}}}$$

$$= 1.97$$

Calculated value of = 1.97.

Table value of t at 5% level with 21 degree of freedom.

$t_{0.05}05 = 1.72$

**Result:**

Calculated value > Table value => Reject $H_0$.

1.97 > 1.72 => Reject $H_0$.

**Example : 3 A sample of 26 bulbs gives a mean life of 990 hours with a S.D of 20hours. The manufacturer claims that the mean life of bulbs is 1000 hours. Is the sample not upto the standard.**

**Null Hypothesis $H_0$ :**

$\mu = 1000$

**Alternative Hypothesis $H_1$ :**

$\mu \neq 1000$

n = 26

n-1 = 25

$\bar{x} = 990$

S = 200

$$t = \frac{\bar{x} - \mu}{\frac{SD}{\sqrt{25}}}$$

$$= \frac{900 - 1000}{\frac{20}{\sqrt{25}}}$$

$$= 2.5$$

Calculated value of t = 2.5.

Table value of t at 5% level with 25 degree of freedom.

$t_{0.05} = 1.708$

**Result :**

Calculated value > Table value => Reject $H_0$.

2.5 > 1.708 => Reject $H_0$

**STUDENT'S 't' TEST FOR DIFFERENCE OF MEANS**

To test the significant difference between two means $\bar{x}_1$ and $\bar{x}_2$ of samples of size $\bar{n}_1$ and $\bar{n}_2$ use the statistic.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{s\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

*where*

$$S^2 = \frac{\sum\left(x_1 - \overline{x_1}\right)^2 + \sum\left(x_2 - \overline{x_2}\right)^2}{s\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

OR

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

$S_1$; $S_2$ sample standard deviation

Degree of freedom d.f = $n_1 + n_2 - 2$

**Example 1: Samples of two types of electric light bulbs were tested for length of life and following data were obtained.**

| | Type I | Type II |
|---|---|---|
| **Sample Number** | $\mathbf{n_1 = 8}$ | $\mathbf{n_2 = 7}$ |
| **Sample Means** | $\overline{x_1}$ **= 124hrs** | $\overline{x_1}$ **= 1036 hrs** |
| **Sample S.D** | $\mathbf{S_1 =}$ **36 hours** | $\mathbf{S_2 =}$ **40hrs.** |

Is the difference in the means sufficient to warrant that type I superior to type II regarding length of life.

**Null Hypothesis $H_0$:**

$\mu_1=\mu_2$

There is no significant difference between two types.

$$S = \sqrt{\frac{n_1 s_1^2 + n_1 s_1^2}{n_1 + n_2 - 2}}$$

$$S = \sqrt{\frac{8x36^2 + 7x40^2}{8+7-2}}$$

$$= \sqrt{\frac{21568}{13}}$$

S = 40.73

$$t = \frac{\overline{x_1} - \overline{x_2}}{s\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

$$t = \frac{1234 - 1036}{40.73\sqrt{\frac{1}{8} + \frac{1}{7}}}$$

$$= \frac{198}{21.079}$$

t = 9.39

Degree of freedom = $n_1 + n_2 - 2$

= 8+7-2

= 13 at 5% level

=1.77

**Result**

Calculated value > Table value => Reject $H_0$.

9.39 > 1.77 => Reject $H_0$

**Example 2: The average number of articles produced by two machines per day are 200 and 250 with standard deviations 20 and 25 respectively. On the basis of records of 25 days production. Can you regard both the machines equally efficient at 1 % level of significance.**

**Null Hypothesis $H_0$:**

$\mu_1 = \mu_2$

**Alternative Hypothesis $H_1$ :**

$\mu_1 \neq \mu_2$

$n_1=25$ $n_2=25$

$\overline{x_1}$ =200 $\overline{x_2}$ =250

$S_1$=20 $S_2$=25

$$S=\sqrt{\frac{n_1 s_1^2+n_1 s_1^2}{n_1+n_2-2}}$$

$$S=\sqrt{\frac{25x20^2+25x25^2}{25+25-2}}$$

$$=\sqrt{\frac{25625}{48}}$$

S = 23.10

$$t=\frac{\overline{x_1}-\overline{x_2}}{s\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}}$$

$$t=\frac{200-250}{23.10\sqrt{\frac{1}{25}+\frac{1}{25}}}$$

$$=\frac{-50}{6.53}$$

|t| = 7.65

Degree of freedom = $n_1+n_1-2$

= 25+25-2

= 48 at 1% level

=2.58

**Result**

Calculated value > Table value => Reject $H_0$.

7.65 > 2.58 => Reject $H_0$

**Example 3: The heights of size randomly chosen sailors are inches 63, 65, 68, 69, 71 and 72. Those of 10 randomly chosen soldiers are 61, 62,65, 66, 69, 69, 70, 71, 72 and 73.**

**Discuss the light that these data throw on the suggestion that sailors are on the average taller than soldiers.**

**Null Hypothesis $H_0$:**

The sailors are not on the average taller than the soldiers. Both have the same average weight.

$$\mu_1 = \mu_2$$

**Alternative Hypothesis H1 :**

$$\mu_1 \neq \mu_2$$

| $x_1$ | $d_1 = X_1 - 60$ | $d_1^2$ |
|---|---|---|
| 63 | 3 | 9 |
| 65 | 5 | 25 |
| 68 | 8 | 64 |
| 69 | 9 | 81 |
| 71 | 11 | 121 |
| 72 | 12 | 144 |
| | $\sum d_1 = 48$ | $\sum d_1^2 = 444$ |
| | | |
| | | |
| | | |
| | | |

| $x_2$ | $d_2 = x$ | $d_2^2$ |
|---|---|---|
| 61 | -4 | 16 |
| 62 | -3 | 9 |
| 65 | 0 | 0 |
| 66 | 1 | 1 |
| 69 | 4 | 16 |
| 69 | 4 | 16 |
| 70 | 5 | 25 |
| 71 | 6 | 36 |
| 72 | 7 | 49 |
| 73 | 8 | 64 |
| | $\sum d_2 = 28$ | $\sum d_2^2 = 232$ |

$$\bar{x}_1 = A + \frac{\sum d_1}{n}$$

$$= 60 + \frac{48}{6}$$

$$\bar{x}_1 = 68$$

$$S_1 = \sqrt{\frac{\sum d_1^2}{n_1} - \left(\frac{\sum d_1}{n_1}\right)^2}$$

$$= \sqrt{\frac{444}{6} - \left(\frac{48}{6}\right)^2}$$

$$S_1 = 3.16$$

$$\bar{x}_2 = A + \frac{\sum d_2}{n}$$

$$= 65 + \frac{28}{6}$$

$$\bar{x}_2 = 69.6$$

$$S_2 = \sqrt{\frac{\sum d_2^2}{n_2} - \left(\frac{\sum d_2}{n_2}\right)^2}$$

$$= \sqrt{\frac{232}{10} - \left(\frac{28}{10}\right)^2}$$

$$S_2 = 3.91$$

$$S = \sqrt{\frac{n_1 s_1^2 + n_2 s_2^2}{n_1 + n_2 - 2}}$$

$$S = \sqrt{\frac{6x3.16^2 + 10x3.91^2}{6+10-2}}$$

$$S = 3.89$$

$$t = \frac{\overline{x_1} - \overline{x_2}}{s\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

$$t = \frac{68 - 69.6}{3.89\sqrt{\frac{1}{6} + \frac{1}{10}}}$$

$$= 0.79$$

Table value = $n_1 + n_1 - 2$

=6+10-2

= 14 at 5% level

=1.76

**Result**

Calculated value > Table value => Reject $H_0$.

0.79 > 1.76 => Accept $H_0$

**Conclusion**

The sailors are not on the average taller than the soldiers.

