

## INTRODUCTION TO RESEARCH

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## 1.0 OBJECTIVES

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After studying this module, you should be able to:

- Understand the meaning and nature of research
- Define the purpose of research
- Assess the different types of research
- Know about the various research approaches
- Generalize the Process of research
- Understand the significance of research in business decision making
- Know about the criteria of good research

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## 1.1 INTRODUCTION

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In the modern complex world, society today is faced with varied social, economic & political problems. These problems need systematic, intelligent and practical solutions. Problem solving is technical process and requires the accumulation of new knowledge. The quest for knowledge is a never ending process and in its simplest form this process has been called as 'research'. In other words, research is a systematic effort of gathering analysis & interpretation of problems confronted by humanity. The world has evolved as a result of consistent efforts to discover new things. In the current times, research has become an organized and specialized field. Newer methods to conduct research have come up. However, whatever be the field in which research is being carried out, the research methodology parameters remain the same, even if the objectives and the population to which the problem is being addressed is different. Certain basic rules, often referred to as standard operating procedures, are common to all fields, although they can be easily developed for scientific research and are fuzzy for social science research. Differences exist between one subject and other, but there is also interdependence. It has been seen that there are inputs of theoretical considerations in empirical studies and in a theoretical study; we look for empirical evidences to support our theory. Understanding research concepts and the methods used in it is important before any researcher picks up the initiative of undertaking research. Research is a thinking process and scientific method of studying a problem and finding solution. It is an in-depth analysis based on reflective thinking. The current module provides an insight into the basic research concepts.

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## 1.2 MEANING AND DEFINITION OF RESEARCH

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From a novice's point of view, research can be defined as the search of knowledge. **Oxford dictionary** defines research as 'the systematic investigation and study of materials and sources in order to establish facts and reach new conclusions'. Research is pursued in almost all the professions. More than a set of skills, it is a critical way of observing, examining, thinking, questioning and formulating principles that hold true at least for the given space. Almost all professions affirm the need of research either for the advancement of business or for the enlightenment

of knowledge. Whatever profession we are in, we ask ourselves a lot of questions for finding new knowledge and ideas. For example, consider that you are running a retail store; there are a lot of questions that may help you in increasing your business:

- How many customers do I can handle daily?
- Which are the most purchased groceries?
- Which groceries combination is more popular?
- What time does the customers hit to maximum at store?
- How the customers rate our store?
- What is the average money a customer spends on a purchase?

Just by finding answers of these, one can always say that, a very valid investigation has been done for the domain and the results. This is a very raw example of research that we practice in everyday life. Essentially speaking research involves a well-developed plan, a systematic approach to developing new theories of finding solutions to various problems.

**Redman and Mory** defined research as ‘a systematized effort to gain new knowledge’. Some professionals consider research as a movement, a movement from the known to the unknown. It is actually a voyage of discovery with pleasure and satisfaction. While considering research as an academic activity, it involves a lot of steps such as problem definition, to solve the problem, literature review, data collections, analysis, drawing inference, making hypothesis and arriving at a solution. Research is not just gathering of information from books and other sources. The transportation of knowledge from one form to another will neither constitute a good research. In short and simple, we can define research as ‘the systematic process of collecting and analysing information (data) in order to increase our understanding of the phenomenon about which we are concerned or interested’.

**Zina O' Leary** defined research as a 'creative and strategic thinking process that involves constantly assessing, reassessing and making decisions about the best possible means for obtaining trustworthy information, carrying out appropriate analysis and tracing credible solutions.'

Thus, research is actually a journey of discovery. Humans since aeons have been trying to discover better methods of doing routine things, a better explanation for why things happen in a particular manner and better answers to recurring problems. The technique which is employed in the search of this knowledge is termed as ‘research’.

Research provides us with right kind of information that helps us in successfully dealing with problems. **Clifford Woody** has very comprehensively defined research as 'a method for the discovery of truth which is really a method of critical thinking. It comprises of defining and

redefining problems, formulating hypothesis or suggested solutions; collecting and organizing and evaluating data; making deductions and reaching conclusions; and at last, carefully testing the conclusions to determine whether they fit the formulating hypothesis.' It can be concluded that research involves:

- (i) A clear definition of the problem
- (ii) Formulation of hypothesis
- (iii) Collection and analysis of data and
- (iv) Relating the findings to existing theories and earlier formulated hypothesis.

Thus, research is re-search, i.e. a revisit on the earlier findings with the intention of correlating them with newly discovered facts. The **Encyclopedia of Social Sciences** has described research as a 'critical and exhaustive investigation or experimentation having as its aim the revision of accepted conclusions in the light of newly discovered facts.'

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### 1.3 OBJECTIVES OF RESEARCH

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The objective of research is to discover answers to questions through the application of scientific procedure. The main aim of research is to find out the truth which is hidden and which has not been discovered as yet. It is primarily concerned with production of knowledge. Though each research study has its own specific purpose, some general objectives of research below:

1. **To Explore:** Research can be carried out with the purpose of gaining familiarity with a particular topic or to gain insight into unexplored areas. Such a research is termed as **exploratory or formative research**. It is often carried out before formulating a hypothesis e.g. a domestic company may think of setting up its manufacturing operations abroad. This kind of investment is new to the company and the initial research conducted to explore the possibility of this new idea can be termed as exploratory research.
2. **To Describe:** Quite often a research can be carried out with the objective of describing a particular situation, event or an individual e.g. a study can be carried out to study the voting pattern in a particular state on the basis of gender, economic status, religion etc. as observed in the previous election. Such researches are termed as **descriptive studies**. Since these studies are about events that have already taken place, these studies are also called as **ex-post facto studies**.
3. **To Diagnose:** When a study is carried out with the objective of finding out how frequently a particular event is associated with another event, it is termed as **diagnostic study** e.g. a fast food chain has conducted a research to find out the feasibility of setting up an outlet in a multiplex.

The chief objective of this study is to find out that how often people eat their meal outside when planning to watch a movie. Doctors frequently employ diagnostic methods to discover what it is that ails the patient. Numerous questions are asked from the patient and through symptomatic and clinical investigation, the doctors can then declare a diagnosis. Such studies are called as **diagnostic studies**.

**4. To Establish Causal Relationship:** A research can be done with the objective of finding out the causal relationship between the dependent variables with independent variables. Such research are called as **hypothesis testing research** e.g. a research carried out so establish the relationship between polio vaccine (independent variable) and its effectiveness in controlling the occurrence of polio (dependent variable) is a hypothesis testing research.

**In simple words, the objectives of research may be:**

- To identify and find solutions to the problems (e.g. "Why is that demand for a product is falling"? "Why is there a business fluctuation once in three years"?)
- To help making decisions (e.g. should we maintain the advertising budget same as last year?)
- To develop new concepts (e.g. Customer Relationship Management, Horizontal Marketing, Multi-Level Marketing, e-tailing etc.)
- To find alternate strategies (e.g. should we follow pull strategy or push strategy to promote the product.)

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## 1.4 CHARACTERISTICS OF RESEARCH

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An understanding of the meaning of research puts us in a position to list the characteristics of research. From the above explanations, the following characteristics of research can be summarized:

1. Research is directed toward the solution of a problem.
2. Research is purposive i.e. it deals with a well-defined significant problem.
3. Research is based upon observable experience or empirical evidences.
4. A research gathers new knowledge and brings to the forefront hitherto unexplored and unexplained phenomenon.
5. Research involves collection of primary data from first hand sources or involves use of existing data for a new purpose.

6. Research activities are carefully detailed and clearly outlined through a research design. These activities are defined by carefully designed procedures and analysis tools.
7. Research emphasizes the development of generalizations, principles, or theories that will be helpful in predicting future occurrences.
8. Research requires a degree of expertise and skill. A research worker is expected to be knowledgeable about the intricacies involved in carrying out a research.
9. Research strives to be objective and logical, applying every possible test to validate the procedures employed the data collected and the conclusions reached. The findings should be free from bias and the results should be carefully verified.
10. Every process, term and tool used in the research should be carefully documented and reported.
11. The research should target towards the discovery of general principles or theories which can find application to a wide range of problems in the present and future context.

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## 1.5 SCOPE OF RESEARCH IN BUSINESS

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Business research refers to any type of research done when starting and inaugurating any type of business organisation. Simply speaking, the application of research, its tools and techniques in business decision making constitutes business research. According to **Zikmund**, “Business research is a management tool that companies use to reduce uncertainty. It is a manager’s source of information about organisational and environmental conditions, and covers topics ranging from long-range planning to the most ephemeral tactical decision”. Looking upon this, the scope of business research includes the following areas. However, the list given below is not exclusive rather indicative.

**1. Business Environment:** The marketing activities are influenced by several internal and external environments. Internal environments include price, promotion, product and place (distribution), whereas the external environments include economic, sociological, political, legal and government motives.

**2. Consumption Pattern:** The pattern of consumption is to be assessed by the management. The study of buyers' behaviour, attitudes and capacity to purchase is very important in research. The purchasing power of a consumer depends upon his disposable personal income. Thus, the total purchasing power of a country or geographical area can be assessed by the disposable income of the place. The research reveals all the factors which influence the pattern of consumption.

**3. Controlling:** Research is used as a control technique of management to find out the weaknesses and shortcoming of the management decisions to re-orient the planning and performance techniques.

**4. Decision-Making:** Research is useful for taking management decisions. It provides necessary information and data in analysed and processed forms for making decisions in various business areas. With advanced technology, higher production functions and increasing complexities in market, the research has become an indispensable tool for taking appropriate decisions.

**5. Finance:** Research in finance helps financial experts and those other individuals involved to study how the financial industry is affected by market changes and trending. The research on finance and financial management mainly revolved around estimating financial requirement, financial management, deciding capital structure, selecting a source of finance, selecting a pattern of investment, proper cash management, implementing financial controls, proper use of surplus etc.

**6. Growing Complex Markets:** The advancement of science and technology and the standard of living of consumers necessitate closer touch with the growing markets. The size and specialisation within the business unit and the intervention of numerous middlemen between the manufacturer and customers created a wide communication gap. The widening gap requires marketing research to fill up the communication gap between the consumer and the producer.

**7. Human Resources Management:** Research on HRM activities provides an understanding of what does work, what does not work, what needs change, the nature and the extent of change. The human resource research seeks to discover the basic relationships which may lead to improved personnel decision-making in such areas as turnover, absenteeism, compensation levels and structure, job satisfaction, employee morale, assessment of managerial potential, training effectiveness, grievance handling, labour relations and collective bargaining.

**8. Management Planning:** Research is used for management planning. It deals with business opportunities, i.e. those opportunities which are viable to be exploited by management. Thus, management can assess the resources that will be useful for the business.

**9. Marketing Strategy:** Marketing management has to lay down appropriate marketing strategies to meet competition, to pursue growth in the market and to attain organisational objectives. The policies and programmes related to pricing, distribution, sales promotion, product etc. can be made with proper research.

**10. Problem-Solving:** Starting from problem identification to formulation of alternative solutions, and evaluating the alternatives in every area of management, is the problem-solving action of research. Problem-solving research focuses on the short-range and long-range decisions that must be taken with respect to the elements of the business viz. marketing, HRM, production, finance etc. It can help managements bring about prompt adjustment and innovations in the above areas of business.

**11. Production Management:** Research helps large-scale production by providing suitable decisions to be undertaken by the producers to exploit the existing production resources to meet the growing markets. The resources of production and market potentials are properly assessed by research. The research performs an important function in product development, diversification, introducing a new product, product improvement, process technologies, choosing a site, new investment etc.

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## 1.6 TYPES OF RESEARCH

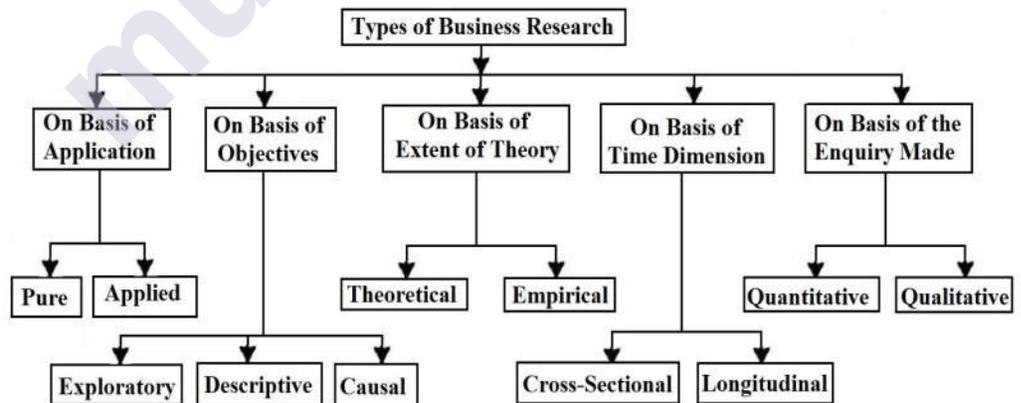
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This part specifically focuses on the types of research. Research can be classified from various perspectives. A detailed description of the same can be had from the figure below and the description that follows:

### 1.6.1. On the Basis of Application

On the basis of application, research is of two types:

**i) Pure/ Basic/ Fundamental Research:** Developing scientific theories or basic principles are called 'pure' or 'basic' or 'fundamental' research. This research is concerned with quest for



knowing more about the phenomenon without concern for its practical use and also with developing and testing hypotheses and theories. Pure research takes place to explore a particular concept, or issue, without regards for a specific problem, and may be carry out to simply gain a better understanding of the overall concept. It is said, there is nothing as practical as a good theory. It is conducted to satisfy any curiosity such as:

What makes things happen?

Why society changes, and

Why social relations are in a certain way.

In fact, it is the source of most new theories, principles, and ideas. To sum-up, basic research is purely theoretical to increase our understanding of certain phenomena or behaviour but does not seek to solve any existing problem. It is essentially positive and not normative. This may take the form of the discovery of totally new idea, invention and reflection where an existing theory is re-examined possibly in a different social context.

**ii) Applied Research:** It is also termed as practical, need based or action research. The objective of this research is to find the solutions to problems that are faced by government, society or the business. Applied Research, thus, is more concerned with actual life. It also suggests remedial measures to alleviate various types of problems. This research is concern with search for ways of using scientific knowledge to solve practical problems. The findings become basis of framing programme and policies, based on principles of pure research. According to **Horton and Hunt**, this research is an investigation for ways of using scientific knowledge to solve practical problems. This type of research is conducted on interdisciplinary basis also.

Examples include like evaluating the impact of a training programme on employee performance, examining consumer response to direct marketing programmes. Although the purpose of these two research forms varies, there is not much difference in the research methods and tools used for their conduct. In the present world situation, more emphasis is being given to applied research to solve problems arising out of various environmental changes.

### 1.6.2. On the Basis of Objectives

On the basis of fundamental objective, research is designed in following ways:

**(i) Exploratory Research:** This type of research is carried out at the very beginning when the problem is not clear or is vague. In exploratory research, all possible reasons which are very obvious are eliminated, thereby directing the research to proceed further with limited options. The main aim of exploratory studies (also known as **formulative research**) is to gather initial information which helps to define problems and recommend hypothesis. It often relies on secondary research such as reviewing available literature, or qualitative approaches such as informal discussions with consumers, employees, management or competitors, and more formal approaches through in-depth interviews, focus groups, projective methods, case studies or pilot studies. It is important to bear in mind that it can mainly be conducted when researchers lack clear idea of the problem. The outcomes of this research are not generally useful for decision-making, but they can provide major insight into a given situation.

**(ii) Descriptive Research:** Descriptive research, also known as **statistical research**, describes data and characteristics about the population or phenomenon being studied. Descriptive research answers the questions who, what, where, when, and how. The description is used for frequencies, averages, and other statistical calculations. Often the best approach, prior to writing descriptive research, is to conduct a survey investigation. In short descriptive research deals with everything that can be counted and studied. But there are always restrictions to that. The research must have an impact to the lives of the people around the researcher. This research is applicable to problem which specifies certain criteria and data is clearly available for accurate objectives.

**(iii) Causal/Experimental Research:** It is commonly used in sciences such as sociology and psychology, physics, chemistry, biology, medicine, etc. It is commonly used in sciences such as sociology and psychology, physics, chemistry, biology, medicine, etc. However, it may also be carried out in social sciences if such research enables us to quantify the findings, to apply the statistical and mathematical tools and to measure the results thus quantified. It is also classified under **conclusive research**.

In many problems, there are many variables involved or influential. It is not always possible or feasible to study all variables simultaneously, so to study limited variables this type of research is conducted. Here, one variable (under study) keep open whereas other variables are kept constant and then open variable effect is studied. The relationship between dependent and independent variables is observed and describe in connecting hypothesis. The variable which is influenced is known as dependent and the variable which influence other is known as independent variable. For example, effect of investment decision (independent) on investment returns (dependent), effect of advertisement (independent) on sales (dependent). Causal research is used to obtain evidence of cause-and-effect (causal) relationships.

### 1.6.3. On the Basis of Extent of Theory

On the basis of extent of theory, research is of two types:

**(i) Theoretical Research:** Theoretical research generally uses the findings from existing theory and explanations to develop new ideas. These new ideas are not tested through collecting evidence in the form of primary data. Theoretical research is held to be a classical way of adding something of value to the body of knowledge. One of the primary roles of theoretical research is to re-work already established ideas in order to improve insights into the subject matter. Such improvements could well-constitute adding something of value to the body of knowledge. A researcher who develops a theory through visiting a library and developing their own explanation through reading existing work will be undertaking theoretical research.

**(ii) Empirical Research:** This is a data based research where we collect primary data and then data is further analysed and used for testing

hypothesis. It is a way of gaining knowledge by means of direct observation or experience. Empirical evidence (the record of one's direct observations or experiences) can be analysed quantitatively or qualitatively. It is based on observation and experience more than upon theory and abstraction. Empirical means based upon observation or measurement rather than theoretical reasoning. Pharmaceutical companies use empirical research to try out a specific drug on controlled groups or random groups to study the effect and cause. This way they prove certain theories they had proposed for the specific drug. Such research is not just useful in science but in many other fields like history, social sciences, business, etc.

#### 1.6.4. On the Basis of Time Dimension

On the basis of time dimension, research can be of two types:

**(i) Cross-Sectional Research:** Cross-sectional study is popular in the field of business and marketing research. Cross-sectional research design involves the collection of information from a sample of a population at only one point of time. Cross-sectional research is usually the simplest and least costly alternative. In this study, various segments of the population are sampled so that the relationship among the variables may be investigated by cross tabulation. Sample surveys are cross-sectional studies in which the samples happen to be a representative of the population. It may reveal how these samples are represented in a cross-section of a population. The cross-sectional study generally involves large samples from the population; hence, they are sometimes referred as “**sample surveys.**” Cross-sectional research can be exploratory, descriptive, or explanatory but it is most consistent with a descriptive approach to research. “What is the effectiveness of an advertisement campaign for an air conditioner?” is an example of cross-sectional study.

**ii) Longitudinal Research:** Longitudinal study involves survey of the same population over a period of time. It is usually more complex and costly than cross-sectional research, but it is also more powerful, especially when researchers seek answers to questions about social change. In this study, the sample remains the same over a period of time. “How have consumers changed their opinion about the performance of air conditioner as compared with that last summer?” is an example of longitudinal study. Longitudinal surveys usually combine both extensive (quantitative) and intensive (qualitative) approaches. Descriptive and explanatory researchers use longitudinal approaches. They consider three types of longitudinal research which can be described as follows:

**(a) Time-Series Research:** A time series design collects data on the same variable at regular intervals (weeks, months, years, etc.) in the form of aggregate measures of a population. Measurements are taken on each variable over two or more distinct time periods. This allows the researcher to measure change in variables over time. For example, the Consumer Price Index (CPI), unemployment rates, poverty rates, etc. Time series designs are useful for establishing a baseline measure, describing changes

over time, keeping track of trends, and forecasting future (short-term) trends. Time series data are nearly always presented in the form of a chart or graph: The horizontal (or x) axis is divided into time intervals, and the vertical (y) axis shows the values of the dependent variable as they fluctuate over time.

**(b) Panel Study:** It is a powerful type of longitudinal research. A panel is a sample of respondents who have agreed to provide responses over a specified time interval. In a panel study, the researcher observes exactly the same people, group, or organisation across time periods. Panels are also of two types: **traditional panels and omnibus panels**. In case of traditional panels, same questions are asked to the respondents on each panel measurement. For example, firms are interested in knowing the change in attitude, opinion, feeling, or emotion of the customers about a particular product over a specific time interval. In the case of omnibus panels, different set of questions are asked to the respondents on each panel measurement. Hence, different set of information is obtained using omnibus panels. Use of panels is based on the objective of the research and the nature of the problem.

**(c) Cohort Study:** A cohort is a group of respondents who experiences the same events within the same time interval. The word “cohort” means a group of people. It is similar to the panel study, but rather than observing the exact same people, a category of people who share a similar life experience in a specified time period is studied. Cohort analysis is ‘explicitly macro analytic’, which means researchers examine the category as a whole for important features. In cohort study, the individuals examined over time may not be the same but they should be representative of a particular group (or cohort) of individuals who have shared a common experience. For example, cohort analysis used to predict changes in voter opinions during the polls.

Cohort studies can be forward-looking or backward-looking. A forward-looking cohort study is also known as a prospective cohort study. ‘Prospective’ means that it relates to the future. A backward-looking cohort study is also called as retrospective cohort study. ‘Retrospective’ means that it relates to the past. To carry out prospective cohort studies, researchers identify a group of people to study and plan the research in advance, collecting data over time. In retrospective cohort studies, researchers use data that are already available for a particular group.

### 1.6.5. On the Basis of Enquiry Made

On the basis of enquiry to be made, research can be of two types:

**(i) Quantitative Research/ Structured Approach:** It usually involves the collection and converting of numerical data into numerical form so that statistical calculations can be done which help in drawing conclusions to answer a specific research question. Quantitative research is applicable to phenomena that are measurable so that they can be expressed in terms of quantity. Objectivity is very vital in quantitative research. Therefore,

researchers seek to avoid their own presence, behaviour or attitude affecting the results (e.g., by changing the circumstances being studied or causing participants to behave differently). The aim of quantitative research is to develop mathematical models, theories related to phenomenon. Quantitative research is mainly used in social sciences. It may involve correlation study, ex-post facto study, longitudinal study, meta-analysis and survey

**(ii) Qualitative Research/ Unstructured Approach:** Qualitative research is usually related with the social constructivist concept which emphasizes the socially constructed nature of reality. This research is designed to find out how people feel or what they think about a particular subject. The sequence to data collection and analysis is logical but allows for greater flexibility in all aspects of the research process. Data is collected in textual form on the basis of observation and communication with the participants, e.g., through participant observations, in-depth interviews and focus groups. The data is not converted into numerical form and is not statistically analysed. It is more appropriate to explore the nature of a problem, issue or phenomenon without quantifying it. The prime objective of such researches is to describe the variation in a phenomenon, situation or attitude. The qualitative research attempts to answer ‘why’ and ‘how’ aspects of decision-making rather than ‘what’ and ‘when’ aspects.

#### 1.6.6. Other Types of Research

**(i) Ex-Post Facto:** In this type of research, an examination of relationship that exists between independent and dependent variable is studied. It is similar to empirical research. In this method, the researcher has no control over an independent variable. Ex-post facto literally means ‘*from what is done afterwards*’. In this research, a variable ‘A’ is observed. Thereafter, the researcher tries to find a causal variable ‘B’ which caused ‘A’. It is quite possible that ‘B’ might not have been caused ‘A’. In this type of analysis, there is no scope for the researcher to manipulate the variable. The researcher can only report ‘what has happened’ and ‘what is happening’. Ex post facto research is the process beginning with a phenomenon and going backward in time to identify casual factors.

**(ii) Historical Research:** The name itself indicates the meaning of the research. Historical study is a study of past records and data in order to understand the future trends and development of the organisation or market. There is no direct observation. The research has to depend on the conclusions or inferences drawn in the past. Historical research is the systematic collection, critical evaluation, and interpretation of historical evidence (i.e., data relating to past occurrences). In general, historical research is undertaken to answer questions about causes, effects, or trends relating to past events that may shed light on present behaviours or practices. For example, study of epics like Ramayana and Mahabharata for TV serial or movie making, biographical research, histories of institutions and organizations etc.

**(iii) Diagnostic Research:** It may be said as another name for descriptive research. This research is conducted to establish whether two or more variables are associated and their degree of association. In a diagnostic research, the researcher is trying to evaluate the cause of a specific problem or phenomenon. This research design is used to understand more in detail the factors that are creating problems in the company. Diagnostic research design includes three steps viz. the inception of the issue, diagnosis of the issue and solution for the issue.

**(iv) Case-Study Research:** This type of research is concerned with exploring and analysing the life or functioning of a social or economic unit, such as a person, a family, a community, an institution, a firm or an Industry. The objective of case study method is to examine the factors that cause the behavioural patterns of a given unit and its relationship with the environment. A researcher conducting a study using the case study method attempts to understand the complexity of factors that are operative within a social or economic unit as an integrated totality.

**(iv) Evaluation Research:** Evaluation research aims at evaluating programme that have been implemented or actions that have taken in order to get an objective. Evaluation means some sort of measurement of the end-product and impact of an effort in the light of the stated goals for which the programmed undertaken. There are so many programmes in which economic gains are not visible, the evaluation of which calls for special techniques. There are three types of evaluations made in research namely concurrent evaluation, periodic evaluation, and terminal evaluation.

**(v) Conclusive Research:** As the name suggests, conclusive research is carried out to provide information that is useful in reaching conclusions or decision-making. The purpose of conclusive research is to provide a reliable or representative picture of the population through the use of a valid research instrument. Conclusive research design provides a way to verify and quantify findings of exploratory studies. Conclusive research usually involves the application of quantitative methods of data collection and data analysis. Moreover, conclusive studies tend to be deductive in nature and research objectives in these types of studies are achieved via testing hypotheses. Conclusive research can be sub-divided into two major categories i.e. descriptive or statistical research, and causal research.

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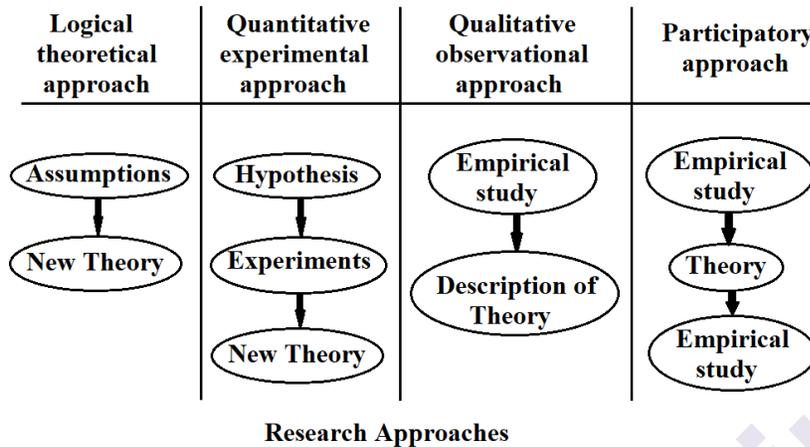
## 1.7 APPROACHES TO RESEARCH

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Approaches to research consists of making a suitable decision regarding research components like types of research, measurement and scaling, development of questionnaire, sample size-determined sampling techniques and data analysis plan. A research approach can vary significantly depending on what is to be studied. If it is a scientific method, it would be appropriate to use similar methods or other scientists who have attempted the experiment. However, if the research was is in social sciences, e.g. assessing consumer behaviour, it would be better to

carry-out surveys, look into past surveys, etc. The general research approach acts as an overall guide for conducting the research work.

There are two major approaches in research literature, i.e., **Qualitative and Quantitative**. In a generalized view, we can add logical and participatory approaches along with aforementioned above.



### 1.7.1 Qualitative Approach

Qualitative research is a research method used extensively by scientists and researchers studying human behaviour and habits. Qualitative methods are used to find and confirm the presence and absence of an element. Qualitative research is often regarded as a precursor to quantitative research, in that it is often used to generate 'possible leads and ideas which can be used to formulate a realistic and testable hypothesis. This hypothesis can then be comprehensively tested and mathematically analysed, with standard quantitative research methods. For these reasons, these qualitative methods are often closely allied with survey design techniques and individual case studies, as a way to reinforce and evaluate findings over a broader scale.

