M.Phil. (Statistics)

Research Methodology

Unit I

Introduction to Research Methods : Definition of research, role and objectives of research, applications and types of research, research process and steps in it. Collecting and reviewing the literature, conceptualization and Formulation of a research problem, Identifying variables, constructing hypothesis, Synopsis.

Unit II

(a) Research Design: Selecting and defining a research problem, need for research design, features of a good research design, different research designs (exploratory, descriptive experimental and diagnostic research).

(b) Design of Sample Survey: Census V/s Sample enumerations, objectives and principles of sampling, Types of sampling, Sampling and Non-sampling errors. Designing Questionnaires and interview. Determination of the sample size.

Unit III

Measurement of Scaling Concepts: Scales of measurements, nominal, ordinal, internal and ratio scales, Errors in measurements. Validity and Reliability in measurement, Scale Construction Techniques.

Unit IV

Data Collection & Analysis: Primary & secondary data, Validity and Reliability of data collection procedures, data preparation, exploratory data analysis, parametric and non-parametric tests, correlation and regression analysis, ANOVA, Multivariate Techniques.

Unit V

Report Writing: Discussions, Conclusion, referencing and various formats for reference writing, Bibliography, Thesis Writing, Thesis writing, Formats of publications in research journals including subject classification, Impact factor, Citation index.

Unit VI

Computer Applications: Data Communication and networks, LAN, WAN,GAN, Internet, Website, Webpage, E-mail, Search Engines, Scientific search engines. PDF and Latex files.

MS WORD : Test formatting, Math Type, MS Equation editor, INFLIBNET, e-journals, e-library, Scopus, Central blatt Math, Mathematical reviews.

Recommended Books:

1. Krishna Swamy K.N., Siva Kumar A.I., Mathirajan M., "Management Research Methodology (2006), Pearson Education, New Delhi.
2. Kothari C.R., "Research Methodology, Methods and Techniques, Second edition, (2008), New Age International Publication.
3. Ranjit Kumar : Research Methodology, A step by step guide for beginners, Pearson Education, Sixth Edition 2009.
4. Mark Saunders, Philip Lewis, Adrain Thornhiu:Research Methods for Business Students, Pearson Education.
5. Ram Ahuja, "Research Methods", (2001), Rawat Publications, New Delhi.
6. Cooper D., Schindler P., Business research methods", (2003) Tata Mc-Graw Hill, New Delhi.

Unit I
Introduction to Research Methods

Unit I (Syllabus)

Introduction to Research Methods : Definition of research, role and objectives of research, applications and types of research, research process and steps in it. Collecting and reviewing the literature, conceptualization and Formulation of a research problem, Identifying variables, constructing hypothesis, Synopsis.

1.1 Introduction

Research is a scientific investigation. Investigation means a search for new facts and ideas in any branch of knowledge. Thus, we can say that research is a search for knowledge. Research may be considered as a movement, a movement from the unknown to the known. It is actually a voyage of discovery.

Research is carried out for two purposes; one is the discovery of new facts and the second, verification of the old ones. The object of every business organization, of course, is the discovery of new facts, new relationship, and new laws governing the business phenomena. But constant verification of the old concepts is also needed especially in dynamic business environment.

Common sense knowledge, based on the accumulated experiences, prejudices and beliefs of the people is often contradictory and inconsistent. On the other hand, scientific observations are based on verifiable evidence or systematic body of proof that can be cited. For example, some common sense statements are: man is more intelligent than woman; married men remain happier than single people; rural people are more hardworking than urban people etc. Contrary to this, the scientific research or scientific inquiry finds that woman is as intelligent as man; there is no association in happiness and marriage; hard work is not related to environment alone. Thus, a statement based on common sense is just a guess or prejudice or mistaken interpretation, though at times it may be true, wise and a useful bit of knowledge. But it is not based on any scientific evidence. A scientific statement is based on accumulated systematic knowledge through research.

1.2 Meaning and Definition of Research

In order to plan and carry out research, it is necessary to know what we mean by research-in general, as well as in the specialized fields of business management.

"*Research* is an *Organized* and *Systematic* way of *Finding answers* to *Questions*."

Systematic because there is a definite set of procedures and steps which you will follow. There are certain things in the research process that are always done in order to get the most accurate results.

Organized in that there is a structure or method in going about doing research. It is a planned procedure, not a spontaneous one. It is focused and limited to a specific scope.

Finding answers is the end of all research. Whether it is the answer to a hypothesis or even a simple question, research is successful when we find answers. Sometimes the answer is no, but it is still an answer.

Questions are central to research. If there is no question, then the answer is of no use. Research is focused on relevant, useful, and important questions. Without a question, research has no focus, drive, or purpose.

The word *research* is derived from the Latin word meaning *to know*. It is a systematic and a replicable process, which identifies and defines problems, within specified boundaries. It employs well-designed method to collect the data and analyses the results. It disseminates the findings to contribute to generalizeable knowledge.

Definitions: Various social and behavioural scientists have defined the word *research* in different ways. Some of the most popular definitions are:

1. "Endeavour to discover facts by scientific study, course of critical investigation", by **Pocket Oxford Dictionary.**
2. "Systematic investigation to establish facts or collect information on the subject", **by Collins Concise Dictionary.**
3. "Research is systematized effort to gain new knowledge", **by Redman and Mory.**
4. "Research is the manipulation of things, concepts or symbols for the purpose of generalizing to extend, correct or verify knowledge, whether that knowledge aids in construction of theory or in the practice of an art", **by Encyclopedia of Social Sciences.**

Thus, we can say that research is a systematic and objective attempt to study a business problem for the purpose of deriving general principles. In other words, research is a systematic, controlled, empirical and critical investigation of hypothetical propositions about the presumed relations among phenomena.

1.3 Characteristics of Research

A well-organized research must possess certain characteristics features, which are as follows:

1. **Solution Oriented:** The problem of research must be clearly defined and stated. The motive of research must be mentioned in the beginning of research work. The research should provide a solution of a business problem.
2. **Logical:** In a research we find out facts about a phenomenon and draw conclusions about it. The inferences and generalizations thus made must be logical. For example, all illiterate people in the village live longer than the

educated people in the cities leads to the conclusions that illiteracy is the cause of longevity. This is an example of illogical research conclusion.

3. **Objective:** Observing true picture of a phenomenon without being affected by observers own opinion is termed as 'objective'. Objectivity means knowing reality. The criterion of objectivity is that all researchers should arrive at the same conclusion about the phenomenon on which they are pursuing research.
4. **Impartiality:** A dishonest research may select data items of individuals to draw conclusions to his favour. This brings bias into research, which affects the objective of the study. Therefore a true research must be impartial and unbiased.
5. **Accuracy:** A research worker needs to gain some expertise in the study he is undertaking. This expertise results in achieving the accuracy in the solution drawn. The accuracy of conclusions is a sensitive issue as it may affect the whole decision-making.
6. **Systematic:** In a research there should be well-defined steps. Each step should be sequentially linked with another, so that, the whole research work is an organized structure.
7. **Verifiability:** the results of a research are subjective to verifications. For building a sound basis for decision making one verifies the research results by replicating the study.
8. **Empirical:** A research is an empirical process and involves data collection. The results are based on observed experience or empirical evidence. Research rejects assumptions and dogma as methods of established knowledge. It accepts only what is verified by empirical observations.

Characteristics of Research

1. Solution Oriented
2. Logical
3. Objective
4. Impartiality
5. Accuracy
6. Systematic
7. Verifiability
8. Empirical

1.4 Role and Significance of Research

A research study plays a very vital role in studying, understanding and solving a business problem. Research is a process of obtaining dependable solutions through systematic and scientific investigations. In the modern business environment where operational problems are of complex nature, research provides a solution oriented carefully designed procedures.

Research helps us to discover the functional relationships among various phenomena that exist in a business or a government organization. Decision-making under

uncertainty is a fact in every sphere of a business. Research provides us inferences and generalizations that help in forecasting the future happenings in the organization. All private or government organizations form their policies on the basis of researches conducted.

1.5 Objectives of Research

The main goal of research is to improve the quality and level of living in the society. The purpose of a research study is to find out the hidden facts about a business phenomenon. The obvious function of research is to add new knowledge to the existing store. It serves the government and the business organizations in forming their future policies. The objectives of a research study are listed below:

1. Understanding a business problem: The first and foremost objective of any study is to understand, analyze and explore a business problem. Once complete familiarity with the phenomenon is achieved, it is easier to decompose the complex problem into smaller once.

2. Identifying the cause and effect relationship: Individuals form groups, and groups form organizations. They are interdependent. It is very important for a researcher to identify the functional relationships among various components of an organization. A scientific investigation is necessary in studying the cause and effect relationship of variables involved in a business phenomenon.

3. To innovate new ideas: One of the objectives of a researcher is to bring constant improvement in the techniques of his trade. Apart from verifying and testifying the existing assumptions, one of the functions of a research is to add new knowledge to the state of the art. Research invokes the innovation of new concepts, theories and idea in a business study. Apart from this, research also removes and discards worthless theories that are prevalent in the society.

4. To improve the quality: The whole exercise of any activity is done for the improvement of quality of a product, machinery, or life of human beings. For a business organization it is atmost important to improve the quality of its products. This can be achieved by a systematic and critical investigation i.e. research.

Objectives of Research

1. Understanding a business problem
2. Identifying the cause and effect relationship
3. To innovate new ideas
4. To improve the Quality

1.6 Types of Research

Research is a multidimensional activity. It comes in various forms and is used in all social, behavioral, educational, economical and management sciences. According to the approach and method involved in a research, one can classify the following types of research.

1. Descriptive v/s Analytical research

Descriptive research basically describes what is. It mainly involves collection, recording, describing and analyzing the facts related to the study. It tries to find the existing status, trend and state of affairs in a phenomenon. Descriptive research involves surveys, but they are not merely data collection as they also involve measurement, classification, analysis, comparison and interpretation. In this type of research the variable under study are uncontrollable. One can only observe and report what is happening in a situation.

Analytical research, on the other hand deals with what will be. In this type of research, the variables involved are carefully and scientifically controlled and manipulated. Analytical research is also known as experimental research and is a very sophisticated technique. This kind of research is based on four important characteristics namely; control, manipulation, observation and replication.

2. Applied v/s Fundamental research

Applied research is action oriented or solution oriented. The main goal of an applied research is to obtain an immediate, specific and practical solution of a problem that a business organization is facing right now. It gives here and now solutions in actual problem situations. It involves scientific investigations but the methods are not so rigorous as in fundamental research. It finds solutions to be applied in local environment and they may not be universally acceptable. Applied research does not promise to add new knowledge to the discipline.

Fundamental research is carried out to scientifically enhance the organized body of knowledge of a discipline. Also know as basic research, it is concerned with formulation of theory and generalizations of principles. To evaluate and expand a formulated theory it may use empirical data. Basic research involves systematic, highly sophisticated scientific techniques. Fundamental research may not suggest the solutions of immediate problems, it rather draws long term conclusions.

3. Quantitative v/s Qualitative research

Quantitative research is based on quantitative variables, which can be measured in appropriate units. These involve objects and individuals that vary in size, quantity, amount, scale or degree. For example, prices of commodity can be measured in rupees,

weight of a product is measured in kilograms and the mileage of vehicle is measured in kilometers per liter.

Qualitative research, on the other hand, is based on qualitative variables, which vary in quality of type. These variables cannot be measured on a scale or in any units. Social scientists use qualitative research for studying human behaviour. In market research surveys qualitative research is carried out to investigate the likes and dislikes of customers. It helps in understanding the current pattern of demand of a company's products.