**PAIRED t-TEST**

**Example 4 :Memory capacity of a student was tested before/after a course of meditation for a month state whether the course was effective or not from the following data?**

| **Before Training (x)** | **10** | **15** | **9** | **3** | **7** | **12** | **16** | **17** | **4** |
|---|---|---|---|---|---|---|---|---|---|
| **After Training (y)** | **12** | **17** | **8** | **5** | **6** | **11** | **18** | **20** | **3** |

**Solution:**

**Null Hypothesis $H_0$ :**

The course was effective

| **x** | **y** | **d = y - x** | **$d^2$** |
|---|---|---|---|
| 10 | 12 | 2 | 4 |
| 15 | 17 | 2 | 4 |
| 9 | 8 | -1 | 1 |
| 3 | 5 | 2. | 4 |
| 7 | 6 | -1 | 1 |
| 12 | 11 | -1 | 1 |

| | | | |
|---|---|---|---|
| 16 | 18 | 2 | 4 |
| 17 | 20 | 3 | 9 |
| 4 | 3 | -1 | 1 |
| | | $\sum d = 7$ | $\sum d^2 = 29$ |

$$\bar{d} = \frac{\sum d}{n}$$

$$= \frac{7}{9}$$

$$= 0.77$$

$$S = \sqrt{\frac{\sum d^2}{n} - \left(\frac{\sum d}{n}\right)^2}$$

$$= \sqrt{\frac{29}{9} - \left(\frac{7}{9}\right)^2}$$

$$= \sqrt{3.22 - 0.59}$$

$$= \sqrt{2.63}$$

$$S = 1.621$$

$$|t| = \frac{\bar{d}}{\frac{S}{\sqrt{n-1}}} - n-1\ d.f$$

$$= \frac{0.77}{\frac{1.621}{\sqrt{8}}}$$

$$|t| = 1.343$$

Table value = n-1 degrees of freedom at 5%

= 9-1

= 8

= 2.31

**Result**

Calculated value > Table value

1.343 > 2.31

We Accept $H_0$

The course is effective

**Example : 5 | Poor students were given intensive coaching and test whether given before and after coaching if any improvement in the coaching class use parity test.**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Before Coaching :** | **50** | **42** | **51** | **26** | **35** | **42** | **60** | **41** | **70** | **55** | **62** | **38** |
| **After Coaching :** | **62** | **40** | **61** | **35** | **30** | **52** | **68** | **51** | **84** | **63** | **72** | **50** |

**Solution:**

**Null Hypothesis $H_0$ :**

The coaching classes is effective

**Alternate Hypothesis H j :**

The coaching classes is not effective.

| **x** | **y** | **d = y-x** | **$d^2$** |
|---|---|---|---|
| 50 | 62 | 12 | 144 |
| 42 | 40 | -2 | 4 |
| .51 | 61 | 10 | 100 |
| 26 | 35 | 9 | 81 |
| 35 | 30 | -5 | 25 |
| 42 | 52 | 10 | 100 |
| 60 | 68 | 8 | 64 |
| 41 | 51 | 10 | 100 |
| 70 | 84 | 14 | 196 |
| 55 | 63 | 8 | 64 |
| 62 | 72 | 10 | 100 |
| 38 | 50 | 12 | 144 |
| | | $\sum d = 96$ , | $\sum d^2 = 1122$ |

$$\bar{d} = \frac{\sum d}{n}$$

$$= \frac{97}{12}$$

$$= 8$$

$$S = \sqrt{\frac{\sum d^2}{n} - \left(\frac{\sum d}{n}\right)^2}$$

$$= \sqrt{\frac{1122}{12} - (8)^2}$$

$$S = 5.43$$

$$|t| = \frac{\bar{d}}{\frac{S}{\sqrt{n-1}}}$$

$$= \frac{8}{\frac{5.43}{\sqrt{12.1}}}$$

$$|t| = 4.87$$

Table value = n-1 degrees of freedom at 5%

= 12-1

= 11

= 2.20

**Result**

Calculated value > Table value

1.343 2.31

We reject $H_0$

The course is not effective

### 4.3 SMALL SAMPLES - F TEST

G.W. Snedecor has discovered a continuous probability distributing called Snedecor's F distributing. Here F is named after R. A Fishes who has contributed a lot to the development of Mathematical statistics.

$$F = \frac{S_1^2}{S_2^2}$$

Where

$$S_1^2 = \frac{n_1}{n_1 - 1} S_1^2$$

(or)

$$S_1^2 = \frac{\Sigma(x - \bar{x})^2}{n_1}$$

$$S_2^2 = \frac{n_2}{n_2 - 1} S_2^2$$

(or)

$$S_2^2 = \frac{\Sigma(y - \bar{y})^2}{n_2}$$

**Example 1: From the following data test if the difference between the varieties is significant at 5% level of significance.**

| | | |
|---|---|---|
| **Sum of squares of deviations from the mean** | **84.4** | **102.6** |
| **Size** | **8** | **10** |
| **Sample** | **A** | **B** |

**Solution :**

$H_0 : \sigma_1^2 = \sigma_2^2$ (The samples are drawn from the populates with equal variances)

$H_1 : \sigma_1^2 \neq \sigma_2^2$ (The samples are drawn from the populates with unequal variances)

Variance of the sample A is

$$S_1^2 = \frac{\sum\left(x-\bar{x}\right)^2}{n_1}$$

$$S_1^2 = \frac{84.4}{8}$$

Variance of the sample B is

$$S_2^2 = \frac{\sum\left(y-\bar{y}\right)^2}{n_2}$$

$$S_2^2 = \frac{102.6}{10}$$

The estimated variances of the population from which the samples A and B are drawn are given by

$$S_1^2 = \frac{n_1 S_1^2}{n_1 - 1}$$

$$S_1^2 = \frac{8}{7} X \frac{84.4}{8}$$

$$S_1^2 = 12.06$$

$$S_2^2 = \frac{n_2 S_2^2}{n_2 - 1}$$

$$S_1^2 = \frac{10}{9} X \frac{102.6}{10}$$

$$S_1^2 = 11.4$$

Hence $S_1^2 > S_2^2$

To carry out the test we use the F-statistic given by

$$F = \frac{S_1^2}{S_2^2}$$

$$F = \frac{12.06}{11.4}$$

F= 1.058

d.f = ($n_1$-l , $n_2$-l) = (7,9)

Table value of F(7, 9) at 5% level = 3.29.

**Conclusion :**

$H_0$ is accepted since the calculated value of F < the table value of F.

Hence the population variances are equal.

**Example : 2 Two random samples drawn from normal populations are**

**Sample I : 20 16 26 27 23 22 18 24 25 19**

**Sample II : 27 33 42 35 32 34 38 28 41 43 30 37**

**Obtain estimates of variances of the population and test whether the two populations have the same variance.**

**Solution:**

Let us first calculate the variance of the samples.

| **Sample I x - 2 2** | | | **Sample II y-35** | | |
|---|---|---|---|---|---|
| **X** | **d** | **$d^2$** | **y** | **d** | **$d^2$** |
| 20 | -2 | 4 | 27 | -8 | 64 |
| 16 | -6 | 36 | 33 | -2 | 4 |
| 26 | 4 | 16 | 42 | ; 7 | 49 |
| 27 | 5 | 25 | 35 | 0 | 0 |
| 23 | 1 | 1 | 32 | -3 | 9 |
| 22 | 0 | 0 | 34 | -1 | 1 |
| 18 | -4 | . 1 6 | 38 | 3 | 9 |
| 24 | 2 | 4 | 28 | -7 | 49 |
| 25 | 3 | 9 | 41 | 6 | 36 |
| 19 | -3 | 9 | 43 | 8 | 64 |
| | | | 30 | -5 | 25 |
| | | | 37 | 2 | 4 |
| 220 | 0 | 120 | 420 | 0 | 314 |

$\bar{x} = \frac{220}{10} = 22$ $\bar{y} = \frac{420}{12} = 35$

$S_1^2 = \frac{220}{10} = 12$

$S_2^2 = \frac{314}{12} = 26.17$

$H_0 = \sigma_1^2 = \sigma_2^2$

$H_1 = \sigma_1^2 \neq \sigma_2^2$

The estimated variances of the populations are given by

$S_1^2 = \frac{n_1 S_1^2}{n_1 - 1} = \frac{10x12}{9} = 13.33$

$S_2^2 = \frac{n_2 S_2^2}{n_2 - 1} = \frac{12x26.17}{11} = 28.55$

$S_2^2 >= S_1^2$

The test statistic is given by

$$F = \frac{S_2^2}{S_1^2}$$

$$F = \frac{28.55}{13.33}$$

Table value of F(l1, 9) DF at 5% level = 3.10

**Conclusion :**

$H_0$ is accepted at 5% level, since the calculated value of F > table value of F. The variance of the populations are equal.