One example of a qualitative research design might be a survey constructed as a precursor to the paper towel experiment. A study completed before the experiment was performed would reveal which of the multitude of brands were the most popular. The quantitative/experiment could then be constructed around only these brands, saving a lot of time, money and resources. Qualitative research can be further classified under two types namely:

- Direct Qualitative Research
- Indirect Qualitative Research

In **direct qualitative research**, in-depth interview is the norm. The group is prepared with the help of a selected few research participants. This is more like a brain storming session. The topic is discussed amongst the focus group with the help of a moderator from amongst the focus group participants only. Subsequently, the group interview is conducted and a

final report is prepared by the researcher based on the outcomes of the discussion. For example, in-depth interviews, focus groups, etc.

In **indirect qualitative research**, the participants are encouraged to come out with their own versions and understandings about the issue/s being taken up by the researcher. The respondents are supposed to 'project' their feelings or attitudes about the situation. For example, word association, sentence completion, role playing, etc.

### 1.7.2 Quantitative Approach

The quantitative approach involves the collection of quantitative data, which are put to rigorous quantitative analysis in a formal and rigid manner. This approach further includes experimental, inferential, and simulation approaches to research. They are most commonly used by physical scientists, in social sciences, education and management. It is the opposite of qualitative research.

Quantitative experiments use a standard format, with a few minor interdisciplinary differences, of generating a hypothesis to be proved or disproved. This hypothesis must be testable by mathematical and statistical methods, and is the basis of which the whole experiment is designed. Quantitative methods are used to measure the degree of an element already present. A sound quantitative design should only manipulate one variable at a time, or statistical analysis becomes cumbersome and open to question. Ideally, the research should be conducted in a manner that allows others to repeat the experiment and obtain similar results. A common perception of quantitative research is that the emphasis is on proof rather than discovery.

Quantitative experiments are useful for testing the results gained by a series of qualitative experiments, leading to a final answer, and a narrowing down of possible directions for follow-up research.

There is one more approach other than these two and it is **mixed approach** as for any research it is very difficult to apply exclusively only one approach. Many number of times objectives and effectiveness of research is more important than the approach and so combination of approaches is the best way to adopt.

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## 1.8 THE PROCESS OF RESEARCH

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According to **Horton and Hunt**, the scientific method of research comprises the following basic steps:

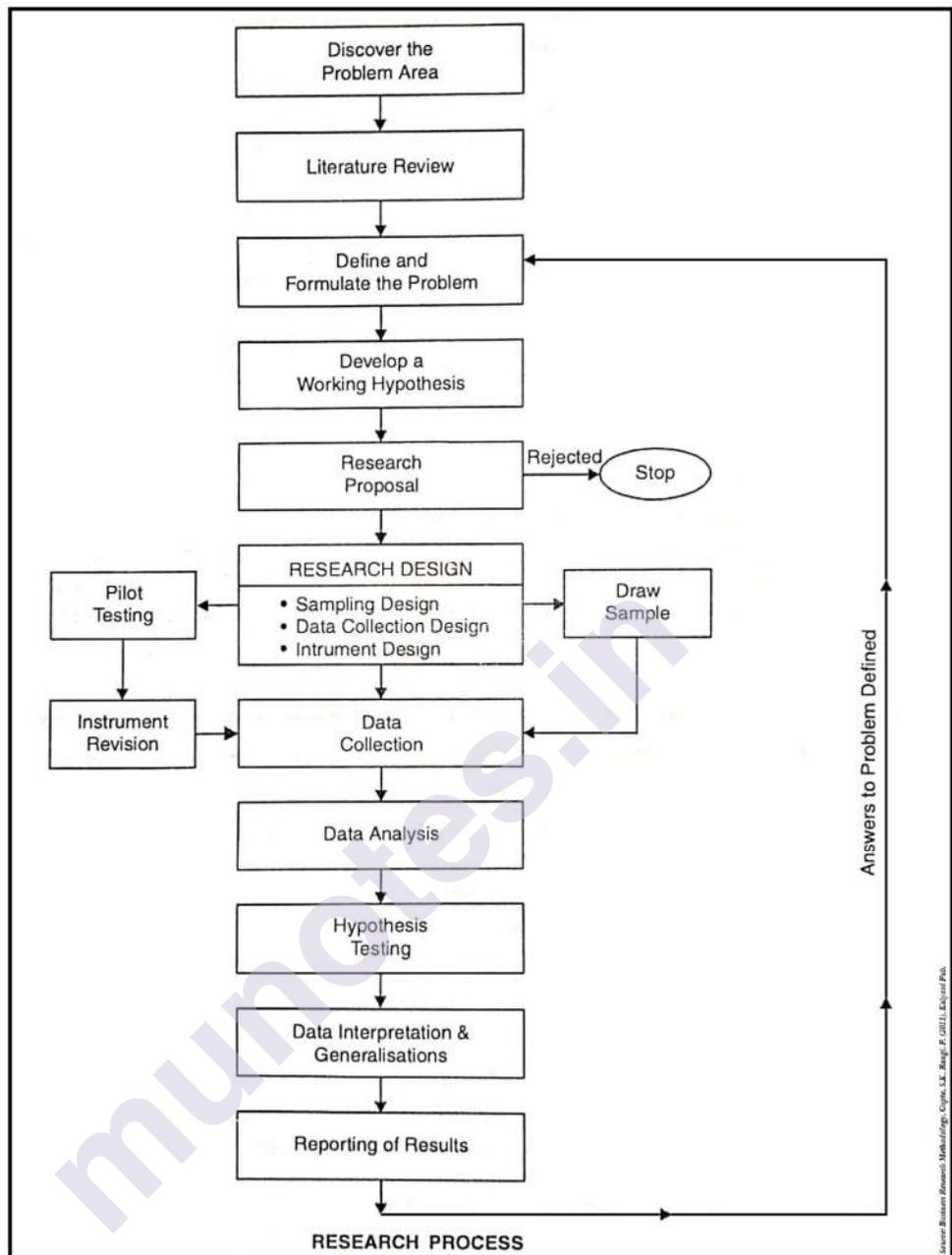
- (i) Defining the problem
- (ii) Review of literature
- (iii) Formulation of hypothesis
- (iv) Developing a research design
- (v) Collection of data
- (vi) Analysis of data
- (vii) Drawing conclusions
- (viii) Replicate the study for generalisations

These steps give us an idea of the essential steps involved in conducting research. However, there is no rigid sequence of research process steps. Depending on each situation, certain steps can be skipped, can be repeated or circumvented. However, in spite of all these variations, it is possible for us to develop a sequence of research process. Although each of the steps discussed here are studied in greater detail in subsequent modules, a brief overview can be provided at this stage. Figure given below shows the detailed sequence of research process. Each of these steps is the natural outcome of the previous steps, but these steps are not mutually exclusive. It is possible for instance to develop our research objectives and working hypothesis simultaneously.

The various steps are:

### **Step 1: Discover the Problem Area**

To start a research, we first of all need to discover the problem which demands solution. The best way to identify the problem would be to look for an unresolved query, a gap in the existing knowledge or an unfulfilled need within the chosen subject. Although the world is filled with unsolved problems, yet not every problem is suitable for research. Researcher should take care that the problem should be one which can be clearly identified and formulated. Further, while choosing the research area the researcher should look into the availability of information relevant to the topic. Mere availability is not enough, it should also be accessible. Sometimes, the cost of obtaining the information being too high, it might not be accessible to the researcher.



## Step 2: Review of Literature

The next step is to become familiar with the problem and formulate it clearly. Literature review involves a comprehensive review of published and unpublished work from the secondary sources of data available in the relevant area of study. The researcher at this stage may review all the available conceptual literature concerning the theories and concepts related to the problem as well as the empirical literature comprising of studies done earlier and bearing similarity to the problem under study. Literature review helps the researcher in two ways; *firstly*, it helps him in specifying his research problem in a meaningful context, *secondly*, it would provide him with an insight into the methods and techniques adopted for handling such problems. The researcher can access bibliographic databases which display only the bibliographic citations like

name of the author, title of the book, publisher, year, volume and page number. He can also use abstract database which along with bibliographic citations also provides him with an abstract of the article. The researcher can also use full text databases which contain the entire text.

### Step 3: Problem Formulation and Definition

Initially, the focus of the problem is not clearly defined. However, after the literature review, the researcher is now in a position to formulate his problem clearly. In the words of Albert Einstein, "The formulation of a problem is far more essential than its solution, which may be merely a matter of mathematical or experimental skill". A problem well formulated will alone yield fruitful results. It is a clear, precise, and concise statement of the matter that is to be investigated. The problem statement is a fact oriented information gathering question. The objectives of the study at this stage are clearly developed. While problem is being formulated, the following should be taken into account:

- Determine the objective of the study
- Consider various environment factors
- Nature of the problem
- State the alternative

### Step 4: Developing a Working Hypothesis

A hypothesis is a tentative assumption regarding the solution to the problem under study. The hypothesis is the focal point around which the future research efforts will be directed. The kind of data to be collected, the tools of analysis are influenced by the hypothesis. The hypothesis is a predictive statement which is made in the light, of the available facts relating to the problem under study. For example, a study conducted to find the amount of research investment being done by the companies will have the following hypothesis:

$H_0$ : Companies invest 1% of their sales revenue in research activities.

$H_1$ : Companies invest less than 1% of their sales revenue in research activities.

The  $H_0$  is called as the **null hypothesis** which assumes there is no difference between the population parameter and the sample mean and the  $H_1$  is called as the **alternative hypothesis** which presents the alternative solution. A hypothesis thus presents a relationship between the different variables. In case of social research relating to human behaviour, the hypothesis helps us in making a prediction about the population parameter.

### Step 5: Research Proposal

A research proposal is a brief summary outlining the objectives of study and the modus operandi of conducting the research. In case of a thesis, the research proposals are in the form of a synopsis stating the research objectives, the proposed methodology of research, benefits of study along

with a detailed bibliography. In case of business or government organizations, the research proposal, in addition to the above information, will contain information about the researcher's qualification, the time and cost schedules, the resources and special facilities required during research. Essentially, they contain an executive summary, right in the beginning stating the objective of the study and benefit derived thereon. Research proposal is very important and should be prepared carefully especially when it is to be reviewed by the concerned authorities for approval to conduct further research.

### Step 6: Research Design

After approval of proposal, the next step is to work out the research design. Research design outlines the conditions for collection and analysis of data. The what, when, where, how much and the method of data collection are detailed in the research design. It will specifically contain information about:

- (a) The Sampling Design
- (b) Data Collection Design
- (c) Instrument Design

**(a) The Sampling Design:** A sample design is a definite plan determined before any data is actually collected for obtaining a sample from a given population. If a research involves the study of each and every unit of the population, it is termed as a census survey. However, it is generally not feasible to conduct a census survey, especially if the universe of the study is very vast. E.g. TRPs of TV programmes are developed on a sample basis rather than covering all the households of an area. A sampling design will include a decision on the sampling unit, the sample size and the sampling method.

'*Sampling unit*' is the most elementary unit which would be a part of the study e.g. in a survey on newspaper readership pattern, a single household comprising of all the members of the household can be regarded as a sampling unit..

Next, the decision on '*sample size*' is taken. The size depends on factors like the availability of time and funds to the researcher, the ability of the researcher, the size of the population and the nature of the population. The important thing to remember is that the sample size should be such as to adequately represent the population.

Finally, a decision on the '*sampling method*' is to be taken. A researcher can use a non-probability method or a probability method of sampling. **Non-probability method** of selecting a sample involves an element of bias. The probability of a unit being a part of the sample is not known. Under this method, one can adopt various methods like convenience sampling (easily accessible), purposive sampling (specific people for purpose), judgment sampling (to choose for best data) and quota sampling.

**Probability method** of sampling involves giving every member a known and unbiased chance of being a part of the sample. Few probability methods are simple random sampling, stratified sampling, cluster sampling, area sampling, and systematic sampling.

**(b) Data Collection Design:** The method of gathering the data is planned here. The data can be collected through an experiment conducted in controlled settings or it can be conducted through field survey. The survey can be a simple one involving data collection from one source or it could involve areas spread all over the world. Hence, a well-planned data collection design becomes necessary. Briefly speaking, some of the data collection techniques available to a researcher are:

(i) **Questionnaire:** A set of questions pertaining to the topic under study are compiled and the questionnaire is then mailed to the respondent through mail. This method of data collection is particularly used in situations where a large number of respondents are to be covered and they are spread over a wide area.

(ii) **Interview:** An interview method involves a direct interaction between the respondent and the researcher/field workers. The interview can be a physical interview where the researcher personally asks questions from the respondent or it can be a telephonic or virtual interview. The telephonic or virtual method is adopted where the respondents are spread over a wide area and time available is very less. An important thing to remember is that while conducting an interview the researcher uses an interview schedule which is like a questionnaire.

(iii) **Observation:** Observation involves collecting data visually and recording the event. Observation besides visual aspect also involves listening, smelling and touching. All behavioural activities as well as non-behavioural activities like physical condition analysis, processes, and records can be analysed through observation. An observation also involves the use of observation schedules which contains a list of all the items that are to be observed.

**(c) Instrument Design:** Instrument refers to the questionnaire or the schedule that the researcher would use to collect data. The researcher while designing the questionnaire must think in terms of following issues:

(i) **Type of Data:** It determines whether the data will be collected in a nominal, ordinal, interval or ratio form. A nominal data has no order, distance or origin, ordinal data has an order but no distance and origin, an interval data has order and distance but no origin and a ratio data has order, distance as well as a unique origin.

(ii) **Communication Approach:** Before designing the instrument the researcher has to decide on how to collect the data i.e. through mailed questionnaire, interview or observation.

**(iii) Question Structure:** This decides the type of questions and their order. The instrument can be completely direct structured, indirect unstructured questionnaire or combination of these two approaches.

**(iv) Question Wording:** It should be the endeavour of every researcher to have questions with simple words leaving no scope for ambiguity. Long questions are to be avoided and the wording should not be biased.

After finalizing instrument, it will now be designed and subject it to *pilot testing*. Pilot testing detects the weakness in the design and contents of the instrument. It involves selecting a small sample from the target population and simulating the procedures for data collection that have been designed.

### **Step 7: Data Collection**

From this stage, the researcher moves ahead to data gathering stage. This involves sending questionnaires to respondents, training field workers in interview and observation methods. A careful control over the data collection process is maintained. Respondents who have remained incommunicado in the first round of communication are once again contacted. The basic aim in this stage is that the data is collected in the correct form and within the specified schedules.

### **Step 8: Analysis of Data**

The data gathered in the previous step does not have any meaning until it has undergone for data analysis. Processing of this raw data will yield some kind of relevant information. The raw data when it is aggregated, organized and analysed yields us some information which helps us in decision making. Data analysis is concerned with reducing the bulk of accumulated data to a manageable size. Generally, it involves the following procedures:

**(a) Coding:** Under this process, the various responses of the respondents are coded using symbols/ legends e.g. respondents can be classified in term of education using symbol of L (Literate) or IL (Illiterate). The basic purpose of coding is to group the responses in well-defined categories which then become easy to tabulate.

**(b) Editing:** The next step is the editing of responses. Many times the response given by the respondent is either incomplete, incomprehensible or is written in short hand. Editing removes ambiguities regarding responses, shunts out the invalid responses and thus improves the quality of data for statistical analysis.

**(c) Tabulation:** It is the process of putting the classified data in the form of tables. Tables can be one dimensional where data is tabulated in terms of one feature e.g. sales figure in terms of time. They can be multidimensional where data is tabulated using two or more features e.g. sales figure in terms of time, region and product are depicted simultaneously in a table.

**(d) Statistical Analysis:** In the last stage, the tabulated data is analysed using various statistical techniques like averages, percentages, trend analysis, correlation and regression techniques etc. Statistical analysis these days has become highly dependent on computers and softwares e.g. IBM SPSS Statistics, e-views.

### Step 9: Hypothesis Testing

After analysing the data, the next step is to test the hypothesis that had been formulated in the beginning of the research process. There are various parametric and non-parametric tests like t-test, z-test, f-test, Kruskal-Wallis test, Wilcoxon-Man-Whitney test etc. The choice of test selected for hypothesis testing depends on factors like the nature and objective of research, characteristics of population distribution, the sampling technique, type of data etc. Hypothesis testing will help a researcher in establishing the validity of his results. It will help in determining whether the difference is real or simply an outcome of random fluctuations.

### Step 10: Data Interpretation and Generalisation

In case of no-hypothesis testing research, data interpretation is done with the intention of seeking explanation for the research results on the basis of existing theories. The results are interpreted in the light of existing theories and doors are thrown open for newer explanations and possibilities for further research. In case of hypothesis testing research, after the data has been analysed, generalizations are made to build a new theory. Such generalizations come up with better explanation and new theories for existing phenomenon and greatly contribute to the existing data bank.

### Step 11: Reporting of Results

The last step is concerned with bringing in public the results of the research so that the findings can be put to application. The style and method of reporting would depend on the target audience, the purpose and the time of reporting the results. Any research report whether it is presented in a detailed form or in the form of a brief note should essentially have the following contents.

- The *preliminary section* containing the title of the report, table of contents, list of tables, graphs, preface and an executive summary, which gives briefly the research objectives and The findings and importance of the study.
- A *main text section* which contains the problem background, research objectives, a note on research methodology used, the importance of conducting the research and the conclusion arrived thereof. A special mention of the recommendation given by the researcher in light of the findings made by him should also be included.

- The *last section* which includes appendices supporting the research with items like questionnaires and schedules used, glossary of terms and any other matter which although not a part of the main research but required in order to support the research can be included.

Thus, this is a brief listing of the steps involved in a research process. A researcher should keep in mind that these steps are not rigid. Their sequence can be altered; steps can overlap or jumped depending on the topic of research.

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## 1.9 RESEARCH APPLICATIONS IN BUSINESS

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For effective planning and implementation of business decisions, accurate information about the internal business environment and the external business environment is of primary importance. The key objective of any business research is to provide accurate, relevant and timely information to the top management, so that they can make effective decisions. The business managers have the option of taking decisions either intuitively or randomly, or under the directions of an authority or through rational analysis. The best approach is to rationally analyse the problem which requires that the managers should have access to the right kind of information. This information could have been gathered by others at some time in the past (secondary data) or it could be gathered by the business managers themselves specifically with the objective of solving the problem at hand (primary data). This information is gathered by a manager through research only. A business manager lives in three time dimensions:

- (a) The past-The objectives achieved and those left unaccomplished are dealt in this dimension.
- (b) The present-There is a perpetual evaluation of what is being currently accomplished.
- (c) The future- An eye on what would be the challenges in future and what endeavours would be required to handle them.

Research is needed in order to gather data regarding the accomplishments and lacunae of the past and the performance level in the present times in order to take strategic decisions relating to future. The process of decision making is a complex one which can be seen in the diagram below. It can be broadly classified into following five steps. Each of these steps requires information that can be collected through research. Let us review these steps:

**Step 1: Defining the problem:** Research is needed to understand the environment in which the organisation is operating e.g. information gathered on work relationships between the employees may help an organisation to define the problem of interpersonal conflict.

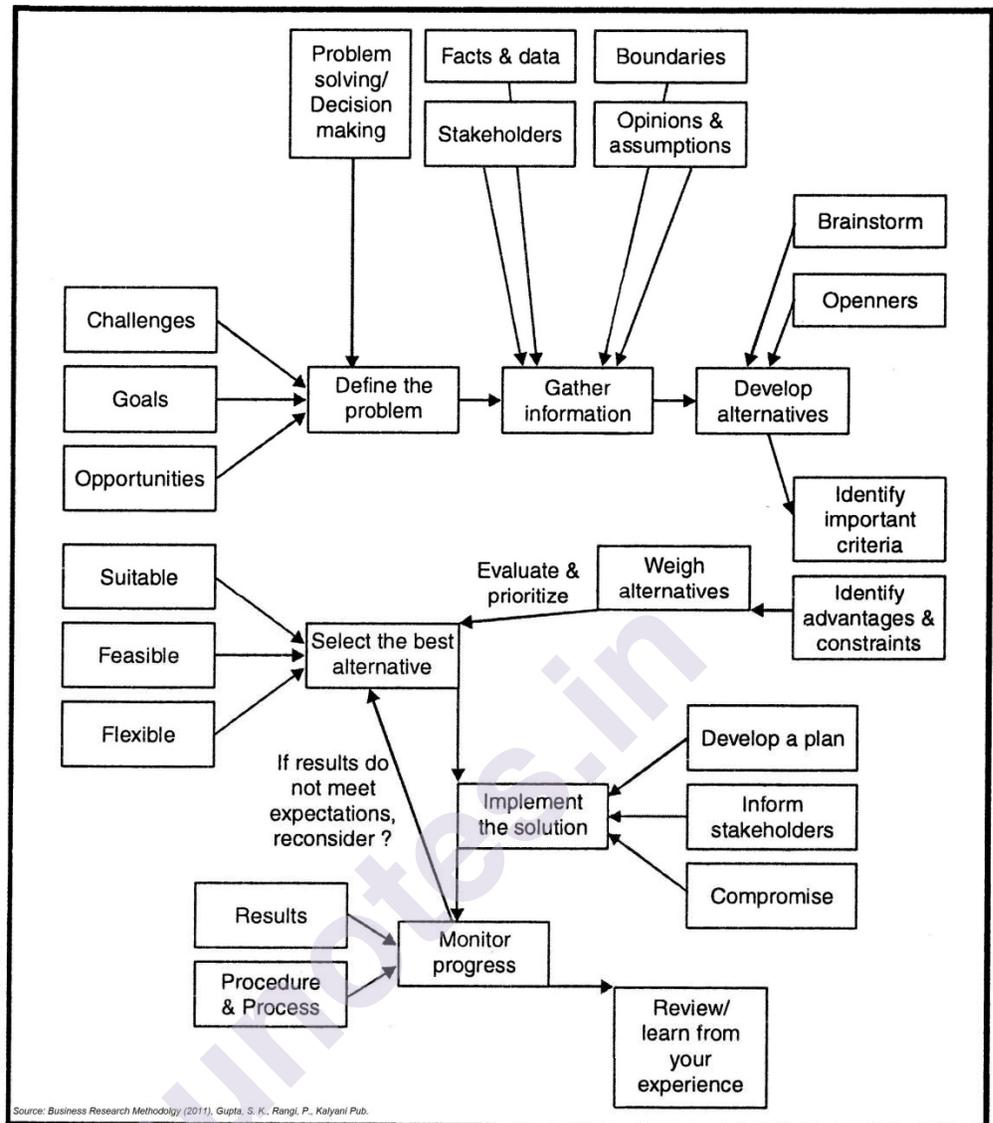
**Step 2: Gathering information:** In this stage, information through research is gathered from individuals, groups or organisations that are

affected by the problem. Opinions of experts, top level managers can be gathered through interviews to thoroughly understand the dimensions and impact of the problem.

**Step 3: Developing and selecting the best alternative:** This step involves looking at the problem from a different perspective. Techniques like brain storming are used to generate a free flow of ideas. The, ideas are generally evaluated to see which suits the problem at hand. Once the ideas have been generated, research can be used to further draw a consensus on the best alternatives.

**Step 4: Implementation:** Implementation converts an intention into a solution. It involves a careful and step-by-step set of actions carried out for solving the problems. The implementation process is carried out within a well-defined framework of time and resource allocation. Research can be used to obtain an inventory of available resources and decide on optimal allocation.

**Step 5: Evaluation:** A continuous monitoring is required to judge the success of implementation. Evaluation is the systematic acquisition and assessment of information to provide useful feedback about some object or action(s). A research that is carried out with the objective of appraising the extent to which a given set of actions have managed to achieve their targets within the given time and resource framework is called as **evaluation research**.



**PROCESS OF BUSINESS DECISION MAKING**

Thus, research is needed at every step of decision making. It is through research only that a manager can remove the uncertainty surrounding a decision. The application of research in business encompasses almost all the business processes of an organisation. In contemporary times it is expected of the organisations to be research oriented. Research is carried out in almost all functional areas e.g. advertising research, marketing research, consumer behaviour research, financial research, performance monitoring research, evaluation research, B2B, B2C marketing research etc.

Research in business is being actively carried out:

- (i) To evaluate the day to day performance of employees;
- (ii) To monitor the organisational effectiveness to improve efficiency and productivity;
- (iii) To improve consumer relations;

- (iv) To review and update existing information which is a key resource;
- (v) To identify business opportunities;
- (vi) To avail potential investment options and maximize returns; and
- (vii) To plan for staff appraisal and development.

Thus business research is needed to place the organisation competitively within the market.

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## 1.10 RESEARCH APPLICATIONS IN SOCIAL SCIENCES

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The term ‘social research’ has been defined by different scholars differently. A broad comprehensive definition of social research has been given by P.V. Young which says that “It a scientific undertaking which by means of logical and systematized techniques, aims to discover new factor verify a test old facts, analyse their sequence, interrelationship and causal explanation which were derived within an appropriate theoretical frame of reference, develop new scientific tolls, concepts and theories which would facilities reliable and valid study of human behaviour. A researcher’s primary goal distant and immediate is to explore and gain an understanding of human behaviour and social life and thereby gain a greater control over time”.

Social research has great social importance because it helps in solving many social problems. It aids the economic policies of a country, both for government and business. Social Research helps to consider the basic necessity of people and thereby provide sufficient allocation of a nation’s resources. A new social research into society and its people helps us to find the truth about various problems in our social setups and relationships. It helps to understand the different social institutions and their functions in society. It provides an overview of the changing trends in social institutions around the world. Moreover, social research helps to compare and contrast among different countries.

Social sciences include various disciplines dealing with human life, human behaviour, social groups and social institutions. They consist of Anthropology, Behaviour Science, Commerce, Demography, Economics, Education, Geography, History, Law, Linguistics management, Political Science, Psychology, Public Administration, Sociology and Social Work. Though these sciences are treated as separate branches of knowledge for the purpose of study, they are interdependent studies of the different aspects of the same object, viz. man. All the branch of social sciences makes use of research to find solution to their problems and enquiries. The contribution made by different discipline should be integrated and the interface between them should become stronger by social researcher.

In context of research in social sciences there are two important things that need to be mentioned; *firstly* that importance needs to be given to the method city in social science research and *secondly* the methodological

paradigm needs to be reworked in the light of profound changes taking place in the field of social science. The importance to methodology in social science stems from the fact that the quality and credibility of research depends on the quality and credibility of the methodology. A philosopher, Heizenberg, has said that 'we observe nature not as it is but as it is exposed to us by our method of questioning'. This implies that it is only if we develop the right questions and state the problem correctly that we can get the right set of answers. A problem correctly identified, a question rightly stated is half the research accomplished. If we know what it is that we want to do, only then can we design the method to achieve it. The social research need not restrict itself to the questions only but should concentrate on following three aspects:

- (i) Method of questioning
- (ii) Method of observation
- (iii) Method of interpretation

The last aspect i.e. method of interpretation assumes importance in social science research because social science data is amenable to diversified interpretations. Information technology has created a virtual reality through television, internet etc. where people believe what they are made to believe. This has made the social reality more complex and dynamic. The effect of such developments on research methodology is that there cannot be a single methodology for all social sciences.

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## **1.11 FEATURES OF A GOOD RESEARCH STUDY**

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

1. The purpose of the research should be clearly defined and common concepts be used.
2. The research procedure used should be described in sufficient detail to permit another researcher to repeat the research for further advancement, keeping the continuity of what has already been attained.
3. The procedural design of the research should be carefully planned to yield results that are as objective as possible.
4. The researcher should report with complete frankness, flaws in procedural design and estimate their effects upon the findings. Good research should have systematically chosen methodologies and datasets to prove the proposed hypothesis.

5. The analysis of data should be sufficiently adequate to reveal its significance and the methods of analysis used should be appropriate. The validity and reliability of the data should be checked carefully.
6. Conclusions should be confined to those justified by the data of the research and limited to those for which the data provide an adequate basis.
7. Greater confidence in research is warranted if the researcher is experienced, has a good reputation in research and is a person of integrity.
8. Related state-of-the-art literature should be studied in depth to avoid reinvention of wheel.
9. It should be time-bound and realistic.

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

**1. Good Research is Systematic:** It means that research is structured with specified steps to be taken in a specified sequence in accordance with the well-defined set of rules. Systematic characteristic of the research does not rule out creative thinking but it certainly does reject the use of guessing and intuition in arriving at conclusions.

**2. Good Research is Logical:** This implies that research is guided by the rules of logical reasoning and the logical process of induction and deduction are of great value in carrying out research. Induction is the process of reasoning from a part to the whole whereas deduction is the process of reasoning from some premise to a conclusion which follows from that very premise. In fact, logical reasoning makes research more meaningful in the context of decision making.

