MODULE ON THE COURSE RESEARCH METHODS AND SENIOR PROJECT (Phys.492)

Prepared by

Fasil Tesema (Msc.)

Edited by

XXXXXXX

Department of Physics and Earth Science

College of Natural Science

Wollo University

Dessie, Ethiopia

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Fasil T.

Introduction to the Module

Aim

This module is mainly intended to train students of physics to become a good researchers by taking a project after introducing them with the basic concepts of research methodology.

Learning Outcomes

By the end of this module students will have acquired an understanding of

- Formulate research problems and objectives and to determine what problem/objective is researchable
- Gain insight into the aspects of literature and studies partially and closely related to the study
- Differentiate the four kinds of research designs and identify the strengths and limitations of each design
- Identify the qualities of a good research instrument
- Diagnose correct statistical tools to answer the research problems/objectives
- Analyze and interpret raw data in terms of quantity, quality,attribute, trait, pattern, trend and relationships
- Follow the widely accepted format and style of writing in the academic community

- Develop the qualities of a good researcher - Research-oriented,Efficient, Scientific,
- analyze the content of selected articles in physics or physics related area and critique the arguments made in those articles.
- Perform a literature search; give a scientific presentation, work in the context of a research group, keep a professional log book, present and defend a scientific poster, write a scientific report.
- present their own work using the formats commonly employed in scientific presentations.
- acquire Time-management transferable skill; working in groups; report writing; keeping a professional journal (log book); oral and written presentation, communication.

Module contents

This course includes nature and characteristic of research, review of literature, designing research, qualities of good research, sampling design, data analysis and interpretation and the styles of research

Chapter 1

Nature and characteristics of research

At the end of this chapter students will be able to

- ♣ define what a research is.
- ♣ list some characteristics of a research.
- ♣ list characteristics of a good researcher.
- ♣ describe the benefits of a research.
- ♣ distinguish and explain different types of research.
- ♣ define what a variable is in research.
- ♣ explain components of research process.

1.1 Meaning of research

Research is a systematic process of collecting, analysing, and interpreting information (data) in order to increase our understanding of a phenomenon about which we are interested or concerned. People often use a systematic approach when they collect and interpret information to solve the small problems of daily living. Here, however, we focus on formal research, research in which we intentionally set out to enhance our understanding of a phenomenon and expect to communicate what we discover to the larger scientific community. Although research projects vary in complexity and duration, research typically has eight distinct characteristics:

1. Research originates with a question or problem.
2. Research requires clear articulation of a goal.
3. Research requires a specific plan for proceeding.
4. Research usually divides the principal problem into more manageable sub-problems.
5. Research is guided by the specific research problem, question, or hypothesis.
6. Research accepts certain critical assumptions.
7. Research requires the collection and interpretation of data in an attempt to resolve the problem that initiated the research.
8. Research is, by its nature, cyclical or, more exactly, helical.

Each of these characteristics is discussed in turn so that you can appreciate more fully the nature of formal research.

Research originates with a question or problem: The world is filled with unanswered questions and unresolved problems. Everywhere we look, we see things

that cause us to wonder, to speculate, to ask questions. And by asking questions, we strike the first spark igniting a chain reaction that leads to the research process. An inquisitive mind is the beginning of research; as one popular tabloid puts it, Inquiring minds want to know! Look around you. Consider the unresolved situations that evoke these questions: What is Such-and-such a situation like? Why does such-and-such a phenomenon occur? What does it all mean? These are everyday questions. With questions like these, research begins.

Research requires clear articulation of a goal:. A clear, unambiguous statement of the problem is critical. This statement is an exercise in intellectual honesty: The ultimate goal of the research must be set forth in a grammatically complete sentence that specifically and precisely answers the question, "What problem do you intend to solve?" When you describe your objective in clear, concrete terms, you have a good idea of what you need to accomplish and can direct your efforts accordingly.

Research requires a specific plan for proceeding: Research is not a blind excursion into the unknown, with the hope that the data necessary to answer the question at hand will somehow fortuitously turn up. It is, instead, a carefully planned itinerary of the route you intend to take in order to reach your final destination your research goal. Researchers plan their overall research design and specific research methods in a purposeful way so that they can acquire data relevant to their research problem.

Depending on the research question, different designs and methods will be more or less appropriate. Therefore, in addition to identifying the specific goal of your research, you must also identify how you propose to reach your goal. You cannot wait until you are chinning deep in the project to plan and design your strategy. In the formative stages of a research project, much can be decided: Where are the data? Do any existing data address themselves to the research problem? If the data exist, are you likely to have access to them? And if you have access to the data, what will you do

with them after they are in your possession? We might go on and on. Such questions merely hint at the fact that planning and design cannot be postponed. Each of the questions just listed and many more must have an answer early in the research process.

Research usually divides the principal problem into more manageable sub-problems: From a design standpoint, it is often helpful to break a main research problem into several sub problems that, when solved, will resolve the main problem. Breaking down principal problems into small, easily solvable sub problems is a strategy we use in everyday living. For example, suppose you want to get from your home-town to a town 50 miles away. Your principal goal is to get from one location to the other as expeditiously as possible. You soon realize, however, that the problem involves several Sub problems:

main problem: How do I get from Town A to Town B?

Sub problems:

1. what is the most direct route?
2. How far do I travel on the highway?
3. Which exit should I take to leave the highway?

What seems like a single question can be divided into at least three smaller questions that must be addressed before the principal question can be resolved. So it is with most research problems. By closely inspecting the principal problem, the researcher often uncovers important sub-problems. By addressing each of the sub-problems, the researcher can more easily address the main problem. If researchers don't take the time or trouble to isolate the lesser problems within the major problem, their research projects can become cumbersome and difficult to manage.

Research is guided by the specific research problem, question, or hypothesis: Having stated the problem and its attendant sub-problems, the researcher

usually forms one or more hypotheses about what he or she may discover. A hypothesis is a logical supposition, a reasonable guess, an educated conjecture. It provides a tentative explanation for a phenomenon under investigation.

It may direct your thinking to possible sources of information that will aid in resolving one or More sub-problems and, in the process, the principal research problem. Hypotheses are certainly not unique to research. They are constant, recurring features of everyday life. They represent the natural working of the human mind. Something happens.

Immediately you attempt to account for the cause of the event by making a series of reasonable guesses. In so doing, you are hypothesizing. As an example, let's take a commonplace event: You come home after dark, open the front door, and reach inside for the switch that turns on a nearby table lamp. Your fingers find the switch. You flip it. No light. At this point, you begin to construct a series of reasonable guesses hypotheses to explain the lamp's failure:

1. The bulb has burned out.
2. The lamp is not plugged into the wall outlet.
3. A late afternoon thunderstorm interrupted the electrical service.
4. The wire from the lamp to the wall outlet is defective.
5. You forgot to pay your electric bill.

Each of these hypotheses hints at a direction you might proceed in order to acquire information that may resolve the problem of the malfunctioning lamp. Now you go in search of information to determine which hypothesis is correct. In other words, you look for data that will support one of your hypotheses and enable you to reject others.

1. You go out to your car, get a flashlight, find a new bulb, and insert the new bulb. The lamp fails to light. (Hypothesis 1 is rejected.)

2. You glance down at the wall outlet and see that the lamp is plugged into it. (Hypothesis 2 is rejected.)

3. You look at your neighbours homes. Everyone has electrical power. (Hypothesis 3 is rejected.)

4. You go back into your house and lift the cord that connects the lamp to the wall outlet. The lamp lights briefly and then goes out. You lift the cord again. Again, the lamp lights briefly. The connecting cord is defective. (Hypothesis 4 is supported. Furthermore, because you clearly do have an active electric current, you can reject hypothesis 5 you did pay your last electric bill.)

5. Fortunately, hypothesis 4 solved the problem. By repairing or replacing the cord, you can count on adequate light from the lamp in the near future.

Hypotheses in a research project are as tentative as those just formed for the malfunctioning lamp. For example, a biologist might speculate that certain human-made chemical compounds increase the frequency of birth defects in frogs. A psychologist might speculate that certain personality traits lead people to show predominantly liberal or conservative voting patterns. A marketing researcher might speculate that humour in a television commercial will capture viewers attention and thereby increases the odds that viewers will buy the advertised product. Notice the word speculate in all of these examples. Good researchers always begin a project with open minds about what they may or may not discover in their data. Even with the best of data, however, hypotheses in a research project are rarely proved or disproved beyond the shadow of a doubt. Instead, they are either supported or not supported by the data. If the data are consistent with a particular hypothesis, the researcher can make a case that the

hypothesis probably has some merit and should be taken seriously. In contrast, if the data run contrary to a hypothesis, the researcher rejects the hypothesis and turns to others as being more likely explanations of the phenomenon in question. Over time, as particular hypotheses are supported by a growing body of data, they evolve into theories. A theory is an organized body of concepts and principles intended to explain a particular phenomenon. Like hypotheses, theories are tentative explanations that new data either support or do not support. To the extent that new data contradict a particular theory, a researcher will either modify it to better account for the data or reject the theory altogether in favour of an alternative explanation.

Once one or more researchers have developed a theory to explain a phenomenon of interest, the theory is apt to drive further research, in part by posing new questions that require answers and in part by suggesting hypotheses about the likely outcomes of particular investigations. For example, one common way of testing a theory is to make a prediction (hypothesis) about what should occur if the theory is a viable explanation of the phenomenon under study.

As an example, let's consider Albert Einstein's theory of relativity, first proposed in 1915. Within the context of his theory, Einstein hypothesized that light passes through space as photons tiny masses of spectral energy. If light has mass, Einstein reasoned, and then it should be subject to the pull of a gravitational field. A year later, Karl Schwarzchild predicted that, based on Einstein's reasoning, the gravitational field of the sun should bend light rays considerably more than Isaac Newton had predicted many years earlier. In May 1919, a group of English astronomers travelled to Brazil and North Africa to observe how the sun's gravity distorted the light of a distant star now visible due to an eclipse of the sun. After the data were analyzed and interpreted, the results clearly supported the Einstein Schwarzchild hypothesis and, thus, Einstein's theory of relativity.

At this point, we should return to a point made earlier, this time emphasizing a particular word: The researcher usually forms one or more hypotheses about what he or she may discover. Hypotheses predictions are an essential ingredient in certain kinds of research, especially experimental research. To a lesser degree, they guide most other forms of research as well, but they are intentionally not identified in the early stages of some kinds of qualitative research. Yet regardless of whether researchers form specific hypotheses in advance, they must, at a minimum, use their research problem or question to focus their efforts.

Research accepts certain critical assumptions: In research, assumptions are equivalent to axioms in geometry self evident truths, the sine qua non of research. The assumptions must be valid or else the research is meaningless. For this reason, careful researchers certainly those conducting research in an academic environment set forth a statement of their assumptions as the bedrock upon which their study must rest. In your own research, it is essential that others know what you assume to be true with respect to your project. If one is to judge the quality of your study, then the knowledge of what you assume as basic to the very existence of your study is vitally important.

An example may clarify the point. Imagine that your problem is to investigate whether students learn the unique grammatical structures of a language more quickly by studying only one foreign language at a time or by studying two foreign languages concurrently. What assumptions would underlie such a problem? At a minimum, the researcher must assume that

a. The teachers used in the study are competent to teach the language or languages in question and have mastered the grammatical structures of the language(s) they are teaching.

b. The students taking part in the research are capable of mastering the unique

grammatical structures of any language(s) they are studying.

c. The languages selected for the study have sufficiently different grammatical structures that students could learn to distinguish between them.

Whereas a hypothesis involves a prediction that may or may not be supported by the data, an assumption is a condition that is taken for granted, without which the research project would be pointless. In the Einstein example presented earlier, we assume that the astronomers who went to observe the stars light were competent to do so and that their instruments were sensitive enough to measure the slight aberration caused by the sun's gravitational pull. Assumptions are usually so self-evident that a researcher may consider it unnecessary to mention them. For instance, two assumptions underlie almost all research:

a) The phenomenon under investigation is somewhat lawful and predictable; it is not comprised of completely random events.

b) Certain cause-and-effect relationships can account for the patterns observed in the phenomenon. Aside from such basic ideas as these, careful researchers state their assumptions so that others inspecting the research project may evaluate it in accordance with their own assumptions. For the beginning researcher, it is better to be overly explicit than to take too much for granted.

Research requires the collection and interpretation of data in an attempt to resolve the problem that initiated the research: After a researcher has isolated the problem, divided it into appropriate sub problems, posited reasonable questions or hypotheses, and identified the assumptions that are basic to the entire effort, the next step is to collect whatever data seem appropriate and to organize them in meaningful ways so that they can be interpreted. Events, observations, and measurements are, in and of themselves, only events, observations, and measurements

nothing more. The significance of the data depends on how the researcher extracts meaning from them. In research, data uninterrupted by the human mind are worthless: They can never help us answer the questions we have posed. Yet researchers must recognize and come to terms with the subjective and dynamic nature of interpretation.