## TEST OF SIGNIFICANCE FOR PROPORTIONS USING NORMAL DISTRIBUTION

### Test for a Single Proportion

Suppose a large sample of size n its taken from a normal population to test the significance difference between a sample population Q and the population proportion P we use statistic. '

$$Z = \frac{P - P}{\sqrt{\frac{PQ}{n}}}$$

## PROBLEMS UNDER PROPORTIONS AND DIFFERENCES

**Example : 1 In a sample of1,000 people in Maharashtra, 540 are rice eaters and the rest are wheat eaters. Can we assume that both rice and wheat are equally popular in this state at 1% level of significance?**

**Solution :**

**Null Hypothesis $H_0$:**

Both rice and wheat eaters are equally popular.

n = 1000, x = 540

$$p = \frac{x}{n} = \frac{540}{1000} = 0.54$$

$$p = 0.5$$

We know that,

P + Q = 1

Q = 1 - P

= 1-0.5

Q = ½

$$Z = \frac{P - P}{\sqrt{\frac{PQ}{n}}} = \frac{0.54 - 0.50}{\sqrt{\frac{(0.5)(0.5)}{1000}}}$$

$$\frac{0.040}{0.0138} = 2.532$$

Z = 2.532

Table value = n degree of freedom at 1%. = 2.58

**Conclusion :**

Calculated value < Table value

2.532 < 2.58.

We accept $H_0$. We may conclude that rice and wheat eaters are equally popular in Maharashtra State.

**Example : 2 In a big City 325 men out of 600 men were found to be smokers. Does this information support the conclusion that the majority of men in this city are smokers?**

**Solution:**

**Null Hypothesis $H_0$:**

Number of smokers = Non smokers in the City.

**Given :**

n = 600, x-325, **p.= ?**

$$p = \frac{x}{n} = \frac{325}{600} = 0.5417$$

P = Population proportion of smokers in City = 0.5

We know that,

P + Q = 1

Q = 1 - P

= 1-0.5

Q =0.5.

$$Z = \frac{P - P}{\sqrt{\frac{PQ}{n}}} = \frac{0.5417 - 0.5}{\sqrt{\frac{(0.5)(0.5)}{600}}}$$

$$\frac{0.5417 - 05}{0.0204} = 2.04$$

Z = 2.04

Table value

= n degree of freedom at 5%.

= 1.96

**Conclusion :**

Calculated value > Table value

2.04 > 1.96.

We reject $H_0$ at 5%Jevel of significance. The number of smokers and nonsmokers are not equal in the city.

**ANALYSIS OF VARIANCE [ANOVA]**

It is a technique used to test equality of means when more than one populations are considered.

In **Z**-test and t-test we consider only the equality of two population means.

If there are more than two populations, for testing the equality of their means the analysis of variance method is applied.

This technique introduced by R.A. Fisher was originally used in agricultural experiment in which different types of fertilizers were applied to plots of land, different types of feeding methods to animals and so on. This technique is widely used in different fields.

***For example :***

To study the pattern of average sales by using different sales techniques; the types of drugs manufactured by different companies to cure a particular disease.

A central point here is that although the ANOVA is literally a technique that *analysis variances*. It provides us with a test for the significance of the difference among means.

Before discussing the procedures used in ANOVA. We consider the general underlying principle.

If the null hypothesis that three population means ($\mu_1, \mu_2, \mu_3$) are equal in true then both, the variation among the sample means. $\left(\overline{X_1}, \overline{X_2}, \overline{X_3}\right)$ and the variation within these groups use chance errors of the sampling process. The first of these types of variations is referred to as variation between samples. The second type is referred to as variation within samples.

"Between Sample Variation" is a variation of the sample means $\overline{X_1}, \overline{X_2}$ and $X_3$ around their general mean $\overline{X}$ .

"Within Sample Variation" is a variation of the individual observations within each sample from their respective means $\overline{X_1}, \overline{X_2}$ and $X_3$

Under the null hypothesis that the population means are equal, between sample variation and within sample variation would be expected not to differ significantly from one another after adjustment for degrees of freedom, since they both reflect the same type of chance sampling errors. On the other hand if the null hypothesis is false and the population means are different then between sample variation should significantly exceed the within sample variation.

Hence a comparison of "between sample variation" and "within sample variation" yields information concerning difference among the sample means.

The ANOVA with different classification, before that we state the assumptions made in this technique.

- Samples are independently drawn from the populations.
- The populations are normally distributed.
- The variances of all the populations are equal.

**Types of ANOVA**

- One-way classification
- Two-way classification
- Three-way classification

**ANOVA '**

It is a statistical technique specially designed to test whether the means of more than two quantitative populations are equal. It consists of classifying and cross classifying statistical results and test whether the means of a specified classification differ significantly.

**One-Way Classification**

The observations are classified according to one factor. This is exhibited column-wise.

**Model**

$$Y_i=\mu+\alpha_1+e_1$$

$Y_i$ → random variable

$\mu$ → General mean effect

$\alpha_1$ → Treatment

$e_1$ → error

**Null Hypothesis $H_0$:**

There is no significant difference in the means of the sample.

**$\mu_1=\mu_2 \ldots. =\mu_n$**

**Alternative Hypothesis $H_1$ :**

There is some significant difference in the means of the sample,

**$\mu_1\neq\mu_2 \ldots.\neq\mu_n$**

**Procedures:**

A set of observations classified in one direction.

| | $X_1$ | $X_2$ | …… | $X_C$ |
|---|---|---|---|---|
| | $X_{11}$ | $X_{21}$ | …… | $X_{C1}$ |
| | $X_{12}$ | $X_{22}$ | …… | $X_{C2}$ |
| | . | . | . | . |
| | . | . | . | . |
| | . | . | . | . |
| | $X_{1r}$ | $X_{2r}$ | …… | $X_{Cr}$ |
| Mean | $\overline{X}_1$ | $\overline{X}_2$ | …… | $\overline{X}_C$ |

$$\overline{\overline{X}} = \frac{\overline{X}_1 + \overline{X}_2 + ..... + \overline{X}_C}{C}$$

**Correction factor =** $\frac{G^2}{n}$

G → Grand Total

n → number of observation

**Treatment [column] sum of square**

$$\mathbf{CSS} = \sum_j \left(\overline{X}_j - \overline{\overline{X}}\right)^2$$

**Error Sum of Square**

$$ESS = \sum_j \sum_i \left(X_{ij} - \overline{X}_J\right)^2$$

**Total Sum of Square**

$$TSS = \sum \sum \left(\overline{X}_{ij} - \overline{\overline{X}}\right)^2$$

$$TSS = CSS + ESS$$

If each of these sum of squares is divided by the corresponding number of degrees of freedom, we get mean sum of squares.

**ANOVA Table**

| **Source of variation** | **Degrees of freedom** | **Sum of square** | **Mean sum of square** | **F-ratio** | **F-table** |
|---|---|---|---|---|---|
| Column | C - l | **C.S.S** | $\frac{C.S.S}{C-1} \rightarrow (1)$ | $\frac{(1)}{(2)}(or) \rightarrow$ | F(C-l , n-C) |
| Error | n - C | **E.S.S** | $\frac{E.S.S}{n-c} \rightarrow (2)$ | $\frac{(2)}{(1)} \rightarrow$ | F(n-C, C-l) |
| Total | n - 1 | **T.S.S** | | | F(n-C, C-l) |

$$\text{F-ratio} = \frac{\text{Largest estimation of variance}}{\text{Smallest estimation of variance}}$$

**Short-Cut Method**

**Step 1 :** find n, the total number of observations

**Step 2:** find G the total of all observations.

**Step 3 :** find, $\frac{G^2}{n}$ the correction factor (C.F)

**Step 4 :** Calculate the total sum of square

$$TSS = \sum Y_{ij}^2 - C.F$$

**Step 5 :** Calculate the column sum of square

$$CSS = \sum \frac{C_{ij}^2}{r_i} - C.F$$

**Step 6:** Prepare the **ANOVA** table to calculate.

F – ratio

**Null Hypothesis $H_0$ :**

Population means are equal.

$\mu_1=\mu_2=\mu_3$

**Alternative Hypothesis $H_1$:**

Population means are not equal

$\mu_1\neq\mu_2\neq\mu_3$

**TYPE I**

**Example : 1 Set up ANOVA table for the following per hectare yield for these varieties.**

**Variety of Wheat**

| A1 | A2 | A3 |
|---|---|---|
| 6 | 5 | 5 |
| 7 | 5 | 4 |
| 3 | 3 | 3 |
| 8 | 7 | 4 |

**Also work out F-ratio and test whether there is a significant difference among the means of the wheat.**

**Null Hypothesis $H_0$ :**

There is no significant difference between the means of the sample.