**3. Good Research is Empirical:** It implies that research is related basically to one or more aspects of a real situation and deals with concrete data that provide a basis for external validity to research results. Validity and reliability of data should be checked and researchers should consider an adequate amount of data.

**4. Good Research is Replicable:** This characteristic allows research results to be verified by replicating the study and thereby building a sound basis for decisions.

**5. Good Research has Utility:** The ultimate objective of any research program should be oriented towards providing benefit to the society/business. The research work should either form foundation for further advancement in the domain, draw some concrete conclusions or it should be beneficial from the social, commercial, or educational point of view.

**6. Good Research is Creative:** Creativity is the most important factor in research proposal. Ideally no two research proposals should be identical to each other. Research proposal should be designed meticulously so as to consider all factors relevant to the objective of the project. Difference in

the formulation and structure of two research programs results in difference in creativity and also in findings. Any sorts of guessing or imagination should be avoided in arriving at conclusions of a research program.

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## 1.12 SELF ASSESMENT QUESTIONS

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### 1. Fill in the blanks with appropriate words:

- (a) The \_\_\_\_\_ approach relies on direct observation and experimentation in the acquisition of new knowledge
- (b) Business research comes within the purview of ..... research.
- (c) ..... methods are concerned with attempts to quantify social phenomena and collect and analyse numerical data.
- (d) The purpose of research is to find solutions through the application of ..... and..... methods.
- (e) Gathering knowledge for knowledge's sake is known as ..... research.
- (f) In exploratory research, all possible reasons which are ..... are eliminated.
- (g) In ..... research, an examination of relationship that exists between independent and dependent variable is studied.
- (h) It is better for the researcher to generate as many alternatives as possible during problem.....
- (i) The..... must decide if data is to be collected by observation method or by interviewing.
- (j) .....is the best type of research type for gathering causal information.

### 2. State *true or false* for the following statements:

- (a) The purpose of doing research is to identify problem and find the solution.
- (b) In an experimental design, the dependent variable is the one that is not manipulated and in which any changes are observed
- (c) Research conducted to find solution for an immediate problem is fundamental research.
- (d) Identification of problem is the first step in starting the research process
- (e) In the process of conducting research 'Formulation of Hypothesis' is followed by selection of research tools.

- (f) "Controlled Group" is a term used in historical research.
- (g) 'Research methodology' refers to the chain of association between the research question and the research design.
- (h) The two main approaches of research are sampling and recording.
- (i) There are various types of research designed to obtain different types of information. Descriptive Research is used to define problems and suggest hypotheses.
- (j) In a longitudinal study, measures are taken from same participants on different occasions usually over extended period of time.

### 3. Match the following:

- A. Research Proposal    (i) Expected relationship between two or more variables
- B. Hypothesis            (ii) Data collection methods used in research
- C. Dependent Variable    (iii) Qualitative and quantitative research
- D. Questionnaire        (iv) Description of research process for a research project
- E. Time dimension        (v) Variable that changes due to the action of another variable

### 4. Answer the following:

- a) Define the term 'Research', Enumerate the characteristics of research. Give a comprehensive definition of research.
- b) Define business research and explain its application in managerial decision making.
- c) What do you mean by Research Methodology? Explain its significance and compile the different types of research.
- d) Describe the various classification of research, Differentiate between fundamental research and action research. Elaborate your answer with examples.
- e) Explain the steps in research process with the help of flow chart of the research process.
- f) What type of research would you undertake in order find why middle income groups go to a particular retail store to buy their products?
- g) Which type of research would you conduct when the problem is not clear and all the possible reasons are eliminated? Why?

- h) Business research methods are tools for decision making in the hands of a researcher. Justify the statement.
- i) What are the different methods in conducting an exploratory research?
- j) What is descriptive research and when do researchers conduct it?
- k) Give a detailed essay on application of research in business and social sciences.
- l) Enlist the features of a good research study.

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### **1.13 SUMMARY**

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This module presents an introductory discussion about research. Researchers systematically collect, compile, analyse, and interpret data to provide quality information based on which the decision maker will be able to take a decision in an optimum manner. In fact, research is tool in the hands of a decision maker to make an optimum decision in an environment of uncertainty. Conducting research to deal with any problem is a scientific, systematic, and interlinked exercise, which requires sound experience and knowledge. This module is an attempt to understand the nature and scope of the research. The purpose of research is to contribute to or develop a body of knowledge.

Research may broadly be classified on the basis of objectives, extent of theory, time dimension, enquiry made and others. Basic/ pure research is generally not related to a specific problem and its findings cannot be immediately applied. Applied research directly addresses the problem at hand. Applied research is launched by the firm, agency, or the individual facing the specific problem. Exploratory research is mainly used to explore the insight of the general research problem. It is used in obtaining background information, research problem formulation or defining it more precisely, identifying and defining key research variables, and developing hypotheses. Exploratory research is conducted through secondary data analysis, expert survey, focus group interviews, case analysis, and projective techniques. Descriptive research is conducted to describe the business or market characteristics. Cross-sectional research design involves collection of information from a sample of a population at only one point of time. Longitudinal study involves survey of the same population over a period of time. Causal research is conducted to identify the cause-and-effect relationship between two or more business (or decision) variables. There are two approaches to research namely; qualitative approach and quantitative approach.

The ability to take an informed decision is generated through a systematic study that is conducted through various interrelated stages. A research design is the detailed blueprint used to guide a research study towards its objective. A good research is conducted through these steps; discover the problem area, review of literature, problem formulation and definition,

developing a working hypothesis, research proposal, research design, data collection, analysis of data, hypothesis testing, data interpretation and generalisation and reporting of results.

There is wide spectrum of application of research in business and social sciences. On one side, research is always required by business managers for solving business problems and decision making. On other side, social scientists makes use of research in various disciplines of social sciences to find social phenomenon, link social sciences, analysing social trends etc. A good research must be systematic, logical, empirical, replicable, useful and creative.

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## 1.14 KEY WORDS

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- **Applied Research:** It refers to scientific study and research that seeks to solve practical problems.
- **Case-Study Research:** It is concerned with exploring and analysing the life or functioning of a social or economic unit, such as a person, a family, a community, an institution, a firm or an. Industry.
- **Causal/ Experimental Research:** A research carried out so establish the relationship between independent variable and dependent variable.
- **Cohort Study:** It is about observing a category of people who share a similar life experience in a specified time period.
- **Conclusive Research:** Conclusive research is carried out to provide information that is useful in reaching conclusions or decision-making.
- **Cross-Sectional Research:** Cross-sectional research design involves the collection of information from a sample of a population at only one point of time.
- **Descriptive Research:** It is used to describe characteristics of a population or phenomenon being studied.
- **Diagnostic Research:** This research is conducted to establish whether two or more variables are associated and their degree of association.
- **Empirical Research:** Research based on first-hand gathering of data through interviews, questionnaires, ethnographies, participant observation, action research and so on.
- **Evaluation Research:** Evaluation research aims at evaluating programme that have been implemented or actions that have taken in order to get an objective.
- **Exploratory Research:** It is a methodology that investigates research questions that have not previously been studied in depth.

- **Ex-Post Facto:** Ex post facto research is the process beginning with a phenomenon and going backward in time to identify casual factors.
- **Historical Research:** Historical study is a study of past records and data in order to understand the future trends and development of the organisation or market.
- **Hypothesis:** A hypothesis is a tentative assumption regarding the solution to the problem under study.
- **Longitudinal Research:** Longitudinal study involves survey of the same population over a period of time.
- **Panel Study:** Panel study is concerned with observing exactly the same people, group, or organisation across time periods.
- **Pure Research:** It is a type of scientific research with the aim of improving scientific theories for better understanding and prediction of natural or other phenomena.
- **Qualitative Research:** Qualitative research is designed to find out how people feel or what they think about a particular subject.
- **Quantitative Research:** It usually involves the collection and converting of numerical data into numerical form to made statistical calculations which help in drawing conclusions to answer a specific research question.
- **Research Design:** Research design refers to the framework of market research methods and techniques that are chosen by a researcher. The design that is chosen by the researchers allows them to utilize the methods that are suitable for the study.
- **Research Proposal:** A research proposal is a brief summary outlining the objectives of study and the modus operandi of conducting the research.
- **Research:** The systematic investigation and study of materials and sources in order to establish facts and reach new conclusions.
- **Theoretical Research:** This research uses the findings from existing theory and explanations to develop new ideas.
- **Time-Series Research:** A time series design collects data on the same variable at regular intervals (weeks, months, years, etc.) in the form of aggregate measures of a population.

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**1.15 ANSWERS TO SELF ASSESMENT QUESTIONS**

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1. (a) empirical (b) social science(c) Quantitative(d) systematic, scientific  
(e) basic (f) very obvious(g) ex-post facto (h) formulation hypothesis  
(i) researcher (j) Experimental
2. (a) True (b) False (c) False (d) True (e) True (f) False  
(g) True (h) False (i) True (j) True
3. A. (iv) B. (i) C. (v) D. (ii) E. (iii)



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# RESEARCH PROBLEM AND FORMULATION OF RESEARCH HYPOTHESES

## Unit Structure

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## 2.0 OBJECTIVES

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After studying this module, you should be able to:

- Understand the concept, importance of and the process used for defining research problem.
- Apply deductive and inductive reasoning strategies to formulate research problem.
- Understand the difference of management decision problem and management research problem.
- Describe research hypothesis and its formulation procedure.
- Identify propositions and convert them into workable research hypothesis.
- Know about the research proposal and its contents.
- Develop the understanding about various types of research proposals and their importance.

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## 2.1 INTRODUCTION

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Selecting the research problem is the first and important step in executing the research work. The success of a research effort lies in choosing the correct problem. This problem setting may not be necessary for exploratory or formative researches where the research work does not start with the formulation of the problem and such studies often precede the setting up of problem. However, in other forms of research it is logical that the researcher must know what is that he wants to do. It is essential that a researcher identifies a problem that demands an answer, a need that requires a solution, a demand that requires satisfaction. The world around has lots of problem e.g. in the social field the problems of crime, poverty, housing, in government the problem of bureaucratic delays and complexities, in business of work culture and technical deficiencies. It is not difficult to find problem areas, the difficulty lies in choosing a problem area where specific problem can be clearly delineated and yet the problem is not a frequently researched one. This module focuses on the conditions under which decision-making occurs and the managers use to clearly define business problems and opportunities. Once the researcher knows what his problem is, he can make a guess or number of guesses. The guesses he makes are the hypothesis which either solve the problem or guide him in further investigation. Hypothesis stands somewhat at the

midpoint of research. From this midpoint one can go back to the problem and also look forward to the date. If the hypothesis is proved, the solution can be found. If it is not proved, alternative hypotheses need to be formulated and tested. The researcher proceeds to test on the basis of facts; already known or that can be made known. The most difficult task in conducting the research is making the research proposal. A research proposal is the representation of the research work in a short and precise manner. Research proposal is made to make it clear what the researcher intends to do in his research. Research proposal is also necessary to be submitted for approval of the concerned authorities i.e. the guide or the client or the funding agency etc. This module would highlight on defining and formulating a problem, hypothesis and describe how to structure a research proposal.

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## 2.2 RESEARCH PROBLEM: MEANING AND DEFINITION

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Primary step in the process of research is selection of a research problem. A person or group of persons having a distinct difficulty with regard to a phenomena and tries to find solution using scientific method may broadly be defined as **research problem**. A problem does not mean that something is seriously wrong with the current situation that needs to be rectified immediately. A problem could indicate that its solution might help to improve the situation. Thus, it is useful to define the problem. Basic researchers define their problems for investigation.

A research problem, in general, refers to some difficulty which a researcher faces in the context of practical situation and wants to obtain solution for the same. It is important that **systems** of problems are not defined as the real problem. For example, a manager may have tried to increase productivity by increasing the piece rate, but with little success. Here the **problem** may be the low morale, and motivation of employees. Here, low productivity may be symptom of morale and motivation problem. Thus, finding the 'right' answers to the wrong problem definition will not help. Hence, identification of correct problem is essential for finding the solutions to critical issues.

The researcher needs to have a vast knowledge in the domain that he wishes to work. Only then, he can analyze the gaps in the present situation and put forward a new proposal. The term problem in its Greek form, *proballein*, means anything through forward; anything proposed for solution; a matter stated for examination. We can visualize this process like a magician's magic box. Whenever we open the box, it contains another one. Similarly, the process continues and he takes something very precious from the innermost boxes. Likewise, in research we start with a big domain and we narrow it down to smaller pieces and finally gets to the core and obtains the real research problem.

**Northrop** during 1966 has explained the research problem in best way. He stated that 'inquiry starts only when something is unsatisfactory, when traditional beliefs are inadequate or in question, when the facts necessary

to resolve one's uncertainties are not known, when the likely relevant hypotheses are not even imagined. What one has at the beginning of inquiry is merely the problem".

**Bajpai Naval** describes research problem as "It is somewhat information oriented and focuses mainly on the causes and not on the symptoms."

**Malhotra Naresh** defines it as "A broad statement of the general problem and identification of the specific components of the marketing research problem.

**Woodworth** defines problem as "a situation for which we have no ready and successful response by instinct or by previously acquired habit. We must find out what to do."

In simple words, we can say that research problem defines the destination before starting the journey. It specifies; what to do, how to do, where to do and what the outcomes are. Thus without a properly defined problem, the research cannot progress. Formulation of research problem is not just finding a topic within our interest. It is the remodeling, reshaping or even reconstruction of facts, theories or hypothesis. The problem thus formulated should also be compact for data collection and analysis. The sole aim of problem definition is creation of research question and creation of hypothesis. We can summarize the goal of formulating research problem as the method of generating measurable, well-defined, directed and in-scope research questions for creating desired hypothesis.

There are certain guidelines that need to be followed while formulating a research problem. The single statement that needs to be in every researcher's mind is that there is no short cut to the research-it is only the hard work and determination that gives you the perfect result. Many scholars hastily skip the primary step of problem formulation, which makes them to face difficulties in later stage.

The definitions of problem given by some other notable authors are:

"To define a problem means to put a fence around it, to separate it by careful distinctions from like questions found in related situations of need." -*Whitney*

"A problem is a question proposed for a solution generally speaking a problem exists when there is a no available answer to same question." -*J.C. Townsend*

"A problem is an interrogative sentence or statement that asks: What relation exists between two or more variables?" -*F.N. Kerlinger*

"To define a problem means to specify it in detail and with precision each question and subordinate question to be answered is to be specified, the limits of the investigation must be determined. Frequently, it is necessary to review previous studies in order to determine just what is to be done. Sometimes it is necessary to formulate the point of view or educational

theory on which the investigation is to be based. If certain assumptions are made, they must be explicitly noted.” -*Monero and Engelhart*

From the above discussion, it can be concluded that **problem definition** is a clear and precise statement of the questions that are to be investigated. Problem definitions may pertain to:

1. Existing business problem that is to be solved by the manager.
2. Situations (currently not creating problem) that have scope for improvement.
3. Areas where conceptual clarity is needed.
4. Situations in which researcher is trying to answer a research question.

The first two cases relate to applied research while remaining two cases come under basic research.

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### **2.3 IMPORTANCE OF PROBLEM DEFINITION**

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Defining a research problem properly is a prerequisite for any study and is a step of the highest importance. Generally, we all hear that a problem clearly defined is a problem half solved. This statement signifies the need for defining a research problem. While defining the problem, it should be noted that definition should be unambiguous i.e. must be defined clearly.

***Example of an ambiguous definition:*** “Why is the productivity in China is much higher than that in India?”

In this type of question, a number of ambiguities are there, such as:

- i. What sort of productivity is to be specified; is it men, machine, materials?
- ii. To which type of industry is the productivity related to?
- iii. In which time-frame are we analysing the productivity?

***Example of an unambiguous definition:*** “What are the factors responsible for increased labour productivity in Chinese mobile manufacturing industries during 2010-15 relative to Indian mobile industries?”

The significance of clearly defined problem can be judged as under:

1. A proper definition of research problem will enable the researcher to be in the right direction whereas ill-defined problem may create hurdles.
2. A well-defined problem gives the answers to the questions like
  - a. What data are to be collected?

- b. Which appropriate techniques are to be used to generate alternative solutions?
  - c. What relations, among variables, are to be explored?
  - d. What kind of study is required?
3. A well-defined problem provides basic for research design.
  4. Problem definition facilitates research process.
  5. A problem definition indicates a specific managerial decision area that will be clarified by answering some research questions.

As a matter of fact, **formulation of a problem** (problem defining) is more essential than its solution.

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## 2.4 SOURCES OF RESEARCH PROBLEM

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One of the initial tasks is to look for the unresolved questions. There are a lot of potential problem areas that require the immediate attention of the researcher. If problem has not been identified in right manner, it is very difficult for researcher to find the right solution of the issue. A researcher may find a potential research problem through any of these sources:

**(i) Personal, Professional and Academic Experience:** An individual's personal, professional and academic experience is one of the best sources of problem. It generates greater interest on the part of the researcher because he has encountered it at some point in his life and realizes the importance of solving the problem. Academic experience helps the researcher to develop critical thinking towards happenings.

**(ii) Review of Literature:** It is another good source to look for research problems. By going through research studies/ works of others, researcher identifies the new dimensions of studies. Many studies have a special section detailing the possibilities of further research. Thus it is important that a researcher goes through literature in his area of interest.

**(iii) Conferences and Seminars:** One can also get good information about potential research problem by attending conferences, seminars etc. Generally such events involve a discussion by experts on problems and issues relevant to the conference. After having brainstorming and intellectual discussions, researcher get to know many new aspects related to specific aspect of the study.

**(iv) Imagination and Creativity:** These are the best brainteasers. They guide an individual to newer hitherto unexplored areas. It empowers the individual to perceive the routine things in a different perception and look for new answers to existing accepted solutions.

**(v) Technical and Social Changes:** These changes are constantly bringing up newer and newer challenges in front of the researchers. The

technology changes overnight and so do the expectations of the users. Hence, these developments offer a good source of research opportunities.

Apart from above, some other sources may be intuition of researcher, consultations with experts, and daily experiences of life and field situations observed by researcher.

These sources throw open numerous potential possibilities of research. However not every problem qualifies for research. Hence the selection of the problem is a very careful and well thought out process.

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## 2.5 CRITERIA OF DETERMINING A RESEARCH PROBLEM

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Like musical appreciation, choice of the problem depends upon one's own taste. It should be a 'problem' which researcher faces and wants to find solution. If the problem springs from others and the researcher wants to find solution then identification or belonging will not be there. However, now days, either in business, or in governmental sector, the research work is carried out for the specific problems set for specific purposes. In such cases the problem is not researcher's 'own' but organizational. Here researcher is only an employed person and personal likes and dislikes are not counted.

*Goode and Hatt* enumerate the following criteria for the selection of a research problem:

- (1) The Researcher's interest, intellectual curiosity and drive
- (2) Practicability
- (3) Urgency of the problem
- (4) Anticipation of the outcomes
- (5) Resources, training, expertise, availability of resources and facilities etc.

However, to generalize it, the criteria for formulation of good research problem out of identified problems can be grouped into:

1. Internal criteria
2. External criteria

### 2.5.1 Internal Criteria

a. **Interest and Curiosity of Researcher:** The problem should be captivating and interesting enough to hold the interest of the researcher. Without interest in problem, it becomes very difficult for researcher to sustain continuity in research and it will not be able to reach its logical end. Interest in a problem shows the researcher's experience, educational background, sensitivity etc.

b. **Resources of Researcher:** Research requires a lot of time and money. The researcher should take care that he has the financial resources required to undertake the research. If researcher does not have enough money and he is unable to manage external finance, researcher should not go for research. Further, research requires more time; he should carefully evaluate the time schedule required to complete the project and make sure that he has the ability and resources to complete it within the specified time.

c. **Researcher's Abilities:** A mere interest in research will not work. The researcher must be competent to plan and carry out a study of the problem. The researcher should choose a problem that is within his capabilities. Researcher should have relevant knowledge of subject matter, relevant methodology and statistical procedures. He should be able to carry out the research confidently and get the required cooperation and guidance from the right sources.

### 2.5.2 External Criteria

a. **Unambiguity and Research-ability:** Too narrow or too vague problems should be avoided. To be researchable, a problem must be one for which observation or other data collection in real world can provide the answer. The problem must be clearly stated and expresses relationship between variables succinctly e.g. 'Studying the relationship between family conditions and performance of students' is a poorly stated problem. In this problem the term 'family conditions' is very vague and does not specify the meaning of family conditions.

b. **Importance and Urgency:** Issues requiring investigation are unlimited but available research efforts are very much limited. Therefore, relative importance and significance of problem is required. The outcome or the results of the research should find an application in solving a problem being faced by the society, organization or a government. Important and urgent issues should be given priority over an unimportant one. The problem should contribute towards the existing knowledge database.

c. **Novelty and Originality:** A problem on which a lot of research work has been done should not be considered for research. A researcher should keep in mind is that a good research problem is original and is not a duplication of existing work. Duplication does not mean that past studies cannot be researched. A researcher may work on existing studies but with the objective of re-interpreting the known findings.

d. **Feasibility:** Novelty of the problem is, not sufficient. If it is not feasible to conduct the study on problem in real world means existence of facts is not there. Even to the novel problems, we should make a small feasibility study first and proceed only after this if study allows.

e. **Facilities Available:** Well-equipped library, proper guidance, data analysis etc. are basic facilities which are required to carry on any research.

f. **Research Staff:** Availability of adequate research personnel like investigators and research officers is very important for data collection, which is a major issue in many developing countries like India

The researcher must be aware of three principle components of research-problem:

- (1) What the researcher wants to know?
- (2) Why a particular problem is being put?
- (3) Possible, alternative solutions to the problem.

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## 2.6 MANAGEMENT DECISION PROBLEM VS. MANAGEMENT RESEARCH PROBLEM

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The management decision problem pertains to the decision makers in which there is ambiguity in the mind of decision makers. It asks what the decision makers need to do. Whereas, the management research problem is the quest for searching the solution. It asks what information is needed and how it can be obtained effectively and efficiently. For making the sound decisions, the necessary information can be provided by research. The management decision problem is action oriented. It is concerned with the possible actions the decision makers can take. For example, how can the loss of market share be coped? How the market can be segmented differently? Whether a new product can be introduced? Is there any need to increase the promotional budget? In comparison to this, the management research problem is information oriented. Whereas, the management decision problem focuses on symptoms, the management research problem focuses on underlying causes.

For better understanding of concept, let's have an example. There is the loss of market share for a particular product line in a company. The decision maker's decision problem is how the company recover this loss and gain market share again. The various alternative courses of action may include changes in existing product line, launching new products, changing other components of the marketing mix and segmenting the market differently. Suppose the decision maker and the researcher agrees upon that this problem is the result of inappropriate segmentation of the market and want research on this issue to provide more information. Then, the management research problem would become the identification and evaluation of an alternative basis for segmenting the market. Note that this process requires much interaction, in the sense that both parties critically evaluate, develop and defend each other's ideas to clarify the nature of decision and research problems, and to ensure there is a clear and logical connection between them. The following example will give clearer distinction between the management decision problem and the management research problem. It also illustrates the interactive nature of identifying the management decision problem and the research problem, each one unfolding and informing the understanding of the other.

*ABC Bank:* It has been observed that our market share is declining in India in corporate banking.

*Researcher:* Only India?

*ABC Bank:* No, but the majority of our business is there in India and the decline of share in that territory is causing us the greatest amount of concern.

*Researcher:* Do you have any idea regarding the reasons behind losing market share?

*ABC Bank:* We wish we knew!

*Researcher:* What about your competitors? How are they coping?

*ABC Bank:* We doubt that many other Indian banks are facing same problem, and the multinational banks are capturing market share.

*Researcher:* What is the feeling of your consumers regarding the quality of services you deliver?

*ABC Bank:* Last year only, we have received the prestigious quality certification 'ISO:9000' from an international agency, which we are proud of!

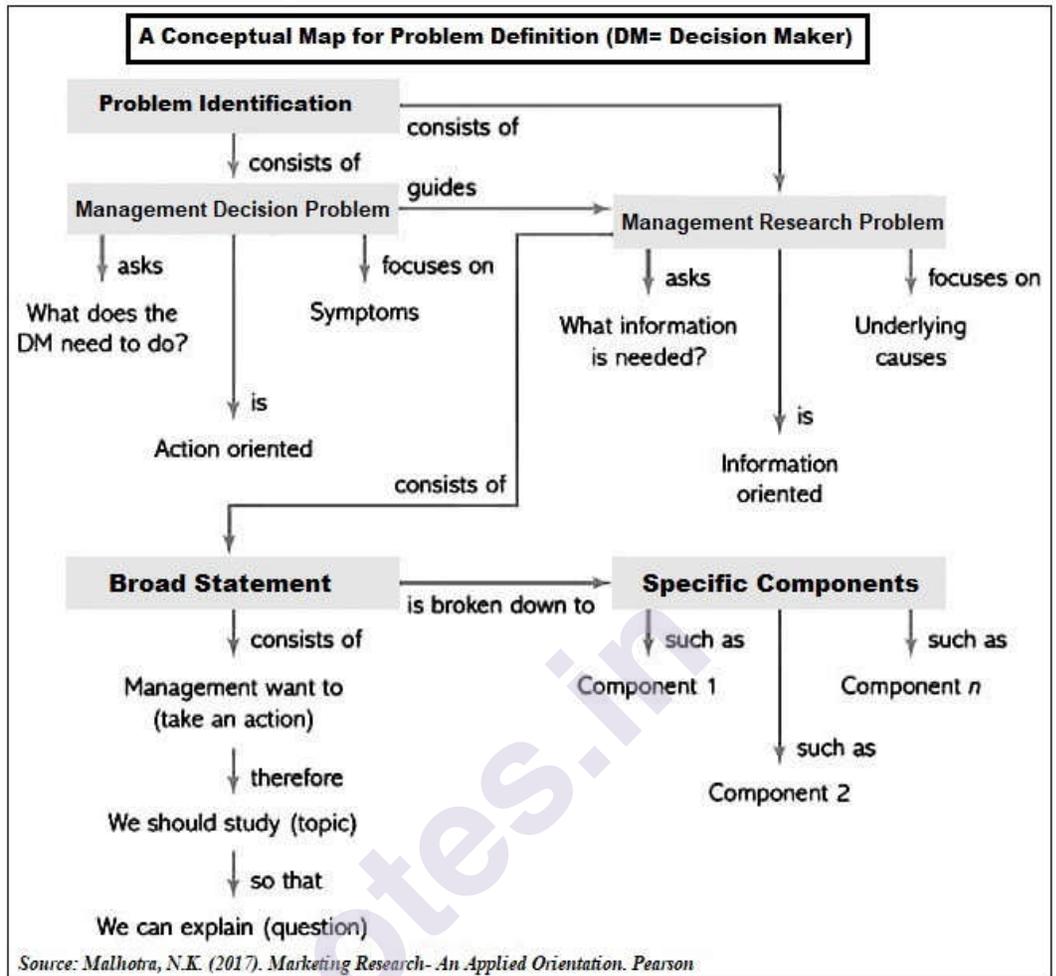
*Researcher:* But how does your service delivery compare with your competitors?

After such lengthy and sequence of discussions with key persons, analysis of secondary data and intelligence sources within the bank and from other sources, the problem was identified as follows:

***Management Decision Problem:*** To improve the relationship experience with clients at all contact points, in order to arrest the decline in market share of ABC Bank.

***Management Research Problem:*** To determine the relative strengths and weaknesses in terms of relationship experiences of ABC Bank, vis-à-vis other major domestic and international competitors in India. It will be carried out with respect to factors that influence a corporate's choice of a bank to handle its transactions.

However different, the management decision problem need to be closely linked to the management research problem. A conceptual map (as diagram given below) is a good way of linking the broad statement of the decision problem with the research problem.



A **conceptual map** involves the following three components:

Management decision maker wants to *(take an action)*

Therefore, we should study *(topic)*

So that, we can explain *(question)*.

The first line states the rationale for the question and the project which is the management decision problem. The second line of the conceptual map declares what broader topic is being investigated. The third line implies the question being investigated – the who/ how/ why that needs to be explained. Thus, the second and third lines define the broad management research problem. An example of the conceptual map for the study of affluent class, assuming that the US luxury brand *Calvin Klein* was developing marketing strategies to develop its brand in India is as follows:

Management decision maker wants to *(deliver differentiated in-store customer experiences for particular types of affluent class individuals)*

Therefore, we should study *(ways to segment different types of affluent class individuals in India)*

So that, we can explain (*the essential demographic, geographic, psychographic, behavioural and psychological factors that could shape differentiated in-store consumer experiences for luxury goods and services*).