Consider the myriad of books written on the assassination of U.S. President John F. Kennedy. Different historians have studied the same events: One may interpret them one way, and another may arrive at an entirely different conclusion. Which one is right? Perhaps they both are; perhaps neither is. Both may have merely posed new problems for other historians to try to resolve. Different minds often find different meanings in the same set of facts. Once we believed that clocks measured time and that yardsticks measured space. In one sense, they still do. We further assumed that time and spaces were two different entities. Then came Einstein's theory of relativity, and time and space became locked into one concept: the time space continuum. What is the difference between the old perspective and the new perspective? The way we think about, or interpret, the same information. The realities of time and space have not changed; the way we interpret them has.

Underlying and unifying any research project is its methodology. The research methodology directs the whole endeavour: It controls the study, dictates how the data are acquired, arranges them in logical relationships, sets up an approach for refining and synthesizing them, suggests a manner in which the meanings that lie below the surface of the data become manifest, and finally yields one or more conclusions that lead to an expansion of knowledge. Thus, research methodology has two primary functions:

1. To dictate and control the acquisition of data

2. To corral the data after their acquisition and extract meaning from them

The second of these functions is what we mean by the phrase interpretation of the data. Data demand interpretation. But no rule, formula, or algorithm can lead the researcher unerringly to a correct interpretation. Interpretation is inevitably subjective: It depends entirely on the researcher's hypotheses, assumptions, and logical reasoning processes.

Research is, by its nature, cyclical or, more exactly, helical: The research process follows a cycle and begins simply. It follows logical, developmental steps:

- A questioning mind observes a particular situation and asks, why? What caused that? How come? (This is the subjective origin of research.)
- One question becomes formally stated as a problem. (This is the overt beginning of research.)
- The problem is divided into several simpler, more specific sub- problems.
- Preliminary data are gathered that appear to bear on the problem.
- The data seem to point to a tentative solution of the problem. A guess is made; a hypothesis or guiding question is formed.
- Data are collected more systematically.
- The body of data is processed and interpreted.
- A discovery is made; a conclusion is reached.
- The tentative hypothesis is either supported by the data or is not supported; the question is either answered (partially or completely) or not answered.
- The cycle is complete.

The resolution of the problem or the tentative answer to the question completes the cycle, as is shown in Figure 1.1. Such is the format of all research. Different academic disciplines merely use different routes to arrive at the same destination. But the neatly closed circle of Figure 1.1 is deceptive. Research is rarely conclusive. In a truer sense, the research cycle might be more accurately conceived of as a helix, or spiral, of research. In exploring an area, one comes across additional problems that need resolving, and so the process must begin anew. Research begets more research.

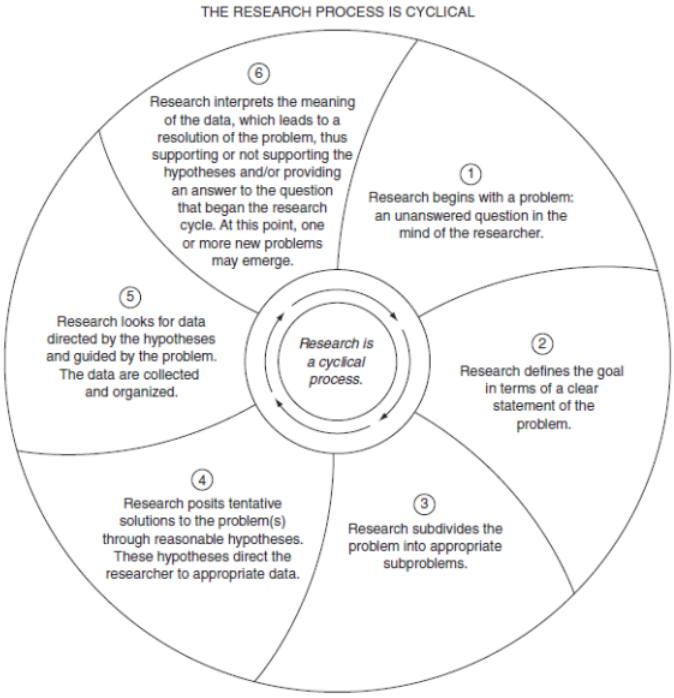

Figure 1.1: The Research cycle

1.2 Qualities and characteristics of a good researcher

It is important for a researcher to have certain qualities to conduct research. Foremost, the researcher being a scientist should be firmly committed to the "articles of faith"

of the scientific method of research. The three main qualities of a good researcher scientist are

1. First of all, the nature of a researcher must be of temperament that vibrates in unison with the theme he is searching. Hence the seeker of the knowledge must be truthful with truthfulness of nature, which is much more important , much more exacting than what is sometimes known as truthfullness the truthfullness relates the desire for accuracy of observation and precision of statement. Ensuring facts is the principle rule of science, which os not an easy matter

2. A researcher must posses an alert mind. The nature is constantly changing revealing itself through various ways. A scientific researcher must be keen and watchful to notice such changes, no matter how small or insignificant they may appear. Such receptivity has to cultivated slowly and patiently over time by the researcher through practice. Research demands a systematic immersion in to the subject matter for the researcher to be able to grasp even the slightest hint that may culminate in to significant research problems.

3. Scientific enquiry is pre-eminently an intellectual effort. It requires the moral quality of courage, which reflects the courage of a steadfast endurance. The science of conducting research is not an easy task. There are occasions when a research scientist might feel defeated or completely lost. This is a stage when a researcher would need immense courage and a sense of conviction. The researcher must learn the art of enduring intellectual hardships.

In selecting a problem, it is very essential for an investigator to possess the following characteristics:

1. He should be sensitive in his nature.

2. He should be problem-minded.

3. He should have mastery on the area and should have specialization in the field studied.

4. He should have a scientific outlook about the area.

5. He should have deep insight into the educational process.

6. He should be able to think reflectively on the field studied.

7. He should have tolerance and patience.

8. He should be interested in the field studied.

9. He should be honest and devotee to his work.

10. He should have the curiosity to find out something new or to answer some questions which are still to be answered.

1.3 Values of research to man

Research inculcates scientific and inductive thinking and it promotes the development of logical habits of thinking and organisation. 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.

Activity

Select a specific research paper and discuss how people might get benefit from it.

1.4 Types and classification 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 inpractice 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 follow 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.

1.5 Meaning and type of variable

A variable is something that can change, such as 'gender' and are typically the focus of a study. Attributes are sub-values of a variable, such as 'male' and 'female'. An exhaustive list contains all possible answers, for example gender could also include 'male transgender' and 'female transgender' (and both can be pre- or post-operative). Mutually exclusive attributes are those that cannot occur at the same time. Thus in a survey a person may be requested to select one answer from a list of alternatives (as opposed to selecting as many that might apply). Quantitative data is numeric. This is useful for mathematical and statistical analysis that leads to a predictive formula. Qualitative data is based on human judgement. You can turn qualitative data into quantitative data, for example by counting the proportion of people who hold a particular qualitative viewpoint. Units are the ways that variables are classified. These include: individuals, groups, social interactions and objects.

Types of variable

a) Descriptive variables are those that which will be reported on, without relating them to anything in particular.

b) Categorical variables result from a selection from categories, such as 'agree' and 'disagree'. Nominal and ordinal variables are categorical.

c) Numeric variables give a number, such as age. Discrete variables are numeric variables that come from a limited set of numbers. They may result from , answering questions such as 'how many', 'how often', etc. Continuous variables are numeric variables that can take any value, such as weight.

d) An independent variable is one is manipulated by the researcher. It is like the knob on a dial that the researcher turns. In graphs, it is put on the X-axis.

e) A dependent variable is one which changes as a result of the independent variable being changed, and is put on the Y-axis in graphs.

f) Extraneous variables are additional variables which could provide alternative explanations or cast doubt on conclusions.

The holy grail for researchers is to be able to determine the relationship between the independent and dependent variables, such that if the independent variable is changed, then the researcher will be able to accurately predict how the dependent variable will change.

Variables may have the following characteristics:

- Period: When it starts and stops.

- Pattern: Daily, weekly, ad-hoc, etc.

- Detail: Overview through to 'in depth'.

- Latency: Time between measuring dependent and independent variable (some things take time to take effect).

1.6 Components of 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. The chart shown in Figure 1.2 well illustrates a research process.

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

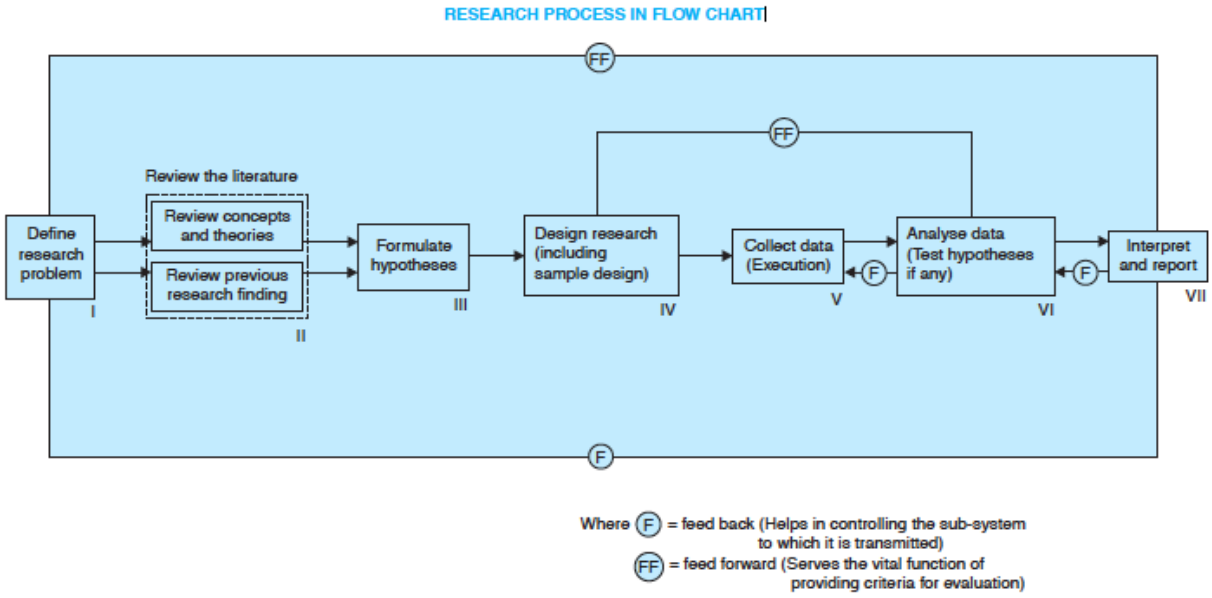

Figure 1.2: The Research process

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. 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 organised 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 drug stores 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 researchers 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 nonoverlapping subpopulations 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 interviewers 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 investigators 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, finanical 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 experience 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 analysing 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 the 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.

2. 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.

3. Charts and illustrations in the main report should be used only if they present the information more clearly and forcibly.

4. Calculated confidence limits must be mentioned and the various constraints experienced in conducting research operations may as well be stated.

Check list

- Can you define research?
- List some characteristics of a good researcher.
- What are the benefits of doing research?
- Can you list and explain types of research?
- What is the meaning of variable?
- Can you list components of research process?

1.7 Summary

Research in a simple terms refers to a search of knowledge. It is also known as a scientific and systematic search for information on particular topic or issue. The objective of a research is to discover answers to questions by applying scientific methods or and procedures. Research methods include techniques or methods that are adopted for conducting research. Thus, research techniques or methods are the researchers adopt for conducting the research process. Research methodology is the science of studying how research is conducted scientifically.

Chapter 2

Research problems and objectives

At the end of this chapter students will be able to

- ♣ define a research problem.
- ♣ describe what do research objectives mean.
- ♣ distinguish the difference between hypothesis and assumption.
- ♣ explain why significance and limitation of the study in a given study should be addressed.
- ♣ explain why terms should be defined for a specific research.

2.1 The 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?

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. 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.

Activity

Using the paper in the first activity, what are the research problems solved in the research paper?

2.2 The research objectives

Research objectives are divided in to two

General objectives: aim of the study in general terms.

Specific objectives: measurable statements on the specific questions to be answered. Unlike the general objectives, the specific objectives are more specific and are related to the research problem situation. They indicate the variable to be examined and measured.