$\mu_1=\mu_2=\mu_3$

**Alternative Hypothesis $H_1$ :**

There is a significant difference between the means of the sample.

$\mu_1\neq\mu_2\neq\mu_3$

**Correction Factor :[C.F]**

$$= \frac{G^2}{n}$$

$$= \frac{3600}{12}$$

$$= 300$$

**Total Sum of Square (TSS)**

$$\text{TSS} = \sum Y_{ij}^2 - C.F$$

$$= 36 + 25 + 25 + 49 + 25 + 16 + 9 + 9 + 9 + 64 + 49 + 16 - 300$$
$$= 332 - 300$$
$$= 32$$

**Column Sum of Square (CSS)**

$$\text{CSS} = \sum \frac{C_{ij}^2}{r_i} - C.F$$
$$= \frac{576 + 400 + 256}{4} - 300$$
$$= = \frac{1232}{4} - 300$$
$$= 8$$

**Error Sum of Square (ESS)**

**= TSS – CSS**

**=32-8**

**=24**

**ANOVA Table**

| **Source of variation** | **Degrees of freedom** | **Sum of square** | **Mean sum of square** | **F-ratio** | **F-table** |
|---|---|---|---|---|---|
| **CSS** | **2** | **8** | **8/2=4** | | |
| ESS | **9** | **24** | **24/9=2.67** | **4/2.67 =1.50** | **F(2,9)=4.26** |
| TSS | **11** | **32** | | | |

**Result :**

Calculated value < Tabulated value

1.50 < 4.26

Accept the $H_0$.

**Conclusion :**

There is no significant difference between the means of the sample.

**Example: 2 The samples A, B, C have been obtained from normal population with equal variances test whether the population means are equal.**

| A | B | C |
|---|---|---|
| 12 | 9 | 7 |
| 14 | 9 | 8 |
| 12 | 5 | 10 |
| 9 | 7 | 11 |
| 13 | 10 | 14 |

**Null Hypothesis $H_Q$:**

There is no significant difference among the means of the sample.

$\mu_1=\mu_2=\mu_3$

**Alternative Hypothesis**

$\mu_1\neq\mu_2\neq\mu_3$

**Correction Factor :[C.F]**

$$=\frac{G^2}{n}$$
$$=\frac{22500}{15}$$
$$=1500$$

**Total Sum of Square (TSS)**

$$\text{TSS} = \sum Y_{ij}^2 - C.F$$
$$=144+81+49+196+81+64+144+25+100+81+49+121+169+100+196-1500$$
$$=1600-1500$$
$$=100$$

**Column Sum of Square (CSS)**

$$\text{CSS} = \sum \frac{C_{ij}^2}{r_i} - C.F$$
$$=\frac{3600+1600+2500}{5}-300$$
$$==\frac{7700}{5}-1500$$
$$=40$$

**Error Sum of Square (ESS)**

= TSS - CSS

=100 - 40

=60

**ANOVA Table**

| Source of variation | Degrees of freedom | Sum of square | Mean sum of square | F-ratio | F-table |
|---|---|---|---|---|---|
| **CSS** | **2** | **40** | **40/2=20** | | |
| ESS | **12** | **60** | **60/12=5** | **20/5=4** | **F(2,12)=3.88** |
| TSS | **14** | **100** | | | |

**Result :**

Calculated value < Tabulated value

4 < 3.88

Reject the $H_0$.

**Conclusion :**

There is a significant difference among the means of the sample.

$\mu_1 \neq \mu_2 \neq \mu_3$

**ANOVA (Two-Way Classification)**

The observations are classified according to two factor. This is exhibited column and row wise.

**Model**

$$Y_{ij} = \mu + \alpha_i + \beta_j + C_{ij}$$

$Y_{ij}$ → random variable

$\mu$ → General mean effect

$\alpha_i$ → Treatment (Column)

$e_i$ → error

$\beta_j$ → row wise

$e_{ij}$ → error

**Null Hypothesis $H_0$ :**

There is no significant difference between columns and rows.

**Alternative Hypothesis $H_1$ :**

There is a significant difference between columns and rows.

**Error Sum of Square**

= Total **S.S** - (Column **S.S** +Row **S.S)**

**Row Sum of Square (RSS)**

$$\frac{\sum r_{ij}^2}{C_i} - C.F$$

**Procedure :**

**Step 1 :** find n, the total number of observations

**Step 2:** find G the total of all observations.

**Step 3 :** find, $\frac{G^2}{n}$ --- the correction factor (C.F)

**Step 4 :** Calculate the total sum of square

$$\text{TSS} = \sum Y_{ij}^2 - C.F$$

**Step 5 :** Calculate the column sum of square

$$\text{CSS} = \sum \frac{C_{ij}^2}{r_i} - C.F$$

**Step 6:** Calculate the Row sum of square

$$\text{RSS} = \sum \frac{r_{ij}^2}{r_i} - C.F$$

**Step** 7; Calculate the Error sum of square

$$\text{ESS} = \text{TSS-(CSS} + \text{RSS)}$$

Prepare the ANOVA Table

| **Source of variation** | **Degrees of freedom** | **Sum of square** | **Mean sum of square** | **F-ratio** | **F-table** |
|---|---|---|---|---|---|
| Column | C - l | **C.S.S** | $\frac{C.S.S}{C-1} \rightarrow (1)$ | $\frac{(1)}{(3)} \rightarrow (a)$ | F(C-l,(C-1)(r-C)) |
| Row | r - 1 | **R.S.S** | $\frac{R.S.S}{r-1} \rightarrow (2)$ | | |
| Error | ( C - 1 ) ( r - 1 ) | **E.S.S** | $\frac{E.S.S}{(C-I)(r-1)} \rightarrow$ | $\frac{(2)}{(3)} \rightarrow (b)$ | F(r-l,(C-1)(r-1)) |
| Total | n - 1 | **T.S.S** | | | |

**Result:**

If calculated value < Tabulated value

accept the $H_0$.

$$\text{F-ratio} = \frac{\text{Largest estimation of variance}}{\text{Smallest estimation of variance}}$$

**Example : 5 Apply the technique of ANOVA to the following data showing the yields of 3 varieties of a crop each from 4 blocks and test whether the mean yields of the varieties are equal or not.**

| **Varieties** | **I** | **II** | **III** | **IV** |
|---|---|---|---|---|
| **A** | **4** | **8** | **6** | **8** |
| **B** | **5** | **5** | **7** | **8** |
| **C** | **6** | **7** | **9** | **5** |

**Null Hypothesis $H_0$:**

There is no significant difference between Columns and Rows.

**Alternative Hypothesis $H_1$ :**

There is a significant difference between Columns and Rows.

**Correction Factor: [C. F]**

$$\frac{G^2}{n}$$

$$= \frac{6084}{12}$$
$$= 507$$

**Total Sum of Square [TSS]**

$$\text{TSS} = \sum Y_{ij}^2 - C.F$$
$$= \frac{225+400+484+441}{3} - 507$$
$$= 534 - 507$$
$$= 27$$

**Error Sum of Square [ESS]**

= Total **SS** - (Column **SS** + Row **SS)**

= 27-(9.67+ 0.5)

= 16.83

**ANOVA Table**

| **Source of variation** | **Degrees of freedom** | **Sum of square** | **Mean sum of square** | **F-ratio** | **F-table** |
|---|---|---|---|---|---|
| Column | 3 | **9.67** | $\frac{9.67}{3} = 3.22$ | $\frac{3.22}{2.81} = 21.45$ | F(3,6)=4.76 |
| Row | 2 | **0.5** | $\frac{0.5}{3} = 0.25$ | | F(6,2)=19.35 |
| Error | 6 | **16.83** | $\frac{16.83}{6} = 32.81$ | $\frac{2.81}{0.25} = 11.24$ | |
| Total | 11 | **27** | | | |

**Result**

**Between Column**

If Calculated value < Tabulated value,

1.45 < 4.76

Accept the $H_0$.

**Between Row**

If Calculated value < Tabulated value

11.24 < 19.35

Accept the $H_Q$.

**Conclusion:**

There is a significant difference between Columns and Rows.

**Example : 6 Three varieties A, B, C of a crop are tested in a randomised block design with four replications. The plot yields are**

**Treatment**

| **Varieties** | **I** | **II** | **III** | **IV** |
|---|---|---|---|---|
| **A** | **6** | **5** | **8** | **9** |
| **B** | **8** | **4** | **6** | **9** |
| **C** | **7** | **6** | **10** | **6** |

**Analyse the experimental yield and state your conclusion.**

**Null Hypothesis $H_0$ :**

There is no significant difference between Columns and Rows.