The above example provides valuable definitions of the management decision problem and the broad management research problems that are closely linked. The problem now looks upon a research approach and research design that will generate understanding and measurements of different types of affluent class individuals in India. This distinction and linkage between the management decision problem and the management research problem helps us in understanding how the marketing research problem should be defined.

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## 2.7 PROBLEM IDENTIFICATION PROCESS

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The problem identification process invariably starts with the decision maker and some difficulty or decision dilemma faced by him. This is action oriented problems that answer the question of what the decision maker should do. Sometimes, the problem might be related to actual and current difficulties faced by the manager (applied research) or gaps experienced in the existing body of knowledge (basic research). The broad decision problem has to be narrowed down to **information oriented problem** which focuses on the information required to arrive at any meaningful conclusion. Management decision problem will give way to the management research problem.

Once the audit process of arriving at management decision problem is over, the researcher now focuses and identifies the issues of concern, which needs to be investigated further, in the form of an unambiguous and clearly-defined research problem. Identifying all possible dimensions of the problem might be a monumental and impossible task for the researcher. The researcher must be able to isolate the underlying issues from the symptoms of the problem. Researchers can make two common errors in problem identification. The first, when the research problem is defined too broadly. A broad definition does not provide clear guidelines for the subsequent steps involved in the project. The second error is just the opposite: the research problem is defined too narrowly. A narrow focus may preclude consideration of some courses of action, particularly those that are innovative and not obvious...

The research problem can be stated in two ways:

- (a) As an interrogative statement, or
- (b) As a declarative statement

Identification of a research problem involves several interrelated, which can be described as follows:

1. Ascertaining decision-Maker's objectives
2. Understand the background of the problem

3. Isolating and identifying the problem not the Symptoms
4. Determining the unit of analysis
5. Determining the relevant variables
6. Stating the research questions and research objectives.

**1. Ascertaining Decision-Maker's Objectives-**The research investigator must make an attempt to satisfy the objectives of decision maker who requested the project. Management theorists suggest the decision maker should express his or her goals to the researcher in measurable terms. However, it is unfortunately said that the decision maker seldom formulates his objective accurately. Consequently, objectives usually have to be extracted by the researcher. In doing so, the researcher may well be performing his most useful services to the decision maker. Often exploratory research can highlight the nature of problem and help the managers clarify their objectives and decisions.

**Iceberg Principle-** Why do so many business research problems begin without clear objectives or inadequate problem definitions? Managers are logical people, and it seems logical that definition of the problem is the starting point for any enterprise. Frequently, managers and researchers cannot discover the actual problem because they lack detailed information. Here, Iceberg principle serves as a useful analogy. A sailor in the sea notices only a small part of an iceberg. Only 10 percent of it is above the surface of the water, and 90 percent is under the water. Similarly, the dangerous part of many business problems, like the under the sea portion (submerged) of the iceberg, is neither visible to nor understood by managers. If the submerged portion of the problem is due to problem definition, the decisions based on the research may be less than desired.

**2. Understanding the Background of the Problem-** The iceberg principle illustrates that understanding the background of a problem is vital. Often experienced managers know more about a situation, and they can provide the researchers with considerable background information about previous events and why those events happened. Institutions, where decision maker's objectives are clear, the problem may be diagnosed by exercising managerial judgment. In other situations, where information is inadequate or managers have trouble identifying the problem, **a situation analysis** is the logical first step in defining the problem.

The researcher should develop a conceptual framework of the problem. The background of the study, underlying theoretical and conceptual basis should be carefully understood. The researcher should make a critical examination of the related studies.

**3. Isolating and Identifying the Problem not the Symptoms-** The anticipation of all dimensions of a problem is impossible for any researcher or an executive. For example, a firm may have a problem with its advertising effectiveness. The possible causes of this problem may be low awareness, the wrong brand image use of the wrong media, or perhaps

low budget allocation. Management's job is to isolate and identify the most likely causes. Sometimes, certain happenings that appear to be 'the problem' may be only symptoms of a deeper problem.

Other problems may be identified only after a research of background information and after conducting exploratory research. The researcher should develop a conceptual framework of the problem. The background of the study, underlying theoretical and conceptual basis should be carefully understood. How does one ensure that the fundamental problem has been identified? There is no easy or simple answer to this question. The researcher should make a critical examination of the related studies. Executive judgment and creativity must be exercised.

**4. Determining the Unit of Analysis-** In the next step, the researcher should state the unit of analysis. It would help him to define the limits of his study. The researcher must specify whether the level of investigation will focus on the collection of data about organizations, departments, work groups, individuals, or objects. The unit of analysis could be an individual, a social structure like a household or an organization etc. e.g. in studies of home buying, the husband-wife is one rather than the individual is the unit of analysis because the purchase decision is jointly made by husband and wife. It must always be kept in mind that the unit of analysis suits our purpose of study. In another example, in case of a study on vehicle ownership, a household can be a unit of analysis.

**5. Determining the Relevant Variables-** The researcher should now determine the essential and relevant variables. A **Variable** is defined as anything that varies or changes in value. It is something that can be observed, manipulated and changes in value in response to certain stimuli. Because a variable represents a quality that can exhibit differences in value, it may be said that a variable is anything that may assume different numerical or categorical values. The variable that is to be predicted or explained called as the dependent variable and the variable that influences the dependent variable is called as the independent variable. The research may also need to identify the extraneous variables i.e. those variables that are not directly a part of the study but may influence the outcome of the study e.g., a study on relationship between tuitions (independent variable) and performance (dependent variable) may have IQ as an extraneous variable. A clear identification of the variables will help in formulating the correct relationships and controlling the extraneous variables effectively.

Key variables should be identified in the problem definition stage. To address the specific problem, managers and researchers should be careful to include all of the relevant variables that must be studied. Similarly, variables that are superfluous (i.e., not directly relevant to the problem) should not be included in the study.

**6. Stating the Research Questions and Research Objectives-** . Now the researcher must specify the relationship which in his opinion exists between the variables. Once the problem to be tackled has been finalized, the variables identified, the relationship stated, the researcher should now

formulate a tentative solution to the problem. Both managers and researchers expect that problem solving efforts should result in statement of research question and research objectives. Depending on the purpose of the study the researcher has to decide which relationship would form a part of the study and which are to be ignored. A well thought decision will help the researcher in having a precise set of objectives and the resources would be optimally utilized on the stated objectives.

**7. Developing a Hypothesis:** The last stage is of developing a hypothesis. These proposed solutions are called as hypothesis, which the researcher would proceed to formulate on the basis of facts known or collected by him. Whether these relationships are scientifically maintainable or not, will be decided after the researcher collects and analyses his data. In case of studies, which are not hypothesis-testing, the researcher may frame a set of research objectives. After the formulation of the working hypothesis, the researcher is now ready to prepare the research proposal.

A researcher should take care that the problem chosen is not an excuse for the personal enlightenment of the researcher i.e. is not being used to enhance the knowledge of the researcher alone. While identification he should take care that it is not too narrow or broad in its scope and matches with his experience, qualifications and resources.

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## 2.8 COMPONENTS OF THE RESEARCH PROBLEM

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A research problem, in general, refers to some difficulty which a researcher experiences in the context of either a theoretical or practical situation and wants to obtain a solution for the same. Once the topic for research is selected, research can not immediately be started unless the specific research problem is formulated. It is investigated by scientific methods. Needless to say that the formulation of enquiry must recognize some difficulty whether it is practical or theoretical.

R. L. Ackoff in his work discussed about the following five most important components of research problem:

1. Research Consumer
2. Research-Consumer's Objective
3. Alternative Means to Meet the Objective
4. Doubt in Regard to Selection of Alternatives
5. There must be one or More Environments

**1. Research Consumer:** It is first and most important component of research problem. There must be individuals, groups or organisations which have some difficulty or problem. The individuals, groups or the organisations themselves may be researchers. There are other participants in the problem. All are affected by the decision on the part of the research

consumer. The individual or the organisation, as the case may be, occupies an environment, which is defined by values of the uncontrolled variables.

**2. Research-Consumer's Objective:** There must be some objectives to be attained as the research consumer must have something he wants to get it. If one wants nothing, one cannot have a problem. There must be at least two courses of action to be pursued. A course of action is defined by one or more values of the controlled variables.

**3. Alternative Means to Meet the Objective:** There must be alternative means or the courses of action for achieving the desired objective. Means are courses of action. A course of action may involve the use of various objects. Objects are the instruments. This means that there must be at least two means available to a researcher. If he has no choice of means, he cannot have a problem. Of the two possible outcomes of the course of action, of which one should be preferable to the other. In other words, this means that there must be at least one outcome that the researcher wants, i.e., an objective.

**4. Doubt in Regard to Selection of Alternatives:** The existence of alternative courses of action is not enough. To experience a problem, the researcher must have some doubt as to which alternative to select. Without such a doubt, there can be no problem. This means that research must answer the question concerning the relative efficiency of the possible alternative. The courses of action available must provide some chance of obtaining the objective, but they cannot provide the same chance, otherwise the choice would not matter. In simple words, we can say that the choices must have unequal efficiencies for the desired outcomes.

**5. There must be one or More Environments:** There must be some environments to which the difficulty or problem pertains. A change in the environment may produce or remove a problem. A researcher may have doubts as to which will be the most efficient means in one environment but may entertain no such doubt in another. Some problems are quite general. Thus, a research problem is one which requires a researcher to find out the best solution for the given problem i.e., to find out by which course of action the objective can be attained optimally in the context of a given environment.

There are several factors which may result in making the problem complicated. For instance, the environment may change affecting the efficiencies of the courses of action or the values of the outcomes; the number of alternative courses of action may be very large; persons not involved in making the decision may be affected by it and react to it favorably or unfavorably, and similar other factors. All such elements (or at least the important ones) may be thought of in context of a research problem.

Over and above these conditions, the individuals or the organisations can be said to have the problem only if they do not know what course of action is best, i.e. they must be in doubt about the solution. Thus, an individual or a group of persons can be said to have a problem which can

be technically described as a research problem, if they (individual, group, the organisation), having one or more desired outcomes, are confronted with two or more courses of action that have some but not equal efficiency for the desired objective(s) and are in doubt about which course of action is best.

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## 2.9 SELF ASSESSMENT QUESTIONS

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### 1. Fill in the blanks with appropriate words:

- (a) If you have a specific idea about what is to be researched you should formulate .....
- (b) Of all the steps in the research process, the one that typically takes the most time is formulating .....
- (c) Developing a researchable question would ..... (involve/not involve) deciding what statistical software to use.
- (d) R. L. Ackoff in his work discussed about the ..... most important components of research problem
- (e) The research problem can be stated in two ways: one is as an interrogative statement and other is as a ..... Statement.

### 2. State *true or false* for the following statements:

- (a) The formulation of a research problem is the most crucial part of the research journey as the quantity and vanity of the project entirely depends upon it.
- (b) A variable that changes due to the action of another variable is known as the independent variable
- (c) The research problem determines what methodology will be used.
- (d) Knowledge of the subject area helps when developing a research question.
- (e) A research problem is feasible only when it is researchable, new and adds something to knowledge and has utility and relevance.

### 3. Answer the following:

- (a) Describe why a research problem is the heart of the research process?
- (b) Do you agree that formulating research problem should be the first thing to do in undertaking a research project? Discuss.
- (c) Elaborate in detail the various steps of research problem identification?

- (d) Write an essay on the various components of research problem?  
How they help in better definition of research problem?
- (e) What are the major criteria for selecting a research problem?

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## 2.10 RESEARCH HYPOTHESIS: MEANING AND DEFINITION

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When a researcher observes known facts and takes up a problem for analysis, he first has to start somewhere and this point of start is hypothesis. The term hypothesis has been derived from the ancient Greek, *hypotithenai*, meaning “to put under” or “to suppose”. The development of hypothesis is a very vital aspect of a research. A research work without hypothesis is a rare phenomenon. It gives direction and focus to the research. It refines the process research. Without the hypothesis, research is unfocussed and random empirical wandering. When a research problem is articulated a researcher will have in his mind a tentative generalisation about possible outcome of the research. This tentative generalisation may be proved or disproved based upon the analysis of data or material that is processed for research. This is generally called the **hypothesis**. Bachrach opined, "A researcher observes an event, wonders about it, formulate some tentative ideas about it, and sets out to test the accuracy of his ideas." While giving provisional answer to the problem, the researcher tries to establish relationship between two variables.

In other words, one has to proceed to formulate tentative solutions as soon as the problem to be talked is finalised. These proposed solutions or explanations constitute the hypothesis which the researcher proceeds to test on the basis of facts; already known or that can be made known. Even collection of facts merely for the sake of collecting such that they are for or against some point of view of proposition. Such a point of view or proposition (*statement*) is the hypothesis.

The dictionary meaning of hypothesis indicates that, ‘Hypo’ means ‘less than’, ‘Thesis’ means ‘generally held view’, so ‘Hypothesis’ means ‘less than generally held view’.

The definitions of hypothesis given by several authors are as follows:

According to **Moshin**, “Hypothesis is a conjectural statement about a relationship among two or more variables.”

According to **George A. Lundberg**, “A hypothesis is a tentative generalisation, the validity of which remains to be tested. In its most elementary stage, the hypothesis may be very hunch, guess, imaginative data, which becomes the basis for action or investigation.”

According to **Goode and Hatt**, “a hypothesis looks forward. It is a proposition which can be put to a test to determine its validity. It may seem contrary to, or in accord with common-sense. It may prove to be correct or incorrect. In any event, however, it leads to an empirical test.”

According to **Webster's** New International Dictionary, “A hypothesis is a proposition, condition or principle which is assumed, perhaps without belief, in order to draw out its logical consequences and by this method to test its accord with facts which are known or may be defined.”

Comprehensively, we can explain hypothesis as “a proposition or a set of propositions set forth as explanation for the occurrence of some specified group of phenomena either asserted merely as a provisional conjecture to guide some investigation or accepted as highly probable in the light of the established facts. Quite often a research hypothesis is a predictive statement, capable of being tested by scientific methods, that relates an independent variable to some dependent variable.”

### Hypothesis and Research Question

All the research works start with tentative generalisations. These generalisations may be in the form of either research question or hypothesis. A research question and hypothesis are similar in nature except for the aspect that a research question does not predict the outcome of the research where as a hypothesis predicts the outcome. Research questions are generally used in the exploratory research or in the areas where a phenomenon is studied marginally. The research is carried to know indications rather than causality. Hypothesis is tentative, testable generalisation regarding the relationship between variables. For e.g., advertising & increase in sales.

### Relationship between Theory and Hypothesis

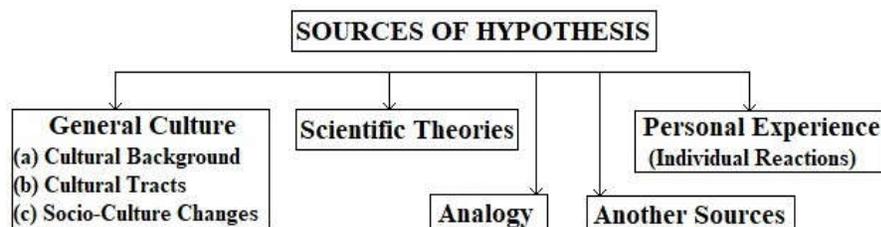
Formulation of deductions from the existing theory constitute hypothesis. If these deductions are proved they become part of theory. According to William H. George, “theory is an elaborate hypothesis”. Every worthwhile theory permits the formulation of hypothesis. Hypothesis is necessary link between theory and investigations, which leads to discovery of addition of knowledge.

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## 2.11 SOURCES OF HYPOTHESIS

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According to Goode and Hatt, sources of hypothesis are as under:



**(1) General Culture:** The general culture in which a science develops furnishes many of its basic hypotheses. Hypothesis develops based upon the researcher's attention which generally will be influenced by cultural values. In India, for example- religion and custom dominate the way of life. This has had its reaction on economic values and individual initiative

in various walks of life. Such a situation could give rise to any number of sociological, cultural, political and economic hypotheses.

**(2) Scientific Theories:** Hypothesis originates in science itself. The history of science provides testimony to the fact that personal experiences of the scientist contributes a great deal to the type and form of questions he may ask as also to the kinds of tentative answers to these questions, (hypothesis) that he can provide. Science is twined with values and it influences the tentative generalization. Learning experience always influences the sketching of the hypothesis. Socialization process in learning a science also affects the hypothesis which will be developed by the scientists.

**(3) Analogies:** Analogies are often a spring of valuable hypothesis. Students of sociology in the course of their studies would have come across analogies wherein a society is compared to a biological organism, the natural law to the social law, thermodynamics to social dynamics, etc. Julian Huxley opined that casual observations in nature or in the framework of another science may be a fertile source of hypothesis.

**(4) Personal Experience:** Personal experience and individual reaction may give rise to hypothesis. For example- Mr. Lambrosa- developed the concept 'In born criminal type' when he was working with soldiers.

Hypothesis

#### 5) Another Sources:

- I. "Cases which are exceptions to accepted theory" is also the source for formulating hypothesis.
- II. Another source of hypothesis is *folk* (people in general) *wisdom* or *current popular beliefs* (faith) and practices suggesting both the problems and the hypothesis. It is also consequences of personal, idiosyncratic experiences.
- III. Hypothesis may also rest on the *findings of other studies*. Comparative studies are energetic sources of research.
- IV. *Theory* is indeed and extremely fertile seed bed of hypothesis. It gives direction to research by stating what is known. Logical deduction from the theory leads to new problems.

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## 2.12 CHARACTERISTICS OF GOOD HYPOTHESIS

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All hypotheses are not equally helpful or workable to the enquiry and some are perhaps not at all. The researcher therefore has to separate the more from the less useful ones. A good usable hypothesis is the one which satisfies many of the following criteria:

**(1) Relevant and Available Technique-** An investigation to be practical should relate the hypothesis to the investigational techniques feasible in the particular discipline. This requires, in the researcher, a sound

knowledge of techniques to test the hypothesis and thus, to formulate practical questions.

**(2) Conceptual Clarity-** It is advisable that the concepts embodied in hypothesis be clearly defined in a manner commonly accepted and communicable. The conceptual clarity is required in both formally as well as operationally. It should be operationally defined.

**(3) Closest to Things Observable—**Hypothesis should be closest to the things observable. Failing this, it would not be possible to test their accord with empirical facts. Hypothesis must be an adequate answer to the problem. It must be compatible with the current knowledge in the area concerned.

**(4) Brevity-**The hypothesis should be brief so that its observation may be possible. It would help the better understanding of the underlying concept and meaning. It should be precise.

**(5) Empirically Testable (Easy to experience)-** A hypothesis should be capable of being tested, have empirical references. It should be so stated that it is possible to deduce logically certain inferences from it, in which term can be tested by observation in the field.

**(6) Specific in Nature-** The hypothesis must be specific in nature and precise i.e. it must help in detail all the operations and predictions connected with it in the process of investigation. It should not involve the investigator into unnecessary roaming about and discussion.

**(7) Related to a Body of Theory-** The hypothesis should be related to a body of theory or some theoretical orientation. If hypothesis is related to some theory, research will help to qualify, support, correct, or refute (reject) the theory. It should establish relationship between variables.

**(8) Simple-** The hypothesis should be simple to the point. Insight of the phenomenon is essential for simplicity. According to **P. V. Yong**, 'The more insight the researcher has into the problem, the simpler will be the hypothesis about it.' The better hypothesis is the simple one requiring fewer conditions or assumptions.

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## 2.13 FORMULATION OF RESEARCH HYPOTHESIS

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Hypothesis formulation is mostly related to causal research or empirical research. Usually, exploratory and its similar researches are exceptions, where a hypothesis is not a necessity. But, in most researches, the researcher has an 'intelligent guess' about the outcome of his research. This 'guess' paves way to a formal hypothesis. However, hypotheses are not unique to research. Hypotheses are constantly generated in the human mind as we work to understand day-to-day phenomena. By formulating a series of reasonable guesses of cause and effect, we are able to understand and explore the events in our surrounding environment. Hypothesis formulation has been an integral part of philosophy since the early days.

Formulation of the hypothesis basically varies with the kind of research conducted. Causal studies tend to study the relationship that exists within the variable while qualitative studies tend to generalize upon the subject. Qualitative studies are characterized by:

- Use of words- what, how.
- Use of non-directional wording in the question.
- The questions are under continual review and reformulation- will evolve and change during study.
- Use of a single focus.

On the other hand, quantitative research is characterized by:

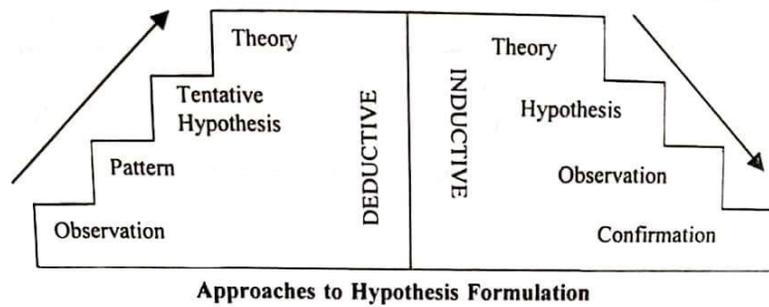
- The testable proposition to be deduced from Theory.
- Independent and dependent variables to be separated and measured separately.

Based on above explanation, researcher has to use **two logical approaches** to drawn upon in developing a hypothesis. The processes are known as:

- a) Deductive Approach, and**
- b) Inductive Approach.**

For qualitative studies 'deductive approach' is more useful in formulation of a hypothesis. The deductive method tries to establish a pattern after observation and formulate a tentative hypothesis (which gets modified as the research progresses) and eventually leading to theory. Archimedes observation that there is a rise in the level of water, when an object is immersed in water, let him to formulate a hypothesis that 'there is a change in the level of water when a body is immersed in water.' Further observation made him refine the hypothesis from change in the level of water to 'volume of water dispersed'. And finally after this hypothesis was found to be true for different objects, the hypothesis was established as a theory.

In quantitative studies, an 'inductive approach' is used for hypothesis formulation. The inductive method contrary to the deductive method starts from an established theory and the hypothesis is formulated prior to the observation and the hypothesis is, consequently, confirmed, e.g., the Demand theory states that the demand for a product or service is related to its price. A researcher is interested in knowing if the theory of demand holds true for a market segment of quality conscious upper-middle class consumers. He will use the inductive method in formulating the hypothesis. Figure given below represents the two approaches to the hypothesis formulation.



Based on the above research approaches, there are **two methods** of hypothesis formulation:

1. Qualitative
2. Quantitative

### **Qualitative Methods**

It is very frequent in the use of research questions against the objectives. The questions mainly start with what or how and seek to explore or describe the experiences. These questions describe to compare groups or variables. The questions under continual review are revised at the time of study. Usually, questions are open ended which will not refer any literature or theory. The qualitative methods include naturalistic inquiry (e.g. study real-world situations), emergent design flexibility (e.g. avoid rigid designs) and purposeful sampling (e.g. case studies with organizations or people). Selected characteristics of qualitative research methods are as follows:

- It is an effort to understand situations in their uniqueness as part of a particular context and the interactions there.
- The researcher is the primary instrument for data collection and analysis.
- Qualitative research involves fieldwork for data collection.
- The uses of a deductive research strategy and the research build abstractions, concepts, hypothesis or theories rather than tests existing theory.

### **Quantitative Methods**

It is very frequent of getting research questions in the objectives of survey projects. The use of hypothesis is also more frequent in quantitative experimental research in variables. The comparison and relationship between variables are represented in experiments. Theories are useful to deduce testable propositions. Dependent and independent variables are separated at the experiments and measured separately. Combinations of objectives and hypothesis are not considered. Make an alternate forms of experiments crated to focus to the audience of research. It is analysed frequent comparison of relationships between variables.

**Selected characteristics of quantitative research methods are:**

- This method emphasize on collecting and analysing information in the form of numbers.
- It emphasis on collecting scores that calculate distinct attributes of people and organizations.
- This method emphasizes on the procedures of comparing groups or relating factors about people or groups in experiments, correlation studies and surveys.

**2.13.1 Process of Formulating Research Hypothesis**

The process of formulating a research hypothesis is usually made up of two phases.

Phase 1: Addressing Primary Problems

Phase 2: Phrase the Hypothesis

**Phase 1: Addressing Primary Problems**

In the first phase, the researcher has to establish the main issues that should be addressed in the hypothesis. It is in this phase that the researcher decides on the variables or other phenomena that should be addressed in the hypothesis. In other words, a researcher has to refer to the primary problems that are supposed to be addressed in the research when managing this part of the process of formulating hypothesis.

**Phase 2: Phrase the Hypothesis**

In the second phase, the researcher has to phrase the hypothesis in a language that is logical, complete, and reflective of the theoretical foundations of the research. A language is regarded as logical when it clearly elucidates the main issues of concern. In this case, it makes sense for a research hypothesis to be framed in a language that clearly states the proposed relationship among variables. For example, if a researcher frames the hypothesis in a superfluous language, then the researcher may not easily test it. Similarly, it is important for the researcher to clearly identify the relationship that they intend to test in the hypothesis.

These two phases of the process of formulating a research hypothesis have to be adequately addressed for the entire research process to be completed successfully.

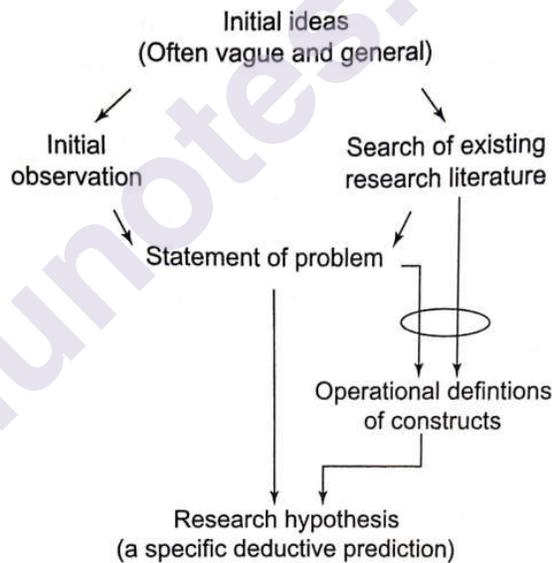
**2.13.2 Generation of Research Hypothesis**

The normal approach is to set two hypotheses instead of one, in such a way, that if one hypothesis is true, the other is false. Alternatively, if one hypothesis is false or rejected, then the other is true or accepted. Figure given below shows how a research hypothesis is formulated. Take an example, a hypothesis is formulated with two-sample variable association of x and y.

1. If there is an association between x and y, then "x and y are associated".
2. If x is dependent on y, then "y is related to x".
3. Increase in the values of x appears to result fall in value of y, then "x increases, y decreases".

From this scenario, we have different hypothesis formulations from the two variables. We can formulate three different hypotheses:

1. A simple statement of association between two variables x and y. There is no indication in the association of variables x and y that cause change in any other variable.
2. A simple statement of association between two variables x and y. It is the conditional of the values of y and contingent upon the condition of the variable x.
3. Consider a relation between variables x and y with reference to its values. The values may be depending on nature of association between the variables.



**Formulation of research hypothesis**

Source: Chandra, S.S.V. & Hareendran, S.A. (2018). India: Pearson.

**Difficulties in Formulating Hypothesis**

Goode and Hatt observed that the researcher often suffers from the following deficiencies which pose problems in formulating good, definite and testable hypothesis.

- (1) Lack of knowledge of scientific methods
- (2) Lack of a clear theoretical framework.
- (3) Lack of ability to utilize the theoretical framework logically.

- (4) Failure to be acquainted with available research techniques resulting in inability to phrase the hypothesis properly.

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## 2.14 TYPES OF RESEARCH HYPOTHESIS

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Theoretically, there should be only one type of hypothesis that is the research hypothesis- the basis of any investigation. However, because of the conventions in scientific enquiries and because of the wording used in the construction of a hypothesis, hypotheses can be classified into several types. These are as follows:

**Simple Research Hypotheses:** Simple research hypotheses predict the relationship between a single independent variable and a single dependent variable.

**Complex Research Hypotheses:** Complex hypotheses predict the relationship between two or more independent variables and two or more dependent variables.

**Directional Hypotheses:** If, in stating the relationship between two variables or comparing two groups, terms such as *positive*, *negative*, *more than*, *less than*, and the like are used, then these hypotheses are directional because the direction of the relationship between the variables (positive/negative) is indicated (e.g. *The greater the stress experienced in the job, the lower the job satisfaction of employees*), or the nature of the difference between two groups on a variable (more than/less than) is postulated (e.g. *Women are more motivated than men*).