The formulation of objectives will help us to:

- Focus the study (narrowing it down to essentials)
- Avoid collection of data that are not strictly necessary for understanding and solving the identified problem
- Organize the study in clearly defined parts

We have to make sure that our objectives:

- Cover the different aspects of the problem and its contributing factors in a coherent way and in a logical sequence
- Are clearly expressed in measurable terms
- Are realistic considering local conditions
- Meet the purpose of the study
- Use action verbs that are specific enough to be measured

Research objectives can be stated as:

- Questions - the objectives of this study are to answer the following questions —
- Positive sentence - the objectives of this study are to find out, to establish, to determine, —
- Hypothesis - the objective of this study is to verify the following hypothesis (examples are given below)

2.3 Statement of the research problem

The heart of any research project is the problem. At every step in the process, successful researchers ask themselves: What am I doing? For what purpose am I doing it? Such questions can help focus your efforts toward achieving your ultimate purpose for gathering data: to resolve the problem.

Researchers get off to a strong start when they begin with an unmistakably clear statement of the problem. After identifying a research problem, therefore, you must articulate it in such a way that it is carefully phrased and represents the single goal of the total research effort. Following are some general guidelines to help you do just that:

1. State the problem clearly and completely.

   Your problem should be so clearly stated that anyone who reads English can read and understand it. If the problem is not stated with such clarity, then you are merely deceiving yourself that you know what the problem is. Such self-deception will cause you difficulty later on. You can state your problem clearly only when you also state it completely. At a minimum, you should describe it in one or more grammatically complete sentences. As examples of what not to do, following are some meaningless half-statementsverbal fragments that only hint at the problem.

2. Think through the feasibility of the project that the problem implies.

   Students sometimes rush into a problem without thinking through its implications. Its great to have ideas. Its much better to have practical ideas.

3. Say precisely what you mean.

   When you state your research problem, you should say exactly what you mean. You cannot assume that others will be able to read your mind. People will

always take your words at their face value: You mean what you say. Thats it. Your failure to be careful with your words can have grave results for your status as a scholar and a researcher. In the academic community, a basic rule prevails: Absolute honesty and integrity are assumed in every statement a scholar makes.

4. State the problem in a way that reflects an open mind about its solution.
   In our own research methods classes, we have occasionally seen research proposals in which the authors state that they intend to prove that such-and-such a fact is true.

5. Edit your work.
   You can avoid the difficulties we have been discussing by carefully editing your words. Editing is sharpening a thought to a gemlike point and eliminating useless verbiage. Choose your words precisely. Doing so will clarify your writing.

2.4 The hypothesis and assumption

Hypotheses are intelligent, tentative guesses about how the research problem may be resolved. Research questions are somewhat different in that, in and of themselves, they dont offer any speculative answers related to the research problem. Hypotheses are essential to experimental research, whereas research questions are more common in many forms of qualitative research. Both hypotheses and research questions provide guidance for the kinds of data the researcher should collect and suggest how the researcher should analyze and interpret those data. It is not unusual for a researcher to form hypotheses and ask questions related to a research problem.

Research hypotheses and questions may originate in the subproblems. Often a one-to-one correspondence exists between the subproblems and their corresponding hypotheses or questions, giving us as many hypotheses or questions as we have subproblems. In essence, a hypothesis or research question is to a researcher what a point

of triangulation is to a surveyor: It provides a position from which the researcher may initiate an exploration of the problem or subproblem and also acts as a checkpoint against which to test the findings that the data reveal. After collecting and analyzing data, the researcher must ultimately ask: How do the data answer my research questions? What do they say about my research hypotheses?

Certainly, the data from a research study can (and should) answer each research question, and they may support or not support each research hypothesis. But notice how we just said that the data may support or not support each research hypothesis; we intentionally did not say that the data would prove or disprove a hypothesis. As weve previously pointed out, hypotheses are nothing more than tentative propositions set forth to assist in guiding the investigation of a problem or to provide possible explanations for the observations made. A researcher who deliberately sets out to prove a hypothesis does not have the objective, impartial open-mindedness so important for good research. The researcher might bias the procedure by looking only for those data that would support the hypothesis. Difficult as it may be at times, we must let the chips fall where they may. Hypotheses have nothing to do with proof.

Rather, their acceptance or rejection depends on what the dataand the data aloneultimately reveal. If you discover that your data do not support your research hypothesis, do not let such an outcome disturb you. It merely means that your educated guess about the outcome of the investigation was incorrect.

Assumptions are so basic that, without them, the research problem itself could not exist. For example, suppose we are attempting to determine, by means of a pretest and a posttest, whether one method of classroom instruction is superior to another. A basic assumption in such a situation is that the pretest and posttest measure knowledge of the subject matter in question.1 We must assume, too, that the teacher(s) in the study can teach effectively and that the students are capable of learning the subject matter. Without these assumptions, our research project would

be meaningless.

In research, we try to leave nothing to chance in order to prevent any misunderstandings. All assumptions that have a material bearing on the problem should be openly and unreservedly set forth. If others know the assumptions a researcher makes, they are better prepared to evaluate the conclusions that result from such assumptions. To discover your own assumptions, ask yourself, What am I taking for granted with respect to the problem? Ideally, your answer should bring your assumptions into clear view.

2.5 Significance of the study

In dissertations or research reports, researchers frequently set forth their reasons for undertaking the study. In a research proposal, such a discussion may be especially important. Some studies seem to go far beyond any relationship to the practical world. Of such research efforts one inwardly, if not audibly, asks, Of what use is it? What practical value does the study have? In the 1970s, contemplating the exploration of the moon, the average citizen frequently asked, What good is it? Whats the use of it all? How will spending all of this money on space flights benefit anyone? Perhaps those engaged in space research did not set forth clearly and succinctly enough the reasons the missions were undertaken. Only now are we beginning to appreciate the practical value of those early missions.

2.6 Scope and limitation of the study

We need to know precisely what the researcher intends to do. We also need to know precisely what the researcher does not intend to do. What the researcher intends to do is stated in the problem. What the researcher is not going to do is stated in the delimitations. The limits of the problem should be as carefully bounded for a research

effort as a parcel of land is for a real estate transfer.

Research problems typically emerge from larger contexts and larger problem areas. The researcher can easily be beguiled by discovering interesting information that lies beyond the precincts of the problem under investigation. For instance, in the PalestrinaByrd problem, it is possible that, because the two men were contemporaries, Byrd may have met Palestrina or at least come in contact with some of his motets. Such contact may have been a determinative influence on Byrds compositions. But we are not concerned with influences on the motets of the two composers. We are interested only in the characteristics of the motets, including their musical style, musical individualism, and contrapuntal likenesses and differences. Study the contrapuntal characteristics that is what a researcher of this problem will do. What the researcher will not do is become involved in any data extraneous to this goal no matter how enticing or interesting such an exploratory safari may be.

Only a researcher who thinks carefully about the problem and its focal center can distinguish between what is relevant and what is not relevant to the problem. All irrelevancies to the problem must be firmly ruled out in the statement of delimitations. Figure 3.3 may make the matter of delimitations more understandable.

2.7 Definition of terms

What precisely do the terms in the problem and the subproblems mean? For example, if we say that the purpose of the research is to analyze the harmonic characteristics of motets, what are we talking about? What are harmonic characteristics? Without knowing explicitly what a term means, we cannot evaluate the research or determine whether the researcher has carried out what was proposed in the problem statement.

Sometimes, novice researchers rely on dictionary definitions, which are rarely either adequate or helpful. Instead, each term should be defined as it will be used in the researchers project. In defining a term, the researcher makes the term mean whatever

he or she wishes it to mean within the context of the problem and its subproblems. We must know how the researcher defines the term. We won't necessarily agree with such a definition, but as long as we know what the researcher means when using the term, we are able to understand the research and appraise it appropriately.

A formal definition contains three parts: (a) the term to be defined; (b) the genera, or the general class to which the concept being defined belongs; and (c) the differentia, the specific characteristics or traits that distinguish the concept being defined from all other members of the general classification. For example, harmonic characteristics (the term to be defined) might be defined as the manner (the genera) in which tonal values are combined to produce individualized polyphonic patterns associated with the works of a particular composer (the differentia: telling what particular manner we mean).

The researcher must be careful to avoid circular definitions, in which the terms to be defined are used in the definitions themselves. For instance, if we were to define harmonic characteristics in a circular manner, we might describe them as those characteristics that derive from the harmonic patterns found in the works of a particular composer. Here the words characteristics and harmonic are used to define harmonic characteristics, giving others little if any guidance in understanding what the researcher means by the term.

Especially when talking about insubstantial (rather than substantial) phenomena that have no obvious basis in the physical world it is often helpful to include an operational definition. That is, the researcher defines a characteristic or variable in terms of how it will be measured in the research study. For instance, a researcher might, for purposes of his or her study, define intelligence as a score on a certain intelligence test or define popularity as the number of peers who specifically identify an individual as being a desirable social partner.

Check list

- Can you explain what a research problem is?
- What do we mean by research objectives?
- What is the difference between hypothesis and assumptions?
- What is the significance of defining terms?

Chapter 3

Review of related literature

At the end of this chapter students will be able to

- ♣ discuss on meaning of related literature.
- ♣ address the crucial objectives of reviewing related literature.
- ♣ explain the main principles and procedures in reviewing literatures.
- ♣ list some sources of literatures.
- ♣ explain how literatures will be utilized in doing a specific research.

3.1 Introduction

A literature review is an evaluative report of studies found in the literature related to your selected area. The review should describe, summarize, evaluate and clarify this literature. It should give a theoretical basis for the research and help you determine the nature of your own research. Select a limited number of works that are central to your area rather than trying to collect a large number of works that are not as closely connected to your topic area. The phrase 'review of literature' consists of two words: Review and Literature. The word 'literature' has conveyed different meaning from the traditional meaning. It is used with reference to the languages e.g. Hindi literature, English literature, Sanskrit literature. It includes a subject content: prose, poetry, dramas, novels, stories etc. Here in research methodology the term literature refers to the knowledge of a particular area of investigation of any discipline which includes theoretical, practical and its research studies.

The term 'review' means to organize the knowledge of the specific area of research to evolve an edifice of knowledge to show that his study would be an addition to this field. The task of review of literature is highly creative and tedious because researcher has to synthesize the available knowledge of the field in a unique way to provide the rationale for his study. The very words 'review' and 'literature' have quite different meanings in the historical approach. In historical research, the researcher does much more than review already published material, he seeks to discover and to integrate new information which has never been reported and never considered. The concept and process implied in the term 'review of literature' have such different meanings in historical as compared with survey and experimental research.

The review of literature is essential due to the following reasons:

1. One of the early steps in planning a research work is to review research done previously in the particular area of interest and relevant area quantitative and

qualitative analysis of this research usually gives the worker an indication of the direction.

2. It is very essential for every investigator to be up-to-date in his information about the literature, related to his own problem already done by others. It is considered the most important prerequisite to actual planning and conducting the study.

3. It avoids the replication of the study of findings to take an advantage from similar or related literature as regards, to methodology, techniques of data collection, procedure adopted and conclusions drawn. He can justify his own endeavour in the field.

4. It provides as source of problem of study, an analogy may be drawn for identifying and selecting his own problem of research. The researcher formulates his hypothesis on the basis of review of literature. It also provides the rationale for the study. The results and findings of the study can also be discussed at length.

The review of literature indicates the clear picture of the problem to be solved. The scholarship in the field can be developed by reviewing the literature of the field.

3.2 Objectives of review of related literature

The review of literature serves the following purposes in conducting research work:

1. It provides theories, ideas, explanations or hypothesis which may prove useful in the formulation of a new problem.

2. It indicates whether the evidence already available solves the problem adequately without requiring further investigation. It avoids the replication.

3. It provides the sources for hypothesis. The researcher can formulate research hypothesis on the basis of available studies.

4. It suggests method, procedure, sources of data and statistical techniques appropriate to the solution of the problem.

5. It locates comparative data and findings useful in the interpretation and discussion of results. The conclusions drawn in the related studies may be significantly compared and may be used as the subject for the findings of the study.

6. It helps in developing experts and general scholarship of the investigator in the area investigated.

7. It contributes towards the accurate knowledge of the evidence or literature in ones area of activity is a good avenue towards making oneself. This knowledge is an asset ever afterwards, whether one is employed in an institution of higher learning or a research organization.

3.3 Principles and procedures of related literature

The following is the specific procedure through which review can be done appropriately

1. Consulting a general source like text books which let one to get a clear picture of the problem to be solved.

2. review the empirical resources of the area.

3. collecting references.

4. uniform, accurate and systematic notes should be taken.

5. record useful and necessary materials.

6. skim materials to see what it has to contribute to the study.

7. spend long hours to take notes by hand.

3.4 Sources of review of literature

There are various sources of literature, which can be divided in to the following heads;

(a) Books and text-books material.