Treatment

| Varieties | I | II | III | TV |
|---|---|---|---|---|
| A | 6 | 5 | 8 | 9 |
| B | 8 | 4 | 6 | 9 |
| C | 7 | 6 | 10 | 6 |

**Correction Factor: [C. F]**

$$= \frac{G^2}{n}$$

$$= \frac{(84)^2}{15}$$

$$= 588$$

**Total Sum of Square [TSS]**

$$\text{TSS} = \sum Y_{ij}^2 - C.F$$

$$= 36+25+64+81+64+16+16+81+49+36+100+36-507$$

$$= 534-240$$

$$= 36$$

**Coloumn Sum of Square (CSS)**

$$\text{CSS} = \sum \frac{C_{ij}^2}{r_i} - C.F$$

$$= \frac{(21)^2+(15)^2+(24)^2+(24)^2}{3} - 588$$

$$= 18$$

**Row Sum of Square (RSS)**

$$\text{RSS} = \sum \frac{r_{ij}^2}{C_i} - C.F$$

$$= \frac{(28)^2+(27)^2+(29)^2}{4} - 588$$

$$= 0.5$$

**Error Sum of Square [ESS]**

= Total SS - (Column SS + Row SS)

= 36-(18+ 0.5)

= 17.5

| **Source of Variation** | **Degrees of freedom** | **Sum of square** | **Mean sum ,of square** | **F-ratio** | **F-table** |
|---|---|---|---|---|---|
| Column | 3 | 18 | $\frac{18}{3}=6$ | $\frac{6}{2.92}=2.05$ | F(3,6)=4.76 |
| Row | 2 | 0.5 | $\frac{0.5}{2}=0.25$ | $\frac{2.92}{0.25}=11.68$ | F(6,2)=19.35 |
| Error | 6 | 17.5 | $\frac{17.5}{6}=2.92$ | | |
| Total | 11 | 36 | | | |

**Result:**

**Between Column**

If Calculated value < Tabulated value

**2.05 < 4.76**

Accept the $H_0$.

**Between Row**

If Calculated value < Tabulated value

11.68 < 19.35

Accept the $H_0$.

**Conclusion :**

There is no significant difference between Columns and Rows.

**THREE WAY ANOVA**

The three-way ANOVA is used to determine if there is an interaction effect between three independent variables on a continuous dependent variable (i.e., if a three-way interaction exists). As such, it extends the two-way ANOVA, which is used to determine if such an interaction exists between just two independent variables (i.e., rather than three independent variables).

**Unit V**

*Interpretation – meaning, Techniques of interpretation, Report writing – significance and steps – layout of report – types of reports – oral presentation – executive summary – mechanics of writing research report – Precautions for writing report – norms for using tables, chart and diagrams – Appendix – norms of using Index and Bibliography.*

# 5.1 INTERPRETATION AND REPORT WRITING

After collecting and analyzing the data, the researcher has to accomplish the task of drawing inferences followed by report writing. This has to be done very carefully, otherwise misleading conclusions may be drawn and the whole purpose of doing research may get vitiated. It is only through interpretation that the researcher can expose relations and processes that underlie his findings. In case of hypotheses testing studies, if hypotheses are tested and upheld several times, the researcher may arrive at generalizations. But in case the researcher had no hypothesis to start with, he would try to explain his findings on the basis of some theory. This may at times result in new questions, leading to further researches. All this analytical information and consequential inference(s) may well be communicated, preferably through research report, to the consumers of research results who may be either an individual or a group of individuals or some public/private organisation.

**Meaning of interpretation**

Interpretation refers to the task of drawing inferences from the collected facts after an analytical and/or experimental study. In fact, it is a search for broader meaning of research findings. The task of interpretation has two major aspects viz., (i) the effort to establish continuity in research through linking the results of a given study with those of another, and (ii) the establishment of some explanatory concepts. "In one sense, interpretation is concerned with relationships within the collected data, partially overlapping analysis. Interpretation also extends beyond the data of the study to include the results of other research, theory and hypotheses."1 Thus, interpretation is the device through which the factors that seem to explain what has been observed by researcher in the course of the study can be better understood and it also provides a theoretical conception which can serve as a guide for further researches.

**Technique of interpretation**

The task of interpretation is not an easy job, rather it requires a great skill and dexterity on the part of researcher. Interpretation is an art that one learns through practice and

experience. The researcher may, at times, seek the guidance from experts for accomplishing the task of interpretation.

The technique of interpretation often involves the following steps:

I. Researcher must give reasonable explanations of the relations which he has found and he must interpret the lines of relationship in terms of the underlying processes and must try to find out the thread of uniformity that lies under the surface layer of his diversified research findings. In fact, this is the technique of how generalization should be done and concepts be formulated.

II. Extraneous information, if collected during the study, must be considered while interpreting the final results of research study, for it may prove to be a key factor in understanding the problem under consideration.

III. It is advisable, before embarking upon final interpretation, to consult someone having insight into the study and who is frank and honest and will not hesitate to point out omissions and errors in logical argumentation. Such a consultation will result in correct interpretation and, thus, will enhance the utility of research results.

IV. Researcher must accomplish the task of interpretation only after considering all relevant factors affecting the problem to avoid false generalization. He must be in no hurry while interpreting results, for quite often the conclusions, which appear to be all right at the beginning, may not at all be accurate.

## 5.2 REPORT WRITING AND ITS SIGNIFICANCE

Research report is considered a major component of the research study for the research task remains incomplete till the report has been presented and/or written. As a matter of fact even the most brilliant hypothesis, highly well designed and conducted research study, and the most striking generalizations and findings are of little value unless they are effectively communicated to others. The purpose of research is not well served unless the findings are made known to others. Research results must invariably enter the general store of knowledge. All this explains the significance of writing research report. There are people who do not consider writing of report as an integral part of the research process. But the general opinion is in favour of treating the presentation of research results or the writing of report as part and parcel of the research project. Writing of report is the last step in a research study and requires a set of skills somewhat different from those called for in respect of the

earlier stages of research. This task should be accomplished by the researcher with utmost care; he may seek the assistance and guidance of experts for the purpose.

## 5.3 STEPS IN WRITING REPORT

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

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

Preparation of the final outline: It is the next step in writing the research report "Outlines are the framework upon which long written works are constructed. They are an aid to the logical organisation of the material and a reminder of the points to be stressed in the report."

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

Rewriting and polishing of the rough draft: This step happens to be most difficult part of all formal writing. Usually this step requires more time than the writing of the rough draft. The careful revision makes the difference between a mediocre and a good piece of writing. While rewriting and polishing, one should check the report for weaknesses in logical

development or presentation. The researcher should also "see whether or not the material, as it is presented, has unity and cohesion; does the report stand upright and firm and exhibit a definite pattern, like a marble arch? Or does it resemble an old wall of moldering cement and loose brick."4 In addition the researcher should give due attention to the fact that in his rough draft he has been consistent or not. He should check the mechanics of writing—grammar, spelling and usage.

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

For books and pamphlets the order may be as under:

1. Name of author, last name first.
2. Title, underlined to indicate italics.
3. Place, publisher, and date of publication.
4. Number of volumes.

Example

Kothari, C.R., Quantitative Techniques, New Delhi, Vikas Publishing House Pvt. Ltd., 1978.

For magazines and newspapers the order may be as under:

1. Name of the author, last name first.
2. Title of article, in quotation marks.
3. Name of periodical, underlined to indicate italics.
4. The volume or volume and number.
5. The date of the issue.
6. The pagination.

Example

Robert V. Roosa, "Coping with Short-term International Money Flows", The Banker, London,September, 1971, p. 995.

The above examples are just the samples for bibliography entries and may be used, but one should also remember that they are not the only acceptable forms. The only thing important is that, whatever method one selects, it must remain consistent.

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

## 5.4 LAYOUT OF REPORT

Anybody, who is reading the research report, must necessarily be conveyed enough about the study so that he can place it in its general scientific context, judge the adequacy of its methods and thus form an opinion of how seriously the findings are to be taken. For this purpose there is the need of proper layout of the report. The layout of the report means as to what the research report should contain. A comprehensive layout of the research report should comprise (A) preliminary pages; (B) the main text; and (C) the end matter. Let us deal with them separately.