**Non-directional Hypotheses:** These hypotheses do postulate a relationship or difference, but offer no indication of the direction of these relationships or differences. In other words, though it may be conjectured that there would be a significant relationship between two variables, we may not be able to say whether the relationship would be positive or negative (e.g. *there is a relationship between age and job satisfaction*). Likewise, even if we can conjecture that there will be differences between two groups on a particular variable, we will not be able to say which group will be more and which less on that variable (e.g. *there is a difference between the work ethic values of American and Asian employees*).

**Associative Hypotheses:** Such hypotheses propose relationships between variables- when one variable changes, the other changes. They do not indicate cause and effect.

**Statistical Hypothesis:** To test whether the data support or reject the research hypothesis, it needs to be translated into a statistical hypothesis. It is given in statistical terms. In the context of inferential statistics, it is statement about one or more parameters that are measures of the population under study. To use inferential statistics, we need to translate the research hypothesis into a testable form. A testable hypothesis contains variables that are measurable or able to be manipulated. It can be classified in two types:

1. **Null Hypothesis:** The null hypothesis is a proposition that states a definitive, exact relationship between two variables. That is, it states that the population correlation between two variables is equal to zero or that the difference in the means of two groups in the population is equal to zero (or some *definite* number). In general, the null statement is expressed as no (*significant*) relationship between two variables or no (*significant*) difference between two groups. It is denoted by  $H_0$  or  $H_n$ . Null hypotheses can be:

- Simple or Complex
- Associative or Causal

2. **Alternate Hypothesis:** It is the opposite of the null hypothesis, is a statement expressing a relationship between two variables or indicating differences between groups. It is denoted by  $H_1$  or  $H_a$ . It is only reached if  $H_a$  is rejected.

**Descriptive Hypotheses:** This is simply a statement about the magnitude, trend or behaviour of a population under study. Based on past records, the researcher makes some presumptions about the variable under study. For example, the current advertisement for the soft drink will have a 20–25 per cent recall rate; the literacy rate in the city of Mumbai is 100 per cent.

**Relational Hypotheses:** These are the typical kind of hypotheses which state the expected relationship between two variables. While stating the relation if the researcher makes use of words such as increase, decrease, less than or more than, the hypothesis is stated to be directional or one-tailed hypothesis. For example, higher the likeability of the advertisement, the higher is the recall rate; ban on smoking has an impact on the cigarette sales. Such hypotheses are of two types viz. Causal or Correlational:

1. **Causal or Explanatory Hypotheses:** Such hypotheses propose a cause and effect interaction between two or more variables. The variable which causes or influences change is called independent, causal or explanatory variable and the other variable which gets influenced is called dependent variable. The independent variable is manipulated to cause effect on the dependent variable. The dependent variable is measured to examine the effect created by the independent variable. For example, change in sales turnover is caused or explained by change in advertising expenses.

2. **Correlational Hypotheses:** Such hypotheses are used when we want to test whether there is any correlation between two variables. For example, return on a stock and return on BSE Sensex/ NIFTY; marks in entrance examination and final MBA grade.

**Universal Hypothesis:** Based on statistical significance, if a hypothesis is used to cover all the phenomena, then it is regarded as a universal hypothesis. It is one, which denotes that, the stated relationship holds for all specified variables for all times at all places. The universality of the hypothesis arises from the fact that it is used to describe a relationship

between variables under all circumstances and at all times. For example, sun rises from the east.

**Existential Hypothesis:** Based on statistical significance, the hypotheses that are restricted to phenomena that meet particular criteria are regarded as existential. It is one in which the stated relationship is said to exist for at least one particular case. It is clearly stated that the supposed relationship between the variables only exists for a single case or under specific conditions which may not necessarily be universal.

**Question-based Hypothesis:** In this hypothesis, the researcher formulates a question and then endeavours to answer the question by conducting the research study. The action that follows depends on whether the researcher accepts the question which is posed as the hypothesis of the research study.

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

**Common Sense Hypotheses:** These represent the common sense ideas. They state the existence of empirical uniformities perceived through day to day observations. Common sense statements are often a confused mixture of clichés and moral judgments. Researchers have a large-scale job in transforming and testing them. This requires three tasks. Firstly, the removal of value judgment; secondly, the clarification of terms; and thirdly, the application of validity tests.

**Analytical Hypotheses:** These are concerned with the relationship of analytic variables. These hypotheses occur at the highest level of abstraction. These specify relationship between changes in one property and changes in another.

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## 2.15 RESEARCH PROPOSAL

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The next stage after developing the hypothesis is to prepare a research proposal for submission to the management. By making a research proposal, the researcher puts himself, his intentions and his ideas in front of management and also in front of himself for any queries, new ideas, criticism or improvements in his research project plan. It also helps in creating the budget estimates-, costs, time etc. statements. When a researcher needs approval and/ or financial support for an intended research, he prepares all format proposals and submits it to an appropriate approving/sponsoring authority. It is a bid for undertaking research. The proposal is the form of a research design, which is the blue print for conducting and controlling research. It can also be considered a research plan or a research projects.

Broadly speaking, a research proposal encompasses the methodology of conducting the research to solve the formulated research problem. The main objective of writing a research proposal or synopsis is to proof the

committee that one is undertaking a good research on to support his aims and objectives of the research to make the thesis or a dissertation worthy of it.

A research proposal is a written account of the plan for the research project. It presents an argument as to why a particular problem should be investigated and what the appropriate research design is to investigate it. It sets out what the researcher intends to do- how, why, where, when and at what cost. For quantitative research, the research proposal is like a pattern for a garment or a blueprint for a building in that it assists the researcher to follow a process that has been laid down. For qualitative research, the research proposal is much more flexible because the method tends to evolve with the research.

Research proposal may be defined as a document that sets out the purpose of the study and the research design details of the investigation to be carried out by the researcher.

### 2.14.1 Objectives/Purposes of Research Proposal

The purpose of a research proposal can be understood as the following:

**I) Prevents Distraction from Actual Topic:** A thoroughly prepared research plan or project proposal prevents distraction from the actual topic. A research plan also promotes the (continual) fit between the parts of the research. The research problem, research questions, purposes, sample, data collection, analysis and reporting should be tuned to each other.

**II) Important For Third Parties:** A research proposal not only has a function for a researcher but also extremely important for third parties, like instructors, supervisors, granting organisations, commissioners, ethical committees and so on.

**III) To Convince Others:** A research proposal is intended to convince others that one has a worthwhile research project and that one has the competence and the work-plan to complete it.

**IV) Focus and Define Research Plans:** The purpose of the proposal is to help to focus and define the research plans. These plans are not binding, in that they may well change substantially as one progress in the research.

**V) Other Purposes:** There are several other purposes of research proposal which are being discussed below:

- To present the management question to be researched and relate its importance.
- To discuss the research efforts of others who have worked on related management questions.
- To suggest the data necessary for solving the management question and how the data will be gathered, treated and interpreted.

- To present the researcher's plan, services and credentials in the best possible way to encourage the proposal's selection over competitors.
- To help the researcher to define the contents and to plan and execute his research project.
- To inform potential collaborators and supporters about the topic and the expected quality of the research.

A research proposal is critical, for it makes the researcher think of the possible roadblocks on the way and alternate by passes to be taken in such cases. Another very important use of a research proposal is that it helps the decision-maker and the researcher to arrive at agreements on the problem with regard to objectives, information required, and the methods of analysis.

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## 2.16 WRITING A RESEARCH PROPOSAL

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While referring previous researches, one has to be totally objective and abstain from any iota of past bias. Only facts and figures are to be supplied without any comment. Based on these facts and figures and the developments that have taken place or those that are being envisaged, one has to justify the relevance and the benefit of the proposal. The emphasis has to be on 'Improvement' that is visualised in future rather than 'Criticising' what happened in the past. In fact, one could endeavour to appreciate the past efforts and results, while indicating scope for further improvement in quality or expanding and creating new products/ services/ systems. Use of such appreciative phrases makes the proposal as 'constructive'. One has to remember that the strategies, their relevance and effectiveness keep on changing with time; therefore the emphasis has to be on improvement rather than on criticism.

It is said that a research is as good as one's proposal. A good quality proposal, in addition to the increased chances of acceptance by the concerned authorities also creates a good impression as well as establishes credibility of the researcher. It is, therefore, necessary to put in best efforts to ensure high degree of acceptance of the proposal and its smooth execution.

A research proposal serves the purpose of convincing that the research is worthwhile and the researcher has the requisite competence and ability to complete the project as per schedule.

It should reflect good grasp of various issues related to the topic supported by survey of relevant literature. Accordingly, it should answer the following questions:

- What is the objective to be achieved?
- What is its relevance and importance?
- What is the methodology to be used?

- What is the plan and schedule of completion?
- What are the scope and limitations?
- What is the extent to which the objectives might be achieved?

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## 2.17 CONTENTS OF A RESEARCH PROPOSAL

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The contents of a research proposal differ on the type of research conducted and proposal given. The proposal can be tailored to suit the intended audience. The proposal can be structured under the following heads:

**1. Title-** The title should indicate the gist or theme of the research. However, it should be catchy, and should instantaneously arouse the curiosity and interest of the reader. This would induce further reading of the proposal with favourable disposition towards the proposal.

**2. Preamble or Executive Summary-** The executive summary is an informative abstract. It highlights the essential points of the proposal. Executives can understand the meaning without going into detail. The goal of summary is to secure a positive evaluation by the executive who will pass the proposal for full evaluation.

**3. Statement of the Problem-** This section of research proposal clarifies the management question (problem) and importance of answering the management question. In this section, it should also be stated that a particular area of a management question will not be studied. Be sure that problem statement is clear without the use of idioms. As a matter of fact, after reading this section of research proposal, potential sponsor or researcher should know the actual problem

**4. Objective/s of the Research-** This section of research proposal states the objectives of investigation. In a descriptive study, the objectives can be stated as the research question (Investigative question). If the proposal is for a causal study, then the objectives can be stated as a hypothesis.

It is best to prepare a list of objectives from the problem statement. It will give real picture of goals to the sponsor. The research objective section is the basis for selection of proposal.

**5. Review of Literature-** The literature review section examines recent researches, company data or industry reports that acts as a basis for the proposed study. If the problem has historical background, begin with earliest references.

Avoid the excessive details; a brief review of the information may be undertaken. If you find something of interest in a quotation, find the original publication and ensure you understand it. In this way, you will avoid any errors of interpretation. Emphasize the important results, relevant data and trends from previous research, and particular methods or design that could be repeated, should be avoided.

**6. Benefits of the Study-** In this section, you describe benefits that will accrue from your study. The importance of 'doing study now' should be emphasised. If you find it difficult to explain the benefits, then you have not adequately clarified the problem. You should convince the sponsoring organisation that your plan will meet the needs.

**7. Research Design-** The research design describes that what you are going to do in technical terms. This section should include the phases of project. Research design includes information relating to sample selection, size of sample, data collection method, procedures and ethical requirements etc.

**8. Analysis of Data-** In this section, you will describe the proposed handling of data and the theoretical basis for using selected techniques. The objective of this selection is to assure the sponsor that you are following correct assumptions and sound data analysis procedures.

**9. Forms of Results-** In this section, the sponsor should be able to know that goal of study has been covered. One should also specify the types of data to be collected and interpretations that will be made in the analysis. This section also contains the contractual statement telling the sponsor about the type of information to be received.

**10. Researcher's Brief:** When hiring a contract researcher, this element of proposal should be taken into consideration. Two elements are critical in this regard:

- **Professional Research Competence** (relevant research experience, the highest academic degree held, and membership in business and technical societies).
- **Relevant Management Experience**

There are so many individuals and research firms providing research services. Therefore, it is essential that researchers should be professionally competent. Past research experience is the best barometer of competence, followed by the highest academic degree.

**11. Budget-** This section will include the statement of proposed expenses and financial liabilities. Budget statement in an internal research proposal is based on employee and overhead costs. However, in case of external research, budget is decided on the basis of charges to be charged by contracting firms. Hence, budget for research proposal should be presented in the form of sponsor requests.

**12. Schedule-** Schedule must include the major phases of the project, their timetables etc. It should also specify the completion time of a project. For example, the major phases may be:

- Exploratory Interviews
- Final Research Proposal

- Questionnaire Revision
- Field Interviews
- Editing
- Data Analysis
- Report Preparation

It may be helpful to you and your sponsor if you chart your schedule. If the project is large and complex, a critical path method (CPM) of scheduling may be used.

**13. Special Facilities and Resources-**Often, projects will require special facilities or resources. However, these requirements may vary from study to study. The proposal must carefully list the relevant facilities and resources to be used. The costs of such facilities must be recorded on your budget. E.g. research laboratory, computer and ICT facilities, special softwares.

**14. Project Management-** The purpose of the project management is to do the project efficiently. A master plan is required for complex projects in order to show how all the phases will be completed. A master plan includes

- Management Procedures
- Control Techniques for Executing the Research Plan
- Financial and Legal Responsibility
- Management Competence
- The Research Team's Organisation
- Example of Management and Technical Reports.

Tables and charts are most helpful in presenting the master plan. This section also discusses details such as printing facilities, clerical help or information processing capabilities to be provided by the sponsor.

**15. Bibliography-**For all projects, that require literature review, a bibliography is necessary. Use the bibliographic format required by the sponsor. If none is specified, a standard style manual will provide the details necessary to prepare bibliography.

**16. Appendices-** Glossary of term should be included whenever there are many words you need to the research topic and not understood by the general management community. This is a simple section consisting of glossary, measurement instrument and other reference materials which are not the part of main text.

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## 2.18 TYPES OF RESEARCH PROPOSALS

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The research proposal can be classified in a number of ways. Following are some of the basis of classifying research proposals:

### On the Basis of Origin

This classification is on the basis of place of origin of proposal.

**1. Internal Proposals:** These are proposals generated within an organisation or agency and submitted to its management for approval or funding. They are responses to specific management needs of problem solving or product or process development, and are funded internally. The emphasis is on solving the immediate problem or developing new product/process or modifying old ones. They do not emphasise literature reviews. An executive summary is required in these proposals for quick management appreciation. Schedule of funds and time frame for completion should also be included.

**2. External Proposals:** A proposal generated within an organisation and directed to an outside customer, organisation, or funding agency, is an external proposal. This may be against an advertisement or solicitation from the customer. Then the proposal becomes a competing bid. The researcher is generally from outside and the proposal is much more formal in structure. In case of an external proposal, apart from the objectives, methodology, time and budget schedules it essentially contains information about the researcher's qualifications and experience. An external proposal may be solicited or unsolicited.

### On the Basis of Solicitation

This classification is on the basis of solicitation or invitation of the proposal.

**1. Solicited Proposals (RFP):** Sometimes organizations make a Request for Proposal (RFP) for a particular research problem that they have in mind. The proposal is a document that identifies a specific research problem of interest to the funding agency for which they are seeking a solution. Interested investigator then submits a proposal, briefly outlining their proposed solution to the problem. The researchers include a background on the problem, the objectives, research methodology, the time schedule, the cost and resource requirements as well as the researcher's qualifications and experience in handling similar problems. The solicited proposal competes with numerous other proposals.

**2. Unsolicited Proposals:** In this case the proposing researcher or organisation makes the proposal based on a perceived general/ natural need after a preliminary/ feasibility study. Under such circumstances, the proposal plays a key role in securing an affirmation for the research to go ahead. Since the proposal has not been invited hence the research proposal contains an executive summary where the benefit to be derived from the

study is stated as succinctly as possible. A non-solicited proposal has the advantage of not competing with others.

### **On the Basis of Content**

This classification is on the basis of contents of the proposal.

1. **Basic Proposals:** If the proposal is for a basic research it is called as a basic research proposal
2. **Applied Proposals:** If the proposal is for an applied research it is termed as applied research proposal.

### **On the Basis of Time**

This classification is on the basis of time needed to complete of the proposal.

1. **Short-Term Proposals:** When the proposal is for solving the immediate problem and sponsoring organisation has less time for completion of the project then it can be termed as short-term proposal.
2. **Long-Term Proposals:** When the proposal is for strategic problem or long term objectives and sponsoring organisation has enough time for completion the project then it can be termed as long-term proposal.

### **On the Basis of Teaming**

This classification is on the basis of investigators involved in carrying out the research.

1. **Single Investigator Proposals:** The research where only a single researcher works on the problem are called as single investigator proposals.
2. **Multiple Investigator Proposals:** The research where a team of researchers work on the problem are called as multiple investigator proposals. In a multiple investigator proposal, the proposal must contain complete information on the qualifications and experience of all the researchers. It should also contain information on who would be the project leader and what all project management techniques will be used by him to manage his team effectively.

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## **2.19 SELF ASSESMENT TEST QUESTIONS (B)**

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### **1. Fill in the blanks with appropriate words:**

- (a) A ..... is a tentative generalisation, the validity of which remains to be tested.
- (b) "Officers in my organization have higher than average level of commitment." Such a hypothesis is an example of..... hypothesis.

- (c) “There is no relationship between higher motivation level and higher efficiency.” is an example of ..... hypothesis
- (d) In quantitative studies, an ..... approach is used for hypothesis formulation.
- (e) .....presents a problem, discusses related research efforts, outlines the data needed for solving the data and shows the design used to gather and analyze the data.
- (f) In case of proposals, the proposing researcher or organisation makes the proposal based on a perceived general/ natural need after a preliminary/ feasibility study.
- (g) ..... hypothesis is simply a statement about the magnitude, trend or behavior of a population under study.
- (h) .....are proposals generated within an organisation or agency and submitted to its management for approval or funding.

**2. State true or false for the following statements:**

- (a) Deductive thought demands generating a conclusion beyond the available fact and information.
- (b) All hypotheses are always formulated in question form.
- (c) If one is formulating a proposition about the magnitude or behaviour of a particular population, we call it a descriptive hypothesis.
- (d) A hypothesis that has two sub-hypotheses is called two-directional hypothesis.
- (e) A deductive approach is one that involves testing an explicitly defined hypothesis.
- (f) A research proposal is just like a research report and written before the research project.
- (g) A research proposal doesn't show that the researcher is capable of successfully conducting the proposed research project.
- (h) Every research proposal, regardless of length should include two basic sections namely research question and research methodology

**3. Match the following:**

- A. Deductive Approach      (i) quantitative studies
- B. Inductive Approach      (ii) Null Hypothesis, Alternate Hypothesis
- C. Statistical Hypothesis      (iii)  $H_1$  or  $H_a$
- D. Variables      (iv) qualitative studies
- E. Alternate Hypothesis      (v) Dependent, Independent

**4. Answer the following:**

- (a) There is an advantage in stating the hypothesis both in the null and in the alternate; it adds clarity to our thinking of what we are testing. Explain.
- (b) What is a research hypothesis? Do all researchers require hypotheses formulation? Explain
- (c) Write a detailed note on the various types of hypothesis.
- (d) Why is the research proposal considered as a technical part of research? Explain.
- (e) What do you mean by RFP? What are the different bases of classification of research proposal?
- (f) Explain the various contents that would be the part of a research proposal.

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**2.20 SUMMARY**

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Defining the research problem is the most important step in a research project. Problem definition is a difficult step, because, frequently, decision makers have not determined the actual problem or only have a vague notion about it. The researcher's role is to help decision makers identify and define their marketing research problem. The formal ways in which decision makers and researchers communicate their perspectives on a research problem and how to solve it are through the development of a research brief and a research proposal. To develop these documents fully, researchers should be proactive in arranging discussions with key decision makers, which should include a problem audit whenever possible. They should also conduct, where necessary, interviews with relevant experts, and secondary data collection and analyses. These tasks should lead to an understanding of the environmental context of the problem.

The management decision problem asks what the decision maker needs to do, whereas the management research problem asks what information is needed and how it can be obtained effectively and efficiently. The researcher should avoid defining the management research problem either too broadly or too narrowly. An appropriate way of defining the management research problem is to make a broad statement of the problem and then identify its specific components.

Hypothesis formulation is mostly related to causal research or empirical research. The term hypothesis has been derived from the ancient Greek, *hypotithenai*, meaning to put 'under' or 'to suppose'. A hypothesis is a "supposition made as a starting point for further investigation from known facts". It provides an investigator with a relational statement that is directly testable in a research study. One of the major purposes for which a hypothesis is formulated is defining the relationship between the *variables*. A hypothesis has four components; the subject group, the

treatment, the outcome measure and the control group. Two approaches are used in formulating a hypothesis, the inductive approach or the deductive approach. Hypothesis is formulated in pairs that are mutually complimentary of each other. These are called is null and alternate hypothesis. After the hypothesis has been formulated, the hypothesis needs to be tested for its truthfulness.

The next stage after developing the hypothesis is to prepare a research proposal. The proposal is the form of a research design, which is the blue print for conducting and controlling research. It can also be considered a research plan or a research projects. A good research proposal serves the purpose for answering various questions like objective to be achieved, relevance and importance, methodology to be used, plan and schedule of completion, scope and limitations and the extent to which the objectives might be achieved. The contents of a model research proposal includes title, executive summary, statement of the problem, objective/s of the research, review of literature, benefits of the study, research design, analysis of data, forms of results, researcher's brief, budget, schedule, special facilities and resources, project management, bibliography and appendices. The research proposal can be of many types' viz. internal proposals, external proposals, solicited proposals, unsolicited proposals, basic proposals, applied proposals, short-term proposals, long-term proposals, single investigator proposals and multiple investigator proposals.

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## 2.21 KEY WORDS

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- ***Alternate Hypothesis:*** An educated conjecture that sets the parameters that one expects to find. The alternate hypothesis is tested to see whether or not the null is to be rejected.
- ***Associative Hypotheses:*** Such hypotheses propose relationships between variables- when one variable changes, the other changes.
- ***Causal Hypothesis:*** The hypotheses which propose a cause and effect interaction between two or more variables.
- ***Correlational Hypothesis:*** Such hypotheses are used when we want to test whether there is any correlation between two variables.
- ***Deductive Approach:*** The process of arriving at conclusions based on the interpretation of the meaning of the results of data analysis.
- ***Descriptive Hypotheses:*** This is simply a statement about the magnitude, trend or behaviour of a population under study.
- ***Directional Hypothesis:*** An educated conjecture as to the direction of the relationship, or differences among variables, which could be positive or negative, or more or less, respectively.

- **External Proposals:** A proposal generated within an organisation and directed to an outside customer, organisation, or funding agency, is an external proposal.
- **Hypothesis:** A hypothesis is a proposition, condition or principle which is assumed, perhaps without belief, in order to draw out its logical consequences and by this method to test its accord with facts which are known or may be defined.
- **Inductive Approach:** The process by which general propositions based on observed facts are established.
- **Internal Proposals:** These are proposals generated within an organisation or agency and submitted to its management for approval or funding.
- **Management Decision Problem:** It pertains to the decision makers in which there is ambiguity in the mind of decision makers. It asks what the decision makers need to do.
- **Management Research Problem:** It is the quest for searching the solution. It asks what information is needed and how it can be obtained effectively and efficiently.
- **Non-directional Hypothesis:** An educated conjecture of a relationship between two variables, the directionality of which cannot be guessed.
- **Null Hypothesis:** The conjecture that postulates no differences or no relationship between or among variables.
- **Research Problem:** A statement about a problematic situation that identifies the issues which researcher is trying to address.
- **Research Proposal:** It is an offer to produce or render a service to the potential buyer or sponsor. The research proposal presents a problem, discusses related research efforts, outlines the data needed and shows the research design.
- **Solicited Proposals:** When organizations make a Request for Proposal (RFP) for a particular research problem that they have in mind and ask for bids from outside researchers.
- **Statistical Hypothesis:** Given in statistical terms, to test whether the data support or reject the research hypothesis, it needs to be translated into a statistical hypothesis.
- **Unsolicited Proposals:** In this case the proposing researcher or organisation makes the proposal based on a perceived general/ natural need after a preliminary/ feasibility study.

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## 2.22 ANSWERS TO SELF ASSESMENT QUESTIONS

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- A. 1. (a) research objectives (b) the problem (c) not involve (d) five  
(e) declarative
2. (a) False (b) False (c) True (d) True (e) True
- B.1. (a) hypothesis (b) descriptive (c) null (d) inductive  
(e) Research Proposal (f) unsolicited (g) Descriptive (h) Internal  
proposals
2. a) False (b) False (c) True (d) False (e) True (f) True  
(g) True (h) True
3. A (i) B (iv) C (ii) D (v) E (iii)



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## RESEARCH DESIGN

### Unit Structure

#### 3.0 Objectives

#### 3.1 Meaning of Research Design

#### 3.2 Nature and Classifications of research design

#### 3.3 Exploratory Research Design

##### 3.3.1 Secondary Resource Analysis

##### 3.3.2 Case Study Method

##### 3.3.3 Expert Opinion Survey

##### 3.3.4 Focus Group Discussion

#### 3.4 Descriptive research design

##### 3.4.1 Cross Sectional Studies

##### 3.4.2 Longitudinal Studies

#### 3.5 Experimental Design

#### 3.6 Errors affecting research design

#### 3.7 Conclusion

#### 3.8 Self - Assessment Questions

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### 3.0 OBJECTIVES

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1. To understand process of research design as an essential part of research.
2. To explore classifications of research design and understand application of each of the type in various research situation.
3. To explore various methods of exploratory research design.
4. To learn cross sectional studies and longitudinal studies as an important types of descriptive research design.
5. To understand framework and application of experimental research design.

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### 3.1 MEANING OF RESEARCH DESIGN

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Research design refers to Framework or blue print for conducting research project. It specifies the details of the procedures necessary for obtaining the information needed to structure and solving research problem. Research design is heart and soul of the research project, it outlines how the research project will be conducted and guides data collection, analysis, and report preparation. Research design is arrangements of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure. Research design is conceptual structure within which research is conducted. As such the design includes an outline of what the researcher will do from writing the hypothesis and its operational implications to final analysis of data e.g. Course structure of academic program, Building construction plan, research project.

Let us take the example of course structure of MMS program offered by IDOL of Mumbai University, here you will find that the course is divided in four semesters and each semester consist of few subjects, in second year you will be introduces to subjects of your choice from various functional specializations such as marketing management, financial management and human resources management besides others. Then credits allocated to each of the course such as Managerial economics can be understood from Course structure, further how many items to be covered in continues assessments and how many items to be covered in end semester examinations can be understood with the help of course structure, simply course structure is an outline for each and every activity to be carried out in the entire two years of MMS program. Similarly, research design is a blue print which will guide you in entire research process about what to do and what to choose. It is a frame work available. It can also be understood with the help of one more example. Let us consider that you want to construct a home. Before construction of home you will visit architect and explain him about your requirements and budget. The architect will provide you building plan consist of number of rooms, ventilations, beams, foundations, materials to be used and lot of similar information along with drawings. This plan presented by building architect is highly helpful for you throughout your constriction activities, similarly research design is helpful to you in understanding the requirements of research projects and various phases with detailing about the activities.

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### 3.2 NATURE OF RESEARCH DESIGN

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The research design is crucial element in entire research process. Better research design gives clear idea about following questions.

What type hypothesis should be formed?

What type of Secondary data to be analyzed?

What is the study about?

Where will the study be carried out?

Where can the required data be found?

What will be the sample design?

What techniques of data collection are to be used?

How will the data be analyzed?

It is well said that Clarity about research design will help you half solve your research journey, as research design is that framework which will brief about your entire research process. Audience or public or beneficiaries of your research can understand about methods and techniques you have adopted in your research. It is also very helpful for reviewer of the research thesis as it gives understanding of researcher about his research study. We need to understand that any research objectives are associated with some problem or opportunity in the present situation and you want better understanding of the situation. Based on objectives of research study, you are supposed to form hypothesis statements. In line with type of your hypothesis you should adopt measurement and scales design, based on your measurement and scales design your next role is to develop questionnaire, based on responses of questionnaire you should adopt right coding and tabulation technique which will facilitate required data for already chosen test of hypothesis, after this the findings of the research should be drawn from your research data.

Various elements of research design are as follows

Define the information needed

Choose the appropriate research design type.

Measurement and scale design

Construct and pretest questionnaire

Sampling Process and Sampling Size.

Data Analysis Plan.