(b) The periodical literature (year book, documents, almanacs, abstracts, journals, newspapers, magazines).

(c) general references (encyclopaedias, specialized dictionaries, dissertations and thesis)

Activity

List and categorize all the sources of literature in the paper used in the previous activities. **Check list**

- Can you define review of related literature?
- Can you tell the advantage of review of literature?
- Can you list sources of review of literature?

Chapter 4

Research design

At the end of this chapter students will be able to

- ♣ define research design.
- ♣ explain the importance of research design.
- ♣ list types of design.
- ♣ differentiate and explain different types of designs.

4.1 Introduction

In this unit you will learn about the first phase in planning the research project, which is formulating a research design. Based on causality, research designs have been divided into four categories of exploratory, descriptive, quasi-experimental and experimental designs. While exploratory and descriptive studies provide information on events and attributes from which inferences can be drawn, they can only offer tenuous conclusions. In order to draw conclusions it is important to formulate quasi-experimental or experimental designs. This units describes different types of designs within the four categories mentioned above as well as the marketing situations where these designs could be most appropriately applied.

4.2 Meaning and importance of research design

The research design is a comprehensive master plan of the research study to be undertaken, giving a general statement of the methods to be used. The function of a research design is to ensure that requisite data in accordance with the problem at hand is collected accurately and economically. Simply stated, it is the framework, a blueprint for the research study which guides the collection and analysis of data. The research design, depending upon the needs of the researcher may be a very detailed statement or only furnish the minimum information required for planning the research project. To be effective, a research design should furnish at least the following details.

a) A statement of objectives of the study or the research output.

b) A statement of the data inputs required on the basis of which the research problem is to be solved.

c) The methods of analysis which shall be used to treat and analyse the data inputs.

4.3 Types of research designs

There are four types of research designs which are broadly classified as:

1) Exploratory Designs

2) DescriptiveDesigns

3) Quasi-Experimental Designs

4) Experimental Designs

4.3.1 Exploratory designs

The exploratory research design, as the name suggests, involves getting a feel of the situation and emphasises a discovery of ideas and possible insights that may help in identifying areas of further rigorous study. For example a food product manufacturer, wanting in introduce a breakfast cereal may be in knowing the desirable attributes of such a product before really defining the product concept. The main objective of the exploratory research is to fine tune the broad problem into specific problem statement and generate possible hypotheses. It therefore, gives useful direction for farther research. The exploratory studies are mainly used for:

1) Providing information to enable a more precise problem definition or hypothesis formulation.

2) Establishing research priorities.

3) Giving the researcher a feel of the problem situation and familiarising him with the problem.

4) Collecting information about possible problems in carrying out research, using specific collection tools and specific techniques for analysis.

Since exploratory studies are not conclusive studies, the design of the study is highly flexible and informal. However, rarely ever does formal design exist in case. of exploratory studies. Structured and/or standardised questionnaires are replaced by judgement and intuitive inference drawing on the basis of collected data. Convenience sampling rather than probability sampling characterises exploratory designs. The generally used methods in exploratory research are:

a) Survey of existing literature

b) Survey of experienced individuals

c) Analysis of selected case situations.

Survey of existing literature

Published literature presents a very economical source of study for the purpose of hypothesis generation and problem definition. A large variety of published and unpublished data is available through books and journals, newspapers and periodicals, government publications and individual research projects as well as data collected by trade associations. A lot of data is also generated internally in the company and some of it could be relevant to given problem situations. You will read more about types of secondary data and their use in marketing research in the unit on Data Collection. While survey of existing literature may not provide solutions to the research problem, it can certainly provide direction to the research process.

Survey of experienced individuals

Clue to solving many a marketing problems can be had by talking to individuals who have expertise and ides about the research subject. These individuals could be top executives, sales managers, sales men and channel members who handle the product or related products and consumers or potential consumers. The information collection exercise does not involve a scientifically designed survey, it is merely an attempt

together all possible information about the subject of research from people who have specific knowledge about it. The success of this type of experience survey depends upon the freedom of response given to the respondent as well as upon the expertise and communication ability of the people questioned. However, at this stage, since the researcher also has very limited experience with the research problem, he may not be able to elicit very valuable responsers from the individulse.

Analysis of selected cases

This method involves the selection of a few extreme examples reflecting the problem situation and a thorough analysis of the same, In certain cases this sort of study may help in identifying the possible relationships that exist between the variables in a given marketing problem situation. The emphasis in this type of study is upon understanding the research subject as a whole. For example, a company is interested in finding out the reasons for the wide variation in sales productivity of its salesmen, as an exploratory study it could thoroughly analyse the case of some of its best and some of its worst salesmen. This exercise may help in identifying possible relationships between demographic and /or personality variables which may affect variation in sales productivity. The relationships, their extent and direction can then be measured using conclusive research designs.

4.3.2 Descriptive research designs

Primarily in use for preliminary studies, this type of designs are employed to facilitate description and inference building about population parameters and the relationship among two or more variables. Description or inference could be' quantitative or qualitative in nature. Descriptive designs only describe the phenomenon under study attempting to establish a relationship between factors. The data collected may relate to the demographically or the behavioural variables of respondents under study or some situational variables. For example, descriptive research design could be suited

to measure the various attributes of successful sales people, or evaluate a training programme or a retailing situation.

The design could be used to study how customers behaved when a new sales promotion programme was introduced. It does not, however, determine the extent of association between the different variables i.e. the income and age of people as associated with response to the sales promotion. Descriptive design can however, be used to draw inferences about the possible relationships between variables.

As descriptive designs are aimed only at providing accurate descriptions of variables relevant to the problem under consideration, they are generally used for preliminary and explorative studies. Very often however, the decision makers choose to accept descriptive data which would permit inference drawing about causality between variables. They may not want to or may not be able to afford experimental studies in terms of time involved and as such descriptive design may at times be used for conclusive studies also.

Descriptive designs are a very frequently used, perhaps the most commonly used category of research design. In short descriptive research can be used for the following purposes.

a) To describe the characteristics of certain groups of interest to the marketer e.g. users of the product, potential users, non users, possible receivers of promotional communication by the company and so on.

b) To estimate the proportion of people in a given population who behave in a certain way for example the proportion of consumers who are prone to deals.

c) To make specific predictions for specified future periods.

d) To develop inferences whether certain variables are associated, for example income and shopping place preference.

In comparison to an exploratory research study, the descriptive study is more formal and less flexible. As the descriptive design in directed at collecting qualitative and quantitative data to enable, description of variables, it involves formulation of more specific hypothesis and testing them through statistical inference of discipline designs may include case research designs, longitudinal and cross sectional designs as well as focus group studies. Of these we shall discuss the panel, cross-sectional and focus group designs.

4.3.3 Quasi experimental Designs

In these designs the researcher has control over data collection procedures but lacks control over the scheduling of the treatments and also lacks the ability to randomize test units exposure to treatments. There are various designs which fall under the category of quasi-experimental designs. Some of these will be discussed here. These design have inherent weakness as their internal validity is questionable. They lack the control attributes of the truly experimental designs .The following quasi-experimental designs will be discussed in this section.

4.3.4 Experimental designs

True experimental design provide a stronger and more reliable basis for the existence of casual relationship between variables. Here, the researcher is able to eliminate all extraneous variables from the experimental and the control group through the use of a random selection procedure. One of the advantages of using random selection procedure is that we can use inferential statistical techniques for the analysis of experimental results. One such technique is the analysis of variance.

Check list

- Can you define what a research design mean?

- Can you explain the importance of research design?
- List types of research designs?
- Can you explain the difference between types of research designs?

Chapter 5

Qualities of a good research instrument

At the end of this chapter students will be able to

- ♣ define a research instrument.
- ♣ describe a good research instrument.
- ♣ list qualities of a good research instrument.
- ♣ explain and differentiate validity, reliability and usability of an instrument.

5.1 Validity

The validity of a measurement instrument is the extent to which the instrument measures what it is intended to measure. Certainly no one would question the notion that a yardstick is a valid means of measuring length. Nor would most people doubt that a thermometer measures temperature; for instance, in a mercury thermometer, the level to which the mercury rises is a function of how much it expands, which is a function of the degree to which it is hot or cold.

But to what extent does a standardized intelligence test actually measure a person's intelligence? How accurately do people's annual incomes reflect their social class? And how well does a sociogram capture the interpersonal dynamics in a group of nine people? Especially when we are measuring insubstantial phenomena without a direct basis in the physical world our measurement instruments may be somewhat suspect in terms of validity.

Let's return to the rating-scale item we presented earlier to assess a professor's availability for students (see p. 26) and consider its validity as such a measure. Notice how fuzzy some of the labels are. The professor is always available. What does always mean? Twenty-four hours a day? Could you call the professor at 3 A.M. any day of the week, or only whenever the professor is on campus? If the latter is the case, could you call your professor out of a faculty meeting or out of a conference with the president of the college? We might have similar problems in interpreting generally available,seldom available, and never available. What seems at first glance to be a scale that anyone could understand does, on careful inspection, have limitations as a measuring instrument for research purposes.

A paper-and-pencil test may be intended to measure a certain characteristic, and it may be called a measure of that characteristic, but these facts don't necessarily mean that the test actually measures what its creators say it does. For example,

consider a paper-and-pencil test of personality traits in which, with a series of check marks, a person indicates his or her most representative characteristics or behaviors in given situations. The person's responses on the test are presumed to reveal relatively stable personality traits. The question that validity asks is: Does such a test, in fact, measure the person's personality traits, or does it measure something else altogether? The answer depends, at least in part, on the extent to which the person is, or can be, truthful in responding. If the person responds in terms of characteristics and behaviors that he or she believes to be socially desirable, the test results may reveal not the person's actual personality, but rather an idealized portrait of how he or she would like to be seen by others.

5.2 Reliability

Imagine that you are concerned about your growing waistline and decide to go on a diet. Every day you put a tape measure around your waist and pull the two ends together snugly to get a measurement. But just how tight is snug? Quite possibly, the level of snugness might be different from one day to the next. In fact, you might even measure your waist with different degrees of snugness from one minute to the next. To the extent that you are not measuring your waist in a consistent fashion even though you always use the same tape measure you have a problem with reliability.

More generally, reliability is the consistency with which a measuring instrument yields a certain result when the entity being measured hasn't changed. As we have just seen in our waist measuring situation, instruments that measure physical phenomena arent necessarily completely reliable. As another example, think of a balance scale that a storekeeper might use. When weighing out a pound of rice, the storekeeper wont always measure exactly the same amount of rice each time.

Instruments designed to measure psychological characteristics (insubstantial phenomena) tend to be even less reliable than those designed to measure physical (substantial) phenomena. For example, a student using the preceding rating-scale item for measuring professor availability might easily rate the professor as 70 one day and 90 the next, not because the professor's availability has changed overnight but because the student's interpretations of the phrases generally available and always available have changed. Similarly, if we asked the nine people portrayed in Figure 2.1 (Gretchen, Joe, Greg, etc.) to indicate the people they liked best and least among their colleagues, they wouldn't necessarily always give us the same answers they gave us previously, even if the interpersonal dynamics within the group have remained constant.

We can measure something accurately only when we can also measure it consistently. Yet measuring something consistently doesn't necessarily mean measuring it accurately. In other words, reliability is a necessary but insufficient condition for validity. For example, we could use a tape measure to measure a person's head circumference and claim that the result is a good reflection of intelligence. In this situation, we might have reasonable reliability (we are apt to get similar measures of an individual's head circumference on different occasions) but absolutely no validity (head size is not a good indication of intelligence level).

Both validity and reliability, then, reflect the degree to which we may have error in our measurements. In many instances and especially when we are measuring insubstantial phenomena a measurement instrument may allow us to measure a characteristic only indirectly and so may be subject to a variety of biasing factors (e.g., people's responses on a rating scale are apt to be influenced by their interpretations, prejudices, memory lapses, etc.). In such cases, we have error due to the imperfect validity of the measurement instrument. Yet typically even when we are measuring substantial phenomena we may get slightly different measures from one time to the

next simply because our measurement tool is imprecise (e.g., the waist or head size we measure may depend on how snugly we pull the tape measure). In such cases, we have error due to the imperfect reliability of the measure. Generally speaking, validity errors reflect biases in the instrument itself and are relatively constant sources of error. In contrast, reliability errors reflect use of the instrument and are apt to vary unpredictably from one occasion to the next. Validity and reliability take different forms, depending on the nature of the research problem, the general methodology the researcher uses to address the problem, and the nature of the data that are collected.

5.3 Usability

The usability (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.

Check list

- List the three qualities of a good research instrument.
- Can you define instrument validity and reliability?
- What is the difference between validity and reliability?
- How one can measure the usability of a research instrument?