4. Conceptual v/s Empirical research

Conceptual research involves the development of new theories, abstract ideas, and generalized principles. Philosophers, intellectuals and thinkers carry out this kind of research. On the basis of their conceptual knowledge they build theoretical models. Conceptual research is an intellectual process to develop and verify knowledge.

Empirical research is based on observation and experimentation. The information collected in the form of facts develops the conclusions and theories about a phenomenon. The models, so developed, can again be verified by a replication of data collection. To test a given hypothesis empirical research is most popular and powerful tool in the modern world.

5. Other types of research:

Any research study is derivation of one or the other of above four types of research. One can further classify a research on the basis of its purpose, time taken and the discipline of knowledge it relates to. For example, *Historical research* is the study of past events, historical documents, remains and relics. *Clinical research* is employed to study the effects of a new drug. *Market research* is performed to forecast the potential demand of a product. *One- time research* is carried out on a small scale in short period with a specific purpose. *Educational research* is directed towards the study and development of educational system. *Social research* is concerned with the social problems of the society. *Field research* is done by going out in the field or market, where as *Laboratory research* is carried out with in four walls of a laboratory.

Types of Research

1. Descriptive v/s Analytical research
2. Applied v/s Fundamental research
3. Quantitative v/s Quantitative research
4. Conceptual v/s Empirical research
5. Other types of research

1.7 Research Process

Research is a search for knowledge. It helps in taking appropriate decisions. Research involves asking a question and then trying to find an answer to it. Research is essentially a systematic, scientific and structured inquiry seeking facts through objective methods. Therefore a research must have a clearly defined step-by-step process. A knowledge of the research process is essential both for those who conduct the research and for those who wish to be benefited by the conclusions drawn from the research. A meaningful knowledge should have a definite purpose and direction.

In developing a research process, one would like to list the sequence of step-by-step activities. In a research process these steps are inter- dependent and may overlap each other. They may not follow a strict sequence and the researcher has to be vigilant of their order continuously through out the research process. However, one can broadly enlist the main steps involved in a research process as a procedural guideline to the researcher. These steps are:

1. Problem formulation
2. Literature survey
3. Development of hypothesis
4. Research design
5. Choice of sample design
6. Data collection
7. Analysis and interpretation of data
8. Hypothesis testing
9. Interpretation of results
10. Report writing

The above procedure can be depicted in a diagrammatic form as shown in the flowchart in figure 1.1. A brief description of the above steps is given below.

1. Problem formulation

Formulation of a problem is the first and foremost step in a research process. It is not always easy to identify and define a problem in an ever-changing business environment. A researcher not only discovers and defines a problem area but also a specific problem within that area concerning his interest in business. The problem should be clearly and precisely stated. The statement of the problem must be complete.

The problems in a business may sometimes be obvious and one can pinpoint them. Many a problems is not so apparent and needs explorations. Thus, first of all one has to identify a problem specifically and thoroughly, and then it has to be expressed in scientific terms so that statistical analysis can be performed on that problem.

2. Literature survey

After the formulation and identification of a problem, the next important step is the review of literature survey. An exhaustive and critical review of professional literature familiarizes the researcher with the current state of knowledge. It helps in understanding of the problems and hypothesis that others have studied. It clarifies the concepts, theories, major variables involved, operational definitions and research methods used in the past. This contributes to the cumulative nature of scientific knowledge.

Every year thousands of articles, books and monographs are published in any field of study. Therefore, it is important to sort out the relevant literature connected with the field of one's interest. It is best to begin any search for literature with one of the guides to published literature. These guides are increasingly computerized and include bibliographies, indexes and abstracts.

With the advent of Internet the modern life has changed drastically. One can find an ocean of information within the four walls of one's study room through Internet. Some of the popular search engines like google, yahoo and rediff are becoming more popular in searching for literature on any topic.

3. Development of hypothesis

Once a problem is defined and a review of literature is made, the next step is to define clearly the hypothesis in a research problem. A hypothesis is a tentative assumption in a research problem, which has to be tested empirically with the help of observed data. When formulating a hypothesis, a researcher does not know whether it will be rejected or accepted. A hypothesis is constructed and tested; if it is rejected, another one is formulated; if it is accepted, it is incorporated in the scientific body of knowledge.

One should arrive at a clear and specific working hypothesis for which research methods already exist. A good hypothesis states a research problem in concise and precise terms so that the researcher is focused on the problem at hand.

4. Research design

A research design is a well-defined plan of action. It is a planned sequence of the entire research process. It is a blue print of research activity. In a big business scenario designing a research study is very complex. Therefore, a research design may change during the operation of a project. A good research design must use minimum of resources like time, money and manpower. A research design must be able to translate the general scientific model into a practical research operation. A scientifically developed research design possess the characteristics like (i) objectivity (ii) Reliability (iii) Validity (iv) Generalization .

5. Choice of sample design

In any investigation the group of all items, objects or individuals under study is called 'population' or 'universe'. For all purpose of determining population characteristics, instead of enumerating entire population, some items of the population, called a sample, are observed. Then the sample characteristics are utilized to approximately determine or estimate the population. For example, on examining the sample of particular product, we arrive at a decision of purchasing or rejecting that product. There will be surely some error in such an approximation and is inherent and unavoidable in any and every sampling scheme. But samples results in considerable gains in terms of time, money, accuracy and efforts.

Drawing a sample of some predetermined size from an entire population is not a child's play. These have to be a systematic plan to choose the sample items. This plan or a technique of drawing a sample is known as sample design or sample plan or sampling technique. Researchers have suggested various sample designs. One research situation may be different from another, therefore, simple random sample, though most popular, may not be suitable in each case. Depending on the requirement of a situation one can choose one of the following sample designs:

1. Purposive or Judgment Sampling
2. Simple Random Sampling
3. Stratified Random Sampling
4. Systematic Sampling
5. Cluster Sampling
6. Area Sampling
7. Multi-stage Sampling
8. Multi-phase Sampling

6. Data collection:

Once a sample design is formulated, the next step in a research process is the collection of relevant data. There can be two sources of data (i) *Internal data*, that refers to the happenings and functions of a business organization. For example, the sale-purchases details of a company. (ii) *External data*, which is related to outside sources and external agencies. There are two types of data (a) Primary data (b) Secondary data. *Primary data* are those observations, which are collected by an investigator for the first time, *Secondary data* are already available in the records and have been collected by some other researcher for the purpose of studying a similar problem.

Methods of collecting primary data are:

(i) by direct observation and experimentations
(ii) by direct personal interview
(iii) by direct interviews through phone, sms and email.
(iv) by indirect personal interview
(v) by mailed / emailed Questionnaire
(vi) by schedules through enumerators

Methods of collecting secondary data:

(i) International organizations like WHO, UNO etc.
(ii) Government publications like economic survey, CSO, NSSO.
(iii) Journal and Newspapers
(iv) Research articles
(v) Reports of business organization and financial institutions.

A method and source of data collection is chosen by an investigator taking into account the objectives and requirements of the inquiry. The adopted method should incur minimum cost and time should have a reasonable level of accuracy and unbiasedness.

7. Analysis and interpretation of data

After the collection of data, what we have is a huge chunk of observations and numerical values. The data at the beginning are in raw form. For the purpose of applying further statistical techniques, one has to put the raw data in a useful form by classification, tabulation and categorization of data. If one has to feed the data in a computer, the data should bear the same form as required by the software used. This kind of processing of data involves one or more of the following activities:
(i) coding (ii) labeling (iii)editing (iv) tabulation (v) classification.

8. Hypothesis testing

After analyzing and processing of data, it is time now to test the hypothesis that were formed in step 3 of the research process. A hypothesis is skeptically formulated regarding the relationship between phenomena and variables involved in a study. Then by empirical investigation the hypothesis is tested for possible acceptance or rejection. In other words, the researcher decides on the basis of the observed facts that he has collected, whether or not an assumption is valid. A hypothesis is tested by making use of a predefined decision rules established in statistical methods. Some of the popular statistical tests are, Z- test, Chi- square test, t- test and F- test.

In a situation where no hypothesis is formulated in a study, the observations are made on the data directly and conclusions are drawn to formulate new generalizations and assumptions for future purposes.

9. Interpretations of results

After the data collection and testing of hypothesis one has to reach to the conclusions of the research study. These conclusions are the most vital outcomes of the study and have to be dealt with very carefully. On the basis of findings of the research work done we draw inferences about the phenomenon under study. This is a useful activity as without any outcome a research study is fruitless. The results obtained from the analysis of data are to be interpreted skillfully. A wrong interpretation my lead to wrong decisions. Interpretation may also lead to generalizations of the phenomena

understudy. It may also help in developing new theories and can suggest new research problems to be explored in future.

10. Report writing

Last but not the least is the step of reporting the facts and findings of the research study. A report is a summary of the whole research process. The layout of a report must be attractive. The words used in the text must be easily comprehensive to a reader. Even a non- technical person understands a good report. In the beginning of the report one should give the title, time period of work, acknowledgement and preface. In the main text an introduction to the problem, summary of findings, results and inferences, and then the recommendations of the researcher are given. The report should conclude with appendices, bibliography and a subject or / and author indexes.

1.8 Significance of Research

In any scientific inquiry research has been the most powerful tool for knowledge seeking people. Research is a kind of power with which one can foresee the implications of a particular phenomenon. Research is all pervading and is used in every discipline of study. Some of the applications of research are listed below.

1. *In psychology,* research is done to study psychological, cultural and motivational factors of different types of persons.
2. *In sociology,* research studies are performed to analyze changing relationships among age and sex groups, emerging class patterns, social mobility and social values etc.
3. *In economics,* planned development of a country and an organization is achieved through research. It helps us in deciding the wages, salaries of all employees, profit and risk involved in a business activity, and the effects of government policies on the economic structure.
4. *In geography,* research is used to study environmental control, climatic complexities, geographical appraisal of a country's foreign policy, geographical patterns of changes in agricultural wastelands.
5. *In education,* research helps in the improvement of teaching methods, inter-relationship of teachers and students, expenditure share of primary, technical and higher education.
6. *In medical science,* clinical trials are performed to study the effects of medicine. No medicine or medical treatment is accepted by medical associations without completing a thorough research process on the medicine or treatment.
7. *In the field of business management,* marketing research is the backbone of marketing a product. Before launching a new product, market surveys are conducted to identify the needs and satisfaction level of customers. It helps not only in solving existing problems but also in identifying new opportunities. In every manufacturing industry there is a research and development section, which is involved in improving the quality of products. Research is carried out in production units to decide the amount, time and potential customers of its

products. Research methods are applied in statistical quality control and maintaining the optimum inventory level. For a human resource manager it is important to have the knowledge of its employee's, salary structure, and satisfaction level, cost of living performance appraisal. The HR department achieves the objective through research studies

8. *The government* cannot function without having clear and true picture of what is happening in its state with its subjects. Every government department has a research officer with separate section on research. The collection of data is done round the year in every department and the government policies, budget, development programs take shape on the basis of these research surveys.

Significance of Research

1. In psychology
2. In sociology
3. In economics
4. In geography
5. In education
6. In medical science
7. In business management
8. In government functioning

1.9 Problems Encountered by Researchers

Research plays a vital role in the development of a country or business organization. The developed countries are developed because they have strong research support system. In India the state of research was not very good before independence. The government realized the importance of research in framing the policies for the development of the country later on. In the modern times the business organizations have realized the importance of research in last three to four decades only. India being a developing country is striving hard to achieve higher levels of research. But , Researches in India face several problems are listed below.

1. Lack of skilled researchers:

Research is a scientific and systematic investigation into a problem. In India there is scarcity of competent researchers due to the lack of scientific training in research methodology.