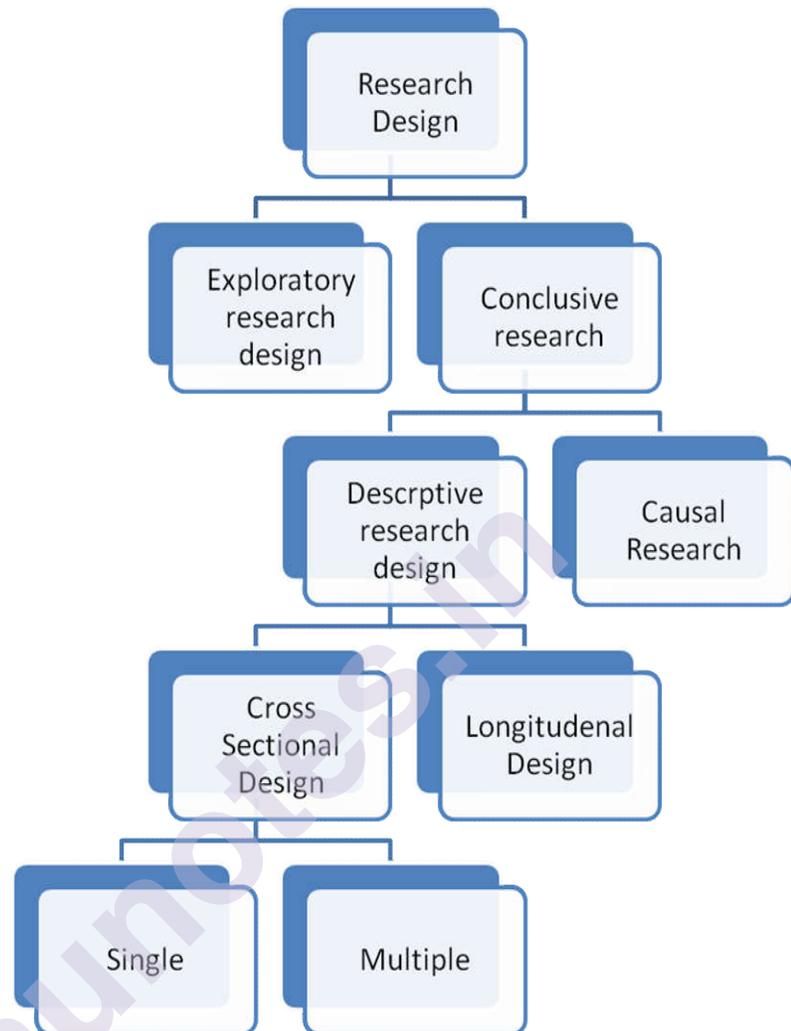
Let us consider the above mentioned elements of research design in detail. Management problems can be translated to research problem with the help of researchers. Based on problems we may have clarity on information needed for drawing conclusions and making decisions. Based upon the type of information needed we can choose appropriate research design from exploratory research design and conclusive research design. Research situation which presents requirement of better insights will be completed by exploratory studies. In situation where you have exact idea about problem statement and want to take decision for a problem statement then you should choose amongst various types of conclusive research designs such as descriptive and causal research design. Measurement of variables under study refers to evaluating variables by

using right scales. We can measure physical variables such as weight in kgs but behavioral variables such as happiness measurement is difficult as we don't have any set standard to measure happiness as we have kg in case of weight measurement. These behavioral variables can be measured with the help of scales. There are four types of scales such as nominal scale, ordinal scale, interval scale, ratio scale. Nominal data and interval data is generally known as non metric data. Such type of data is useful in analyzing the categories such as studies involving behavior of rural and urban, male & female, various regions etc. here rural and urban can be classified as 1 & 2 respectively. Numbers 1 & 2 is only symbolic and does facilitate any mathematical calculations. You cannot use many statistical tests on such non metric data. In contrast to this metric data, which can be obtained from interval and ratio scale facilitates common test of hypothesis such as t test, z test, f test etc. It is to be noted that many a times similar information can be obtained with the help of different scales for example we can collect the information about respondent's height in exact centimeters such as 170 cm or 172 cm, similarly we may give classes like tall and short and collect information about height in the form of categorical data.

As mentioned required data can be collected in various forms, care should be taken so that stated statistical test can be applied to the collected data. We can incorporate all such things while designing questionnaire. Different types of questions can be asked such as multiple choice questions, Linier scale questions, Likert scale questions and so on. Choice of questions selected based on objective, hypothesis and data analysis techniques to be used. The designed questionnaire has to be tested with few respondents in pilot survey, data so obtained in pilot survey to be checked for weather it is in line with the required format of tabulation, further it has to be checked with few statistical test for its validity, minor corrections can be done in questionnaire if required and data from sample so selected can be collected with the help of validated questionnaire.

Sampling refers choose few representative elements from the given population. It can again be done in two styles, probability sampling and non probability sampling. Based on situation and constrain you can choose the sampling technique. Sample size can be estimated with the help available references.

### 3.2.1 Classifications Of research design



As shown in figure, research design is broadly classified in three classes, exploratory research design, Descriptive research design and causal research. Descriptive research design can be of Cross Sectional Design or longitudinal design. Further cross sectional design can be classified as single cross sectional design and multiple cross sectional design. Let us discuss each of this type in detail.

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### 3.3 EXPLORATORY RESEARCH DESIGN

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It is one type of research design which has as its primary objective the provision of insights in to and comprehension of problem situation confronting the researcher. E.g. post pandemic academic abilities of students, Entrepreneurship environment and placement situation. Exploratory research studies are also termed as formulate research studies. The main purpose of studies is that formulating a problem for more precise investigation or of developing a working hypothesis from an operational point of view. Research question is not exactly pre defined in case of exploratory studies. The major emphasis of such studies is on the discovery of ideas and insights. Exploratory design must be flexible

enough to provide opportunity for different aspects of a problem under study. Inbuilt flexibility in research design is needed because the research problem broadly defined initially is transformed into one with more precise meaning in exploratory studies, which may necessitate change in research procedure for gathering relevant data.

Let us discuss the above mentioned examples in detail. The example of research is to be carried out on estimating impact of pandemic on academic abilities of students. As the pandemic has brought many new biological and economical challenges which the world has never faced, it is to be understood that many educational institutes went online so as to minimize the academic loss of the students, teaching learning and evaluation process in pandemic was altogether different. Suppose we want to study post pandemic academic abilities of students such as learning, paying attention, listening and writing. We know the said variables but in case because of over exposure to the mobile eye sight of few students is reduced. Their attention in offline class is less than the attention in pre covid era. This aspect of eyesight was earlier not known, it may also be possible that many students are facing many problems related to brain such as Migraine and more such variables were not known but they do have impact on academic abilities of students, by studying this situation government or university may grant additional time for writing answers in end semester examination.

It is well known fact that Indian economy is driven by high levels of consumption and its huge consumption size present many entrepreneurship opportunities. This opportunity is well understood by the government and many schemes which will motivate people to start their entrepreneurship careers. It is noticed that entrepreneurship has grown only in few packets of India and not all around the country, few packets such as western Maharashtra, part of Gujrat, Tamil Nadu, and Karnataka might be doing well in case of entrepreneurship but few other packets such as Madhya Pradesh, Bihar, Vidharbha region might not do equally well. Now government is concerned and they are providing much support in various areas such as technology, finance and marketing, export, banking and others. While doing survey these variables are known but fear of loss, insecurity, changing tastes, dynamic changes in market structure and unlawful demands from some pressure groups can be few more variables which are restricting growth of entrepreneurship in above mentioned areas. These variables were not known earlier but while exploring we may come across such variables.

Thus in an exploratory research study which merely leads to insights or hypothesis, whatever method or research design outlined above is adopted, the only thing essential is that it must continue to remain flexible so that many different facets of a problem may be considered as and when they arise and come to the notice of researcher. Exploratory research design is helpful in proving insight in subject of interest and develop hypothesis. It can be executed by various methods namely secondary resource analysis, case study method, expert opinion method and focus group interviews.

### 3.3.1 Secondary Resource Analysis

Secondary resource analysis happens to be most simple and fruitful method of formulating precisely the research problem or developing hypothesis. Hypothesis developed by earlier workers may be reviewed and their usefulness may be evaluated as a basis for further research. It may also be considered whether the already stated hypothesis suggest new hypothesis. In this way the researcher should review and build upon the work already done by others, but in case hypothesis have not been yet formulated, his task is to review the available literature and define the hypothesis from it.

Besides, the bibliographical survey of studies, already made in once area of interest may as well be made by the researcher for precisely formulating problem. He should also make an attempt to apply his understanding in different research context to the area in which he is working. Many a times referring from others thesis or research projects gives an idea about development of working hypothesis from it.

### 3.3.2 Case Study Method

In the case study method, a unit under study may be an individual, department of the organization or a company is taken. All the factors relating to research area are explored in detail and the study is done. Case studies generally focus on collecting information from specific object like individual or a business unit. The case can be any one or few from individual, event, group, organization or it may also be situation. The objective of case studies is to have a clear picture of a problem by examining real life situation from various angles and perspective using multiple methods of data collection. Case studies are empirical investigation of particular contemporary phenomenon within its real life context using multiple methods of data collection. Case studies leads to generation or collection of qualitative and quantitative data both. Case study method is highly useful to develop the hypothesis. E.g. A case study can be done for particular branch of bank for challenges in effective implementation crop loan scheme of government.

### 3.3.3 Expert Opinion Survey

In this method, group of people having expertise in particular domain are surveyed. The object of the survey is to obtain insight in to the relationship between variables and new ideas relating to research problem. To conduct such survey a group of people having expertise is carefully selected. The selected respondents are generally interviewed instead of questionnaire to get further insight in to problem. Interviews should be unstructured instead of structured interviews so that various views of these expert people can be accommodated in research problem. Every interview may last for several hours based on expertise of a particular respondent. It is preferred to inform the respondent well in advance so that he can arrange his schedule and be prepared for the said topic. It is general practice that respondents are well communicated with research topic so

that he can be well prepared. Thus an expert opinion survey may enable the researcher to define the problem more concisely and help in the formation of hypothesis. This survey may as well provide information about practical possibilities for doing different types of research. E.g. survey of bank managers can be taken so as to design new product focused on consumer durable loans from the bank. In this survey challenges and opportunities in this segment can be explored by the researcher. The survey can be in the form of interviews.

### 3.3.4 Focus Group Discussion

A focus group discussion is an interview conducted by a trained moderator among a small group of respondents in an unstructured and natural manner. In this method of research, a moderator acts as a stimulator in the group discussion. The group selected consists of 7 to 12 people from experts. Here many a time unexpected finding may emerge from the discussion of these experts. Such focus group discussion can be carried out online or offline. Focus group is the most important qualitative research procedure. They are very popular and many times used as synonymous with qualitative research. Various online meeting platforms such as zoom meetings, google meetings, Jio meetings or some subscribed platforms can be used for discussion. In this method the respondents are informed in advance about the research topic and well studied respondents with the help of moderator participate in the discussion forum. The output in these methods depends heavily on art of moderator to explore the vision of participating respondents. The focus group selected is from similar demographic background. If you have selected working class of women then they should not be combined with college going girls as the lifestyle of both the groups might be different and research may not get exact output from such focus group. E.g. A focus group of university professors may be selected for a discussion on providing students online learning and evaluation platform. In this focus group various university professors of about 7 to 12 can be selected and moderator can lead to discussion about challenges in online education.

#### ▪ Conclusive research Design

As main objective of exploratory research is get insight in research problem, it is helpful in understanding nature of problem, conclusive research design are those research design where finding are very helpful in decision making unlike exploratory design. Conclusive research can be descriptive research design and causal research design.

▪ **Difference between Exploratory research and conclusive research**

Parameter	Exploratory	Conclusive
Objective	To provide insights and understanding	To test specific hypothesis
Characteristics	Information needed is defined only loosely, research process is flexible and unstructured. Study is qualitative and sample size is small.	Information needed is clearly defined. Research process is structured. Quantitative data analysis is used. Sample size is large.
Findings/ Results	Tentative	Conclusive
outcomes	Followed by conclusive research	Findings are used for decision making.

### **3.4 DESCRIPTIVE RESEARCH DESIGN**

It is type of conclusive research that has as its major objective the description of some things usually market characteristics or functions. E.g. A research conducted about customer satisfaction, employee satisfaction, brand preference, brand awareness etc. Special characteristic of descriptive research is that, researcher do not have any control on the situation, he is only passive observer and describe what situation is? He will not emphasize on what situation ought to be? Majority of marketing research studies are descriptive in nature. Let us discuss the given example in detail. A motor cycle company wants to study level of customer satisfaction for its servicing units. After motor cycle is serviced then with the billing customer satisfaction form may be presented at service outlet, customer is requested to fill out the form and data so gathered may be analyzed with the help of predefined descriptive and inferential analysis and conclusions from the data can be drawn. Here researcher is not supposed to control the situation but just the collect real information from the customers of service department. Descriptive research design is further classified as cross sectional studies and longitudinal studies.

#### **3.4.1 Cross Sectional Studies**

A type of research design involving the collection of information from any given sample of population elements only once. Cross sectional design is further classified as single cross sectional design and multiple cross sectional design as explained below.

### 3.4.1.1 Single Cross sectional design

A cross sectional design in which one sample of respondents is drawn from the target population and the information is obtained from the sample once. E.g. we want to conduct survey of MMS students about their Industrial exposure. We can finalize Industrial exposure as dependent variable and Industrial visits, guest lectures and internship as independent variables. The survey can be made out of respondents from MMS final year passed students and conclusions can be drawn based on findings of the study.

### 3.4.1.2 Multiple Cross Sectional Design

Multiple cross sectional design in which there are two or more sample of respondents and information from each sample is collected only once. Here we can conduct a similar survey as explained above on various post graduate students in university. Similar questionnaire can be given to respondents from various departments such as commerce, management, chemistry and physics. Data obtained from final year passed students of various courses. Such research is known as multiple cross sectional study.

### 3.4.1.3 Cohort Analysis

It is multiple cross sectional design consist of series of surveys conducted at appropriate time intervals. The cohort refers to group of respondents who experience the same events within the same time intervals.

### 3.4.2 Longitudinal Studies

A type of research design involving a fixed sample of population elements that is measured repeatedly. The sample remains the same over time, thus providing a series of picture that when vied together; portray a vivid illustration of the situation and the changes that are taking place over time. Let us consider the same example of MMS students and their industrial exposure as explained above. Dependent and independent variables remain same but we now want to understand growth in industrial exposure semester wise. To fulfill this objective, we will conduct this survey five times starting with survey immediately after starting of MMS program, second survey can be carried out at the end of semester I and similarly at the end of each semester till final year. We can see the output of industrial exposure at the end of each semester and compare with industrial exposure of same students at the time of joining MMS program. From such study we can understand impact of each semester on increase in industrial exposure of students.

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## 3.5 CAUSAL RESEARCH DESIGN

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It is a type of conclusive research where the major objective is to obtain evidence regarding cause and effect relationship. It is also known as experimental design. Consider an example of estimating consumer demand for shoes. Here dependent variable is consumer demand and independent variable can be Price, consumer income, advertising,

competition and substitutes available with their respective prices. We know that when ever price decreases quantity demanded increases. Here quantity demanded is effect caused by change in price so here we can state this as an example of cause and effect. In many type of research, we are interested to understand cause and effect and strength of relationship between cause and effect e.g. Demand depends on price as well as income but if we see strength of relationship, data shows stronger relationship with price of the product. Such relationship can be stated well with the help of regression and correlation analysis. Greater the values of coefficients of regression and correlation stronger are the relation between the variables. Research in which the independent variable is manipulated is termed as experimental design. Further principle of replication, principle of randomization and principle of local control is used in case of experimental design. Experimental design is further classified as informal experimental and formal experimental design explained as follows.

#### Informal Experimental Design

- ✓ Before and after experimental design
  - After only with control design
  - Before and after with control design.
- ✓ Formal Experimental design
  - Completely randomized design
  - Randomized block design
  - Latin square design
  - Factorial design

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### 3.6 ERRORS AFFECTING RESEARCH DESIGN

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Several potential sources of error can affect a research design. A good research design take care of potential sources of errors and try to avoid or control errors. Total errors can be sampling errors and non sampling errors. Total error is the variation between true mean value in the population of the variable of interest and the observed mean value obtained in the marketing research project. Random sampling error is due to the particular sample selected being an imperfect representation of the total population of interest. It may be defined as the variation between true mean values for the sample and true mean value of the population. Non sampling errors are errors that can be attributed to sources other than sampling, and they can be random or non random.

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### 3.7 CONCLUSION

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Research design refers to Framework or blue print for conducting research project. It specifies the details of the procedures necessary for obtaining the information needed to structure and solving research problem. Research design is broadly classified in three classes, exploratory research design, Descriptive research design and causal research. Exploratory research design is helpful in proving insight in subject of interest and develop hypothesis. It can be executed by various methods namely secondary resource analysis, case study method and expert opinion

method and focus group interviews. Descriptive research design can be of Cross Sectional Design or longitudinal design. Further cross sectional design can be classified as single cross sectional design and multiple cross sectional design. Research in which the independent variable is manipulated is termed as experimental design. Further principle of replication, principle of randomization and principle of local control is used in case of experimental design. Experimental design is further classified as informal experimental and formal experimental design. Several potential sources of error can affect a research design. Total errors can be sampling errors and non sampling errors.

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### 3.8 SELF ASSESSMENT QUESTIONS

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- Q1. Explain meaning and significance of research design.
- Q2. What are the various types of research design?
- Q3. What are the potential sources of errors in research design?
- Q4 Present a differentiation between Exploratory, descriptive and causal research design.
- Q5. Fill In the Blanks
1. Research design refers to \_\_\_\_\_ for conducting research project (System / Blueprint)
  2. Sampling refers choose \_\_\_\_\_ elements from the given population. (All / Few)
  3. Descriptive research involves \_\_\_\_\_ of respondents. (Correction / Observation)
  4. Research design is broadly classified in \_\_\_\_\_ classes. (Three/ five)
  5. Random sampling error is due to the particular \_\_\_\_\_ selected (Sample / Population)
- Q6. MCQ Questions.
1. Research design involves techniques for...
    - a. Collection of Data
    - b. Analysis of data
    - c. both A & B
    - d. None Of the Above
  2. Various elements of research design are \_\_\_\_
    - a) Define the information needed
    - b) Choose the appropriate research design type.
    - c) Measurement and scale design
    - d) All of These

3. "Provision of insights in to and comprehension of problem situation" is feature of\_\_
  - a) Exploratory Research design
  - b) Descriptive Research design
  - c) Causal Research design
  - d) All Of these
  
4. Group of respondents who experience the same events within the same time intervals refers to \_\_.
  - a) Sample
  - b) Cohort
  - c) Population
  - d) None of these
  
5. All the factors relating to research area are explored in detail and the study is done in \_\_ type of Experimental research design.
  - a) Case study Method
  - b) Focus Group Interview
  - c) Expert Opinion Survey
  - d) None of these



## **BUSINESS RESEARCH METHODS**

### **Unit Structure**

#### 4.0 Objectives

#### 4.1 Primary and Secondary Data

#### 4.2 Classification of Data

##### 4.2.1. Types of Data Classification

##### 4.2.2. Objectives of Data Classification

#### 4.3 Primary Data

##### 4.3.1. Primary Data Sources

##### 4.3.2. Advantages of Primary Data

##### 4.3.3. Disadvantages of Primary Data

#### 4.4. Observation Method

##### 4.4.1. Advantages of Observation Method

##### 4.4.2. Disadvantages of Observation Method

#### 4.5 Focus Group Discussion

##### 4.5.1. Advantages of focus group discussion

##### 4.5.2. Disadvantages of focus group discussion

#### 4.6 Interview Method

##### 4.6.1. Structured Interview

##### 4.6.2. Semi – Structured Interview

##### 4.6.3. Unstructured Interview

#### 4.7 Secondary Data

##### 4.7.1 Uses of Secondary Data

##### 4.7.2. Advantages of Secondary Data

##### 4.7.3. Limitations of Secondary Data

##### 4.7.4. Types of Secondary Data

#### 4.8 Self- Assessment Questions

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## 4.0 OBJECTIVES

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By the end of the chapter, you should be able to

- 1) Understand and differentiate between primary and secondary data
- 2) Identify the advantages and disadvantages of primary and secondary data
- 3) Classify types of primary and secondary data collection techniques.
- 4) Distinguish between the various types and sources of secondary data

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## 4.1 PRIMARY AND SECONDARY DATA

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### Introduction

Data can be defined as different kinds of information formatted in a particular way to enable ease of use. Data collection is the process of collecting, measuring and examining accurate data for research using standard validated tools and techniques. Data is a very important part of any research. Without data, research cannot be conducted. Data collection is the primary and most important step for research, irrespective of the field of research.

The approach of data collection is different for different fields of study, depending on the required information. Along with research, data collection is also required for any kind of business decision making, ensure quality assurance, and keep research integrity in check. Hence data collection methods and process is given utmost importance as it is the first step towards achieving the above mentioned objectives.

During data collection, the researchers must identify the data types, the sources of data, and what methods would be used to obtain the data.

Before a researcher begins collecting data, they must be able to answer a few basic questions:

- What's the objective or purpose of this research?
- What kinds of data is to be gathered?
- What methods and procedures will be used to collect, store, and process the information collected?
- How would the data be presented for analysis of the study?

### *Data Collection – Why do we need it?*

Before a judge makes a ruling in a court case or a general creates a plan of attack on the enemy, they should have as many relevant and accurate facts as possible. The best courses of action come from informed decisions, and information and data are corresponding to each other.

Whether one is in the world of academia, trying to conduct research, or part of the corporate sector, thinking of how to promote a new product, one requires data collection to help make informed and better choices.

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## 4.2 CLASSIFICATION OF DATA

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Classification of data is can be defined as the process of organizing data by relevant categories so that it may be used more efficiently during the research process. This helps to locate the required data more easily. Classifying data into correct categories can help avoid duplication of data along with easy presentation.

### 4.2.1. Types of Data Classification

Data classification can be carried out based on content, context, or user selections:

- **Content-based classification**—involves reviewing files and documents, and classifying them.
- **Context-based classification**—involves classifying files based on meta data like the application that created the file (for example, accounting software), the person who created the document (for example, finance staff), or the location in which files were authored or modified (for example, finance or legal department buildings).
- **User-based classification**—involves classifying files according to a manual judgement of a knowledgeable user. Individuals who work with documents can specify how sensitive they are—they can do so when they create the document, after a significant edit or review, or before the document is released.

### 4.2.2. Objectives of Data Classification

- It compresses the volume of data in an easily understandable form such that the similarities and variations can be instantly recognised.
- It reduces unnecessary details in the data.
- It helps in comparisons and highlights the important aspects of the data.
- It helps in statistical processing of the data gathered by converting it into tables, graphs or bars for easy understanding.
- It gives importance to the prominent data collected and helps in classifying the data of lesser importance.

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## 4.3 PRIMARY DATA

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Primary data refers to the firsthand data collected by the researcher himself. This type of data is collected with some specific purpose in mind or a particular study. It is sometimes a very long process with lots of involvement. In order to get effective and accurate data, the researcher has to spend a lot of time and energy into collecting this type of data. While the accuracy and reliability of this type of data is more, however the data

collected by this method is of crude, that is unfiltered nature, meaning it has to be filtered and categorized before analyzing and making inferences out of it.

Primary data is also very specific to the researchers needs as per his research and methodology and area of interest and hence may or may not be useful for other research projects or areas. A lot of elaborate pre planning and designing is involved before a researcher begins to collect data by this method. The researcher also has the flexibility to change or alter his method of data collection during the process as he is obtaining this information at the very basic level.

In terms of cost effectiveness, the primary method of data collection can at most times be an expensive and time consuming process.

There are different methods by which this type of data can be collected.

#### **4.3.1. Primary Data Sources**

The primary data can be collected by using

Quantitative Methods or

Qualitative Methods

##### **Quantitative Methods**

Survey is one of the most popular techniques of primary data collection by using quantitative methods. A survey is a method for collecting quantitative information about items in a sample population. The information is collected by using different kinds of interview questions addressed to a large amount of population. Surveys may have different approaches like personally administered surveys or a telephonic survey, a mail survey or an electronic survey. All surveys are basically conducted using a prefixed format of questions, termed as a questionnaire.

##### **Qualitative Methods**

This type of data collection does not necessarily use questionnaires. The emphasis of such methods is to have a flexible approach while collecting data. This method is usually used when the research is in the exploratory stage and due to the lack of enough research conducted on the topic, the researcher does not have enough knowledge about the research topic. In such situations, it is extremely difficult for a researcher to design and draft a questionnaire and follow a systematic approach. In all such situations that require exploring new insights and perspectives from the respondents, the qualitative methods of data collection are considered the most appropriate method.

Qualitative methods of data collection include observations, focus groups unstructured and semi structured interviews etc.

### 4.3.2. Advantages of Primary Data

- **Obtain specific research**

Performing your own research allows the researcher to address and resolve issues specific to the research topic. The collected information is the exact information that the researcher wants and he is able to present it in a way that benefits his research.

- **Better accuracy**

Primary data is much more accurate because it is directly collected from a given population.

- **A higher level of control**

The researcher can control easily the research design and method. In addition, He also has a higher level of control over how the information is gathered.

- **Up-to-date information**

The primary market research is a great source of latest and up-to-date information as you collect it directly from the field.

- **Information ownership**

Information collected by the researcher is their own property and the researcher reserves the right to share the information.

### 4.3.3. Disadvantages of Primary Data

- **Expensive process**

It could be very expensive to obtain primary data collection methods because the research team has to start from the beginning. They have to follow the whole study procedure, organizing materials, process and etc.

- **Time-consuming**

It takes a lot of time to conduct the research from the beginning to the end. Often it is much longer in comparison with the time needed to collect secondary data.

- **Limitation of other factors**

Primary data is limited to the specific time, place or number of participants. To compare, secondary data can come from a variety of sources to give more details.

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## 4.4 OBSERVATION METHOD

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This is a qualitative method of data collection. In this technique, the information is captured by observing variety of factors like, objects, human behaviour, systems, processes, structures etc. For example, in a

study about a product, instead of asking consumers a fixed set of questions about their attitude towards the product, it would be more beneficial to appoint a person as an observer in a store to observe and analyse the behaviour of the consumers while they make their purchase decision.

Although this method could turn out to be time consuming and an expensive matter, the results obtained through this method would be reliable. The observer generally does not interfere in the process of data collection and because of that the observer's bias is also eliminated to an extent. This technique may reveal some important information that otherwise may not be disclosed in the other form of data collection.

Few examples of Observation Method are

A Doctor watching a patient after giving him an injection.

An astronomer looking at the night sky to view movement of objects.

An observer looking at a customer's buying behaviour towards a product.

#### **4.4.1. Advantages of Observation Method**

- The researcher can collect, check and record accurate data by observing himself first-hand.
- It generates a permanent record of the observation activity and the researcher or others can refer to it later
- The organization method is one of the simplest methods of data collection. It does not require too much technical knowledge
- Observation method is one of the most common methods used in all sciences and is very easy to follow and accept
- The observation method does not require the willingness of the participant to record his observation. The researcher can observe from a distance and record his findings

#### **4.4.2 Disadvantages of Observation Method**

- This method of data collection takes a longer time frame compared to other data collection methods
- There is a chance of higher observer bias in the observation method
- Several personal behaviors are not open for observation and this proves a limitation in case of observation method
- Many of the incidents are abstract like love, affection and the researcher can't gain an exact and correct account of those
- Observation method is considered an expensive affair as it requires hard effort, plenty of time and high cost

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## 4.5 FOCUS GROUP DISCUSSION

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This is a type of interviewing technique. A small, selected group of participants are chosen who are interviewed by a researcher. The participants are generally from a target research audience whose opinion is of interest to the said researcher. The discussion is generally a collaboration of experiences, attitudes, perception, ideas and how they feel about a certain topic. The researcher generally moderates the discussion in a direction that will lead to some quality opinions by the participants.

The discussion during this activity is generally free and open, sometimes allowing the researcher to a new chain of thoughts. The researcher may also receive varied ideas and insights, enabling him to increase his quality of research work.

It is however important that the selection of the participants be given due importance. Smaller groups are generally preferred for a natural and well-coordinated discussion. The participants are to be selected, as far as possible, from a similar economic, social and cultural background. This would minimize any conflict that could arise within the group and contribute towards achieving the set objectives. The researcher's skills are extremely important in keeping the discussion relevant without getting involved in any controversy or bias. The researcher should have adequate knowledge of the topic that would be discussed and should be able to follow and utilize effectively, the opinions provided in the focus group discussion.