Chapter 6

Sampling designs

At the end of this chapter students will be able to

- ♣ define sampling.
- ♣ list advantages and disadvantages of sampling.
- ♣ understand how to plan a sampling survey.
- ♣ explain what to include in planning a sampling design.
- ♣ define what a scientific sampling mean.
- ♣ explain and differentiate between probability and non-probability samplings.

6.1 Introduction

Sampling may be defined as the selection of some part of an aggregate or totality on the basis of which a judgement or inference about the aggregate or totality is made. In other words, it is the process of obtaining information about an entire population by examining only a part of it. In most of the research work and surveys, the usual approach happens to be to make generalisations or to draw inferences based on samples about the parameters of population from which the samples are taken. The researcher quite often selects only a few items from the universe for his study purposes. All this is done on the assumption that the sample data will enable him to estimate the population parameters. The items so selected constitute what is technically called a sample, their selection process or technique is called sample design.

A sample design is a definite plan for obtaining a sample from a given population. It refers to the technique or the procedure the researcher would adopt in selecting items for the sample. Sample design may as well lay down the number of items to be included in the sample i.e., the size of the sample. Sample design is determined before data are collected. There are many sample designs from which a researcher can choose. Some designs are relatively more precise and easier to apply than others. Researcher must select/prepare a sample design which should be reliable and appropriate for his research study.

6.2 Advantages of sampling

Sampling is used in practice for a variety of reasons such as:

1. Sampling can save time and money. A sample study is usually less expensive than a census study and produces results at a relatively faster speed.

2. Sampling may enable more accurate measurements for a sample study is generally conducted by trained and experienced investigators.

3. Sampling remains the only way when population contains infinitely many members.

4 . Sampling remains the only choice when a test involves the destruction of the item under study.

5. Sampling usually enables to estimate the sampling errors and, thus, assists in obtaining information concerning some characteristic of the population.

6.3 Limitation of sampling

Some limitations of sampling are:

1. Inadequacy of the samples.

2. Chances for bias.

3. Problems of accuracy.

4. Difficulty of getting the representative sample.

5. Untrained manpower.

6. Absence of the informants.

7. Chances of committing the errors in sampling.

6.4 Planning a sampling survey

A sample design is a definite plan for obtaining a sample from a given population. It refers to the technique or the procedure the researcher would adopt in selecting

items for the sample. Sample design may as well lay down the number of items to be included in the sample i.e., the size of the sample. Sample design is determined before data are collected. There are many sample designs from which a researcher can choose. Some designs are relatively more precise and easier to apply than others. Researcher must select/prepare a sample design which should be reliable and appropriate for his research study.

Steps in sample design While developing a sampling design, the researcher must pay attention to the following points:

(i) Type of universe: The first step in developing any sample design is to clearly define the set of objects, technically called the Universe, to be studied. The universe can be finite or infinite. In finite universe the number of items is certain, but in case of an infinite universe the number of items is infinite, i.e., we cannot have any idea about the total number of items. The population of a city, the number of workers in a factory and the like are examples of finite universes, whereas the number of stars in the sky, listeners of a specific radio programme, throwing of a dice etc. are examples of infinite universes.

(ii) Sampling unit: A decision has to be taken concerning a sampling unit before selecting sample. Sampling unit may be a geographical one such as state, district, village, etc., or a construction unit such as house, flat, etc., or it may be a social unit such as family, club, school, etc., or it may be an individual. The researcher will have to decide one or more of such units that he has to select for his study.

(iii) Source list: It is also known as sampling frame from which sample is to be drawn. It contains the names of all items of a universe (in case of finite universe only). If source list is not available, researcher has to prepare it. Such a list should be

comprehensive, correct, reliable and appropriate. It is extremely important for the source list to be as representative of the population as possible.

(iv) Size of sample: This refers to the number of items to be selected from the universe to constitute a sample. This a major problem before a researcher. The size of sample should neither be excessively large, nor too small. It should be optimum. An optimum sample is one which fulfills the requirements of efficiency, representativeness, reliability and flexibility. While deciding the size of sample, researcher must determine the desired precision as also an acceptable confidence level for the estimate. The size of population variance needs to be considered as in case of larger variance usually a bigger sample is needed. The size of population must be kept in view for this also limits the sample size. The parameters of interest in a research study must be kept in view, while deciding the size of the sample. Costs too dictate the size of sample that we can draw. As such, budgetary constraint must invariably be taken into consideration when we decide the sample size.

(v) Parameters of interest: In determining the sample design, one must consider the question of the specific population parameters which are of interest. For instance, we may be interested in estimating the proportion of persons with some characteristic in the population, or we may be interested in knowing some average or the other measure concerning the population. There may also be important sub-groups in the population about whom we would like to make estimates. All this has a strong impact upon the sample design we would accept.

(vi) Budgetary constraint: Cost considerations, from practical point of view, have a major impact upon decisions relating to not only the size of the sample but also to the type of sample. This fact can even lead to the use of a non-probability

sample.

(vii) Sampling procedure: Finally, the researcher must decide the type of sample he will use i.e., he must decide about the technique to be used in selecting the items for the sample. In fact, this technique or procedure stands for the sample design itself. There are several sample designs (explained in the pages that follow) out of which the researcher must choose one for his study. Obviously, he must select that design which, for a given sample size and for a given cost, has a smaller sampling error.

6.5 Determination of sample size

Sample size refers to the number of items to be selected from the universe to constitute a sample. This a major problem before a researcher. The size of sample should neither be excessively large, nor too small. It should be optimum. An optimum sample is one which fulfills the requirements of efficiency, representativeness, reliability and flexibility. While deciding the size of sample, researcher must determine the desired precision as also an acceptable confidence level for the estimate. The size of population variance needs to be considered as in case of larger variance usually a bigger sample is needed. The size of population must be kept in view for this also limits the sample size. The parameters of interest in a research study must be kept in view, while deciding the size of the sample. Costs too dictate the size of sample that we can draw. As such, budgetary constraint must invariably be taken into consideration when we decide the sample size.

6.6 Scientific sampling

There are different types of sample designs based on two factors viz., the representation basis and the element selection technique. On the representation basis, the

sample may be probability sampling or it may be non-probability sampling. Probability sampling is based on the concept of random selection, whereas non-probability sampling is non-random sampling. On element selection basis, the sample may be either unrestricted or restricted. When each sample element is drawn individually from the population at large, then the sample so drawn is known as unrestricted sample, whereas all other forms of sampling are covered under the term restricted sampling. The following chart exhibits the sample designs as explained above.

Thus, sample designs are basically of two types viz., non-probability sampling and probability sampling. We take up these two designs separately.

Non-probability sampling: Non-probability sampling is that sampling procedure which does not afford any basis for estimating the probability that each item in the population has of being included in the sample. Non-probability sampling is also known by different names such as deliberate sampling, purposive sampling and judgement sampling. In this type of sampling, items for the sample are selected deliberately by the researcher; his choice concerning the items remains supreme. In other words, under non-probability sampling the organisers of the inquiry purposively choose the particular units of the universe for constituting a sample on the basis that the small mass that they so select out of a huge one will be typical or representative of the whole. For instance, if economic conditions of people living in a state are to be studied, a few towns and villages may be purposively selected for intensive study on the principle that they can be representative of the entire state. Thus, the judgement of the organisers of the study plays an important part in this sampling design.

In such a design, personal element has a great chance of entering into the selection of the sample. The investigator may select a sample which shall yield results favourable to his point of view and if that happens, the entire inquiry may get vitiated. Thus, there is always the danger of bias entering into this type of sampling technique. But in the investigators are impartial, work without bias and have the

necessary experience so as to take sound judgement, the results obtained from an analysis of deliberately selected sample may be tolerably reliable. However, in such a sampling, there is no assurance that every element has some specifiable chance of being included. Sampling error in this type of sampling cannot be estimated and the element of bias, great or small, is always there. As such this sampling design in rarely adopted in large inquires of importance. However, in small inquiries and researches by individuals, this design may be adopted because of the relative advantage of time and money inherent in this method of sampling. Quota sampling is also an example of non-probability sampling. Under quota sampling the interviewers are simply given quotas to be filled from the different strata, with some restrictions on how they are to be filled. In other words, the actual selection of the items for the sample is left to the interviewers discretion. This type of sampling is very convenient and is relatively inexpensive. But the samples so selected certainly do not possess the characteristic of random samples. Quota samples are essentially judgement samples and inferences drawn on their basis are not amenable to statistical treatment in a formal way.

Probability sampling: Probability sampling is also known as random sampling or chance sampling. Under this sampling design, every item of the universe has an equal chance of inclusion in the sample. It is, so to say, a lottery method in which individual units are picked up from the whole group not deliberately but by some mechanical process. Here it is blind chance alone that determines whether one item or the other is selected. The results obtained from probability or random sampling can be assured in terms of probability i.e., we can measure the errors of estimation or the significance of results obtained from a random sample, and this fact brings out the superiority of random sampling design over the deliberate sampling design. Random sampling ensures the law of Statistical Regularity which states that if on an average the sample chosen is a random one, the sample will have the same composition and characteristics as the universe. This is the reason why random sampling is considered

as the best technique of selecting a representative sample. Random sampling from a finite population refers to that method of sample selection which gives each possible sample combination an equal probability of being picked up and each item in the entire population to have an equal chance of being included in the sample. This applies to sampling without replacement i.e., once an item is selected for the sample, it cannot appear in the sample again (Sampling with replacement is used less frequently in which procedure the element selected for the sample is returned to the population before the next element is selected. In such a situation the same element could appear twice in the same sample before the second element is chosen). In brief, the implications of random sampling (or simple random sampling) are:

(a) It gives each element in the population an equal probability of getting into the sample; and all choices are independent of one another.

(b) It gives each possible sample combination an equal probability of being chosen.

So far we have talked about random sampling, keeping in view only the finite populations. But what about random sampling in context of infinite populations? It is relatively difficult to explain the concept of random sample from an infinite population. However, a few examples will show the basic characteristic of such a sample.

Probability sampling under restricted sampling techniques, as stated above, may result in complex random sampling designs. Such designs may as well be called mixed sampling designs for many of such designs may represent a combination of probability and non-probability sampling procedures in selecting a sample. Some of the popular complex random sampling designs are as follows:

(i) Systematic sampling: In some instances, the most practical way of sampling is to select every i^{th} item on a list. Sampling of this type is known as systematic sampling. An element of randomness is introduced into this kind of sampling by using random numbers to pick up the unit with which to start. For instance,

if a 4 per cent sample is desired, the first item would be selected randomly from the first twenty-five and thereafter every 25th item would automatically be included in the sample. Thus, in systematic sampling only the first unit is selected randomly and the remaining units of the sample are selected at fixed intervals. Although a systematic sample is not a random sample in the strict sense of the term, but it is often considered reasonable to treat systematic sample as if it were a random sample.

Systematic sampling has certain plus points. It can be taken as an improvement over a simple random sample in as much as the systematic sample is spread more evenly over the entire population. It is an easier and less costlier method of sampling and can be conveniently used even in case of large populations. But there are certain dangers too in using this type of sampling. If there is a hidden periodicity in the population, systematic sampling will prove to be an inefficient method of sampling. For instance, every 25th item produced by a certain production process is defective. If we are to select a 4 percent sample of the items of this process in a systematic manner, we would either get all defective items or all good items in our sample depending upon the random starting position. If all elements of the universe are ordered in a manner representative of the total population, i.e., the population list is in random order, systematic sampling is considered equivalent to random sampling. But if this is not so, then the results of such sampling may, at times, not be very reliable. In practice, systematic sampling is used when lists of population are available and they are of considerable length.

(ii) Stratified sampling: If a population from which a sample is to be drawn does not constitute a homogeneous group, stratified sampling technique is generally applied in order to obtain a representative sample. Under stratified sampling

the population is divided into several sub-populations that are individually more homogeneous than the total population (the different sub-populations are called strata) and then we select items from each stratum to constitute a sample. Since each stratum is more homogeneous than the total population, we are able to get more precise estimates for each stratum and by estimating more accurately each of the component parts, we get a better estimate of the whole. In brief, stratified sampling results in more reliable and detailed information.

(iii) Cluster sampling: If the total area of interest happens to be a big one, a convenient way in which a sample can be taken is to divide the area into a number of smaller non-overlapping areas and then to randomly select a number of these smaller areas (usually called clusters), with the ultimate sample consisting of all (or samples of) units in these small areas or clusters.

Thus in cluster sampling the total population is divided into a number of relatively small subdivisions which are themselves clusters of still smaller units and then some of these clusters are randomly selected for inclusion in the overall sample. Suppose we want to estimate the proportion of machineparts in an inventory which are defective. Also assume that there are 20000 machine parts in the inventory at a given point of time, stored in 400 cases of 50 each. Now using a cluster sampling, we would consider the 400 cases as clusters and randomly select n cases and examine all the machineparts in each randomly selected case.