### (A) Preliminary Pages

In its preliminary pages the report should carry a title and date, followed by acknowledgements in the form of 'Preface' or 'Foreword'. Then there should be a table of contents followed by list of tables and illustrations so that the decision-maker or anybody interested in reading the report can easily locate the required information in the report.

### (B) Main Text

The main text provides the complete outline of the research report along with all details. Title of the research study is repeated at the top of the first page of the main text and

then follows the other details on pages numbered consecutively, beginning with the second page. Each main section of the report should begin on a new page. The main text of the report should have the following sections: (i) Introduction; (ii) Statement of findings and recommendations; (iii) The results; (iv) The implications drawn from the results; and (v) The summary.

(i) Introduction: The purpose of introduction is to introduce the research project to the readers. It should contain a clear statement of the objectives of research i.e., enough background should be given to make clear to the reader why the problem was considered worth investigating. A brief summary of other relevant research may also be stated so that the present study can be seen in that context. The hypotheses of study, if any, and the definitions of the major concepts employed in the study should be explicitly stated in the introduction of the report.

The methodology adopted in conducting the study must be fully explained. The scientific reader would like to know in detail about such thing: How was the study carried out? What was its basic design? If the study was an experimental one, then what were the experimental manipulations? If the data were collected by means of questionnaires or interviews, then exactly what questions were asked (The questionnaire or interview schedule is usually given in an appendix)? If measurements were based on observation, then what instructions were given to the observers? Regarding the sample used in the study the reader should be told: Who were the subjects? How many were there? How were they selected? All these questions are crucial for estimating the probable limits of generalizability of the findings. The statistical analysis adopted must also be clearly stated. In addition to all this, the scope of the study should be stated and the boundary lines be demarcated. The various limitations, under which the research project was completed, must also be narrated.

(ii) Statement of findings and recommendations: After introduction, the research report must contain a statement of findings and recommendations in non-technical language so that it can be easily understood by all concerned. If the findings happen to be extensive, at this point they should be put in the summarised form.

(iii) Results: A detailed presentation of the findings of the study, with supporting data in the form of tables and charts together with a validation of results, is the next step in writing the main text of the report. This generally comprises the main body of the report, extending over several chapters. The result section of the report should contain statistical summaries and reductions of the data rather than the raw data. All the results should be presented in logical

sequence and splitted into readily identifiable sections. All relevant results must find a place in the report. But how one is to decide about what is relevant is the basic question. Quite often guidance comes primarily from the research problem and from the hypotheses, if any, with which the study was concerned. But ultimately the researcher must rely on his own judgement in deciding the outline of his report. "Nevertheless, it is still necessary that he states clearly the problem with which he was concerned, the procedure by which he worked on the problem, the conclusions at which he arrived, and the bases for his conclusions."

(iv) Implications of the results: Toward the end of the main text, the researcher should again put down the results of his research clearly and precisely. He should, state the implications that flow from the results of the study, for the general reader is interested in the implications for understanding the human behaviour. Such implications may have three aspects as stated below:

(a) A statement of the inferences drawn from the present study which may be expected to apply in similar circumstances.

(b) The conditions of the present study which may limit the extent of legitimate generalizations of the inferences drawn from the study.

(c) The relevant questions that still remain unanswered or new questions raised by the study along with suggestions for the kind of research that would provide answers for them.

It is considered a good practice to finish the report with a short conclusion which summarises and recapitulates the main points of the study. The conclusion drawn from the study should be clearly related to the hypotheses that were stated in the introductory section. At the same time, a forecast of the probable future of the subject and an indication of the kind of research which needs to be done in that particular field is useful and desirable.

(v) Summary: It has become customary to conclude the research report with a very brief summary, resting in brief the research problem, the methodology, the major findings and the major conclusions drawn from the research results.

**(C) End Matter**

At the end of the report, appendices should be enlisted in respect of all technical data such as questionnaires, sample information, mathematical derivations and the like ones. Bibliography of sources consulted should also be given. Index (an alphabetical listing of names, places and topics along with the numbers of the pages in a book or report on which they are mentioned

or discussed) should invariably be given at the end of the report. The value of index lies in the fact that it works as a guide to the reader for the contents in the report.

## 5.5 TYPES OF REPORTS

Research reports vary greatly in length and type. In each individual case, both the length and the form are largely dictated by the problems at hand. For instance, business firms prefer reports in the letter form, just one or two pages in length. Banks, insurance organisations and financial institutions are generally fond of the short balance-sheet type of tabulation for their annual reports to their customers and shareholders. Mathematicians prefer to write the results of their investigations in the form of algebraic notations. Chemists report their results in symbols and formulae. Students of literature usually write long reports presenting the critical analysis of some writer or period or the like with a liberal use of quotations from the works of the author under discussion. In the field of education and psychology, the favourite form is the report on the results of experimentation accompanied by the detailed statistical tabulations. Clinical psychologists and social pathologists frequently find it necessary to make use of the case-history form.

News items in the daily papers are also forms of report writing. They represent firsthand on-the scene accounts of the events described or compilations of interviews with persons who were on the scene. In such reports the first paragraph usually contains the important information in detail and the succeeding paragraphs contain material which is progressively less and less important.

Book-reviews which analyze the content of the book and report on the author's intentions, his success or failure in achieving his aims, his language, his style, scholarship, bias or his point of view. Such reviews also happen to be a kind of short report. The reports prepared by governmental bureaus, special commissions, and similar other organisations are generally very comprehensive reports on the issues involved. Such reports are usually considered as important research products. Similarly, Ph.D. theses and dissertations are also a form of report-writing, usually completed by students in academic institutions.

The above narration throws light on the fact that the results of a research investigation can be presented in a number of ways viz., a technical report, a popular report, an article, a monograph or at times even in the form of oral presentation. Which method(s) of presentation to be used in a particular study depends on the circumstances under which the study arose and the nature of the results. A **technical report** is used whenever a full written report of the

study is required whether for recordkeeping or for public dissemination. A **popular report** is used if the research results have policy implications. We give below a few details about the said two types of reports:

**(A) Technical Report**

In the technical report the main emphasis is on (i) the methods employed, (it) assumptions made in the course of the study, (iii) the detailed presentation of the findings including their limitations and supporting data.

A general outline of a technical report can be as follows:

1. Summary of results: A brief review of the main findings just in two or three pages.
2. Nature of the study: Description of the general objectives of study, formulation of the problem in operational terms, the working hypothesis, the type of analysis and data required, etc.
3. Methods employed: Specific methods used in the study and their limitations. For instance, in sampling studies we should give details of sample design viz., sample size, sample selection, etc.
4. Data: Discussion of data collected, their sources, characteristics and limitations. If secondary data are used, their suitability to the problem at hand be fully assessed. In case of a survey, the manner in which data were collected should be fully described.
5. Analysis of data and presentation of findings: The analysis of data and presentation of the findings of the study with supporting data in the form of tables and charts be fully narrated. This, in fact, happens to be the main body of the report usually extending over several chapters.
6. Conclusions: A detailed summary of the findings and the policy implications drawn from the results be explained.
7. Bibliography: Bibliography of various sources consulted be prepared and attached.
8. Technical appendices: Appendices be given for all technical matters relating to questionnaire, mathematical derivations, elaboration on particular technique of analysis and the like ones.
9. Index: Index must be prepared and be given invariably in the report at the end.

The order presented above only gives a general idea of the nature of a technical report; the order of presentation may not necessarily be the same in all the technical reports.

This, in other words, means that the presentation may vary in different reports; even the different sections outlined above will not always be the same, nor will all these sections appear in any particular report.

It should, however, be remembered that even in a technical report, simple presentation and ready availability of the findings remain an important consideration and as such the liberal use of charts and diagrams is considered desirable.

**(B) Popular Report**

The popular report is one which gives emphasis on simplicity and attractiveness. The simplification should be sought through clear writing, minimization of technical, particularly mathematical, details and liberal use of charts and diagrams. Attractive layout along with large print, many subheadings, even an occasional cartoon now and then is another characteristic feature of the popular report. Besides, in such a report emphasis is given on practical aspects and policy implications.

We give below a general outline of a popular report.