### 4.5.1. Advantages of focus group discussion

- It is an inexpensive and fast method of obtaining valuable data.
- Co-workers and friends are more comfortable in voicing views in each other's company than on their own with the researcher.
- Participants are given a chance to reflect or react to the viewpoint of others with which they may disagree or of which they're unaware.
- The dynamic discussion between participants stimulates their thoughts and reminds them of their own thoughts regarding the research subject.
- All individuals along with the researcher have a chance to ask questions, and these will produce more information when compared with individual interviews.
- Informants can build on the answers of others.

### 4.5.2. Disadvantages of focus group discussion

- The researcher sometimes face problem controlling discussion and managing the process in comparison to individual interview.

- A few individuals could possibly be introverts while others take control of the debate and impact the end result, or possibly even introduce bias.
- Recording data can present difficulties; it is actually not possible to record when so many participants are speaking at the same time.
- Data analysis could be time consuming and challenging task.
- Focus group discussions cannot be repeated. The validity and dependability of the findings are tough to determine.

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## 4.6 INTERVIEW METHOD

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This is the most commonly used method of data collection. A prefixed set of questions are designed by the researcher in order to ask the target participants. The analysis is further done on the answers provided by them.

There are basically three types of interviews.

1. Structured Interview
2. Semi – Structured interview
3. Unstructured Interview

### 4.6.1. Structured Interview

Structured interviews are the most systematized type of interview. Opposite to semi-structured or unstructured interviews, the interviewer uses predetermined questions in a set order.

Structured interviews are mostly closed-ended. They can be divided, which means asking participants to answer “yes” or “no” to each question, or multiple-choice options.

Asking a fixed set questions in a set order allows you to easily compare responses between participants in a uniform context. This can help you see patterns and highlight areas for further research. A structured interview is straightforward to conduct and analyze. Asking the same set of questions lowers potential biases and leads to fewer uncertainties in analysis. It is an undertaking you can likely handle as an individual, provided you remain organized.

A survey is generally conducted by a structured interview where the set of questions do not change for the entire population of participants the survey is taken from.

#### *Advantages of structured interviews*

- **Reduced bias**

The fixed nature of structured interviews reduces context effects and other biases. Asking the same questions in the same order to all participants

minimizes the risk of introducing bias via the order or nature of questions asked, or via any environmental factors.

- **Increased credibility, reliability and validity**

Structured interviews are thought to be more credible than other types of interviews because they are very carefully planned and set. All participants are presented with the same questions in the same order, which makes it easier to compare the answers. This contributes to their reliability and validity.

- **Simple, cost-effective and efficient**

Similar to questionnaires and surveys, structured interviews introduce more variation and diversity to the topic being studied without representing too much more work for the interviewer. Relatedly, there is less preparation needed for the interviewee, so the process is also less time-consuming on their part.

#### *Disadvantages of structured interviews*

- **Formal in nature**

The fixed structure of such an interview means that there is very little opportunity to build a bond between the interviewer and the participant. The method of structured interviews can cause participants to feel uncomfortable or nervous, which can affect their answers.

- **Limited flexibility**

Once the questions are selected, they cannot be altered or removed without affecting the quality of the interview. Even if a question is poorly worded, excess, or unnecessary, it still has to be presented to all respondents.

- **Limited scope**

Since most structured interviews are closed-ended, their scope is limited. Participants cannot go into much detail with their answers, and there is little room for any kind of explanation. If a participant doesn't truly identify with any of the multiple-choice answers, it can be difficult to know how much their answer reflects their true opinions.

#### **4.6.2. Semi – Structured Interview**

This method is used when the researcher asks the respondents some basic questions, the researcher sometimes interferes wherever necessary. In this method, the interviewer sets some simple guidelines for the questions to be asked. The succession questions are generally on the basis of the preceding questions. Hence we can say that in a semi structured interview, while there is some flexibility to the questioning path, there is also some fixed structure to the questions being asked to the respondents. A 'job interview' is the most common example of a semi structured interview.

### 4.6.3. Unstructured Interview

This type of interview allows the interviewer to get opinions and get a feel of general attitudes of the respondents. The questions drafted by the researcher are extremely flexible. There is no pre fixed set of questions. Since the questioning takes place in a very flexible mode, a researcher is able to get deeper insight into the subject. This can help the researcher understand the respondents' views and opinions better than in structured questions. Such interviews are generally used in exploratory research and are usually time consuming. One of the biggest challenge of this method is that the data generated is in a much unstructured format, this makes it very difficult for quantitative analysis. The segregation of this type of data is not only time consuming but also expensive. Coding such kind of raw data is extensive to allow methodical analysis and needs expertise. However, there are multiple software available for this purpose in order to cut short such a tedious task.

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## 4.7 SECONDARY DATA

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Secondary data is research data that has previously been collected by another source and can be accessed by researchers. This is the opposite of primary data, which is data collected directly from its source. Secondary data is almost always past data which is inexpensive and less time consuming to identify. Although secondary data is economical to get, it may or may not be specific to the researchers needs. A lot of filtering and scanning may be required in order to arrive at the correct data as per researchers' topic of interest. However, the ultimate source of any secondary data has to be primary data. The most common example of secondary data are the data collected from published sources like newspapers, magazines/ journals, books, reports, publications, /economic survey and census published by Government of India.

Secondary data can be of 2 types, depending on the kind of research:

- **Quantitative data** – data that can be expressed as a number or can be quantified. Examples – the weight and height of a person, the number of working hours, the volume of sales per month, etc. Quantitative data can be easily modified to statistical manipulation.
- **Qualitative data** – data that can't be expressed as a number and can't be measured. Qualitative data consist of words, pictures, observations, and symbols, not numbers. It is about qualities. Examples – colour of the eyes (black, brown, blue, green), your socioeconomic status, customer satisfaction, loyalty towards a product, etc. (To measure this type of data we create tools that help us quantify the above parameters).

### 4.7.1 Uses of Secondary Data

Secondary data can be used for a number of purposes such as

1. To identify the research problem
2. To develop strategies and plans that will lead to solutions.
3. To help develop a good research design
4. To help find answers to certain research questions and support hypothesis testing.
5. To help analyze primary data.
6. To validate the results of primary data.
7. To identify possible problems if any.
8. To get more background information and improve the credibility of the study.

### 4.7.2. Advantages of Secondary Data

There are several advantages to secondary data.

1. The data available is quick and easy to use. Therefore, for a study with limitations of time, it is easier to use secondary data method than the primary data method.
2. If the source of data collected is reliable such data can avoid the errors that otherwise could come in while collecting primary data.
3. In many cases secondary data could be less expensive to obtain than the primary data because it does not involve elaborate processes like in primary data collection.
4. Secondary data enables the researcher to cover a wider geographic, cross-sectional range
5. Information gathered by secondary data can generate more accurate data than that obtained through primary research.
6. Secondary data allows you to generate new insights from previous analysis and helps to come at relevant conclusions.
7. Secondary data allows you to carry out a longitudinal analysis which means the studies are performed spanning over a large period of time. This can help you to understand different trends. In addition to this, sometimes you can also find secondary data from many years back up to the latest month. It also allows you to compare data over time.

It is basically an economic use of time and resources that also comes with an ease of access. This is because the data is already prepared, segmented and categorized for the researcher to use and analyze and incorporate into his study.

### 4.7.3. Limitations of Secondary Data

While there are many advantages to obtaining and using secondary data one must also look at the limitations attached to using secondary data.

1. One of the biggest challenges while using secondary data is that the data should be relevant, recent and reliable to the researcher for the given purpose of his study.
2. The research conducted by primary data collection methods is generally controlled by the researcher himself. However, if the data used is secondary data or not collected directly by the researcher himself, the origin of the data may be questionable if the data is not verified appropriately.
3. Secondary data does not address the specific needs of the researchers. For example, if the researcher wants the demographic profile in a specific category like income, the categories defined by the researcher may not match with the categories defined in the secondary data.
4. Since the secondary data available may not be specifically required by the researcher, it can be considered as inefficient spending of resources for the secondary data. The quality control of the data is also not possible.
5. Since the secondary data is available to many others, the exclusiveness of the information derived from the data is lost.
6. The secondary researcher may have to compromise on the forecasted objectives and scope of the study depending on the availability of data that is available via this method.
7. The secondary data might lack quality. The source of the information may be questionable, especially when you gather the data via the Internet and other such secondary sources. As the researcher is much dependent on secondary data as a part of the research process, one must evaluate the reliability of the information by finding out how the information was collected and analysed.

One should note that the choice between collecting primary data or using secondary data depends on the objective, confidentiality or exclusiveness of the study among other objectives in mind.

#### 4.7.4. Types of Secondary Data

There are two types of secondary data, based on the data source:

- **Internal sources of data:** information gathered within the researcher's company or organization (examples – a database with customer details, sales reports, marketing analysis, your emails, your social media profiles, etc).
- **External sources of data:** the data collected outside the organization (i.e. government statistics, mass media channels, newspapers, etc.)

Examples of secondary data are

- Tax records and social security data
- Census data
- Electoral statistics
- Health records
- Books, journals, or other print media
- Social media monitoring, internet searches, and other online data
- Sales figures or other reports from third-party companies
- Libraries and electronic filing systems
- App data, e.g. location data, GPS data, timestamp data, etc.

### **Sources of Secondary Data**

Sources of secondary data include:

- Government departments
- Public sector organizations
- Industry associations
- Trade and industry bodies
- Educational institutions
- Private companies
- Market research providers

### **Internal secondary data**

Secondary data does not only come from different organizations. It can also come from within an organization itself.

**Sources of internal secondary data include:**

- Sales reports
- HR filings
- Annual accounts
- Quarterly sales figures
- Customer relationship management systems
- Emails and metadata
- Website cookies

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## **4.8 SELF ASSESSMENT QUESTIONS**

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Q1. Distinguish between primary and secondary methods of data collection.

Q2. What are the sources of primary and secondary data collection?

- Q3. Explain the different types of Interviews, what are the advantages of structured interviews?
- Q4. What is the purpose and use of primary data and secondary data?
- Q5. You plan to export semi-precious stones from Jaipur to countries like South Africa, Canada, USA. What would be the nature of information required by you? How can you use secondary data sources in this example?
- Q6. Ritesh wants to plan a holiday to a few countries in Europe to experience the winter weather. How will he go about making his decisions of choosing the right places to enjoy his vacation? What kind of sources would be helpful?
- Q7. A school teacher wants to set up a primary school in a small town. How should she proceed to collect data for the same?



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## ATTITUDE MEASUREMENT AND SCALING

### Unit Structure

- 5.0 Objectives
- 5.1 Introduction
- 5.2 Attitude
- 5.3 Measurement
- 5.4 Measurement Level/Scales or Classification of Scales
- 5.5 Single item Vs Multiple Items
- 5.6 Comparative Vs Non-Comparative Scales
- 5.7 Measurement Error
- 5.8 Criteria for good Measurement
- 5.9 Exercise

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### 5.0 OBJECTIVES:

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**After studying this unit students should be able to:**

1. Introduce the concept of Attitude measurement or scaling and its types.
2. Provide the details of the various scales
3. Identify the difference between single item Vs multiple items and Comparative Vs Non-Comparative Scales.
4. Learn the Measurement errors.
5. Present the Criteria for Good Measurement.

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### 5.1 INTRODUCTION:

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In our day-to-day life, when we have to measure the weight, height, or some other features of a physical object or we have to judge the person or his / her qualities, song, or painting then we use some yardstick. Thus, we measure physical objects as well as abstract concepts. In organizations, many decisions are taken in each of the functional areas of management: production, marketing, finance and personnel. Some of the examples of decisions in the area are - acquisition or disposal of materials, manufacturing, and marketing of products and services promoting or demoting the employees, opening new plants, or closing down the existing ones, and potential buyers or customers for the company's products or services, brand awareness, interest in new product purchase. In all the

cases or examples, the businessman or decision-maker needs to learn something about the attitude of present or potential consumers. Most of the time in the business the attitude measures can be used to learn which features of a new product or service concept are acceptable or unacceptable. The study and measurement of attitudes are important since it is assumed that there is a relationship between attitude and behavior. The research, however, indicates that such a relationship holds more at the aggregate level than at the individual level.

In every research information or data is the lifeline of the research as the entire project outcome is dependent upon this data. If everything else is in place but the data are not collected keeping in mind the measurement aspects, then the entire efforts of the researcher go waste. Hence it is very important to understand the way different scales are to be constructed to measure the qualitative data.

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## 5.2 ATTITUDE:

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In the business, research scales are generally constructed to measure behavior, knowledge, and attitude. Attitude may be defined as the degree of positive or negative affect associated with some psychological object. It is a pre-disposition of the individuals to evaluate some object or symbol or aspect of his world favorably or unfavorably.

Attitude comprises three components.

1. A cognitive component - a person's belief or information about the object.
2. An affective component - a person's feeling about the object such as "like" or "dislike", "good" or "bad"
3. A behavioral component - a person's readiness to respond behaviorally to the object.

The number of definitions of 'attitude' that have been proposed, the following are a few definitions:

- 1) "Attitude is a mental and neural state of readiness expecting a directive influence upon individual's response to all objects and situations with which it is related".
- 2) "Attitude is the probability of occurrence of a defined behavior in a defined situation".
- 3) "Attitude is an enduring system of three components centering about a single object: positive or negative evaluations or beliefs (the cognitive component), emotional feelings (affective component), and disposition to take action (action tendency component)".

- 4) **L.L. Bernard:** “The behavior which we define attitudinal or attitude is a certain observable ‘set’ organism or relative tendency preparatory to and indicative of more complete adjustment”.
- Attitude is a psychological construct and is a very of conceptualizing the intangible. So, attitude scales are among the most difficult to construct. Attitude Measurement is a relatively complex and demanding task especially when it concerns qualitative or abstract phenomena. This chapter covers the concept of attitude measurement and its procedures that will help the researcher to understand the criteria for a good measurement scale and expected measure errors, which will help them to select or design appropriate measures for their research.
  - An attitude is an individual’s enduring perceptual knowledge-based evaluation and action-oriented process concerning an object or phenomenon.
  - Attitude is a learned tendency of individuals to respond consistently to a given object of orientation.

**Elements of measuring attitude are as follows:**

- Persons, objects, events, concepts, or states to be observed
- Environmental conditions of the study
- Instruments to be used to perform the steps
- Observations to be collected.

**5.3 MEASUREMENT:**

**Meaning:**

Measurement means assigning numbers or other symbols to certain characteristics of the objects of interest, according to some pre-specified rules. Measurement is the actual assignment of a number from 1 to 100 to each respondent.

The term scaling is applied to the attempts to measure the attitude objectively. Attitude is a result of several external and internal factors. Depending upon the attitude to be measured, appropriate scales are designed. Scaling is a technique used for measuring qualitative responses of respondents such as those related to their feelings, perception, likes, dislikes, interests and preferences.

**Definitions:**

- 1) George Lundberg: “Measurement is the way of defining things and not only a process”
- 2) Kenneth D. Biley: “Measurement is the process of determining the value or level, either qualitative or quantitative, of a particular attribute for a particular unit of analysis.”

- 3) G.C. Helmstadter: “Measurement is a process of obtaining a numerical description of the extent to which a person or object possesses some characteristics.”
- 4) Blalock: “Measurement is a systematic assignment of numbers to a set of observations to reflect the status of each member of the set-in terms of the various properties”.

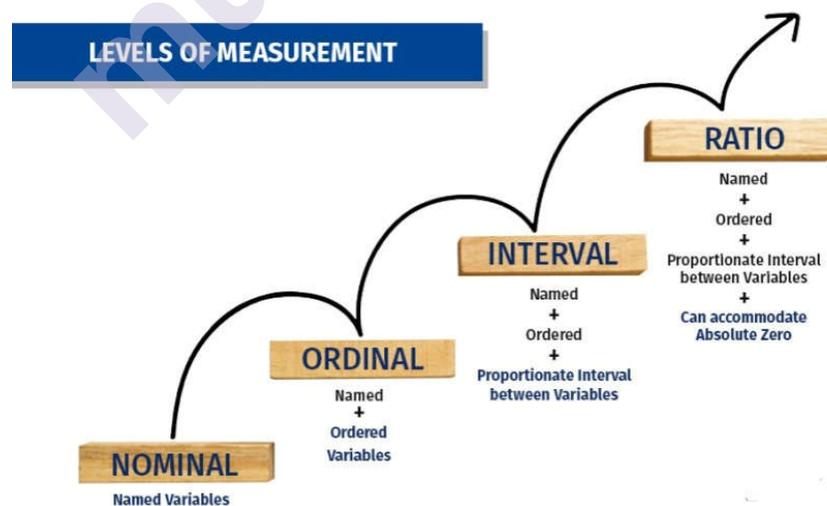
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## 5.4 MEASUREMENT LEVEL/SCALES OR CLASSIFICATION OF SCALES:

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Levels or scale of Measurement is a Yardstick. It is similar to an instrument for finding weight or volume. The scale doesn't possess the properties related to most physical measures. Scales are the methods most often used to turn responses obtained in surveys into numerical indices to be used within the analysis. Inconclusive research, the researcher has to rely on quantitative techniques to express in numeric terms the difference in responses. Hence, a scale is used to represent the item being measured in the spectrum of possibilities. The values assigned in the measuring process can then be manipulated in line with bound mathematical rules.

**As per, the dictionary meaning of Measurement scale, in Britannica:** it is the type of information provided by numbers. Each of the four scales (i.e., nominal, ordinal, interval, and ratio) provides a distinct kind of information. Measurement refers to the assignment of numbers in a very important manner and understanding measurement scales is very important to interpreting the numbers assigned to people, objects, and events.



## 1) **Nominal scales:**

The nominal scale is the simplest method of measurement. This scale is simply a system of assigning number symbols to events to label them. The nominal scale classifies individuals, companies, products, brands, or other entities into two or more categories, Nominal scale is the least powerful level of measurement. It indicates no order or distance relationship. A Nominal Scale simply describes differences between things by assigning them categories.

Gender is an example of a nominal measurement in which a number (e.g., 1) is used to label one gender, such as males, and a different number (e.g., 2) is used for the other gender, females. Numbers do not mean that one gender is better or worse than the other; they simply are used to classify persons. Any other numbers could be used because they do not represent an amount or a quality.

The numbers 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. In addition, in nominal measurement, the numerical values just “name” the attribute uniquely.

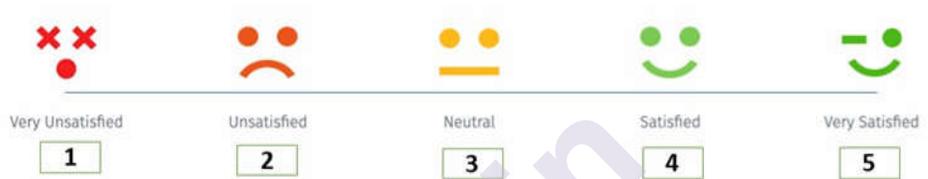
Some examples of variables that can be measured on a nominal scale include:

- **Gender:** Male, female
- **Eye color:** Blue, green, brown
- **Hair color:** Blonde, black, brown, grey, other
- **Blood type:** O-, O+, A-, A+, B-, B+, AB-, AB+
- **Place you live:** City, suburbs, rural

## 2) **Ordinal scales**

Ordinal scales involve the ranking of individuals, attitudes, or items along the continuum of the characteristic being scaled. It is more powerful than a nominal scale in that the numbers possess the property of rank order. The ordinal scale provides a rank order of categories and arranges objects according to their magnitude in an ordered relationship. For example, ranking the products of a company according to the satisfaction of customers, ranking operators in a shop according to their skills, ranking the products on a shop floor according to their quality, etc.

Transformations that do not change the order of properties are permissible at this level of measurement. Reacher can perform any statistical operations that do not change the order of properties that are permissible at this level of measurement.

**Rate your experience while using products:****Product Packaging:****Product Design:**

In ordinal scales, numbers represent rank order and indicate the order of quality or quantity, but they do not provide an amount of quantity or degree of quality.

Some examples of variables that can be measured on an ordinal scale include:

- **Satisfaction:** Very unsatisfied, unsatisfied, neutral, satisfied, very satisfied
- **Socioeconomic status:** Low income, medium income, high income

**3) Interval Scale:**

The interval scale has all characteristics of the ordinal scale and in addition, the units of measurement or intervals between successive positions are equal. The interval scales are also termed Rating scales. Interval means space between two objects. In the interval scale, numbers are assigned to objects or events which can be categorized, ordered and assumed to have an equal distance between scale values. An interval level of measurement embodies the characteristics of both the nominal and ordinal scales. This is the first quantitative application of numbers.

The centigrade thermometer and Fahrenheit thermometer are some examples of an interval scale. In a centigrade thermometer, the minimum number is  $0^{\circ}\text{C}$  and the maximum number is  $100^{\circ}\text{C}$ . between these two numbers the numbers are placed at equal distances in a Fahrenheit thermometer, the minimum number is  $32^{\circ}\text{F}$  and the maximum number is  $212^{\circ}\text{F}$ .

The Interval scale provides a more powerful measurement than the ordinal scales as it incorporates the concept of equality of interval. The statistical tools range, mean and standard deviation are used in research studies, especially in collecting attitudinal and overall brand rating information.

Some examples of variables that can be measured on an interval scale include:

- **Temperature:** Measured in Fahrenheit or Celsius
- **Income Level (Rs):** 0 to 10,000, 10,001 to 20,000, 20,001 to 30,000, and so on.
- **Credit Scores:** Measured from 300 to 850
- **SAT Scores:** Measured from 400 to 1,600

#### 4) **Ratio scales:**

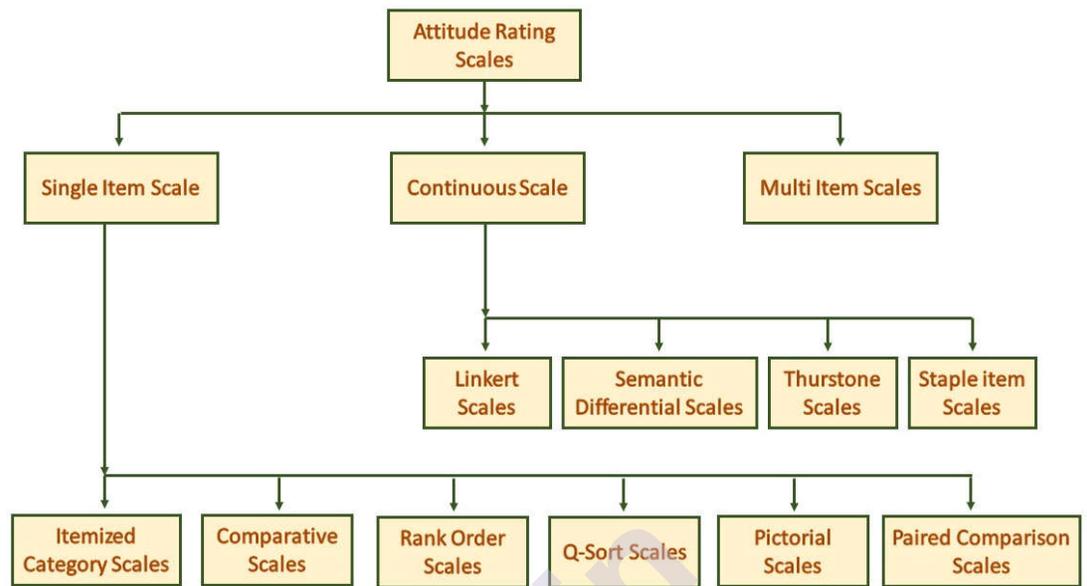
*The highest level of measurement is a ratio scale. This has the properties of an interval scale together with a fixed origin or zero point. Measurement of physical dimensions like height, weight, and age are examples of ratio levels. The mathematical and statistical operations can be performed at this level of measurement. A ratio scale has a natural zero point and further numbers are placed at equally appearing intervals. The numbers on the scale indicate the actual amounts of the property that are measured.*

A score of 0 means there is a complete absence of height or weight. A person who is 1.2 meters (4 feet) tall is two-thirds as tall as a 1.8-meter (6-foot-) tall person. Similarly, a person weighing 45.4 kg (100 pounds) is two-thirds as heavy as a person who weighs 68 kg (150 pounds).

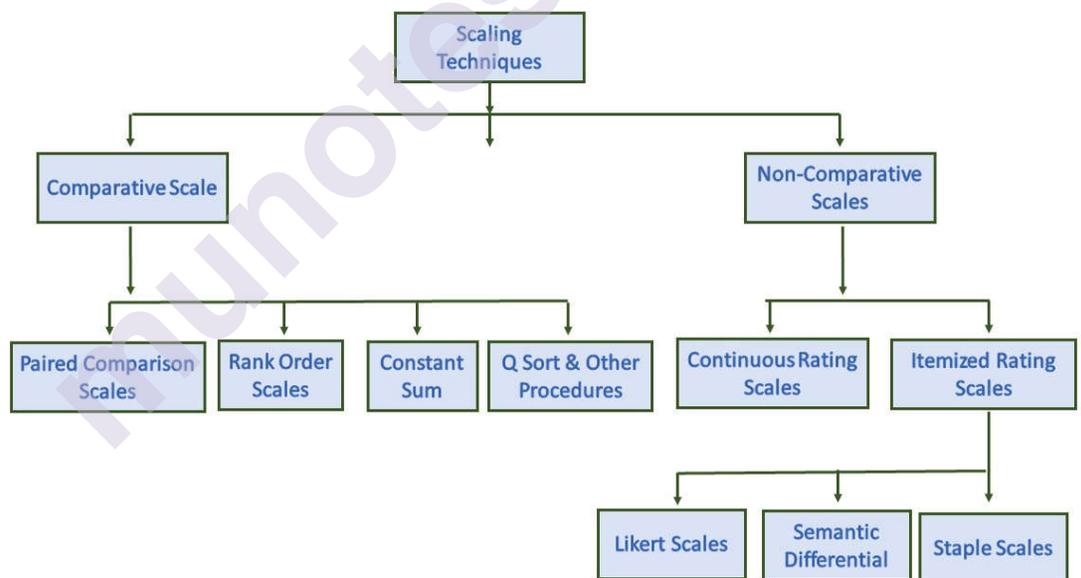
Some examples of variables that can be measured on a ratio scale include:

- **Height:** Can be measured in centimeters, inches, feet, etc. and cannot have a value below zero.
- **Weight:** Can be measured in kilograms, pounds, etc. and cannot have a value below zero.
- **Length:** Can be measured in centimeters, inches, feet, etc. and cannot have a value below zero.

## 5.5 SINGLE ITEM VS MULTIPLE ITEMS



## 5.6 COMPARATIVE VS NON-COMPARATIVE SCALES



### Scaling techniques:

The scaling technique is a method of placing respondents in continuation of gradual change in the pre-assigned values, symbols, or numbers based on the features of a particular object as per the defined rules. All the scaling techniques are based on four pillars, i.e., order, description, distance and origin.

#### 1) Comparative Scale:

In the comparative scaling, the respondent is asked to compare one object with another. A comparative scale is an ordinal or rank order scale that

can also be referred to as a non-metric scale. Respondents evaluate two or more objects at one time and objects are directly compared with one another as part of the measuring process. For Example, the researcher can ask the respondents whether they prefer brand A or Brand B of a detergent. Or in another example, If the researcher asks the respondent to express his attitude regarding the reasonableness of the price of one face cream against that of another brand of face cream it becomes a comparative scale.

Following are the different types of comparative scaling techniques: a) paired comparison Scale, b) Rank order Scales, c) Consent Sum Scale and d) Q sort Scale.

**a) Paired comparison Scale:** This is the simplest case of a ranking scale. In this paired Comparison rating scale, the respondent is asked to rate between the two items at a time. Paired comparison is a widely used scaling technique wherein a respondent has presented a pair of objects to which he is supposed to provide his/her preference for the object from a pair. A paired comparison symbolizes two variables from which the respondent needs to select one. This technique is mainly used at the time of product testing, to facilitate the consumers with a comparative analysis of the two major products in the market.

For Example, a respondent may be asked to indicate his/her preference for Mobiles in a paired manner.

Mobile	Carbon	Apple	Mi	Samsung
Carbon	*	+	+	+
Apple	-	*	-	-
Mi	-	+	*	+
Samsung	-	+	-	*
No of time a brand is preferred	0	3	1	2

‘+’: Column brand is preferred over row brand

‘-’: Row Brand is preferred over column brand

Based on the column totals the ordinal ranking of the 4 brands is as follows:

- 1<sup>st</sup> - Apple
- 2<sup>nd</sup> - Samsung
- 3<sup>rd</sup> - Mi
- 4<sup>th</sup> - Carbon (No one preferred)

This method is useful when the number of brands is limited, as it requires direct comparison and clear choice.