Cluster sampling, no doubt, reduces cost by concentrating surveys in selected clusters. But certainly it is less precise than random sampling. There is also not as much information in n observations within a cluster as there happens to be in n randomly drawn observations. Cluster sampling is used only because of the economic advantage it possesses; estimates based on cluster samples are usually more reliable per unit cost.

(iv) Area sampling: If clusters happen to be some geographic subdivisions, in that case cluster sampling is better known as area sampling. In other words, cluster designs, where the primary sampling unit represents a cluster of units based on geographic area, are distinguished as area sampling. The plus and minus points of cluster sampling are also applicable to area sampling.

(v) Multi-stage sampling: Multi-stage sampling is a further development of the principle of cluster sampling. Suppose we want to investigate the working efficiency of nationalised banks in India and we want to take a sample of few banks for this purpose. The first stage is to select large primary sampling unit such as states in a country. Then we may select certain districts and interview all banks in the chosen districts. This would represent a two-stage sampling design with the ultimate sampling units being clusters of districts.

If instead of taking a census of all banks within the selected districts, we select certain towns and interview all banks in the chosen towns. This would represent a three-stage sampling design. If instead of taking a census of all banks within the selected towns, we randomly sample banks from each selected town, then it is a case of using a four-stage sampling plan. If we select randomly at all stages, we will have what is known as multi-stage random sampling design.

Ordinarily multi-stage sampling is applied in big inquires extending to a considerable large geographical area, say, the entire country. There are two advantages of this sampling design viz., (a) It is easier to administer than most single stage designs mainly because of the fact that sampling frame under multi-stage sampling is developed in partial units. (b) A large number of units can be sampled for a given cost under multistage sampling because of sequential clustering, whereas this is not possible in most of the simple designs.

(vi) Sampling with probability proportional to size: In case the cluster sampling

units do not have the same number or approximately the same number of elements, it is considered appropriate to use a random selection process where the probability of each cluster being included in the sample is proportional to the size of the cluster. For this purpose, we have to list the number of elements in each cluster irrespective of the method of ordering the cluster. Then we must sample systematically the appropriate number of elements from the cumulative totals. The actual numbers selected in this way do not refer to individual elements, but indicate which clusters and how many from the cluster are to be selected by simple random sampling or by systematic sampling. The results of this type of sampling are equivalent to those of a simple random sample and the method is less cumbersome and is also relatively less expensive.

(vii) Sequential sampling: This sampling design is some what complex sample design. The ultimate size of the sample under this technique is not fixed in advance, but is determined according to mathematical decision rules on the basis of information yielded as survey progresses. This is usually adopted in case of acceptance sampling plan in context of statistical quality control. When a particular lot is to be accepted or rejected on the basis of a single sample, it is known as single sampling; when the decision is to be taken on the basis of two samples, it is known as double sampling and in case the decision rests on the basis of more than two samples but the number of samples is certain and decided in advance, the sampling is known as multiple sampling. But when the number of samples is more than two but it is neither certain nor decided in advance, this type of system is often referred to as sequential sampling. Thus, in brief, we can say that in sequential sampling, one can go on taking samples one after another as long as one desires to do so.

Check list

- Can you define sampling?
- What are the advantages and disadvantages of sampling?
- Can you define scientific sampling?

Chapter 7

Data processing and statistical treatment

At the end of this chapter students will be able to

- ♣ explain the meaning of data processing.
- ♣ understand what to consider in categorizing a given data.
- ♣ know the advantage of coding of data.
- ♣ understand when to use tabulation of data.
- ♣ list some of principles of tabulation of data.
- ♣ explain the role of statistics in processing data.

7.1 Data processing

The data, after collection, has to be processed and analysed in accordance with the outline laid down for the purpose at the time of developing the research plan. This is essential for a scientific study and for ensuring that we have all relevant data for making contemplated comparisons and analysis. Technically speaking, processing implies editing, coding, classification and tabulation of collected data so that they are amenable to analysis. The term analysis refers to the computation of certain measures along with searching for patterns of relationship that exist among data-groups. Thus, in the process of analysis, relationships or differences supporting or conflicting with original or new hypotheses should be subjected to statistical tests of significance to determine with what validity data can be said to indicate any conclusions.1 But there are persons (Selltiz, Jahoda and others) who do not like to make difference between processing and analysis. They opine that analysis of data in a general way involves a number of closely related operations which are performed with the purpose of summarising the collected data and organising these in such a manner that they answer the research question(s). We, however, shall prefer to observe the difference between the two terms as stated here in order to understand their implications more clearly.

7.2 Categorization of data

Most research studies result in a large volume of raw data which must be reduced into homogeneous groups if we are to get meaningful relationships. This fact necessitates classification of data which happens to be the process of arranging data in groups or classes on the basis of common characteristics. Data having a common characteristic are placed in one class and in this way the entire data get divided into a number of groups or classes. Classification can be one of the following two types, depending

upon the nature of the phenomenon involved:

a) Classification according to attributes: As stated above, data are classified on the basis of common characteristics which can either be descriptive (such as literacy, sex, honesty, etc.) or numerical (such as weight, height, income, etc.). Descriptive characteristics refer to qualitative phenomenon which cannot be measured quantitatively; only their presence or absence in an individual item can be noticed. Data obtained this way on the basis of certain attributes are known as statistics of attributes and their classification is said to be classification according to attributes.

   Such classification can be simple classification or manifold classification. In simple classification we consider only one attribute and divide the universe into two classesone class consisting of items possessing the given attribute and the other class consisting of items which do not possess the given attribute. But in manifold classification we consider two or more attributes simultaneously, and divide that data into a number of classes (total number of classes of final order is given by 2n, where n = number of attributes considered).* Whenever data are classified according to attributes, the researcher must see that the attributes are defined in such a manner that there is least possibility of any doubt/ambiguity concerning the said attributes.

b) Classification according to class-intervals: Unlike descriptive characteristics, the numerical characteristics refer to quantitative phenomenon which can be measured through some statistical units. Data relating to income, production, age, weight, etc. come under this category. Such data are known as statistics of variables and are classified on the basis of class intervals. For instance, persons whose incomes, say, are within Rs 201 to Rs 400 can form one group, those whose incomes are within Rs 401 to Rs 600 can form another group and so on.

In this way the entire data may be divided into a number of groups or classes or what are usually called, class-intervals. Each group of class-interval, thus, has an upper limit as well as a lower limit which are known as class limits. The difference between the two class limits is known as class magnitude. We may have classes with equal class magnitudes or with unequal class magnitudes. The number of items which fall in a given class is known as the frequency of the given class. All the classes or groups, with their respective frequencies taken together and put in the form of a table, are described as group frequency distribution or simply frequency distribution. Classification according to class intervals usually involves the following three main problems:

(i) How may classes should be there? What should be their magnitudes?

(ii) How to choose class limits?

(iii) How to determine the frequency of each class?

7.3 Coding of data

Coding refers to the process of assigning numerals or other symbols to answers so that responses can be put into a limited number of categories or classes. Such classes should be appropriate to the research problem under consideration. They must also possess the characteristic of exhaustiveness (i.e., there must be a class for every data item) and also that of mutual exclusively which means that a specific answer can be placed in one and only one cell in a given category set. Another rule to be observed is that of unidimensionality by which is meant that every class is defined in terms of only one concept.

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 precode the questionnaire choices and which in turn is helpful for computer tabulation as one can straight forward key punch from the original questionnaires. But in 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.

7.4 Tabulation of data

When a mass of data has been assembled, it becomes necessary for the researcher to arrange the same in some kind of concise and logical order. This procedure is referred to as tabulation. Thus, tabulation is the process of summarising raw data and displaying the same in compact form (i.e., in the form of statistical tables) for further analysis. In a broader sense, tabulation is an orderly arrangement of data in columns and rows.

Tabulation is essential because of the following reasons.

1. It conserves space and reduces explanatory and descriptive statement to a minimum.

2. It facilitates the process of comparison.

3. It facilitates the summation of items and the detection of errors and omissions.

4. It provides a basis for various statistical computations.

Tabulation can be done by hand or by mechanical or electronic devices. The choice depends on the size and type of study, cost considerations, time pressures and the availaibility of tabulating machines or computers. In relatively large inquiries, we may use mechanical or computer tabulation if other factors are favourable and

necessary facilities are available. Hand tabulation is usually preferred in case of small inquiries where the number of questionnaires is small and they are of relatively short length. Hand tabulation may be done using the direct tally, the list and tally or the card sort and count methods. When there are simple codes, it is feasible to tally directly from the questionnaire. Under this method, the codes are written on a sheet of paper, called tally sheet, and for each response a stroke is marked against the code in which it falls. Usually after every four strokes against a particular code, the fifth response is indicated by drawing a diagonal or horizontal line through the strokes. These groups of five are easy to count and the data are sorted against each code conveniently. In the listing method, the code responses may be transcribed onto a large work-sheet, allowing a line for each questionnaire. This way a large number of questionnaires can be listed on one work sheet. Tallies are then made for each question. The card sorting method is the most flexible hand tabulation. In this method the data are recorded on special cards of convenient size and shape with a series of holes. Each hole stands for a code and when cards are stacked, a needle passes through particular hole representing a particular code. These cards are then separated and counted. In this way frequencies of various codes can be found out by the repetition of this technique. We can as well use the mechanical devices or the computer facility for tabulation purpose in case we want quick results, our budget permits their use and we have a large volume of straight forward tabulation involving a number of cross-breaks.

Tabulation may also be classified as simple and complex tabulation. The former type of tabulation gives information about one or more groups of independent questions, whereas the latter type of tabulation shows the division of data in two or more categories and as such is deigned to give information concerning one or more sets of inter-related questions. Simple tabulation generally results in one-way tables which supply answers to questions about one characteristic of data only. As against this,

complex tabulation usually results in two-way tables (which give information about two inter-related characteristics of data), three-way tables (giving information about three interrelated characteristics of data) or still higher order tables, also known as manifold tables, which supply information about several interrelated characteristics of data. Two-way tables, three-way tables or manifold tables are all examples of what is sometimes described as cross tabulation.

Generally accepted principles of tabulation: Such principles of tabulation, particularly of constructing statistical tables, can be briefly states as follows:

1. Every table should have a clear, concise and adequate title so as to make the table intelligible without reference to the text and this title should always be placed just above the body of the table.

2. Every table should be given a distinct number to facilitate easy reference.

3. The column headings (captions) and the row headings (stubs) of the table should be clear and brief.

4. The units of measurement under each heading or sub-heading must always be indicated.

5. Explanatory footnotes, if any, concerning the table should be placed directly beneath the table, along with the reference symbols used in the table.

6. Source or sources from where the data in the table have been obtained must be indicated just below the table.

7. Usually the columns are separated from one another by lines which make the table more readable and attractive. Lines are always drawn at the top and bottom of the table and below the captions.

8. There should be thick lines to separate the data under one class from the data under another class and the lines separating the sub-divisions of the classes should be comparatively thin lines.

9. The columns may be numbered to facilitate reference.

10. Those columns whose data are to be compared should be kept side by side. Similarly, percentages and/or averages must also be kept close to the data.

11. It is generally considered better to approximate figures before tabulation as the same would reduce unnecessary details in the table itself.

12. In order to emphasise the relative significance of certain categories, different kinds of type, spacing and indentations may be used.

13. It is important that all column figures be properly aligned. Decimal points and (+) or (-) signs should be in perfect alignment.

14. Abbreviations should be avoided to the extent possible and ditto marks should not be used in the table.

15. Miscellaneous and exceptional items, if any, should be usually placed in the last row of the table.

16. Table should be made as logical, clear, accurate and simple as possible. If the data happen to be very large, they should not be crowded in a single table for that would make the table unwieldy and inconvenient.

17. Total of rows should normally be placed in the extreme right column and that of columns should be placed at the bottom.

18. The arrangement of the categories in a table may be chronological, geographical, alphabetical or according to magnitude to facilitate comparison. Above all, the table must suit the needs and requirements of an investigation.

7.5 Statistical treatment

The role of statistics in research is to function as a tool in designing research, analysing its data and drawing conclusions therefrom. Most research studies result in a large volume of raw data which must be suitably reduced so that the same can be read easily and can be used for further analysis. Clearly the science of statistics cannot be ignored by any research worker, even though he may not have occasion to use statistical methods in all their details and ramifications. Classification and tabulation, as stated earlier, achieve this objective to some extent, but we have to go a step further and develop certain indices or measures to summarise the collected/classified data. Only after this we can adopt the process of generalisation from small groups (i.e., samples) to population. If fact, there are two major areas of statistics viz., descriptive statistics and inferential statistics. Descriptive statistics concern the development of certain indices from the raw data, whereas inferential statistics concern with the process of generalisation. Inferential statistics are also known as sampling statistics and are mainly concerned with two major type of problems: (i) the estimation of population parameters, and (ii) the testing of statistical hypotheses.