1. The findings and their implications: Emphasis in the report is given on the findings of most practical interest and on the implications of these findings.
2. Recommendations for action: Recommendations for action on the basis of the findings of the study is made in this section of the report.
3. Objective of the study: A general review of how the problem arise is presented along with the specific objectives of the project under study.
4. Methods employed: A brief and non-technical description of the methods and techniques used, including a short review of the data on which the study is based, is given in this part of the report.
5. Results: This section constitutes the main body of the report wherein the results of the study are presented in clear and non-technical terms with liberal use of all sorts of illustrations such as charts, diagrams and the like ones.
6. Technical appendices: More detailed information on methods used, forms, etc. is presented in the form of appendices. But the appendices are often not detailed if the report is entirely meant for general public.

There can be several variations of the form in which a popular report can be prepared. The only important thing about such a report is that it gives emphasis on simplicity and

policy implications from the operational point of view, avoiding the technical details of all sorts to the extent possible.

## 5.6 ORAL PRESENTATION

At times oral presentation of the results of the study is considered effective, particularly in cases where policy recommendations are indicated by project results. The merit of this approach lies in the fact that it provides an opportunity for give-and-take decisions which generally lead to a better understanding of the findings and their implications. But the main demerit of this sort of presentation is the lack of any permanent record concerning the research details and it may be just possible that the findings may fade away from people's memory even before an action is taken. In order to overcome this difficulty, a written report may be circulated before the oral presentation and referred to frequently during the discussion. Oral presentation is effective when supplemented by various visual devices. Use of slides, wall charts and blackboards is quite helpful in contributing to clarity and in reducing the boredom, if any. Distributing a board outline, with a few important tables and charts concerning the research results, makes the listeners attentive who have a ready outline on which to focus their thinking. This very often happens in academic institutions where the researcher discusses his research findings and policy implications with others either in a seminar or in a group discussion.

Thus, research results can be reported in more than one ways, but the usual practice adopted, in academic institutions particularly, is that of writing the Technical Report and then preparing several research papers to be discussed at various forums in one form or the other. But in practical field and with problems having policy implications, the technique followed is that of writing a popular report. Researches done on governmental account or on behalf of some major public or private organisations are usually presented in the form of technical reports.

## 5.7 SUMMARY, ABSTRACT OR EXECUTIVE SUMMARY

While your lecturers will certainly read your whole report (in order to mark it and give you feedback) in the workplace, reports are received differently. Some readers will not wish to read the entire report, but only the parts relevant to them, so the summary, abstract, or executive summary presents the entire report in brief - generally on no more than one page. Include:

- who requested the report
- the purpose
- background/context
- brief description of methodology
- main findings, and
- recommendations

Use paragraphs for an abstract and paragraphs/dot points for an executive summary. Make sure the layout is methodical, working through each section of the report clearly and in order.

## 5.8 MECHANICS OF WRITING A RESEARCH REPORT

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

**1. Size and physical design**: The manuscript should be written on unruled paper 81/ $2^{//} \times 11^{//}$ in size. If it is to be written by hand, then black or blue-black ink should be used. A margin of at least one and one-half inches should be allowed at the left hand and of at least half an inch at the right hand of the paper. There should also be one-inch margins, top and bottom. The paper should be neat and legible. If the manuscript is to be typed, then all typing should be double spaced on one side of the page only except for the insertion of the long quotations.

**2. Procedure**: Various steps in writing the report should be strictly adhered (All such steps have already been explained earlier in this chapter).

**3. Layout**: Keeping in view the objective and nature of the problem, the layout of the report should be thought of and decided and accordingly adopted (The layout of the research report and various types of reports have been described in this chapter earlier which should be taken as a guide for report-writing in case of a particular problem).

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

**5. The footnotes**: Regarding footnotes one should keep in view the followings:

a) The footnotes serve two purposes viz., the identification of materials used in quotations in the report and the notice of materials not immediately necessary to the body of the research text but still of supplemental value. In other words, footnotes are meant for cross references, citation of authorities and sources, acknowledgement and elucidation or explanation of a point of view. It should always be kept in view that footnote is not an end nor a means of the display of scholarship. The modern tendency is to make the minimum use of footnotes for scholarship does not need to be displayed.

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

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

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

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

(i) Regarding the single-volume reference

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

Example

John Gassner, Masters of the Drama, New York: Dover Publications, Inc. 1954, p. 315.

(ii) Regarding multivolumed reference

1. Author's name in the normal order;
2. Title of work, underlined to indicate italics;
3. Place and date of publication;
4. Number of volume;
5. Pagination references (The page number).

(iii) Regarding works arranged alphabetically

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

Example 1

"Salamanca," Encyclopaedia Britannica, 14th Edition.

Example 2

"Mary Wollstonecraft Godwin," Dictionary of national biography.

But if there should be a detailed reference to a long encyclopedia article, volume and pagination reference may be found necessary.

(iv) Regarding periodicals reference

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

(v) Regarding anthologies and collections reference

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

(vi) Regarding second-hand quotations reference

In such cases the documentation should be handled as follows:

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

Example

J.F. Jones, Life in Ploynesia, p. 16, quoted in History of the Pacific Ocean area, by R.B. Abel, p. 191.

(vii) Case of multiple authorship

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

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

**7. Punctuation and abbreviations in footnotes**: The first item after the number in the footnote is the author's name, given in the normal signature order. This is followed by a comma. After the comma, the title of the book is given: the article (such as "A", "An", "The" etc.) is omitted and only the first word and proper nouns and adjectives are capitalized. The title is followed by a comma. Information concerning the edition is given next. This entry is followed by a comma. The place of publication is then stated; it may be mentioned in an abbreviated form, if the place happens to be a famous one such as Lond. for London, N.Y. for New York, N.D. for New Delhi and so on. This entry is followed by a comma. Then the name of the publisher is mentioned and this entry is closed by a comma. It is followed by the date of publication if the date is given on the title page. If the date appears in the copyright notice on the reverse side of the title page or elsewhere in the volume, the comma should be omitted and the date enclosed in square brackets [c 1978], [1978]. The entry is followed by a comma. Then follow the volume and page references and are separated by a comma if both are given. A period closes the complete documentary reference. But one should remember that the documentation regarding acknowledgements from magazine articles and periodical literature follow a different form as stated earlier while explaining the entries in the bibliography.

Certain English and Latin abbreviations are quite often used in bibliographies and footnotes to eliminate tedious repetition. The following is a partial list of the most common abbreviations frequently used in report-writing (the researcher should learn to recognise them as well as he should learn to use them):

anon., anonymous

| | |
|---|---|
| ante., | before |
| art., | article |
| aug., | augmented |
| bk., | book |
| bull., | bulletin |
| cf., | compare |
| ch., | chapter |
| col., | column |
| diss., | dissertation |
| ed., | editor, edition, edited. |
| ed. cit., | edition cited |
| e.g., | exempli gratia: for example |
| eng., | enlarged |
| et.al., | and others |

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

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

**10. Bibliography**: Bibliography should be prepared and appended to the research report as discussed earlier.

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

## 5.9 PRECAUTIONS FOR WRITING RESEARCH REPORTS

Research report is a channel of communicating the research findings to the readers of the report. A good research report is one which does this task efficiently and effectively. As such it must be prepared keeping the following precautions in view:

1. While determining the length of the report (since research reports vary greatly in length), one should keep in view the fact that it should be long enough to cover the subject but short enough to maintain interest. In fact, report-writing should not be a means to learning more and more about less and less.
2. A research report should not, if this can be avoided, be dull; it should be such as to sustain reader's interest.
3. Abstract terminology and technical jargon should be avoided in a research report. The report should be able to convey the matter as simply as possible. This, in other words, means that report should be written in an objective style in simple language, avoiding expressions such as "it seems," "there may be" and the like.
4. Readers are often interested in acquiring a quick knowledge of the main findings and as such the report must provide a ready availability of the findings. For this purpose, charts, graphs and the statistical tables may be used for the various results in the main report in addition to the summary of important findings.
5. The layout of the report should be well thought out and must be appropriate and in accordance with the objective of the research problem.
6. The reports should be free from grammatical mistakes and must be prepared strictly in accordance with the techniques of composition of report-writing such as the use of quotations, footnotes, documentation, proper punctuation and use of abbreviations in footnotes and the like.