2. Lack of code of conduct

The researcher in India does not have a well-defined code of conduct. They do not have ethical or moral guidelines for becoming good researcher. Therefore, they often face non-co-operation in team members. There is a clean need of proper distribution of work, assignment of responsibility and answerability and a well-defined code of conduct for researchers in India.

3. Insufficient interaction

There is a wide gap between university research departments, other research institutions, and the policy-making bodies. This leads to the confusion for research workers what data are to be collected and analysis to be performed. The policy maker should provide a well-defined problem and a guideline of the data to be collected, to the researchers. There should be regular meetings of the decision makers and the field researchers.

4. Overlapping research studies:

Due to the lack of proper information and inter-departmental interaction many times there is a duplication of research studies. Some time two or more research studies overlap one another leading to confusion and misleading results.

5. Lack of confidence

In India we lack confidence in research organizations and its people. Business organizations are reluctant to provide information about their companies for it may be misused. In the surveys of individuals common public is shy or secretive in providing personal information. Therefore, research organizations in India will have to win the confidence that the data obtained from companies and individuals will be kept strictly confidential and will not be misused.

6. Lack of funds and facilities:

In a developing country like India research is kept at a last priority where as for fast and organized development research should be first priority. Researcher in India face the difficulties of lack of funds, secretarial assistance, trained staff and computational facilities. Efforts should be made to provide and meet the requirements of research studies by the government agencies as well as business enterprises.

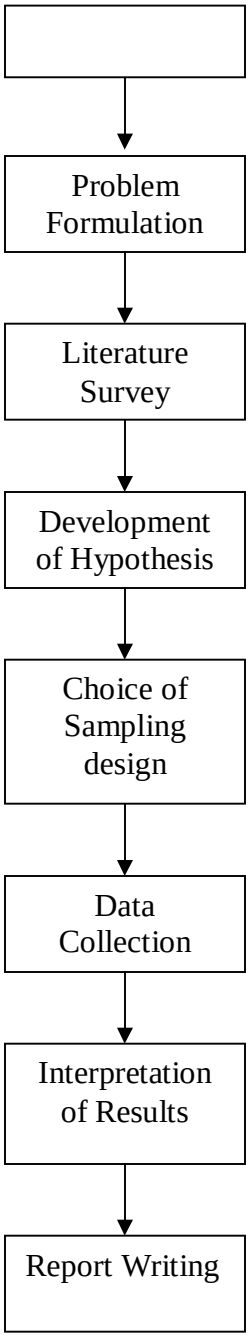
7. Lack of literature:

The management of published data is quite poor in libraries and other official sources. The researcher has to spend unnecessarily a lot of time in tracing books, journals and reports relevant to his study. Even the supply of government publications is not timely and regular. Through Internet has given some relief to researchers and a lot of research material is available on Internet. But authenticity of data on Internet is doubtful.

Problems Encountered by Researchers

1. Lack of skilled researchers
2. Lack of code of conduct
3. Insufficient interaction
4. Overlapping research studies
5. Lack of confidence
6. Lack of funds and facilities
7. Lack of literature

Figure 1.1
The Research Process Flowchart



Unit I
Introduction to Research Methods

Exercises

Write short notes on the following:

1. Meaning of research
2. Role of research in business
3. Objectives of research
4. Types of research
5. Literature survey
6. Interpretation of results
7. Report writing

Short answer type questions

1. Define scientific method of investigation and distinguish it from non-scientific method of investigation.
2. Enlist various characteristics of research.
3. Distinguish between
    (a) Descriptive and analytical research
    (b) Applied and fundamental research
    (c) Conceptual and empirical research
    (d) Quantitative and qualitative research
4. Describe briefly the research process and its stages.

Long answer type questions

1. What is the meaning of research? Explain its significance in business organizations.
2. Give various definitions of research explaining its meaning and scope.
3. "Many a time management is not convinced about the utility of research and regards it as an unnecessary activity over which no funds should be spent". Comment on this statement explaining the objectives of research.
4. Describe in detail various types of research.
5. Describe the steps involved in research process with suitable examples.
6. "Creative management, whether in public administration or private industry, depends on methods of inquiry that maintain objectivity, clarity, accuracy and consistency". Discuss this statement and examine the significance of research.

Unit II (a)
Research Design

Unit II (a) (Syllabus)

(a) Research Design: Selecting and defining a research problem, need for research design, features of a good research design, different research designs (exploratory, descriptive experimental and diagnostic research).

2.1 Meaning of Research Problem

Research is a scientific, systematic and purposeful search, for new knowledge or for re-interpretation of existing knowledge. It is a journey, which starts with a problem and ends with a solution. Identifying a research problem is the first and foremost step in a research process. The statement of research problem is the axis around which the whole research revolves, because it explains in brief the aims and objectives of the research.

A research problem is a specific statement in the general area of investigation. It is a precise identification of a problem situation in a certain context involving what, why, who, where and when of the problem area.

Who– means the person or business organization that is facing a problem.
Why– means that there is a purpose, goal aim or objective to solve this problem.
How– means the options of actions one can take to solve the problem.
When– means the time frame in which the problem is to be solved.
Where–means the environment in which the problem exists.
What– means the optimum action that is to be taken in solving the problem to attain the best results.

2.2 Selecting a Research Problem

The old saying goes, "Necessity is the mother of invention". A research study is another form of invention. Thus, if there is some necessity or a difficulty a business organization is facing, it forms a research problem that is to be investigated in order to fulfill that necessity or remove that difficulty. However, simple it may look, but selecting a research problem is a big problem in itself. Specially, when there is no apparent problem in an organization or when a students wants to select a research problem for the purpose of a dissertation or thesis for a degree or a diploma it becomes utmost important that the research problem must be very carefully chosen. Some of the guidelines that researcher must follow in selecting a research problem are listed below.

1. Sources of problems: First of all one should look at the sources from which one can select a research problem. Those may be readily available problem that has been identified by a person or an organization. If that is not the case, one can make use of the experience of experts of that field. The survey of related literature may also help in selection of a research problem.

2. Potential to be a research problem: One must ensure that the problem one has undertaken has potential to be called as a research problem. One should avoid trivial or meaningless problem. A research problem must provide solution to an existing problem or contribute to the body of knowledge.

3. Select non-controversial issues: Unless the problem is specifically related to issues such as religion, dogmas, beliefs, sexual preferences etc; one should try to avoid taking up controversial subjects.

4. Researcher's interest and competency: In selection of research problem a researcher should choose a topic of his own field of study in which he has independent mastery in both the subject and method. The problem should sustain his interest, stimulate his imagination and should be within the range of his competencies.

5. Resources available: To conduct a research study various resources are needed. A researcher must ensure the following points about the inputs of the problem:

(a) Time: The study must be completed in the allotted time frame.
(b) Funds: The amount of funds available from the sponsoring agencies must be known in advance and the study must be completed within given budget.
(c) Size of research: The size of the investigation must be manageable and should not be too large to handle. It should also not be too small to appear as a trivial problem.
(d) Co-operation of others: A researcher must ensure the necessary co-operation of colleagues and operational help of administrative authorities is available to the problem he is selecting.
(e) Literature and Material: Related literature is readily available to compare and support the research findings.
(f) Obtainable data: The selection of a problem should be such that the information or data needed for it is either readily available or obtainable.

In short a researcher must select a research problem of his area of interest and should ensure the availability of all the comments needed to conduct the study. The consultation and guidance of experts, who have experience in that area, is a must. A researcher must seek help of such supervisors and guides in selecting a research problem.

Selecting a Research Problem

1. Sources of problems
2. Potential to be a research problem
3. Select non-controversial issues
4. Researcher's interest and competency
5. Resources available
    (a) Time
    (b) Funds
    (c) Size of research
    (d) Co-operation of others
    (e) Literature and Material
    (f) Obtainable data

2.3 Defining a Research Problem

Research is a disciplined approach to inquiry. It is a tool for testing as well as generating theories. Every research plan is unique in itself and has its unique research problems. An old saying is, " a problem well defined is a problem half solved".

By defining a research problem we mean a systematic way of asking and answering research questions. Meaningful, productive and useful research depends on the development of appropriate research questions, the identification of appropriate constructs and confidence we can have in our findings. There are two main steps in defining a research problem:

1. Formulation of the problem
2. Establishment of research objectives

Formulation of a problem is the most important step in a research process. A clear statement of the problem is a key to good research. A firm may spend hundreds or thousands of rupees cunducting research, but if it has not correctly identified the problem, this money is wasted. A clearly formulated research problem must answer all questions of the type Who, Why, How, When, Where, and What, regarding a research study.

With the problem or opportunity defined, the next step is to set objectives for research operations. Clear objectives can lead to clear results. Research objectives, related to and determined by the problem formulation, are set so that when achieved they provide the necessary information to solve the problem. A good way of setting research objectives is to ask, "What information is needed in order to solve the problem?" Your objective might be to explore the nature of a problem so you may further define it, or perhaps it is to determine how many people will buy your product packaged in a certain way and offered at a certain price. Your objective might even be to test possible cause and effect relationships. For example, if you lower your price, how much will it increase your sales volume? And what impact will it have on your profit?

The problem description, the research question, sub questions and the research objectives are part of an overall definition of a research problem.

2.4 Meaning of Research Design

A research design is a controlling plan for a research study in which the methods and procedures for collecting and analyzing the information to be collected is specified. It is a framework or plan for study that guides the collection and analysis of data.

The word 'design' means to work out the structure of form', as by making a sketch or plan. Thus, 'Research Design' is planning a strategy or drawing a blue print of conducting research. It is a guideline for collecting and utilizing data so that desired information can be obtained with sufficient precision and hypothesis can be tested properly. A research is designed for the purpose of producing results

that may be applied to real world situations. It not only enables a researcher to anticipate potential problems that can occur during the actual operation of the research, but also to limit boundaries of research study.

Definitions of Research Design

Some of the popular definitions of research design are:

1. "Research design is the planned sequence of the entire process involved in conducting a research study." By Miller.
2. "Research design is a catalogue of the various phases and facts relating to the formulation of a research effort. It is an arrangement of the essential conditions for collection and analysis of data in a form that aims to combine relevance to research purpose with economy in the procedure". By Selltiz and others.
3. "A research designates the logical manner in which individuals or other units are compared and analyzed, it is the basis of making interpretations from the data". By Anonymous.
4. "Also known as a market research briefing, this is a basic plan which guides the data collection and analysis phased of the research project. It acts a frame work which details the type of information to be collected, the data sources and the data collection procedure". By Market Intelligence Group, India

In short, research design is a plan of what data to gather, from whom, how and when to collect the data, and how to analyze the data obtained.

2.5 Need for Research Design

Research is a scientific investigation of a problem for which we need a systematic planning of research. For a successful research we need a research design because it includes (i) the formulation of a strategy to resolve a particular question (ii) the collection and recording of information and evidence (iii) the processing and analysis of these data and their interpretation and (iv) the publication of results.

A research design states structure and process of conducting a research process. Thus, it shows a path to researcher without which he may be lost or confused as to what next step he has to take. More so, it also takes care of budget and time frame of the research study. All this planning can only make a research study a success story.