The important statistical measures* that are used to summarise the survey/research data are: (1) measures of central tendency or statistical averages; (2) measures of dispersion; (3) measures of asymmetry (skewness); (4) measures of relationship; and (5) other measures.

Amongst the measures of central tendency, the three most important ones are the arithmetic average or mean, median and mode. Geometric mean and harmonic mean are also sometimes used.

From among the measures of dispersion, variance, and its square rootthe standard deviation are the most often used measures. Other measures such as mean deviation, range, etc. are also used. For comparison purpose, we use mostly the coefficient of standard deviation or the coefficient of variation.

In respect of the measures of skewness and kurtosis, we mostly use the first measure of skewness based on mean and mode or on mean and median. Other measures of skewness, based on quartiles or on the methods of moments, are also used sometimes. Kurtosis is also used to measure the peakedness of the curve of the frequency distribution.

Amongst the measures of relationship, Karl Pearsons coefficient of correlation is the frequently used measure in case of statistics of variables, whereas Yules coefficient of association is used in case of statistics of attributes. Multiple correlation coefficient, partial correlation coefficient, regression analysis, etc., are other important measures often used by a researcher.

Index numbers, analysis of time series, coefficient of contingency, etc., are other measures that may as well be used by a researcher, depending upon the nature of the problem under study.

Check list

- Can you define data processing?
- How one can code a data for processing?
- What is the meaning of tabulation?
- What are the basic principles in tabulation of data?
- What is the meaning of statistical data treatment?

Chapter 8

Data analysis and interpretation

At the end of this chapter students will be able to

- ♣ define data analysis and interpretation.
- ♣ list types of analysis.
- ♣ understand the basic difference between types of analysis.

8.1 Introduction

After administering and scoring research tools scripts, data collected and organized. The collected data are known as 'raw data'. The raw data are meaningless unless certain statistical treatment is given to them. Analysis of data means to make the raw data meaningful or to draw some results from the data after the proper treatment. The 'null hypotheses' are tested with the help of analysis data so to obtain some significant results. Thus, the analysis of data serves the following main functions: to make the raw data meaningful, to test null hypothesis, to obtain the significant results, to draw some inferences or make generalization, and to estimate parameters.

8.2 Univariate, bivariate, multivariate analysis

Univariate analysis is the simplest form of quantitative (statistical) analysis. The analysis is carried out with the description of a single variable and its attributes of the applicable unit of analysis. For example, if the variable age was the subject of the analysis, the researcher would look at how many subjects fall into a given age attribute categories. Univariate analysis contrasts with bivariate analysis the analysis of two variables simultaneously or multivariate analysis the analysis of multiple variables simultaneously. Univariate analysis is also used primarily for descriptive purposes, while bivariate and multivariate analysis are geared more towards explanatory purposes. Univariate analysis is commonly used in the first stages of research, in analyzing the data at hand, before being supplemented by more advance, inferential bivariate or multivariate analysis.

A basic way of presenting univariate data is to create a frequency distribution of the individual cases, which involves presenting the number of attributes of the variable studied for each case observed in the sample.This can be done in a table format, with a bar chart or a similar form of graphical representation. A sample

distribution table and a bar chart for an univariate analysis are presented below (the table shows the frequency distribution for a variable "age" and the bar chart, for a variable "incarceration rate"): - this is an edit of the previous as the chart is an example of bivariate, not univariate analysis - as stated above, bivariate analysis is that of two variables and there are 2 variables compared in this graph: incarceration and country.

In a univariate study, you examine the effects of the independent variable on a single dependent variable. For an experimental study, the experimental group is given the treatment (a new drug, for instance) and the control group is not given the treatment. You measure the same dependent variable for each subject in each group (blood sugar, heart rate, grades or attitudes, for example). With univariate statistics, you try to establish a causal relationship between the independent variable and a change in the dependent variable. Did the drug work? In univariate studies, you can also have more than one independent variable (a drug cocktail, for example), so long as there is still a single dependent variable.

Bivariate analysis is one of the simplest forms of the quantitative (statistical) analysis.[1] It involves the analysis of two variables (often denoted as X, Y), for the purpose of determining the empirical relationship between them. In order to see if the variables are related to one another, it is common to measure how those two variables simultaneously change together (see also covariance). Bivariate analysis can be helpful in testing simple hypotheses of association and causality checking to what extent it becomes easier to know and predict a value for the dependent variable if we know a case's value on the independent variable (see also correlation). Bivariate analysis can be contrasted with univariate analysis in which only one variable is analysed. Furthermore, the purpose of a univariate analysis is descriptive. Subgroup comparison the descriptive analysis of two variables can be sometimes seen as a very simple form of bivariate analysis (or as univariate analysis extended to two variables).

The major differentiating point between univariate and bivariate analysis, in addition to looking at more than one variable, is that the purpose of a bivariate analysis goes beyond simply descriptive: it is the analysis of the relationship between the two variables.

Bivariate studies measure the relationship between two variables. Neither of the variables being studied is an independent variable, so the procedure is not experimental, such as in univariate studies. Correlations are common bivariate tools and are used to study how one variable influences the other. For example, if you wanted to see how family income influenced graduation rates, you could use a bivariate correlation to examine the two variables.

Multivariate studies are similar to univariate studies, but they have more than one dependent variable. For example, if you wanted to examine the ability of three new chemicals to clean an oil spill, the three chemicals would be your independent variables. You could measure the chemicals' dispersant properties, detoxification of the oil, toxicity of the chemical and effect on the environment as your dependent variables. You would then use a multivariate statistical analysis to examine the relationships between all of the variables.

In the classic univariate study, a group of randomly selected subjects is assigned to a control or treatment group and examined on a single factor (dependent variable). In subjects like psychology, you are typically interested in more than one factor and want to try several different treatment methods. Say you wanted to study the efficacy of a new behavioral treatment on people with depression. The people gathered for the study will likely come with a host of differing qualities, all of which could be classified as an independent variable. Additionally, the new treatment may affect other aspects of people as well as depression, such as self-esteem or self-image. This multivariate study is much more realistic than assigning people to groups and hoping they all turn out as you predicted.

8.3 Descriptive analysis

Descriptive statistics is the discipline of quantitatively describing the main features of a collection of data. Descriptive statistics are distinguished from inferential statistics (or inductive statistics), in that descriptive statistics aim to summarize a sample, rather than use the data to learn about the population that the sample of data is thought to represent. This generally means that descriptive statistics, unlike inferential statistics, are not developed on the basis of probability theory. Even when a data analysis draws its main conclusions using inferential statistics, descriptive statistics are generally also presented. For example in a paper reporting on a study involving human subjects, there typically appears a table giving the overall sample size, sample sizes in important subgroups (e.g., for each treatment or exposure group), and demographic or clinical characteristics such as the average age, the proportion of subjects of each sex, and the proportion of subjects with related comorbidities. Descriptive statistics is also a set of brief descriptive coefficients that summarizes a given data set, which can either be a representation of the entire population or a sample. The measures used to describe the data set are measures of central tendency and measures of variability or dispersion. Measures of central tendency include the mean, median and mode, while measures of variability include the standard deviation (or variance), the minimum and maximum variables, kurtosis and skewness.

8.4 Cost-effective analysis

Cost-effectiveness analysis (CEA) is a form of economic analysis that compares the relative costs and outcomes (effects) of two or more courses of action. Cost-effectiveness analysis is distinct from cost-benefit analysis, which assigns a monetary value to the measure of effect. Cost-effectiveness analysis is often used in the field of health services, where it may be inappropriate to monetize health effect. Typically the CEA is

expressed in terms of a ratio where the denominator is a gain in health from a measure (years of life, premature births averted, sight-years gained) and the numerator is the cost associated with the health gainThe most commonly used outcome measure is quality-adjusted life years (QALY). Cost-utility analysis is similar to cost-effectiveness analysis. Cost-effectiveness analyses are often visualized on a cost-effectiveness plane consisting of four-quadrants. Outcomes plotted in Quadrant I are more effective and more expensive, those in Quadrant II are more effective and less expensive, those in Quadrant III are less effective and less expensive, and those in Quadrant IV are less effective and more expensive.

Cost-effectiveness analysis refers to the consideration Of decision alternatives in which both their costs and consequences are taken into account in a systematic way. It is a decisionoriented tool, in that it is designed to ascertain which means of attaining particular educational goals are most efficient.

Cost-effectiveness analysis is closely related to cost-benefit analysis in that both represent economic evaluations of alternative resource use and measure costs in the same way (see Cost- Benefit Analysis). However, cost-benefit analysis is used to address only those types of alternatives where the outcomes can be measured in terms of their monetary values. For example, educational alternatives that are designed to raise productivity and- income, such as vocational education, have outcomes that can be assessed in monetary terms and can be evaluated according to cost-benefit analysis. However, most educational alternatives are dedicated to improving achievement or some other educational outcome that cannot be easily converted into monetary terms. In these cases, one must limit the comparison of alternatives to those that have similar goals by comparing them through cost-effectiveness analysis.

The purpose of cost-effectiveness analysis in education is to ascertain which program or combination of programs can achieve particular objectives at the lowest cost. The underlying assumption is that different alternatives are associated with different

costs and different educational results. By choosing those with the least cost for a given outcome, society can use its resources more effectively. Those resources that are saved through using more costeffective approaches can be devoted to expanding programs or to other important educational and social endeavors.

Cost-effectiveness analysis may contribute to answer the following questions:

a) How much does a programme or a measure costs compared with the cost of a particular component of its objective?

b) Is it preferable to invest resources in an intervention, to the detriment of another, to achieve the target?

c) What kind of intervention or group of interventions yields the best outcomes regarding the final objectives and available resources?

d) How can the use of the resources be optimised, given competing needs between programmes?

e) At what level of additional investment will the chosen intervention clearly give an improved outcome?

Check list

- Can you define data analysis and interpretation?
- Define univariate, bivariate and multivariate analysis?
- Can you define statistical descriptive analysis?
- Define cost effective analysis?
- What conditions force a researcher to use cost-effective analysis?

Chapter 9

Form and style in writing a research

At the end of this chapter students will be able to Understand

- ♣ the importance of format of a report
- ♣ contents of a title page
- ♣ what should be in introductory pages
- ♣ content of a body text
- ♣ References
- ♣ contents of appendix

9.1 General format of a research

A written format of a research work is known as thesis or research report. All such works may differ considerably in scope of treatment and details of presentation. Even then all types of research reports are expected to follow a general uniform, common pattern of format, style and structure. The general format of research report is evolved and it has become a tradition in academic area. A research report or thesis is an organized format of research work done. It is viewed in three major categories:A. Preliminaries, B. Textual Body, and C. References.

Each category has been outlined further as follows:

A. Preliminary Section

1. Title page
2. Preface or acknowledgements
3. Table of content
4. List of tables (if any)
5. List of figures (if any).

B. Main Body of Report or Textual Body

1. Introduction
   (a) Statement of the problem
   (b) Objectives of the study
   (c) Hypotheses to be tested
   (d) Significance of the problem
   (e) Assumptions and delimitations.
   (f) Definitions of Important terms used.

2. Review of related literature.
3. Design of the study
   (a) Method and procedure used
   (b) Tools of research or sources of data
   (c) Techniques of data collection
   (d) Description of techniques used.
3. Analysis and presentation of data
   (a) Analysis of data
   (b) Tables and interpretation
   (c) Figures and interpretation.
4. Conclusions
   (a) Discussion of results
   (b) Main Findings and inferences
   (c) Implication of the findings and limitations
   (d) Suggestions for further studies.

C. Reference Section

1. Bibliography
2. Appendices (if any)
3. Index or glossary (if any).

9.2 The preliminaries of a research

As the preliminaries form a significant part of the whole thesis report, due care should be taken in preparing them. If the specifications are already laid down by

some colleges or universities they should be observed. However, a general standard pattern suggested here in each case will be helpful for a researcher.

1. **Title page**

   This is the first page of a thesis or a dissertation. It includes:

   (a) Title of thesis.

   (b) Name of the candidate.

   (c) Purpose or relationship of the thesis to the course or degree requirement.

   (d) College and/or department in which the candidate has been admitted for the degree.

   (e) Name of the university to which it is submitted.

   (f) Month and year of submission or acceptance.