7. The report must present the logical analysis of the subject matter. It must reflect a structure wherein the different pieces of analysis relating to the research problem fit well.
8. A research report should show originality and should necessarily be an attempt to solve some intellectual problem. It must contribute to the solution of a problem and must add to the store of knowledge.
9. Towards the end, the report must also state the policy implications relating to the problem under consideration. It is usually considered desirable if the report makes a forecast of the probable future of the subject concerned and indicates the kinds of research still needs to be done in that particular field.
10. Appendices should be enlisted in respect of all the technical data in the report.
11. Bibliography of sources consulted is a must for a good report and must necessarily be given. Index is also considered an essential part of a good report and as such must be prepared and appended at the end.
12. Report must be attractive in appearance, neat and clean, whether typed or printed.
13. Calculated confidence limits must be mentioned and the various constraints experienced in conducting the research study may also be stated in the report.
14. Objective of the study, the nature of the problem, the methods employed and the analysis techniques adopted must all be clearly stated in the beginning of the report in the form of introduction.

## 5.10 NORMS OF USING FIGURES, TABLES AND GRAPHS

Figures, tables and graphs are often used in scientific reports. They are valuable because they can be used to present complex results in a readable way, but it is important that they are used carefully.

**Labelling and using tables and diagrams**

Tables and graphs should be:

- numbered sequentially
- labelled clearly and
- positioned as close to the relevant text as possible.

**Placement of tables and diagrams**

- Put graphs, tables, figures and diagrams in the Results section and complex raw data in the Appendix.

**Refer to figures and tables**

- Make specific reference to each figure and table. Do not assume that the reader will make the necessary connection between the text and the figure or table. Write something about each figure and table.
- Refer to each figure or table in the text by its figure or table number.
- Remember to guide the reader in interpreting the information in the table or figure. What does the table show? What specific point are you making?

**Labelling**

- Label tables above the table and figures below the figure.
- A table or figure from an outside source should be labelled like any other outside information and its source should be provided.
- Number all tables and figures, even if you use only one of each.

**Figures and tables in appendices**

- Number figures and tables in appendices according to the appendix in which they appear. For example in Appendix A you would have:
    - Figure A1
    - Table A1
    - and so on.

Example

The results are shown in Table 3 below, and the graph of V against M is found in Appendix A3.

**Titles of tables**

- Keep titles brief but informative. You can include explanatory notes, if needed, as footnotes under the table or figure.

Example

Table 1. Reagent tests of known nutrients for specific food substances (Table here)

(Note: Numbers in parentheses indicate the range of response for each reagent.)

**Referring to tables and figures**

When referring to tables and figures, you can use:

- clauses beginning with as

Example

As shown in Table I below, lipids were found in hamburgers, hot dogs, potato chips, pizza and doughnuts.

- passive voice

  Example

  Mean weights for samples are shown in Table 1.

- brackets

You may refer to Tables or figures by using brackets with or without the verb see

Examples

On average female wasps were twice as numerous as male wasps (Table 1).

Each sample tested positive for the three nutrients (see Table 2).

Plant growth did not differ across irrigation treatments (Figure 1).

**5.11 APPENDIX**

Appendices are the place to include any data too bulky to place in the body of your report. You might include:

- your survey tool (but not all your responses)
- raw data
- any graphs or tables too large for the body Make sure you:
- number each appendix clearly (i.e. Appendix 1)
- give it a title, so the reader can see what it contains at a glance, and
- include it in the table of contents

In the body of your paper, you can then refer to this bulky data without having it interrupt the flow of the report. For example:

| |
|---|
| Understand the impact of tourism on the peacock population, a two year study was conducted from January 2007 to February 2009. Data was collected from the tourism board that measured tourist numbers and tourist behaviour patterns in and around the peacock habitat (see Appendix 2), and the peacock population was extensively monitored, with data collected on peacock numbers and behaviours, including feeding, nesting and breeding (see Appendix 3). |

Notice that the appendices are attached AFTER the reference list.

**5.12 NORMS OF USING INDEX AND BIBLIOGRAPHY**

**Index**

An index, while never the most glamorous section of any writing project, is essential to the readability and usability of longer nonfiction pieces, technical articles, and books. It is an alphabetical listing of keywords and concepts in the text. It contains "pointers" to those words and concepts, which are usually page, section, or paragraph numbers. It generally appears at the end of a work. Building one need not be a chore, but it should not be an afterthought, either. It's important to make an index that is useful and comprehensive for your readers, but doesn't occupy too much of your valuable research and writing time. If you think it might, don't worry; you can hire a professional index writer.

**Identify what needs to be indexed.** There are several elements that must be indexed in any text, including.

- The entire text of the book, including the introduction and any content notes
- If the footnotes and/or endnotes continue or expand on the text, they should be indexed. However, if the footnotes and/or endnotes are source citations, they should not be indexed.
- Depending on the field, you may need to index every author named in the text. Check with the publisher about this requirement. It may appear as a separate author index, or be included in your general index.

**Recognize what not to index.** A good index is selective, not exhaustive. Don't index things that are not central or important concepts or keywords.

- Avoid indexing minor mentions. For example, if a famous person's name has been mentioned in a quote but is not discussed anywhere else in the text, this person's name is not index-worthy. Ask yourself: is there something substantial to read about the word or concept within the text? If the answer is no, it does not need to be indexed.
- Do not include title pages, dedications, epigraphs, lists of illustrations and tables, and acknowledgements in the index.
- Do not include glossaries or bibliographies in the index.
- Do not index names of people, places, things, or concepts that are only used as examples or brief mentions.
- In general, do not index illustrative items like tables, charts, pictures, etc.

**Bibliography**

The Bibliography is a list of references relating to a topic or subject. It is located at the end of the main body of the report. It contains all the information found in a first footnote relating to a work.

The function of bibliography is different from that of footnotes. While footnotes are used to cite authority for specific statements quoted or paraphrased, the bibliography lists in alphabetical order references used by the writer. The footnotes designate the exact place {i.e., page/s) where the quoted matter is located. But the bibliography just gives identification details for the works, as a whole. There may be several footnotes to a work, but there is only one entry for it in bibliography. The footnote appears only when a specific matter from a work is cited, whereas, a work may be listed in the bibliography even if it is not quoted in the report, provided it is related to the subject of the study.

Format: The formats for bibliographical listing for books, reports, articles etc. are same as the formats for footnotes except one difference. That is, no page number is stated in the case of books and reports listed in the Bibliography.

Another difference is often indicated: While in the first footnote relating to a work, author's name begins with the first name (e.g., Peter F. Drucker), in the bibliography, name begins with the second or the surname (e.g., Drucker, Peter F.). As the information required for the footnotes and the bibliography is secured from, the same source, viz., source cards, the author-surname format may be used in both cases, as explained earlier.

Classification: References may be grouped according to their form of publications; for examples, books may be listed in one group; periodicals in a second group, and reports in another group. In each group references should be arranged in alphabetical order of the surnames of authors or by initial letter of the first words of listing.

A bibliography containing less than twenty titles need not be sub-divided into categories.

When there are two or more works by the same author repetition of his name is avoided by substituting for it an unbroken line eight spaces in length, beginning with the left margin, e.g., Good Carter V. ed., Dictionary of Education, New York: McGraw-Hill. 1973. v->

— Essentials of Educational Research, New York: Appleton-Century-'Grofts, 1966, and Douglas E. Scates, Methods of Research, New York: Appleton-Century-Crofts, 1954.

**Some examples of bibliographical forms**

**A. Books**

- Brislin, R.W. et al., Cross-culfural Research Methods, New York: John Wiley & Sons, 1973.
- Bulmer, Martin (Ed.), Sociological Research Methods, London: Macmillan, 1977.
- Campbell, D.T. and Stanley, J.C., Experimental and Quasi-Experimental Designs for Research, Chicago: Rand McNally Cp., 1963.

**B. Journals (or Periodicals)**

- Becker, H.S. and Geer, B., "Participant Observation and Interviewing," Human Organisation, 16, 1957, pp. 28-32.
- Neale, W.C., "The Limitations of Indian Village Survey Data," Journal of Asian Studies, 17, 1958, pp. 383-402.
- Roy, P. and Fliegel, F.C., "The Conduct of Collaborative Research in the Developing Nations: the insiders and the outsiders," International Social Science, Journal, 22, 1970, pp. 505-523.

**C. Report**

- UNCTAD, The Least Developed Countries: 1984 Report, New York: United Nations, 1984.
- United Nations (ESCAP), Problems and Methods of Collecting Statistics of Distributive Trades for Household and Small-scale Enterprises, Document E/CN. 11/ASTAT/SDT/L.4., Bangkok: ESCAP,1966. ,
- World Bank, World Development Report 1987, Washington D.C, 1987. /



**Prepared By**
**Mr. S.SHAHUL HAMEED**
Assistant Professor
Sadakathullah Appa College, Tirunelveli.