2.6 Features of a Good Research Design

It is a challenge to translate general scientific model into a practical research operation. Therefore, designing a research study is not a simple task. There is

nothing like completely correct design or completely incorrect design. A design may work very well for one research problem and may not work at all for the other. There are some features, however, a good research design should posses. They are:

1. *Freedom from bias:* A good research design should ensure that the method of data collection and analysis would not cause the data to vary in a systematic way. That is to say that the data should be free from systematic errors.
2. *Freedom from confounding:* In a good research design the variables involved in the study are separated from each other so that they do not influence each other.
3. *Control of extraneous variables:* In a well-designed research study the variables that are not under scrutiny do not influence the experimental variables in a systematic way for example things like temperature, time of day etc.
4. *Statistical precision for testing hypothesis:* A research design should ensure that the data are recorded at a level of precision that will yield statistically meaningful results.
5. *With in resources:* A design should draw limits of a research study so that it could be completed within available resources like time, money and staff.
6. *Optimality:* The best research design is one, which yields maximum precision in terms of bias and variance using minimum resources in terms sample size, time and money.
7. *Objectivity:* If operated by more than one researcher a good research design obtains same results. Thus, a good research design should be free from the subjectivity of its performer.
8. *Flexibility:* It is often observed that one has to deviate from the basic research design during the operation of the research study due to real world problems. A good research design is one, which not only has the potential to predict such practical problems, but also is flexible enough to incorporate changes in it whenever needed.

Features of a Good Research Design

1. Freedom from bias
2. Freedom from confounding
3. Control of extraneous variables
4. Statistical precision for testing hypothesis
5. With in resources
6. Optimality
7. Objectivity
8. Flexibility

2.7 Different Research Designs

After the formulation and definition of research problem, the next step is to choose an appropriate research design. Every research study is unique in itself, but there are certain things common in these studies. On the basis of these commonalities one can categorize the research studies by research methods and procedures used to collect and analyze data. Accordingly a research design is chosen. There are three basic types of research designs:

1. Exploratory
2. Descriptive or diagnostic research design
3. Causal or Hypothesis testing or Experimental research design

1. Exploratory

Exploratory research is defined as collecting information in an unstructured and informal way. For example, a restaurant owner may regularly visit other competing restaurants in order to gather information about menu selection, prices and service quality.

In exploratory type of research, the investigation may be conducted because a problem has not been clearly defined. It helps in determining the best research design, data collection method and selection of subjects. Usually exploratory research is qualitative in nature. Some times exploratory research may even conclude that a perceived problem does not actually exist.

Generally an exploratory research design helps in finding out the feasibility of the research problem, getting familiar with various components of the study, generating new ideas, and formulating the hypothesis. Exploratory research designs are of different forms depending on the nature and objectives of the study. The following three forms are most popular:

(a) Literature Survey: In any research, review of literature is an essential part. The literature survey is carried out at a preliminary stage of the research. Through the review, one understands the work that has already been done and what more can be explored in one's chosen field. The theories and techniques used in the existing literature can be used in the present analysis or these can be modified to give better results.

The literature are the documentary sources of information which are contained in the published and unpublished documents, reports, statistics, manuscripts, letters, diaries, and so on. It is important for scientific workers to scrutinize these sources very closely. Since not all documents can be consulted, it is best to start a selective process early. The theory and techniques of the literature must serve useful purpose in the present study. And, their meaning should not have altered with changing circumstances with the passage of time.

(b) Expert Survey: Expert Survey or experience survey means consulting the experienced researchers who are experts in the field of study. One should not be shy in taking advice and guidance of such people. They should be given sometime with the problem before asking them questions about the study, so that they can give their opinion after a good thought on the problem.

(c) Example Survey: In case of a new type of studies sometimes neither much literature nor expert advice is available. In such situations it is advisable to go through some case studies performed in the past. This refers to 'insight stimulating examples'. Single cases or a group of cases, as may be relevant to the research study are selected and studied in order to collect data for main study.

2. Descriptive or diagnostic research design

Descriptive research refers to a set of methods and procedures that describe the study variables. Descriptive studies portray these variables by answering who, what, why and how questions. These types of research studies may describe such things as consumer's attitudes, intentions, behaviors or the number of competitors and their strategies.

Descriptive research is also known as statistical research or diagnostic research. It describes data and characteristics about the population or phenomenon being studied. The description is used for frequencies, averages and other statistical calculations.

The process of conducting descriptive research can be linked to that of passing an idea through an hourglass. The research starts with a consideration of the larger issues of interest, and these are then narrowed into a specific questions (hypothesis) that can only be evaluated with some degree of control. The components of the hypothesis are operationalized into observable units and behaviors to ensure that the independent and dependent variables can be observed and measured. Research is then conducted to observe the relationships of interest, in the context of the specified research environment. Observations are made, and data are collected to reflect behaviors, changes and other indicators of interest. The data are filtered and analyzed in order to generate conclusions that may support or refute the hypothesis, and then everything is considered in the context of the bigger picture, which usually includes reference and association to the board issues that started the process.

Although data description is factual, accurate and systematic, the research cannot describe what caused a situation. Thus, descriptive research cannot be used to create causal relationship where one variable affects another.

3. Causal or Hypothesis testing or Experimental research design

Causal research designs are used in hypothesis testing research or experimental research studies. This type of research design is conducted by controlling various factors to determine which factors are causing the problem. It isolates causes and effects. By changing one factor, say price you can monitor its effects on a key consequence such as sales. Although experimental research can give a high level of understanding of the variables under study, the designs often require experiments that are complex and expensive. Some of the popular experimental designs are: (a) Completely randomized design (b) Randomized block design (c) Latin square design (d) Factorial design.

Different Research Designs

1. Exploratory
   (a) Literature Survey
   (b) Expert Survey
   (c) Example Survey
2. Descriptive or diagnostic research design
3. Causal or Hypothesis testing or Experimental research design
   (a) Completely randomized design
   (b) Randomized block design
   (c) Latin square design
   (d) Factorial designs

Unit II (a)
Research Design

Exercises

Write short notes on the following:

1. Meaning of research problem
2. Problem of defining a research problem
3. Formulation of a research problem
4. Potential to be a research problem
5. Need for research design
6. Flexibility in a research design
7. Expert survey
8. Example survey

Short answer type questions

1. How do you define a research problem? Give an example to illustrate your answer.
2. Explain the necessity of defining a research problem.
3. Discuss various issues involved in selecting a research problem.
4. Elaborate important features of a good research design.
5. Explain exploratory research design with example.
6. "Descriptive research design answers who, what, why and how questions". Discuss.

Long answer type questions

1. What is a research problem? Define the main issues, which should receive the attention of the researcher in formulating the research problem. Give suitable examples to elucidate your points.
2. Give various definitions of research design explaining its meaning.
3. What is a research design? Explain the major types of research designs.
4. "Research design is the planned sequence of the entire process involved in conducting a research study". Discuss.

Unit II (b)

Design of Sample Survey

Unit II (b) (Syllabus)

Design of Sample Survey: Census V/s Sample enumerations, objectives and principles of sampling, Types of sampling, Sampling and Non-sampling errors. Designing Questionnaires and interview. Determination of the sample size.

2b.1 Introduction

In a research study once the problem is define and a research design is prepared, the next step is to collect data on items or individuals related to the study. Collecting information on all the items, objects, individuals or organizations is a huge task involving a lot of money, time and staff. It is a therefore, sounds reasonable to study a portion of these items and try to draw conclusions on all of them. This is called Sampling.

A population is defined as the totality of all possible values (measurements or counts) of a particular characteristic of interest for a specified group of objects or persons. This specified group of objects is also called a *'universe'*.

A population is called finite if it consists of a finite and fixed number of individuals or elementary units. A population will be called infinite if this number is infinite or statistically very large. For example, students in your university in a particular year constitute a finite population, whereas the number of leaves on a big tree will constitute an infinite population.

As mentioned above it is not always possible, or very expensive and time consuming to study the whole population. We therefore, take out a representative portion of the population, called a sample, and investigate all the items in the sample thoroughly. It results in saving time, money and staff and leads to more accuracy in observation.

2b.2 Census v/s Sample Enumeration

Census survey

If we study each and every unit of a population, it is known as a population survey or census survey. In a census investigation, intensive information is obtained from each and every item; thus, many facets of the problem are brought to light. This type of inquiry is suitable where scope of enquiry is limited, the population contains units having different characteristics, intensive study of each unit is required, the greatest accuracy is expected and the resources of the investigator are sufficient.

Though, the data collected through census method are more true and reliable, it is appropriate only when units of the population are of diverse characteristics or when population is not too large. Census method of investigation is costly and much time consuming. It needs a big organization to handle the investigation. Moreover, it is

sometimes impossible to make the census survey when the investigation involves destruction of items, like testing of blood in human body. It is therefore, statisticians suggest, studying only a part of the population and calling it sample survey.

Sample survey

In our daily life we adopt the sampling techniques almost every moment of our existence. We go to the market and examine a sample of wheat to form an idea about the quality and then decide whether the quality of the whole lot is acceptable or not. We examine a few beads of rice from the bowl on the stove, to check if the rice is cooked or not. We meet a person for a short while, and form opinion about his character and personality. The sampling procedure is based on the assumption that a part of the aggregate represents well the whole population. Sampling is the selection of a part of the population for the purpose of drawing conclusions about the entire universe.

In a sample survey only a selected group of individuals from a population is surveyed and studied. A sample consists of a small collection from larger aggregates about which we seek information. The results obtained from the study of the sample are applicable to the whole universe from which the sample is taken. For example, in order to know the per capita income of a city we study a few households of different income groups of the city. To know the quality of crackers, we burn a few of them out of the lot.

Thus, the basic difference between sample and census enquiry is, that where as in a sample enquiry, only a part of the population is observed and there from conclusions for the whole population are drawn. The basic aim of sampling is to obtain maximum information about the phenomena under study, with the least use of resources like money, time and manpower.

Advantages of sampling over census

It is difficult in most of the cases to take up census enumeration for lack of time money, trained personnel and other constraints. Some of the advantages of sample survey over complete census are as follows:

1. *Less Time:* There is considerable saving in time and labour since we study only a portion of the population in a sample survey. The sampling results can be obtained more rapidly and the data can be analyzed much faster since relatively fewer data have to be collected and processed.
2. *Less Cost:* Sampling certainly results in reducing the cost of survey in terms of money and man- hours. Although the amount of expenses involved in collecting information is generally greater per unit in a sample than in a complete enumeration, the total cost of sample survey is expected to be much smaller than that of a complete census. Since in most of the cases funds are limited in research study, sampling helps in reducing the costs of data collection.
3. *Greater Accuracy:* The results of a sample survey are usually much more accurate and therefore, more reliable than those obtained from a compete census. The

errors due to factors such as training of field workers, measuring and recording observations, location of units, bias due to interviewers, incompleteness due to non-response etc. will certainly be larger and therefore more serious in a census than in sample survey.

4. *Greater Scope:* Sample survey has usually greater scope than census survey. Some inquires may require highly trained personnel or specialized equipment for collection of data, thus making a census practically impossible, or even inconceivable. In a sample survey we may have greater coverage both in respect of the information collected and in respect of the geographical, demographic or other boundaries taken into account.
5. *Census is impossible:* There are many situations in which complete population survey is impossible and one has to resort to sample survey only. Some of such situations are: (a) if the population is infinite or too large to be observed. (b) if the population is hypothetical like the population of all throws that may be made with a coin. (c) if the nature of experimentation is destructive to observe the desired information, like observing the life-length of electricity bulb, or sound of crackers etc.
6. *Administrative Convenience:* The organization and administration of sample surveys are easy as one can choose the units of the sample in such a way that their investigations are administratively convenient. For example, if we wish to choose five districts of Uttar Pradesh, we choose two near by districts from western U.P. and three adjacent districts from eastern U.P., instead of choosing five randomly from all over the U.P.

Remark

If the information is required about each and every unit of the universe, there is no way but to conduct census survey. Moreover, if time and money are not important factors or the population is not too large, a complete census may be better than a sample survey.