   The title should be accurate, concise and clearly printed in capital letters. It should convey the main theme of the problem investigated and if possible one should give a clue about the method or type of research involved. A specimen of title page has been presented here.

2. **Preface or Acknowledgement**

   A preface is different from introduction. It is a brief account of the purport or the origin and the utility of the study for which the thesis is presented. It also includes the acknowledgement to the persons and sources that have been helpful to the investigator. If the researcher does not want to mention anything about the study on this page except acknowledging debt to others, it will be desirable to use the title simple and restrained without flattery and effusive recognition for help by the family members and others. The preface should not be too long with too many details about the research work or its organization, which

can appear in introduction. The word PREFACE or ACKNOWLEDGEMENT should be typed in capital letters. It should be written in an impressive way.

3. **Table of Contents**

   This section lists all the main chapter headings and the essential sub-heading in each with the appropriate page numbers against each. The listing of main chapters is generally preceded by some preliminaries like preface or acknowledgement, list of tables, list of figures, abstract or synopsis and their respective pages in small Roman numbers and followed at the end by appendices, and Indexes.

   Contents should neither be too detailed nor too sketchy the table of contents should serve an important purpose in providing an outline of the contents of the report. The capitalized title 'Contents' should be the central heading of the page and the capitalized word 'CHAPTER' and 'PAGE' should lead to the numbers of chapters and those of pages respectively on the left and right margins.

4. **List of Tables**

   The table of contents is followed by the list of tables on a separate page. This list of tables consists of the titles or captions of the tables included in the thesis along with the page number where these can be located. It has been illustrated here. The capitalized title 'LIST OF TABLES' should be the central heading of the page and the capital words 'TABLE' and 'PAGE' should lead to the numbers and those of pages respectively at left and right margins.

5. **List of Figures and Illustrations**

   If any charts graphs or any other illustrations are used in the thesis, a list of figures on a separate page is prepared in the same form as the list of tables except that they are numbered with Arabic numbers.

9.3 The text of the research paper

The text of the thesis is the most important section in the organization of research report. The quality of worth of thesis is mainly examined. It is the original production of the researcher. The report of the main body serves the function of demonstrating the competence of the researcher. If any sentence, paragraph, concept fails to serve the single function within a given section or chapter, it is irrelevant The subject matter of any chapter should be relevant to that point. Generally the main body of the research reports consists of the following five or six chapters:

I. Introduction or Theoretical Frame Work

II. Review of Related Literature

III. Design or Methodology

IV. Data Collection or Administration of Tools and Scoring.

V. Analysis and Interpretation of Data.

VI. Conclusions and Suggestions for the Further Researches.

Introduction or Theoretical Frame Work

The main purpose of this chapter is to indicate the need and scope of the study. It consists essentially of the statement of research inquiry. It is reported in past tense form of work completed. The problem objectives, hypotheses, assumptions and delimitations of the study are reported precisely.

If an introduction is required, the researcher should make certain that it is an introduction that generates an interest and appropriate mental set which introductions are regarded as capable of producing. It must be long enough to do its jobs and nothing more.

Review of Related Literature

This chapter is essential in most of the research studies. It presents the comprehensive development of the problem background. It Indicates what has already been studied by others, which has a bearing upon the present study.

The review of literature stresses two aspects: the first is the consideration of the subject-matter and it is likely more important than the other. The second is related to methodology and design. The review chapter is devoted to the development of the problem statement or the object of the inquiry. The review is utilized to retain a direct relevancy to the study in hand. It is the balancing chapter of the research report.

Design or Methodology of Research

This chapter indicates the line of approach of the study. The first aspect deals with the method, population and sample of the study and second part provides the tools and techniques employed in the research. It also presents the procedure of the study. The whole plan of the study is discussed in detail under this chapter. Administration of tools and scoring procedure are reported systematically. The data organization and presentation should be given in this section. It may be reported in a separate chapter of the report.

Analysis and Interpretation of the Data

In this chapter analysis and results are reported so as to draw the inferences of the study. The analysis of data are presented in tabular form and in figures or pictorial presentation. The results are interpreted at length. This chapter provides the original work or contribution by the researcher. The communicative accuracy is required in this chapter. The text must be developed to ensure an effective ordering of the evidences.

Conclusions and Suggestions

This is most important chapter of the report. It requires the creative and reflective

aspect of the researcher. The results are discussed to make them more meaningful comparison of the results with the evidence in the review section should be woven into the text whenever such a discussion can serve to clarify the points being reported. This is the final chapter of a report, thus findings of the study are summarized and suggestions for the further studies are also given. The implications and delimitations of the findings are also mentioned in this section. The main thrust in the section is the answer of the question or solution of the problem. The validity of the findings should be mentioned.

9.4 Reference section

This is the third section of a research report. It consists of generally the bibliography and appendices. It is also essential to include glossary and index for the convenience of the readers. The bibliography, appendix, glossary and index all these are written on a separate page - in the centre with capital letters.

Bibliography

The bibliography is a list of the printed sources utilized in the research work. The publications used for information-yield but not quoted in the report may also be included in the bibliography. The format of the bibliography depend on the footnote style. If the foot-notes reference in the text are numbered to refer to the source in the bibliography, the entries must be numerically listed in the order of appearance in the text. The various format manuals include information on form for the bibliography. If the list of sources is too large the bibliography should be categorized in the following sections: Books, monographs, documents and reports, periodicals and journals, essay and articles, unpublished thesis and material and newspapers.

A bibliography reference is written in the following manner and arranged alphabetically to facilitate the readers:

- Name of the author with the last name first and initials afterwards.
- The year of publication is given in bracket after the name of the author and authors.
- Title of the book or the work is written, underlined and followed by a full stop (.).
- Place of Publication followed by a colon (:).
- Name of the publishing agency and publishers and followed by comma (,).
- Total pages of the book are given.

The above sequence is employed in preparing bibliographical references. It is also used for giving footnotes reference with a little deviation. In footnote the name of the author with the Initials first followed by surname or last name is given. The specific page number of the work or the book is given not the total pages. Other things remain the same as mentioned in the bibliography. The bibliography pages are also written in Arabic figure in the sequence of main body of the report.

Appendix

An appendix is the important reference materials category. It includes the material which can not be logically included in the main body or textual body of the research report or the relevant materials too unwieldy to include in the main body. The appendix usually includes: tools of research, statistical tables and sometime raw-data (when data were processed through computer). Even the material of minor importance e.g. forms, letters, reminders, interview sheets, blank questionnaires, charts, tables, lengthy questions, report of cases (if follow-up or case studies have been conducted). The tools and other material should be placed first and tables at the end and page numbers should be assigned in Roman Numbers (i, ii, xxi). The

appendix serves the function of providing greater clarity and authenticity for the readers or consumers of the thesis. The items of the appendix are very essential for a good research report.

Index and Glossary

When a research report is published in index, must be given. The index includes authors and subjects and topics or words in alphabetical order. In the report glossary should be provided. It includes the meanings or definitions of some words and terms used in the research report. Some notations symbols or abbreviations should be explained what actually they mean or indicate in the study.

9.5 Style in writing

A research report writing is a highly technical activity. It includes various mechanics for a smooth flow of the thesis. The mechanical aspect has been standardized which must be followed by researcher in preparing a thesis. Such mechanics involve the following issues:

(a) Footnotes and references,

(b) Style of writing,

(c) Headings,

(d) Tables,

(e) Figures,

(f) Pagination,

(g) Proof reading, and

(h) Binding and submission

(a) Footnotes

Sometimes it is desirable to quote some authoritative views or statements from written works of others in the research report. It may be necessary from various purposes viz. to review the related literature, to support to give the rationale for one's viewpoint. Each quotation must have a footnote or reference indicating the sources from which it is borrowed. All these sources and authority be acknowledged both for intellectual honesty and for validity of one's research. Footnotes serve a number of purposes. They enable the researcher to substantiate his presentation by quotations or citations of other authorities, to give credit to sources of material that he has reported and to provide the reader with specific sources that he may use to verify the authenticity and accuracy of material quoted. The citation or quoted statements are written in single-spaced whereas the text is written double-spaced.

(b) Style of Preparing Thesis

The research report should be written in a style that it is creative, clear and concise. Therefore the following considerations should be kept in view in writing a research report.

1. The research must be reported in full and its results are subjected to criticism and verification.

2. A research report is always written in third person i.e. he, she or the investigator. I, we, you, my, our and us should not be used.

3. It is prepared and written in past tense and present-prefect tense because it is reported usually after completion of the work.

4. The scientific language is used rather than literary language. The British-English pattern is followed in writing a research report. The spellings of the words are employed of the British English.

5. It is typed printed/cyclostyled on 11" 9" size (thesis size) sunlit bond papers. There should be left a margin of 1-1/2" right margin one inch top and bottom margin should be 1-1/4" in each. The same machine of typing must be used for typing research report.

6. The presentation of matter should be in floating sequence. There should be consistency in the form and content organization.

7. An appropriate and proper format of research report should be used.

8. The footnotes, references, tables, figures, heading, subheading and bibliography should be provided in its standard form.

9. It should be typed in double space, quotations or citation should be given in single space. A word should not be split in two aspects due to the shortage of space in a line. A table, figure and diagram should always be given on a single pace. If table size is large. a large size paper should be used. It should not continue on the next page.

10. A typist with great experience and proficiency should be employed for preparing thesis or dissertation, because it is the responsibility of the researcher that a thesis should be typed in proper form. The correction of major errors is not the responsibility of the typist.

11. Good research reports are not written hurriedly. Even an expert and experienced researcher revises many times before he submits a manuscript for typing. Typographical standards for the thesis or dissertation are more exacting. Therefore, every typist cannot prepare a thesis, there are the experts for typing thesis, who should be employed for typing thesis.

(c) Headings

Generally a research report is divided into chapters, each chapter begins from a new page. The title of a chapter is called the chapter heading. The work 'CHAPTER' is written in capital letters, in the centre of the page and title is placed three spaces of the chapter.

(d) Tables

A table is used for presenting statistical data. It enables the readers to comprehend and interpret data quickly and to understand significant aspects at a glance. The work 'TABLE' is followed by the serial Roman number which is placed at the centre two spaces above the title of the table. The title of the table is written in capital letters at the centre of the page. The statistical data are presented in vertical columns and horizontal row, according to some classification of subject matter.

(e) Figures

A figure is a device that presents statistical data in pictorial or visual form. The figure is used to a variety of graphs, charts, maps, sketches, diagrams and drawings. It helps to understand the aspects of data clearly and easily. One idea or fact should be presented in each figure. The description of the figure must be given in the textual body. 'FIGURE' should be written in the centre of the page at the top of the figure. The title of the figure should be written in capital letters two spaces below the figure. The scale of the figure must be given.

(f) Pagination

Assigning page numbers of the report is very essential. The title page or initial page of any section does not have a page number typed on it, but a number is allotted to it in the series of pages. Page numbers are typed in the upper right hand corner, one inch below the top edge of the page. The small or lower Roman numerals (i, ii, iii, iv,) are assigned for the pages of preliminary section. The serial Arabic numbers. 1, 2, 3, 4 so on are assigned for the pages of textual body or main body of the report

i.e. Chapter I to last and Bibliography. The lower Roman numerals are assigned for the pages of appendices and index. The correct pagination depends upon the final edited copy or typed copy.

(g) Proof Reading

A research report should not have errors. It requires that final typed copies must be checked carefully. All types of errors should be deleted before submission. Thus, proof reading of final typed copies should be done two or three times.

(h) Binding and Submission

It is the last activity for preparing research report. Before giving to the binder it should be arranged properly and systematically and the serial number of pages are checked carefully. It should be given to an expert binder who has the experience of binding research thesis. Some universities require three copies of the thesis five copies of the abstract or summary and three copies of synopsis. These should also be prepared. A great precaution must be taken in printing the topic or title of the thesis that it must be the photo-state form of the topic which was approved by research degree committee. The covering page must be the same as inner cover given in preliminary section. After binding the thesis it should be submitted to the university for evaluation purpose. Researcher should ascertain the date of submission and other requirement e.g. certificate of the supervisor. evaluation fees etc. For the post-graduate dissertation. student should plan that he would be able to submit to college or university in time. He must obtain the receipt of the submission of his thesis.

Check list

- What elements should be included in the preliminaries of a research report?
- Can you define text or body of a research paper?
- Can you list sections that might be included in reference section?

Bibliography

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Paul D. Leedy, Jeanne Ellis Ormrod: Practical research planning and design, ninth edition, Pearson Education, Inc., publishing as Merrill, Upper Saddle River, New Jersey 07458, 2010.

Y.K. Singh: Fundamentals of Research methodology and statistics, New Age International (P) Ltd, ISBN : 978-81-224-2418-8, New Delhi, 2006.