Advantages of sampling over census

1. Less time
2. Less cost
3. Greater accuracy
4. Greater scope
5. Census is impossible
6. Administrative convenience

Limitations of sampling

The sample survey has its own limitations, as only a part of the population is studied in sampling. Sampling is not always preferred to a census survey. Sometimes, the sample must be so large in order to achieve the required accuracy, that one might as well

do the census survey. At other times complete accuracy is desired and a census must be done. Sample survey has the following limitations:

(a) Sample survey is not suitable if higher order accuracy is required.
(b) If the items of the sample are not selected without any bias, the conclusions may not be correct.
(c) The investigator's personal bias regarding the choice of units and drawing of sample may lead to false conclusions.
(d) Sample investigation method is not suitable if the information is required about each individual of the population.
(e) Sample survey is a specialized technique and every body cannot use it. Its use requires specialized knowledge and trained personnel.

2b.3 Objectives of Sample Survey

Before choosing an appropriate sample design, we must clearly enlist the objectives of the survey and those of the research study. Without this, it is easy in a complex survey to forget the objectives when engrossed in the details of planning and execution of the survey.

It is the objectives of the survey (or research study) that guides the researcher in deciding the important factors like definition of population, sample size, type of data to be collected, degree of precision required, methods of measurement, sampling technique and the organization of field work.

2b.4 Principles of Sampling

Sampling is a method of drawing inferences about the population by studying only a part of it. Scientific and systematic methods are needed to develop sample design. The techniques of sampling are based on following principles:

1. *Principle of Statistical Regularity:* The principle basically states that, "Other things being equal, as the sample size increases, the results of sample survey tend to be more reliable and accurate". This principle stresses the desirability and importance of selecting the sample at random so that each and every unit in the population has an equal chance of being selected in the sample.
2. *Principle of Validity:* By validity of a sample design we mean that the sample should be so selected that the results can be interpreted objectively in terms of probability. The samples obtained by the technique of probability sampling satisfy these principles.
3. *Principle of Optimization:* Efficiency of a sample design is measured by the inverse of the sampling variance of the estimator. Cost is measured by expenditure incurred in terms of money and man-hours. The principle of

optimization consists in achieving a given level of efficiency at minimum cost and obtaining maximum possible efficiency with given level of cost.

Principles of Sampling

1. Principle of Statistical Regularity
2. Principle of Validity
3. Principle of Optimization

2b.5 Samp

In the c errors and biases occur. These errors are o ng errors.

Sampling errors

These errors have their origin in sampling and arise due to the fact that only a part of the population is enumerated. These errors do not occur in a complete population survey. Sampling errors can be due to one of following reasons.

(a) Defective sample design: This kind of error arises due to a faulty selection of sampling technique. Using simple random sampling where stratified sampling is required can bring a lot of errors in the research findings. Similarly, biases creep in when a researcher adopts purposive or judgment sampling in which he deliberately selects a representative sample to obtain certain results of his choice. It is therefore necessary to consult an expert statistician in choosing a proper sample design.

(b) Substitution of units: Researchers sometimes substitute one convenient unit of the population when difficulties arise in observing another. This will necessarily lead to some error since the characteristics possessed by substituted unit will usually be different from those possessed by the unit originally selected.

(c) Faulty demarcation of sampling units: In area surveys like agricultural experiments in the field or crop cutting surveys etc., the demarcation of sampling units is at the discretion of the investigator. In such survey, while dealing with border line cases steps should be taken to minimize the investigator's bias. This kind of error decreases if we take larger sampling units.

(d) Improper choice of estimates: If an improper choice of the statistic for estimating the population characteristics is made a constant error creeps in the results of the survey. Exact statistical estimates, in consultation with experts should be used in drawing inferences about the population.

Remark

In most of the situations, sampling errors decrease with an increases in the sample size. In fact, it can be proved statistically that in usually sampling error is inversely proportional to the square root of the sample size. This relationship is depicted in figure 3.1.

Sampling errors

1. Defective sample design
2. Substitution of units
3. Faulty demarcation of sampling units
4. Improper choice of estimates

Non –sampling errors

Sampling errors occur because we infer about the population on the basis of a sample. There are errors which can arise in collecting, processing and analyzing the data irrespective of whether a sample survey is conducted or a complete census is done. These errors, known as non-sampling errors are, thus present both in sample surveys and census enumerations. These errors can occur at any stage of planning or execution of a sample or a census survey. Major sources of non-sampling errors are listed below.

(a) Faulty definitions of objectives: In the beginning of a survey, its objectives should be clearly stated. If the specifications about the data to be collected are inadequate and inconsistent with respect to the objectives of the survey, it will obviously result in errors.

(b) Response- bias: These errors are due to supply of improper or incorrect formulation by the respondent. The respondent may provide wrong information due to (i) misunderstanding of a question (ii) his prestige or status (iii) his self –interest (iv) failure of his memory (v) beliefs and prejudices of the respondent.

(c) Non- response bias: In all the surveys researchers face the problem of non- response. Non- response bias occurs of full information is not collected on all the units in the sample. If a respondent is not traceable or does not respond, even after many reminders, or he is not able to give information on all the questions, then there arise errors due to non-response. In such cases some portion of sampling units is excluded from the sample and this brings in bias in the results of the surveys.

(d) Errors due to interviewers: For a scientific investigation, trained and experienced personnel are required to carry out a survey. An ill trained interviewer may ask a question in such a way that the response of the respondent may be affected. He may also record the answers incorrectly. Some times beliefs and prejudices of the interviewer also influence the results of the survey.

(e) Errors in measurement and publication: The observations made in an experiment may be erroneous if the measuring tool is defective. A careless recording on the part of investigator also causes this kind of error. In the processing of data errors may incur during compilation, editing and coding. Printing and publication errors are also found in the survey reports.

Remarks

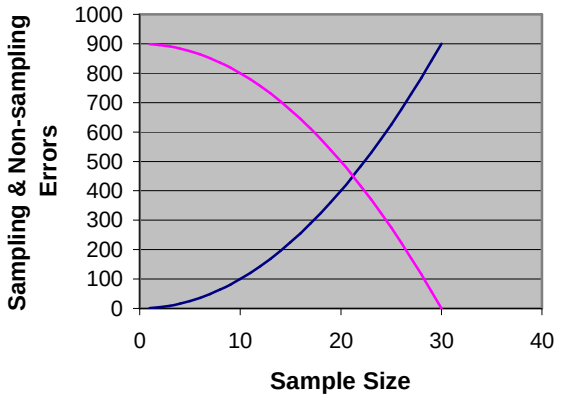
It is obvious that non- sampling errors are larger in a census enumeration than in sample survey. Non- Sampling errors increase with an increase in the number of units in a survey. This has been illustrated in Figure 3.1. As a matter of fact, the amount of non-

sampling errors in a census enumeration is more that the sum of sampling & non-sampling errors in a sample survey, therefore, a sample survey is preferred to census enumeration.

Non –Sampling Errors

1. Faulty definitions of objectives
2. Response- bias
3. Non- response bias
4. Errors due to interviewers
5. Errors in measurement and publication

Figure 3.1



2b.6 Types of Sampling

There are a number of ways of drawing a sample from a population depending on the nature of data and type of enquiry. These sampling techniques can broadly be classified into two headings:

(a) Purposive sampling
(b) Random sampling

(a) Purposive Sampling

This type of Sampling is used with a definite purpose in view. In this sampling method the investigator uses his discretion in the matter of selecting the items that are to be included in the sample. In this kind of selection, the sample entirely depends upon the judgment of the investigator and no formula or principle is followed. A wiser investigator will include those units in the sample, which he thinks are most representative of the population characteristic under study. For example, to calculate the per capita income of a city a wise investigator will choose only a few rich families, more of middle class people and mostly poor people by his own judgment,

to make the sample true representative of the population of the city. This can also be misused if he selects a sample consisting of only rich people in order to show a high per capita income. This is the biggest limitation of this sampling method.

This sampling technique is also known as *Subjective sampling* or *Judgment sampling* or *Non-probability sampling*. In general, this method is not recommended due to element of subjectiveness on the part of investigator. However, if the researcher is an expert and experienced in the art of sampling, he can carefully aply this technique and then, purposive sampling would provide reliable results.

(b) Random Sampling

In order to eliminate the possibility of human prejudice interfering in the selection of a representative sample, the method of random selection has been devised. A random sampling is that in which every item of the population has an equal chance of being selected in the sample. The selection is entirely objective. There are various ways in which a random sample may be drawn. The following are commonly used:

1. Simple random sampling
2. Stratified random sampling
3. Systematic sampling
4. Cluster sampling
5. Area sampling
6. Sub- sampling or Multistage sampling
7. Double sampling & Multiphase sampling

1. Simple random sampling

Simple random sampling is a method of sample selection in which every item of the population has an equal and independent opportunity of being selected in the sample. The selection does not have any personal bias of the investigator. Random selection should not be confused with haphazard selection. There is nothing haphazard about such selection. When we speak of a simple random sample, we use the word random interchangeably with probability not with haphazardness. Random sampling has sometimes been referred to as representative or proportional sampling. If the sample is chosen at random and if the number of cases in it is sufficiently large, it will represent all the groups in the population in approximately correct proportion. Simple random sampling may be with or without replacement, according as a unit selected is replaced or not replaced back into the population before next draw.

There are two methods of selecting a simple random sample:

(i) Lottery method
(ii) Table of random numbers

(i) Lottery method: Under this method all the items of the universe are represented on cards and a blindfold selection is made of these cards. The selection of n (sample size) cards may be made in n draws, one by one. The one by one selection may be with or without replacement. In order to get accurate results, it is necessary that the cards should be similar in size, shape, and thickness, and in all other respects. It is one of the most

reliable methods of drawing a random sample. This will, however, not be practicable if the parent population is large.

(ii) Tables of random numbers: In the recent past, use of random number tables has been frequent for drawing of a simple random sample. A table of random digits is simply a table of digits, which have been generated by a random process. These numbers have been put to all possible tests and have been found to be truly random. With the help of these numbers, the work of selecting random samples has become very simple. What one has to do is to take any table of random numbers and start using the table from any position either horizontally or vertically. But once having started, not a single number should be left out and the order should also not be disturbed.

2. Stratified random sampling

If the population is heterogeneous in nature, that is widely apart in terms of characteristics under study, a simple random sample will not be a true representative of the population. In such cases, the entire heterogeneous population is divided into a number of homogeneous groups called strata or sub-populations. Each such stratum or sub-population is homogeneous with in itself. These sub-populations are non-overlapping and together they comprise the whole of the population. Then units are sampled at random from each of these strata. Generally, the number of units selected from each stratum is proportional to the number of units in that stratum in the population. The sample, which is the set of all the sampling units drawn from each stratum, is called a stratified random sample and the technique of drawing this sample is termed as stratified random sampling.

For example, suppose a college has 10,000 students out of which 5000 are in Arts faculty, 3000 in Commerce and rest 2000 are in Science. If a random sample of size 1000 students is to be drawn for the purpose of calculating their average percentage marks, it is advisable to use stratified random sampling. In this case, a sample to be chosen from Arts faculty will have its size = (5000 / 10000) x 1000 = 500. Similarly, the sub- samples of sizes 300 and 200 will be drawn from Commerce and Science faculties, respectively.

3. Systematic sampling

Systematic sampling is sometimes known as mixed sampling. It has the feature of randomness in it along with a fixed procedure of selection of units. This is a convenient method when complete list of sampling units is assumed to be readily available or can be prepared. Such a list is known as a sampling frame. This sampling scheme consists of selecting only the first unit at random and the rest are then automatically selected according to some predetermined pattern.

Let us suppose that the population size is N and a sample of size n is to be drawn. Then, we calculate the sampling interval k = N / n. Now, a unit from 1 to k is selected. Then, every k^{th} unit in the sampling frame is selected thereafter. For example, in a class of 100 students with roll numbers 1 to 100, suppose a sample of size 10 is to be drawn. In this case k = N / n = 10. First we choose a student from roll numbers 1 to 10. Suppose it comes out be 7. Then, after 7 every 10^{th} student will be selected in the sample. The sample will then, consist of students with roll numbers 7,17,27,37,47,57,67,77,87,97.

4. Cluster sampling

In a random sampling scheme, the population consists of distinct and identifiable units called sampling units. The smallest unit into which the population can be divided is called an element of the population. A group of such elements is known as a cluster. When the sampling unit is a cluster the procedure is called cluster sampling.

It is frequently used in large scale studies, as it is comparatively a less expensive and convenient sample design. In this sample design a large population is divided into smaller groups called clusters. These clusters are non-overlapping and exhaustive. Then out of all clusters a few are chosen by simple random sampling and all the units (elements) in a chosen cluster are observed.

Clusters are usually formed of neighbouring elements and therefore tend to have similar characteristics. As a simple rule, the number of elements in a cluster should be small and the number of clusters should be large. The number of clusters and their formation depends on the research objectives and the resources available for research.

5. Area sampling

If the population or universe is represented by a geographical area and its segments are made to form clusters, the cluster sampling is called Area sampling. For example, to study some characteristics nationwide, India can be divided into small geographical regions, called clusters. These sub areas may be states, cities, districts, blocks or villages depending on the research objective.

6. Sub- sampling or Multistage sampling

In cluster sampling, the whole population is divided into N clusters and then n clusters are chosen randomly. Then, all the elements in the selected cluster are enumerated. Instead of enumerating all the element in a cluster if we survey only a sample of units in each selected cluster it is known as sub-sampling or two stage sampling. In such sample design, since clusters are formed at first stage, they are known as *first stage units* or *primary sampling units* and the elements within a cluster are called *second stage units*.

This procedure can be generalized to three or more stages and will be known as *multistage sampling*. For example, in a marketing survey districts can be used as first stage units, colonies can be called second stage units, and then household can be termed as the third stage units.

7. Double sampling & Multi-phase sampling

There are situations in which it is useful to collect information on some auxiliary variable apart from observing the study variable. For example, if we are interested to know the performance of MBA students in research methodology course, the marks obtained in that paper will be the study variable. A related variable will be the background of the student in graduation classes like arts, science, and commerce. Therefore proportion of students belonging to arts, science, commerce and others will be

observed in the first phase and depending on these proportions the second and main phase of the survey will be conducted i.e. obtaining their marks in research methodology paper.

It is relatively cheaper and faster to collect data on the auxiliary variable. Therefore if such data are not readily available one conducts a large-scale fast survey to obtain information on auxiliary variable in the first phase of the sample design. Then, after this the data on study variable are collected by doing the main survey in the second phase. In the first phase of the survey only a part of the resources are used and most of the part of resources are spent on the main survey. This kind of sample design is known as double sampling or two-phase sampling. When the survey is conducted in three or more phases, it is known as multi-phase sampling.

Types of Sampling

1. Purposive sampling
2. Simple random sampling
3. Stratified random sampling
4. Systematic sampling
5. Cluster sampling
6. Area sampling
7. Sub- sampling or Multistage sampling
8. Double sampling & Multi-phase sampling

2b.7 Designing Questionnaires and Interviews

Primary data are collected for the first time through census or sample survey. The methods of collecting primary data in a research investigation are:

(a) Direct personal interview
(b) Mailed Questionnaire

(a) Direct personal interview

Under the direct personal interview method, the interviewer interviews the respondents personally. That is the investigator establishes personal contact with the respondents (or informants) and conducts on the spot enquiry. He makes direct contacts with the respondents and puts simple and direct questions to them.

The success of this method depends upon the character and efficiency of the interviewer. The interviewer should be polite and tactful. He must identify himself with the people and must be conversant with local conditions such as customs, languages etc.

Advantages

This method possesses certain advantages:

1. By this method original data are collected.
2. Correct and required information is gathered.

3. As one person collects the data, there is uniformity in collection of data.
4. Due to personal presence of the interviewer, there is flexibility in the enquiry, and necessary adjustment can easily be done.
5. Personal approach helps overcome reluctance to respond.
6. It permits probing to explore questions in depth.
7. Promptness is assured.

Disadvantages

But there are certain disadvantages also of this method. They are:

1. Such a method has limited value. Such method can be used in very few cases because most statistical enquiries cover a wider field than any single investigator could possibly examine personally within a reasonably time.
2. This method is very costly and requires more time.
3. Personal bias may vitiate the results.
4. If the field of enquiry is too short, the results may not throw light on the characteristics of the universe.

(b) Mailed questionnaire

Under this method, a questionnaire is prepared. The questionnaire contains a set of questions on the problem under investigation. These questionnaires are addressed to individual informants and sent by post or email. They are requested to answer the questions and post back to the investigator. If necessary, they are also given an assurance that the answers will be kept confidential.

Advantages

This method is useful in following cases:

1. When the area of investigation is large.
2. When the information cannot be obtained directly from the informants.
3. This method is generally used by the Government or committees and commissions appointed by the Government. They collect information about different problems by collecting information from the persons concerned.

Disadvantages

The major disadvantages of this method are:

1. *Limitations:* This method can be used only when the informants are educated. If the informants are illiterate, they cannot understand and reply the questionnaire.
2. *Non- response/incompleteness:* A number of questionnaires may not be returned in case of mailed questionnaire method. In such cases non-response becomes a serious problem. There may be long delay in receiving questionnaire. The returned questionnaire may not be carefully filled in or they may be incomplete.
3. *Dependence of questionnaire:* The success of this method largely depends on the proper drafting of the questionnaire.
4. *Lack of accuracy and reliability:* There is no direct contact between the investigator and the respondent. Therefore, one is not sure about the accuracy and reliability of the data.

5. *Inelastic:* This method is inelastic, because on receipt of inadequate or incomplete answers it is difficult to ask supplementary or complementary questions.
6. *Lack of cross-examination:* The answers given by informants cannot be cross-examined.
7. *No removal of doubts of the informants:* There is no chance to remove the doubts in the minds of informants.

Requirements of a good questionnaire

In both the methods described above, it is needed to design a questionnaire to record the responses of the respondents. A questionnaire is a systematic list of questions to be answered by a respondent. No survey can achieve success without a well-designed questionnaire. Unfortunately, questionnaire design has no theoretical base to guide the marketing researcher in developing a flawless questionnaire. A researcher has to be guided by a lengthy list of do's and don'ts born out of the experience of other researchers in the past and present. Hence, questionnaire design is more of an art than a science.

Questionnaire is a structured set of questions usually sent by mail or e-mail or sometimes interviewers fill it also for the respondents. Proper precautions are necessary in designing a questionnaire. A questionnaire should be so framed as to meet the objectives of the study. The main aspects of a questionnaire design are the contents, structure, format, length and sequence of question. Though there are no set rules of designing a questionnaire, yet following are main points one should take care in a questionnaire design.

1. *Covering letter:* The aim of covering a letter is to introduce the objectives of research study, to give instructions for answering the questions. It assures a respondent the anonymity and confidentiality of the information provided by him. If mailed by post it should be accompanied by a self-addressed, stamped envelope.
2. *Lay out:* The lay out of the questionnaire should be attractive. The use of bold, italic and underline should be done to highlight important things in questions. Proper space should be provided between questions if the respondent needs to write an answer of a question. Paper and printing quality affects a lot the appearance of a questionnaire.
3. *Number of questions:* The size of questionnaire is an important aspect for a respondent. If the number of questions in a questionnaire is too large there will be poor response. A lengthy questionnaire is avoided to be filled due to lack of time and boredom.
4. *Size of a question:* Long and complicated questions should be avoided as they are not understood by respondents. A question should be such that a respondent reads it quickly, understands it’s meaning and gives an answer to it easily.
5. *Sequence of questions:* A haphazard arrangement of questions in a questionnaire may confuse a respondent. The flow of order of questions should be natural and logical. It is illogical to ask a woman if she is married, after asking her the number of children she has.

6. *Clarity in a question:* A question should not be ambiguous or abstract. It should clearly pass the objective of the researcher to the respondent. It should not involve any mathematical calculations to answer a question. A question like, "what are the qualities of an ideal manager", without giving choices, is too abstract a question. Such questions should be avoided.
7. *Avoid personal questions:* A respondent is always reluctant in answering personal questions relating to income, marriage, sex, love affairs, smoking and drinking habits. Unless it is essential in a research study, such questions should not be placed directly in a questionnaire.

Requirements of a good questionnaire

1. Covering letter
2. Lay out
3. Number of questions
4. Size of a question
5. Sequence of questions
6. Clarity in a question
7. Avoid personal questions:

Unit II (b)

Design of Sample Survey

Exercises

Write short notes on the following:

1. Difference between population and sample
2. Census survey
3. Situations where sampling is a must
4. Limitations of sampling
5. Objectives of sample survey
6. Principle of statistical regularity
7. Judgment sampling
8. Sub-sampling
9. Double sampling

Short answer type questions

1. Point out the importance of sampling in solving business problems. Also, state the principles on which the sampling methods rest.
2. Discuss the advantages of sample survey over complete enumeration.
3. Compare and contrast the purposive and random sampling methods. Highlight the situation where each of these can be used.
4. What are the major sources of non-sampling errors in a survey?
5. How should a researcher handle "don't know" response?
6. How to make a sample, a true representative of a population?
7. Discuss the methods of drawing a simple random sample.
8. Explain the situation and the method for drawing a stratified random sample with an example.
9. Describe systematic sampling with an example.
10. Distinguish between cluster sampling and area sampling.
11. Distinguish between multi-stage sampling and multi-phase sampling.
12. Distinguish between direct personal interview and mailed questionnaire methods.

Long answer type questions

1. Explain the meaning of sampling and non-sampling errors. What are the various sources of these errors? Elaborate in detail.
2. Describe various types of random sampling citing their strengths and weaknesses, and explain how to select a sample using each method.
3. Write a critical note on sampling theory and explain various designs of sample survey used in business research.

Unit III

Measurement of Scaling Concepts

3.1 Measurement in Research

Measurement is a device or a process by which we measure things, objects or properties. It is a procedure of assigning numerals, numbers or scores to the observations we make on some phenomenon. In case of physical phenomena we use an instrument of measurement like, thermometer is used to measure temperature in degrees, tape is used to measure height or length in inches, weight is measured by a weighing machine in pounds etc. In this kind of measurement of quantitative variables there are two important things one is the measuring instrument and the other is unit of measurement.

Apart from measurement of quantitative variables, we come across situations in which we need to measure qualitative variables or attributes. For example, in a population, the number of males and females, literate and illiterate people, married and unmarried people etc. Such properties as these can be categorized easily and can be assigned numbers like one and zero, respectively. These are other qualitative facts, which cannot be directly measured. They involve more complex factors like intelligence, liking and taste, discipline, morality etc. These characteristics cannot be directly measured on a numerical scale. Techniques are needed to be developed to convert these qualitative variables into some quantifiable objects so that they can be assigned some numbers or scores. For example, to measure intelligence of a group of MBA students we may conduct a test consisting of 100 questions and the number of correct answers given by a person may be called his score, or popularly known as intelligence quotient (IQ). Similarly, scales have been devised to measure other attributes like emotions, weakness, racism, preferences of some products etc.

For a tea producer, it is important to judge the taste of his customers for the growth of his business. The attributes of tea like colour, aroma and strongness are needed to be measured for producing the most popular tea. Such abstract characteristics are difficult to be qualified. This is where the measurement and scaling techniques come to our rescue. These techniques help us express such qualitative characteristics in quantitative forms i.e. in terms of numbers or scores.

From the point of view of set theory, mathematically we can say that measurement procedure is a mapping from a domain to a range. Here, the domain consists of various levels of a property and the range contains number or score to which these various levels are related.

The quantification of abstract attributes leads to objective measurement in exact magnitude to study a research problem. Further statistical analysis is possible with these numerical data. Mathematical or more precisely algebraic operations like addition, subtraction, multiplication etc. are used on these numbers to draw further inferences.

3.2 Scales of Measurement

There are many measurement scales that are used in research studies. We categorize these scales according to their mathematical and statistical properties. Four types of scales are most commonly used (i) nominal scale (ii) ordinal scale (iii) interval scale (iv) ratio scale. Now we discuss them one-by one in detail.

1. Nominal scale: This, the crudest of measurement scales, classifies individuals, companies, products, brands or other entities into categories where no order is implied. Indeed it is often referred to as a categorical scale. It is at the lowest measurement level. It is a system of classification and does not place the entity along a continuum. It involves a simple count of the frequency of the cases assigned to the various categories, and if desired numbers can be nominally assigned to label each category. A physical example of a nominal scale is the terms we use for colours. The underlying spectrum is ordered but the names are nominal. In research activities a YES/NO scale is nominal. It has no order and there is no distance between YES and NO. Even if numbers like one and zero are assigned to YES or NO respectively, they have no arithmetic properties and act only as labels. The only measure of average, which can be used, is the mode because this is simply a set of frequency counts. The statistical tools, which can be used with nominal scales, are in the non-parametric group. The most likely ones would be mode and cross tabulation with chi-square. There are also highly sophisticated modeling techniques available for nominal data.

Properties of nominal scale:

- The numbers serve only as labels or tags for identifying and classifying objects.
- When used for identification, there is a strict one-to-one correspondence between the numbers and the objects.
- The numbers do not reflect the amount of the characteristic possessed by the objects.
- The only permissible operation on the numbers in a nominal scale is counting.
- Only a limited number of statistics, which are based on frequency counts, are permissible like percentages and mode.

2. Ordinal scale: An ordinal scale is next up the list in terms of power of measurement. The simplest ordinal scale is a ranking. When a market researcher asks you to rank 5 types of beer from most flavourful to least flavourful, he/she is asking you to create an ordinal scale of preference. There is no objective distance between any two points on your subjective scale. For you the top beer may be far superior to the second preferred beer but, to another respondent with the same top and second beer, the distance may be subjectively smaller. An ordinal scale only lets you interpret gross order and not the relative positional distances. Ordinal scales involve the ranking of individuals, attitudes or items along the continuum of the characteristic being scaled. From such scales the researcher knows the order of preference but nothing about how much more one brand is preferred to another that is there is no information about the interval between any two brands. All of the information a nominal scale would have given is available from an ordinal scale. Ordinal data would use non-parametric statistics. These would include Median and mode, rank order correlation, non-parametric analysis of variance. In addition, positional statistics such as the quartile and percentile can be determined.

Properties of ordinal scale:

- A ranking scale in which numbers are assigned to objects to indicate the relative extent to which the objects possess some characteristics.
- Can determine whether an object has more or less of a characteristic than some other object, but not how much more or less.
- Any series of numbers can be assigned that preserves the ordered relationships between the objects.
- In addition to the counting operation allowable for nominal scale data, ordinal scales permit the use of statistics based on positional values, e.g., percentile, quartile and median.

3. Interval scale: It is only with an interval scaled data that researchers can justify the use of the arithmetic mean as the measure of average. The interval or cardinal scale has equal units of measurement, thus making it possible to interpret not only the order of scale scores but also the distance between them. However, it must be recognized that the zero point on an interval scale is arbitrary and is not a true zero. This of course has implications for the type of data manipulation and analysis we can carry out on data collected in this form. It is possible to add or subtract a constant to all of the scale values without affecting the form of the scale but one cannot multiply or divide the values. It can be said that two respondents with scale positions 1 and 2 are as far apart as two respondents with scale positions 4 and 5, but not that a person with score 10 feels twice as strongly as one with score 5. Temperature is interval scaled, being measured either in Centigrade or Fahrenheit. We cannot speak of 50°F being twice as hot as 25°F since the corresponding temperatures on the centigrade scale, 10°C and -3.9°C, are not in the ratio 2:1.

Interval scale data would use parametric statistical techniques like, mean and standard deviation, Correlation & Regression, Analysis of variance, Factor analysis, Plus a whole range of advanced multivariate and modeling techniques.

Properties of interval scale:

- Numerically equal distances on the scale represent equal values in the characteristic being measured.
- It permits comparison of the differences between objects.
- The location of the zero point is not fixed. Both the zero point and the units of measurement are arbitrary.
- Any positive linear transformation of the form $y = a + bx$ will preserve the properties of the scale.
- It is meaningful to take ratios of scale values.
- Statistical techniques that may be used include all of those that can be applied to nominal and ordinal data, and in addition the arithmetic mean, standard deviation, and other statistics commonly used in marketing research.

4. Ratio scale: The highest level of measurement is a ratio scale. This has the properties of an interval scale together with a fixed origin or zero point. Examples of variables, which are ratio scaled, include weights, lengths and times. Ratio scales permit the researcher to compare both

differences in scores and the relative magnitude of scores. For instance the difference between 5 and 10 minutes is the same as that between 10 and 15 minutes, and 10 minutes is twice as long as 5 minutes.

The best way to contrast interval and ratio scales is to look at temperature. The Centigrade scale has a zero point but it is an arbitrary one. The Fahrenheit scale has its equivalent point at -32^{o}. (Physicists would probably argue that absolute zero is the zero point for temperature but this is a theoretical concept.). So, even though temperature looks as if it would be a ratio scale it is an interval scale. Currently, we cannot talk about *no temperature* - and this would be needed if it were a ratio scale.

Apart from all the statistical tools used for all the three scales defined above, virtually all statistical operations can be performed on ratio scales.

Properties of ratio scale:

- Possesses all the properties of the nominal, ordinal, and interval scales.
- It has an absolute zero point.
- It is meaningful to compute ratios of scale values.
- Only proportionate transformations of the form y = bx, where b is a positive constant, are allowed.
- All statistical techniques can be applied to ratio data.

Measurement Scales
1. Nominal scale
2. Ordinal scale
3. Interval scale
4. Ratio scale

3.3 Errors in Measurement

Measurement is a procedure of assigning numerals or scores to properties and attributes. In a research study an ideal research would like to have precise and exact measurement without any errors. But in practice it is found that sometimes there is a difference in scores that have been measured and the true scores. This difference is known as measurement error. These errors occur due to imperfection in the measuring procedure.

The measurement errors can occur due to faults at various stages of research study like in the construction of hypothesis, making of questionnaire, choosing a research or sample design, in data collection, data coding and analysis. These errors can be classified into two types (i) random errors (ii) systematic errors.

(i) *Random errors* are due to assignable causes and therefore are uncontrollable. These errors don't have a pattern and can occur in any measurement. They occur due to honest mistakes

or inaccuracies though the interviewer or the respondent is trying to do a sincere job. In some cases the true value or score of a property is over estimated resulting in positive random error, and in some cases it is under estimated resulting in negative random error. Thus, in a large sample these errors tend to cancel each other and therefore they have little or no effect on the over all sample survey.

(ii) *Systematic errors* unlike random errors, have a pattern in their occurrence. Mostly, they are constant in all the measurements. These errors occur due to assignable causes, therefore by critical examination of the measurement procedure these errors can be corrected if not removed completely. A constant error, for example, may occur due to faulty measuring instruments.

The goal of a researcher is to collect error free data. In reality it remains a dream as the saying goes, "To err is human", and the research study is conducted by humans. Some of the sources of measurement are as follows:

1. *Respondent:* It is most common in sample surveys that the respondents are reluctant to provide personal information to interviewer. In some cases they give false information due to factors like ignorance, status or by not understanding the question correctly. A respondent due to temporary factors like tiredness, boredom or anxiety can also give inaccurate answers.

2. *Interviewer:* An interviewer has to be trained personnel in the art of asking questions. An untrained interviewer may affect the response of a respondent by his behavior of style of asking questions. Sometimes, an interviewer also known as measurer may misunderstand the answers. He may also commit an error at time of coding or tabulating the responses.

3. *Non-response:* Non-response from people is a major problem faced by researchers specially in social surveys. People don't take interest or don't bother to take time out for filling the questionnaire and therefore, about one third of the mailed questionnaires are never received back. To fill this gap sometimes a researcher may fill these questionnaires himself or get them filled by his group of friends. This is a major cause of error in the results of the study. A good researcher, therefore, always starts with a higher number of questionnaires as sample size.

4. *Faulty instrument:* In a quantitative survey a constant error is sometimes found due to faulty instrument like a broken ruler (or inch tape). Likewise such errors can also occur due to a faulty instrument i.e. a faulty questionnaire in a qualitative or social survey. The examples of a faulty questionnaire are use of difficult words, lack of enough response choices, inadequate space for writing answers, illegible or incorrect printing etc.

5. *Choice of sample design:* Measurement errors can also occur due to a poor choice of sampling technique. The choice of simple random sampling or even a cluster sampling when it is needed to use stratified sampling will result in large differences in measurements. A poor choice of sample design is also a faulty measurement instrument.

The aim of an honest researcher will thus, be to remove the systematic errors due to above listed sources and try to minimize the random errors. If not carefully taken care of, the measurement errors may change completely the result of a research study.

Errors in Measurement

1. Respondent
2. Interviewer
3. Non-response
4. Faulty instrument
5. Choice of sample design

3.4 Validity and Reliability in Measurement (Testing of Measurement Scales)

In order to be useful in a research study, it is important for a measurement scale to be accurate. Researchers have developed some criteria to develop sound and error free measurements. For a clear understanding of the accuracy of a measurement look at the following true score model.

$$X_o = X_T + X_S + X_R$$

Where,

X_o= the observed score or measurement

X_T = the true score of the attribute

X_S = systematic error

X_R = random error

The above addition model presents the observed score as the sum of the true value of the characteristics and the two errors. An ideal measurement must have both the systematic error and random error to be zero, i.e. $X_S = 0$, $X_R = 0$, so that the observed score represents true score completely i.e. $X_o = X_T$. But such a measurement in reality remains a dream in most of the research situations. Based on the above model the criteria of testing a good measurement are *Reliability & Validity*.

1. **Reliability:** Reliability can be defined as the extent to which measurements are free from random error, X_R. If $X_R = 0$, the measurement is perfectly reliable. A reliable measurement is consistent and is free from random fluctuations.

   Reliability is a property, which gives same results when repeated measurements are made under constant conditions. For example, with a reliable instrument a respondent would give

same answer to a question, even if he is asked by two or three interviewers or at two different occasions.

In developing good measurements we use three methods to assess the reliability of a measurement. They are (i) Test-retest method (ii) Alternative form method (iii) Split-half method

(i) *Test- retest method:* Since reliability by definition means consistency, it is proper to assess reliability by repeating the measurement. In this method, respondents are asked identical set of questions (or scale items) at two different time points (or by two different interviewers) and the degree of similarity between the two measurements is determined. Thus, this technique applies the same scale items to same population twice and the results so obtained are compared. Note that the time between the two repetitions must not be too long otherwise it will affect this method.

(ii) *Alternative form method:* In this method two equivalent forms of the scale are constructed and are applied on the same population at two different times, with a different form being used each time. The degree of similarity in the two results will determine the reliability of the measurement scale.

(iii) *Split- half method:* In this method the total scale items are divided in two equal halves, for example even and odd numbered items, and the two sets of scales are administered separately. Then, a correlation coefficient between the two groups is obtained. A high positive correlation indicates that the measurement is reliable.

2. Validity: The validity of a scale may be defined as the extent to which differences in observed scale scores reflect true differences among objects on the characteristics being measured rather than systematic or random error. Perfect validity requires that their be no measurement error i.e. $X_o = X_T$, $X_R = 0$, and $X_S = 0$.

A measurement is said to be valid if it measures correctly what it is supposed to measure. To determine the validity of an instrument, its results should be compared with other relevant evidences available for the characteristic. Four types of validity may be defined (i) Face validity (ii) Content validity (iii) Criterion validity (iv) Construct validity.

(i) Face validity: The easiest validation procedure is face validity. A researcher can assess face validity of a measurement by carefully examining and determining whether the measurement arrives at the concept adequately.

For example, if an investigator is interested in measuring the castism in the people, he should check the statements given in his questionnaire to what extent they relate to castism.

(ii) Content validity: Content validity refers to the adequacy and relevance of the contents involved in a measurement. The contents of the measurement should provide adequate coverage of items that accurately reflect what is supposed to be measured. Content validity also incorporates the concept of face validity.

For example in an intelligence test the investigator should check if the questions in the test really judge intelligence of a person. If most of the questions in the test relate to arithmetic calculations, it is only testing mathematical ability, if most questions area on general knowledge based on memory; it is a memory test rather than intelligence test.

An investigator should consult a panel of senior and experience researchers if his measurement truly measures the concept understudy.

(iii) *Criterion Validity:* The type of validity is based on multiple measurement of the same concept. In this method, measurements are taken on the instrument under study along with on an independent external measure. The correlation coefficient is calculated between these two sets of scores on the same population. This correlation coefficient is called validity coefficient and gives criterion validity of a measurement.

For example, in an intelligence test, the scores of the test may be compared with the university results of the students and correlation may be found between the two. This will give us an idea of the validity of our test.

Criterion validity is also known as predictive validity, concurrent validity or pragmatic validity.

(iv) *Construct Validity:* This type of validity is defined as the extent to which a measure matches in its results with the theoretical logic about the concepts. It is the most complex and abstract type of validity. It basically involves the correlation between the measuring instrument and a general theoretical framework of the concepts under study.

For example, to study the use of shampoo among various economic classes we make a theoretical preposition that higher the economic class, greater would be the use of shampoo. If the measuring instrument shows a high degree of agreement, in its observations, to this preposition, it is said to possess construct validity.

Relationship between reliability and validity

Reliability and validity being similar in form should not be confused with each other, as they are not same. Reliability tests consistency and uniformity in a measurement whereas, validity depends on the correctness of a measurement. Reliability is achieved by removing random errors whereas validity is achieved by removing both random and systematic errors. Following four points clarify the relationship between reliability and validity.

- A perfect validity implies perfect reliability. In this case $X_o = X_T$, $X_R = 0$ and $X_S = 0$.
- If a measurement is unreliable, it cannot be perfectly valid, since at a minimum $X_o = X_T + X_R$. Furthermore, systematic error may also be present, i.e., $X_S \neq 0$. Thus, unreliability implies invalidity.

- If a measurement has perfect reliability i.e., X_R =0, it may or may not have perfect validity, because systematic errors may still be present ($X_o = X_T + X_S$).
- Thus, reliability is a necessary but not sufficient condition for validity.

Testing of Measurements

1. Reliability
   (a) Test-retest method
   (b) Alternative form method
   (c) Split-half method
2. Validity
   (a) Face validity
   (b) Content validity
   (c) Criterion validity
   (d) Construct validity

3.5 Scale Construction Techniques (Techniques of Developing Measurement Tools)

A measurement tool is a device by which we measure things, objects and properties. In the study of qualitative phenomena, objective measurement tools are needed to be developed, which are reliable and valid. A number of scales have been developed and used by various social scientists. These scales can broadly be classified as comparative scales and non-comparative scales.

1. Comparative scales

Comparative scales are those measurement tools, which give a direct comparison of stimulus objects. The data obtained from comparative scales are interpreted in relative terms and have only ordinal or rank order properties. Using these scales small differences between stimulus objects can be detected. It is easily understood and can be applied as it involves fewer theoretical assumptions. It has same known reference points for all respondents. Comparative scales are powerful measuring tools because they tend to reduce halo or carryover effects from one judgment to another. Here, we discuss four types of comparative scales:

(a) Method of paired comparison: Paired comparison scaling is the most widely used comparative scaling technique. In this scheme, a respondent is presented with two objects and is used to choose one of them according to some well-defined criterion. If there are more than two objects, say n brands of products, then the number of paired comparisons required is

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

The data obtained by this technique are ordinal in nature. Under the assumption of transitivity, it is possible to convert paired comparison data to rank order.

Example: Let us consider five brands of bathing soap and a consumer is asked to indicate his preference of a brand given two brands at a time. Thus, n=10 and there will be N=5(5-1)/2=10 pairs of soap brands. The responses of a consumer are given in the following table.

Table of Paired comparisons

	A	B	C	D	E
A	-	0	0	1	0
B	1	-	0	1	0
C	1	1	-	1	1
D	0	0	0	-	0
E	1	1	0	1	-
Total no. of times preferred	3	2	0	4	1

In the above table, a 1 in a particular box means that the brand in that column is preferred to the brand in the corresponding row. A 0 means that the row brand is preferred to the column brand. The number of times the brand was preferred is obtained by summing the 1's in each column. This may lead to giving a rank order to various brands. For example, from the above table it can be seen that brand D is preferred most, then brand A, and so on, and the brand C is not preferred at all.

The above paired comparison scale can be used for a number of consumers and their preferences may be summed up to rank various brands.

(b) Method of rank order: Another method of comparative scaling is rank order. In this method, respondents are presented with several objects simultaneously and asked to order or rank them according to some criterion. For example, a respondent may be asked to rank five soap brands from 1 to 5. No two brands should receive the rank number.

In rank order scaling only (n-1) scaling decisions are needed to be made for n brands. On the other hand, in paired comparison n(n-1)/2 preferences are made. Thus, this method is easier and faster. Rank order scaling also results in ordinal data.

(c) Method of constant sum scaling: In this method, a respondent is allocated a constant sum of units, such as 100 points to attributes of a product to reflect their importance. If an attribute is unimportant, the respondent assigns it zero points. If an attribute is twice as important as some other attributes, it receives twice as many points. The sum of all the points is 100. Hence, the name constant sum scaling.

Example: Let us consider six attributes of bathing soap and allocate 100 points among the attributes so that the allocation of a respondent reflects the relative importance he attaches to each attribute. The more points an attribute receives, the more important the attribute is. The following table shows responses of four respondents for six attributes of bathing soaps.

Table of constant sum scaling

Attribute	Respondent I	Respondent II	Respondent III	Respondent IV
Price	50	15	10	40
Fragrance	10	12	27	11
Packaging	12	10	15	3
Cleaning power	8	23	30	22
Lather	4	17	7	12
Shrinkage	16	23	11	12
Sum	**100**	**100**	**100**	**100**

2. Non–comparative scales

In this scaling technique a respondent evaluates only one object at a time. There is an absolute evaluation of an item in this case and no comparative preferences are given to an object relative to another. For this reason non-comparative scales are also known as monadic scales. Non–comparative scaling techniques consists of continuous and itemized rating scales.

(a) Continuous rating scale: In this scheme, respondents rate the objects by placing a mark at the appropriate position on a line that runs from one extreme of the criterion variable to the other. The form of the continuous scale may vary considerably.

Example:
How will you rate this brand of soap?
Form I
Most Preferable----------|----------Least Preferable

Form II
Most preferable----------|----------Least Preferable
100 80 60 40 20 0
Form III

Much Neutral Less
Preferable Preferable
Most Preferable----------|----------Least Preferable
100 75 50 25 0

(b) Itemized rating scales: In itemized rating, the respondents are provided with a scale that has a number of brief description associated with each category. The categories are ordered in terms of scale position and they represent various shades of opinion or preferences. A respondent is asked to choose one category that best describes the object being rated. The commonly used itemized rating scales are the *Likert* and *Thurstone scales*.

(i) Likert Scale: This scale was developed by Likert and generally is known as 'Likert technique' or ' internal consistency scale'. It is most popular and frequently among the social studies of attitudes.

The Likert scale requires the respondents to indicate a degree of agreement or disagreement with each of a series of statements about the stimulus objects. The choice of number of degree may vary from three to seven, but usually taken to five. For example, a respondent may be asked to express his opinion about the statement, " India will be an 'Information Technology Power' in year 2020". He may be asked to choose one of the five options (i) strongly agree (ii) agree (iii) undecided (iv) disagree (v) strongly disagree.

On such a scale each option has some score points. For example, 1 to 5; 1 being assigned to strongly disagree and 5 to strongly agree. An analysis can be conducted on an item by item basis, known as 'profit analysis'. A total score called, 'summated score' can also be calculated in this method.

(ii) Thurstone scale: This scale was developed in 1920s in the USA by L.L. Thurstone. In this scale, a number of statements relevant to the study are given to a number of judges to order them on a continuum (from 1 to 11) to form the scale. These statements concerning the attitude to be measured cover favourable, unfavourable and neutral items. Each statement expresses one and only one unambiguous idea and is written on a separate piece of paper or a slip.

The judges are asked to place each of the items in one of the eleven piles set from 1 to 11 categories. The pile number 1 indicating the least favourable item, 2 representing favourable and so on, and 11 indicating the most favourable. An item can be placed in 2nd category by one judge and in 9th category by another.

If there is significant difference between the assignments of categories for a statement, it is discarded completely. For other items accepted, average scale value (median) is calculated for each item. The statements or items with high average scale are then selected finally for the instrument to be administered to respondents. These items are presented in random order to the respondents.

Techniques of Developing Measurement Tools

1. Comparative scales
   - (a) Method of paired comparison
   - (b) Method of rank order
   - (c) Method of constant sum scaling
2. Non-comparative scales
   - (a) Continuous rating scale
   - (b) Itemized rating scales
     - (i) Likert scale
     - (ii) Thurstone scale

Unit III

Measurement of Scaling Concepts

Exercises

Write short notes on the following:

1. Measurement in business research
2. Nominal scale
3. Ordinal scale
4. Interval scale
5. Ratio scale
6. Additive model for testing the accuracy of measurement scales
7. Comparative scale
8. Likert's scale
9. Thurstone scale

Short answer type questions

1. "Measurement is a device of assigning numbers to objects or properties". Discuss.
2. Describe four levels of measurements popularly used in research with their properties.
3. Distinguish between random and systematic errors.
4. What are various sources of error in measurements?
5. Define reliability of a measuring tool. Discuss various methods to test reliability of a measurement.
6. Explain the types of validity.
7. "Reliability is a necessary but not sufficient condition for validity". Discuss this statement highlighting the relationship between reliability and validity.

Long answer type questions

1. Describe the meaning and objectives of measurement in business research. Explain the four types of measurement scales with examples.
2. Describe in detail the techniques of developing measuring tools enlisting the comparative and non-comparative scales.
3. Explain various indicators of accuracy of measurement scales.