**b) Rank Order Scale:** The rank order Scale is a very popular method of scaling. This method is also called as Force ranking method. This technique is used in business research wherein the respondents are offered different objects simultaneously for ranking from a list of objects presented. This technique of scaling is different from the pattern of rating scales. In this rank order/force ranking rating scale, the respondent is given a set of attributes in terms of verbal statements for a single item and he decides which one or ones, represents the individual being rated most appropriately and accurately. In rank order scaling the respondent needs to rank or arrange the given objects according to his or her preference.

(To understand the concept easily we will continue with the same example of mobile.) **For example**, a mobile manufacturing company conducted a rank order scaling to find out the orderly preference of the consumers. It asked the respondents to rank the following brands in the sequence of their choice:

Mobile Brand	Rank
Carbon	4
Apple	1
Mi	3
Samsung	2

The above scaling shows that Apple brand Mobile is the most preferred brand, followed by Samsung, then Mi and the least preferred one is the Carbon.

**c) Constant Sum Scale:** In this method, the respondent has to allocate a given number of points among the items according to some criterion. The technique involves asking the respondents to assign 10 points to attributes/features of a Product utility. If the attribute is not much important then the respondents would want to enter zero. The attributes are scaled by counting the points assigned to each one by all the respondents and dividing the number of responses. The constant sum scaling method allows the discrimination among stimulus objects without requiring too much time. Normally a hundred- or two-hundred-point scale is used for this.

For Example, the following are the 10 attributes of a newly launched model of a Mobile. Please indicate out of 100 points you will assign to indicate your relative preference of the particular attribute.

	<b>Attributes</b>	<b>points</b>
1	Price	8
2	Speed (RAM)	15
3	Storage Capacity	10
4	Camera (Mega Pixel)	5
5	Battery Backup	12
6	Colour	9
7	Weight	8
8	Warranty	14
9	Service	12
10	Discount	7
	<b>Total Points</b>	<b>100</b>

**d) Q-Sort Scale:** In this, the purpose of sorting is to get an individual's view or attitude towards the object under consideration. The method is widely applied in the study of personality. Q-sort scaling is a technique used for sorting the most appropriate objects out of a large number of given variables. It emphasizes the ranking of the given objects in a descending order to form similar piles based on specific attributes. In Q-sort scaling the respondents are asked to sort the various characteristics or objects that are being categorized into various groups, such that the distribution of the numbers of objects or characteristics in each group follows a normal distribution. It uses a rank order procedure and the objects are sorted into piles based on similarity concerning some criteria. The number of objects to be sorted should be 60 to 140 approximately.

For example, we are taking 10 brands of biscuits. On the basis of taste, we classify the brands into tasty, moderate and non-tasty. We can classify on the basis of price also low, medium, and high. Then we can attain the perception of people whether they prefer a low-priced brand, high or moderate. We can classify sixty brands or piles into three piles. So, the number of objects is to be placed in three piles-low, medium, or high. Thus, the Q-sort technique is an attempt to classify subjects in terms of their similarity to the attribute under study.

## 2) Non-Comparative Scales:

Non-comparative scaling requires respondents to evaluate only a single object. Their evaluation is independent of the other object which the researcher is studying. A non-comparative scale is used to analyze the performance of an individual product or object on different parameters.

When the opinion of the respondent is sought to be obtained without reference to a particular product, it becomes a non-comparative scale.

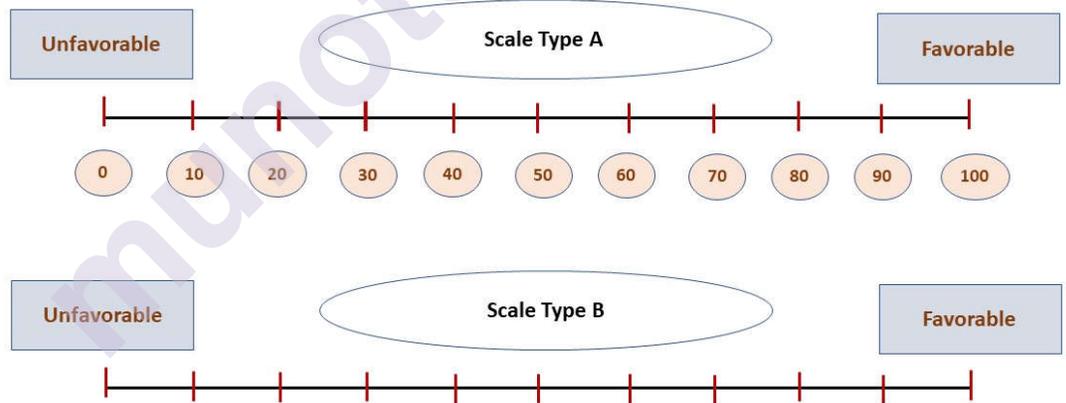
For example, mobile-like Apple companies I phone is reasonably priced or not. While giving the opinion the respondent is free to compare the price of, I phone with that of any other mobile. If there is no guideline about comparative instruction mentioned then the respondent is free to compare the stimulus with any other stimulus that comes to his mind. Following are some of its most common types:

a) Continuous Rating Scales and b) itemized Rating Scale

**a) Continuous Rating Scales:** It is also called a graphic rating scale and it is used to indicate ratings of a particular attribute. It consists of points on a continuum (such as a line) and the respondents rate the objects by placing a mark at the appropriate position on a line. In a graphical rating scale, the respondents are free to place the object in a position of their choice. It is done by selecting and marking a point along the vertical or horizontal line which ranges between two extreme criteria.

For example, a restaurant owner used a continuous rating scale to evaluate the service quality of a restaurant.

**Service Quality of a Restaurant**



**Continuous Rating Scale**

The above diagram shows a non-comparative analysis of the service quality of a restaurant. Thus, making it very clear that the customers are quite satisfied with the quality of service provided in the restaurant.

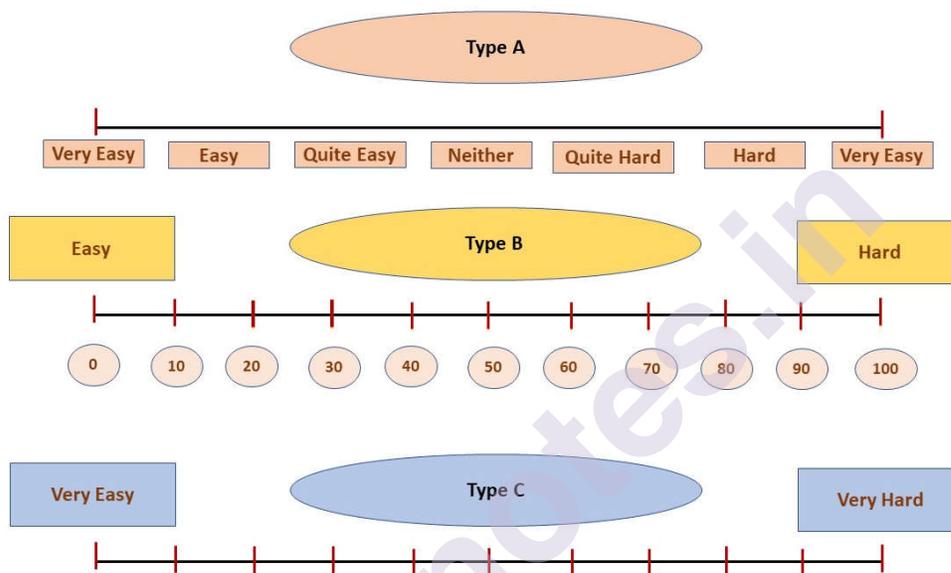
**Advantages of the Continuous Rating Scale** are i) it got developed within less time, ii) This scaling technique allows to conduct a quantitative comparison, iii) This technique is easy to use and not more costly to develop.

**Disadvantages of the Continuous Rating Scale** are i) It doesn't have uniformity as different persons will use the graphic scales in different ways, and ii) difficulties in interpretation of scale item meaning and scale

ranges, iii) Scores received from this scale are difficult to use in all the parameters.

**b) Itemized Rating Scale:** Itemized scale is another essential technique under the non-comparative scales. It emphasizes choosing a particular category among the various given categories by the respondents. Each class is briefly defined by the researchers to facilitate such selection. In this scale, numbers and descriptions, both factors are used. The respondent is provided with a scale having a number and corresponding brief description associated with each category.

**How Easy or difficult do you find to operate new mobile handset?**



Now a days these sales are widely used in research. Variations among the itemised rating scales are – i) Likert Scale, ii) Semantic Scale, iii) Staple Scale.

**i) Likert Scale:** A Likert scale is termed as summated instrument scale. This means that the items making up a liker scale are summoned to produce a total score. Likert Scale was developed by Rensis Likert in 1932. This Scale is most widely used sale in business research particularly in testing models. In the Likert scale, the researcher provides some statements and ask the respondents to mark their level of agreement or disagreement over these statements by selecting any one of the options from the five given alternatives. A Likert scale measures attitudes and behaviours using answer choices that range from one extreme to another.

In this scale the respondents are asked to respond to each of the statement in terms of several degree of agreement or disagreement e.g. 1) Strongly Agree 2) Agree 3) Undecided 4) Disagree 5) Strongly Disagree. These five points constitute the scale; where at one end is strong agreement and at the other end is strong disagreement.

For example, A Mobile manufacturing company adopted the Likert scale technique for its new mobile range named V Pro. The purpose is to know the agreement or disagreement of the respondents.

Attributes	5 Strongly Agree	4 Agree	3 Neither Agree Nor Disagree	2 Disagree	1 Strongly Disagree
Price range of mobile is appropriate					
After Sales Service is Good					
Ad Campaign is effective					
Show room demonstration is proper					
Sales executives are cooperative					

The above illustration will help the company to understand what the customers think about newly launched mobile. Also, whether there is any need for improvement or not.

**Procedure for Likert Scale:**

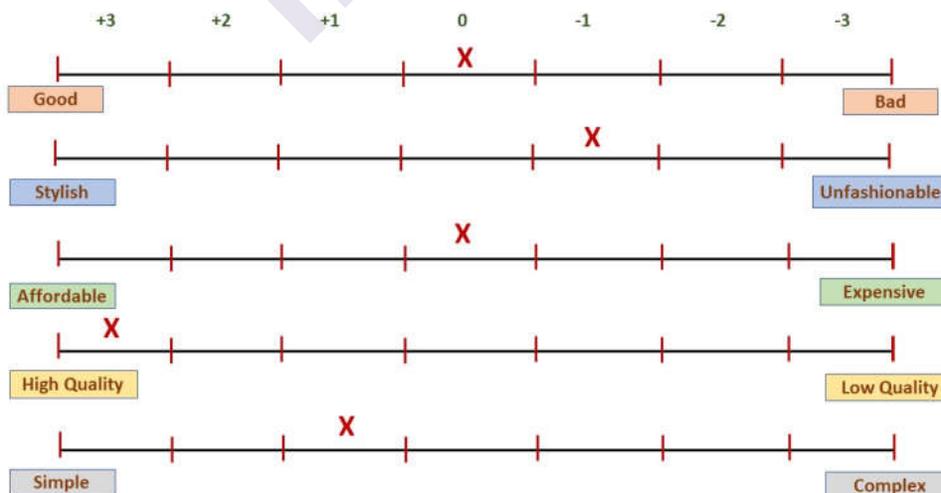
- 1) First step is to collect relevant statements to the attitude being investigated.
- 2) Pre-test for the respondent expressing opinion of each of the item as per the categories of response in conducted.
- 3) Respondents are asked to indicate their responses to statement on the five-point scale as stated above,
- 4) By adding item score total respondent score is obtained.
- 5) By analysing pre-test, items to be included final test are decided.
- 6) The final step is to array these total scores and find out those statements which have a high discriminatory power.

**Advantages of Likert Scale:**

- 1) This Scale method permits the use of items not clearly related to the attitude being studied.
- 2) It is relatively easy to construct Likert-type scale in comparison to other scales.
- 3) These scales are considered more reliable as these scales measure the degree of response.
- 4) The range of responses permitted to a statement in the Likert scale provides more precise information about the individual's responses.
- 5) These sales are highly suitable that are respondent and stimuli oriented.

**ii) Semantic Differential Scale:** The semantic differential scale is an attitude measurement device developed by Charles E. Osgood, G. J. Suci and P.H. Tennenbnum (1975). This is an attempt to measure the psychological meaning of an object to an individual. The semantic differential (SD) scale may be defined as, 'a collection of subscales in which absolute ratings of concept are done'. A bi-polar seven-point non-comparative rating scale is where the respondent can mark on any of the seven points for each given attribute of the object as per personal choice. Respondents describe their feelings about the products or brands on the scales with semantic labels. When bipolar adjectives are used at the end points of the scales, these are termed as semantic differential scales. Thus, depicting the respondent's attitude or perception towards the object. In this scale the term 'concept' refers to the object which is to be rated.

For example, a well-known brand for mobile, carried out semantic differential scaling to understand the customer's attitude towards its product. The pictorial representation of this technique is as follows:



## Semantic Differential Scale

From the above diagram, we can analyze that the customer finds the mobiles of superior quality; however, the brand needs to focus more on the styling of its watches.

### Advantages of Semantic Differential:

- 1) While developing the image profile this scale is simple to construct and it provides a good basis for comparing images of two or more items.
- 2) The scale provides a very convenient and quick way of gathering impressions on one or more than one concept.
- 3) It is Easy and fast to administer.
- 4) Since the scores are summed over the different scales, they tend to average out the peculiarities, if any among the scales as well as provide a basis for finer discrimination among the individuals.

### Limitations of Semantic Differential:

- 1) The appropriateness of pairs of adjectives is questionable and little consensus exists among the experts regarding the suitability of the pairs selected.
- 2) It is not appropriate for children, unless presented in a simplified form.
- 3) Responses given by the subjects are at a superficial and verbal level.

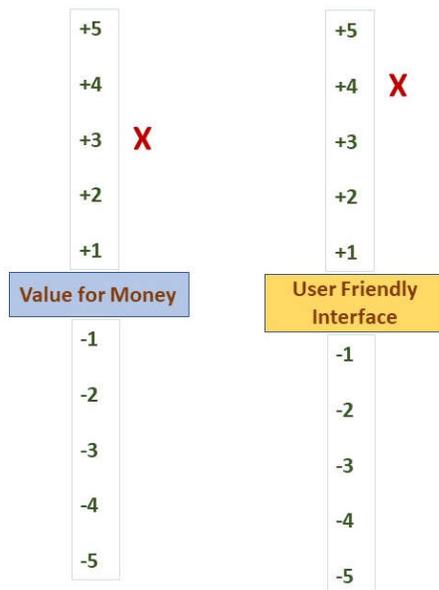
**iii) Stapel Scale:** This Scale was developed by Jan Stapel. This Scale method is a variation of semantic differential scale with unipolar rating scale having generally 10 categories from -5 to 5 without a zero point. A Stapel scale is that itemized rating scale which measures the response, perception or attitude of the respondents for a particular object through a unipolar rating. It is easy to administer. The higher number indicates more accurate description of the object and lower number indicates lower description of the object.

Following are the features of this Stapel Scale:

- 1) For every item there is only one word or phrase indicating the dimension in represents.
- 2) Each Item has ten response categories.
- 3) For every item an even number of categories are allotted.
- 4) There is numerical labels are given not verbal labels.

For example, a tours and travel company asked the respondent to rank their holiday package in terms of value for money and user-friendly interface as follows:

## Stapel Scale



With the help of the above scale, the management or the company owner can take certain policy decisions to improve its package in terms of value for money. However, the decisive point is that the interface is quite user-friendly for the customers so overall we can say that customer are quite satisfied.

### Advantages of Stapel Scale:

- 1) This scale is very easy for developer and respondent as only one descriptive word or phrase at a time must be considered.
- 2) Stapel scale designed to measure both the direction and intensity of attitudes simultaneously.
- 3) It enables the researcher to avoid the task of creating bipolar adjective pairs.
- 4) Scale also permits finer discrimination in measuring attitudes.
- 5) The data obtain stapel scale can be analysed by using procedures similar to the ones for semantic differential scales.
- 6) Overall attitude scores can be computed for the respondents by summing their rating on the individual items.
- 7) In this stapel scale there is no need to develop complete statement.

### Limitations of Stapel Scale:

- 1) Descriptive words may bias respondent if phrased in a positive or negative manner
- 2) A drawback is that descriptor adjectives can be phrased in a positive, neutral or negative vein and the choice of phrasing has been shown to affect the scale results.

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## 5.7 MEASUREMENT ERROR:

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The research study should be free of any measurement errors. Measurement should be precise and unambiguous in an ideal research

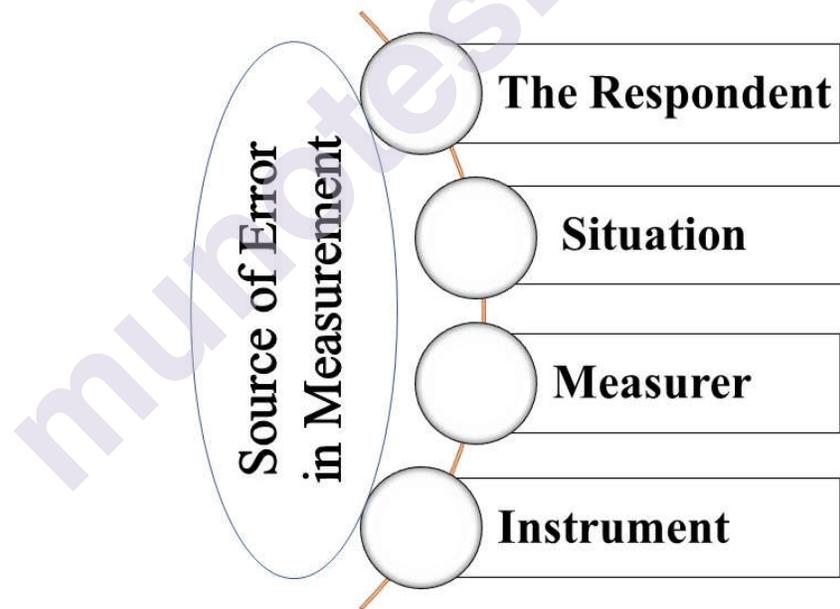
study. Measurement Error (also called Observational Error) is the difference between a measured quantity and its true value.

**Definition:**

- 1) “The measurement error is defined as the difference between the actual value and the measured value. The true value is the average of the infinite number of measurements, and the measured value is the precise value.”
- 2) “Measurement error is the difference between the observed value of a Variable and the true, but unobserved, the value of that Variable.”
- 3) “Measurement error causes the recorded values of Variables to be different from the true ones.”

**Sources of Error in Measurement:**

The researcher should be aware of the causes of measurement errors, however, four major possible sources of error in measurement are as follows:



**1) The Respondent:**

Sometimes the respondent may be reluctant to reveal their strong negative feelings or he may have very little understanding of the situation but he never admits his ignorance. All this reluctance is likely to result in an interview of ‘guesses.’ Transient factors like fatigue, boredom, anxiety, etc. could limit the power of the respondent to report accurately and absolutely.

## **2) Situation:**

Sometimes due to stress and strain, the respondent does not give a proper response which hurts data collection and affects the correct measurement. Situational factors may also come in the way of correct measurement. Any condition which places a strain on the interview can have serious effects on the interviewer-respondent rapport. For example, if the superior is present at the time of the interview, he can distort responses by joining in or merely by being present. If the respondent feels that secrecy about his opinion or views is not assured, he may be reluctant to express the facts about the situation and actual feelings.

## **3) Measurer:**

The interviewer or the person collecting data may arise some errors. The body language of the measurer the voice and the tone may have an impact on the data collection process. The stereotype appearance and actions of the respondent may create bias. Errors may also take place, particularly in the data analysis stage because an incorrect recording of data, incorrect coding, faulty tabulation and statistical calculations leads to errors.

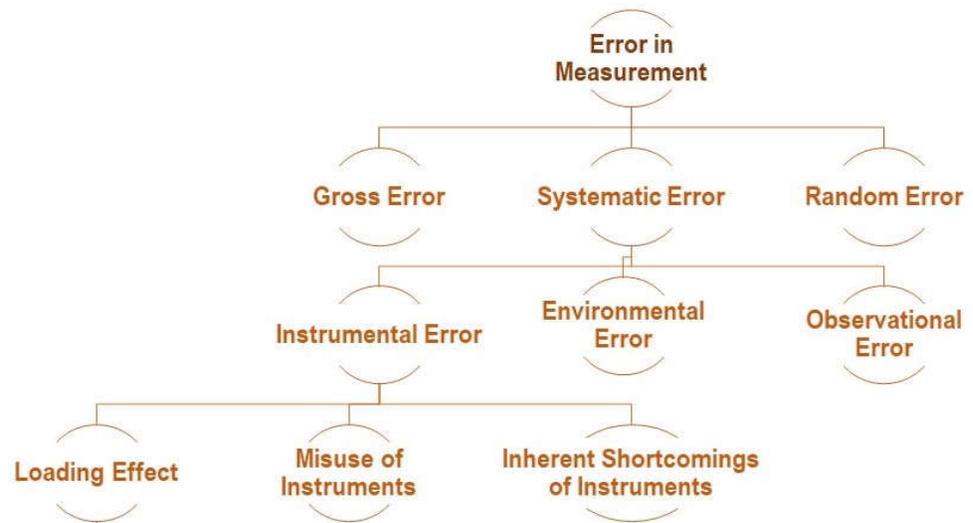
## **4) Instrument:**

Errors may arise because of the imperfect measuring instrument. The use of complex words and jargon used may not be understood by the respondent. Ambiguous meanings, poor priority, inadequate space for replies, response choice deletions, etc. are many effects that make the measuring instrument imperfect and may affect the dimension of expected results.

The researcher must know that the correct dimension depends on successfully meeting all of the problems listed over. He must try to exclude errors or else deal with all the possible errors of measurement so that the final results may not be defiled.

### **Types of Errors in Measurement**

The error that may arise from different sources is usually classified into the following types. These types are 1) Gross Errors, 2) Systematic Errors and 3) Random Errors



These types are explained below in detail.

### A. Gross Errors:

The gross error occurs owing to human mistakes. Such errors occur when a mistake is made while recording data results, using a measurement instrument, or calculating measurement. They are usually caused by abrupt changes in the prevailing physical circumstances, system faults/bugs, or operator errors.

For example, take into account that the experimenter uses the instruments wrongly and takes the incorrect reading, or they will record the incorrect data. Such type of error comes under gross error. For example – The experimenter reads the 40.5°C reading while the actual reading is 50.5°C. This happens because of the oversights. The experimenter takes the wrong reading and because of this, an error occurs in the measurement. The gross error can only be avoided by taking the reading carefully.

Such type of error is incredibly common in measurement. The complete elimination of such type of error is not possible. Some of the gross errors are easily detected by the experimenter but some of them are difficult to find.

The following methods can remove the gross error.

- 1) The reading should be taken very carefully.
- 2) Two or more readings should be taken of the measurement quantity.
- 3) The readings are taken by the different experimenters and at different points for removing the error.

### B. Systematic Errors

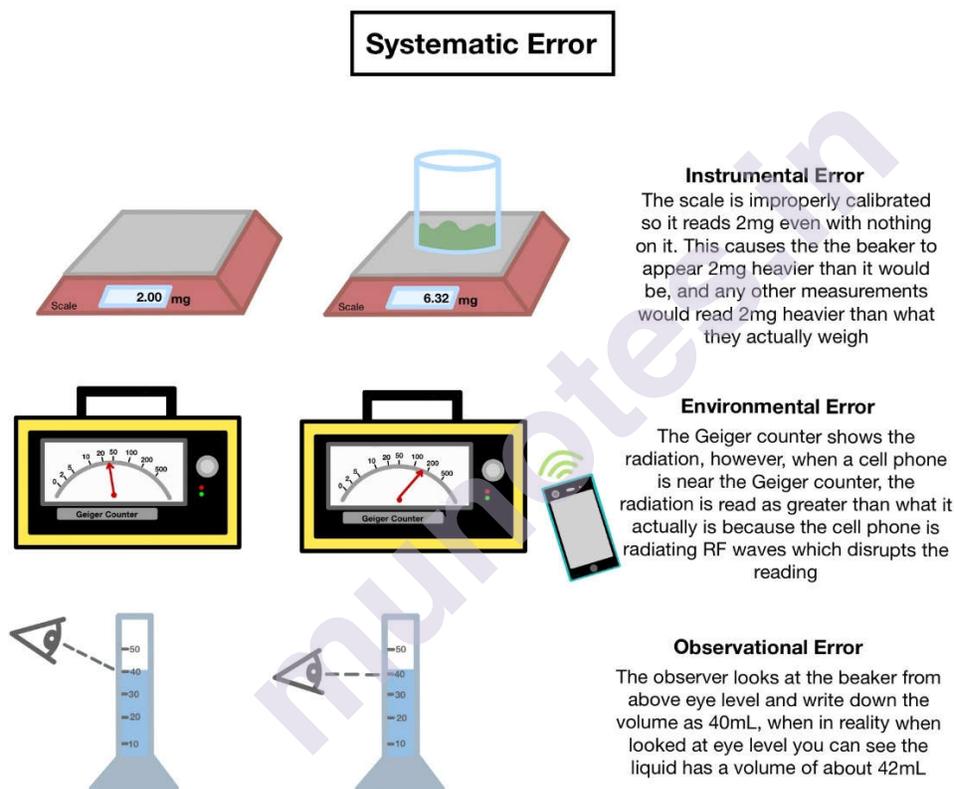
A systematic error means that your measurements of the same thing will vary in predictable ways: every measurement will differ from the true measurement in the same direction, and even by the same amount in some cases.

Systematic error is also referred to as bias because your data is skewed in standardized ways that hide the true values. This may lead to inaccurate conclusions.

Systematic error is caused by many factors that consistently affect the measurement of the variable across the sample. **Systematic errors are errors that have a clear cause and can be eliminated for future experiments.**

The systematic errors are mainly classified into three categories.

- a) Instrumental Errors
- b) Environmental Errors
- c) Observational Errors



**Image Source: - Caroline Monahan**

There are four different types of systematic errors:

### 1) Instrumental Errors:

When the instrument being used doesn't operate properly inflicting error within the experiment (such as a scale that reads 2g quit the particular weight of the thing, causing the measured values to read too high **consistently**). These errors primarily arise because of the three main reasons.

**(a) Inherent Shortcomings of Instruments** – Such varieties of errors in square measure constitutional in instruments owing to their mechanical structure. They will ensure the production, activity, or operation of the device. These errors might cause the error to read too low or too high.

For example – If the instrument uses a weak spring, then it will result in a high value of measuring quantity. The error happens within the instrument because of the friction or physical phenomenon loss.

**(b) Misuse of Instrument** – The error happens within the instrument because of the fault of the operator. A proper or decent instrument used in an unintelligent way may give an enormous result.

For example – the misuse of the instrument might cause the failure to regulate the zero of instruments, poor initial adjustment, and victimization resulting in too high resistance. These improper practices might not cause permanent harm to the instrument; however, all are identical and they cause errors.

**(c) Loading Effect** – It is the foremost common type of error that is caused by the instrument in measurement work. For instance, once the meter is connected to the high resistance circuit it offers a misleading reading, and once it's connected to the low resistance circuit, it offers a dependable reading. This suggests the meter includes a loading impact on the circuit. The error caused by the loading impact will be overcome by using the meters intelligently. For instance, when measuring a low resistance by the ammeter-voltmeter technique, a meter having a high value of resistance ought to be used.

## 2) Environmental Errors:

Environmental errors will happen because of the outside situation of the measurement instruments. Such kinds of errors primarily occur because of the effect of temperature, pressure, humidity, dust, vibration, or as a result of the magnetic or electric field. When the surrounding environment (such as a lab) causes errors within the experiment. The corrective measures utilized to eliminate or scale back these undesirable effects are:

- a) The arrangement ought to be created to stay the conditions as constant as attainable.
- b) Using the instrumentation that is free from these effects.
- c) By using the techniques which eliminate the result of those disturbances.
- d) By applying the computed corrections.

## 3) Observational Errors:

The observational errors square measure because of wrong observation of the reading or the fault study of the instrument reading, and therefore the sources of those errors square measure several. For example, the indicator of a meter retunes a touch over the surface of the scale. As a result, a fault happens except the line of the image of the witness is accurately on top of the indicator. To reduce the parallax error extremely precise meters are offered with reflected scales. When the scientist inaccurately reads a measuring wrong (such as when not standing straight-on when reading the quantity of a flask inflicting the quantity to be incorrectly measured)

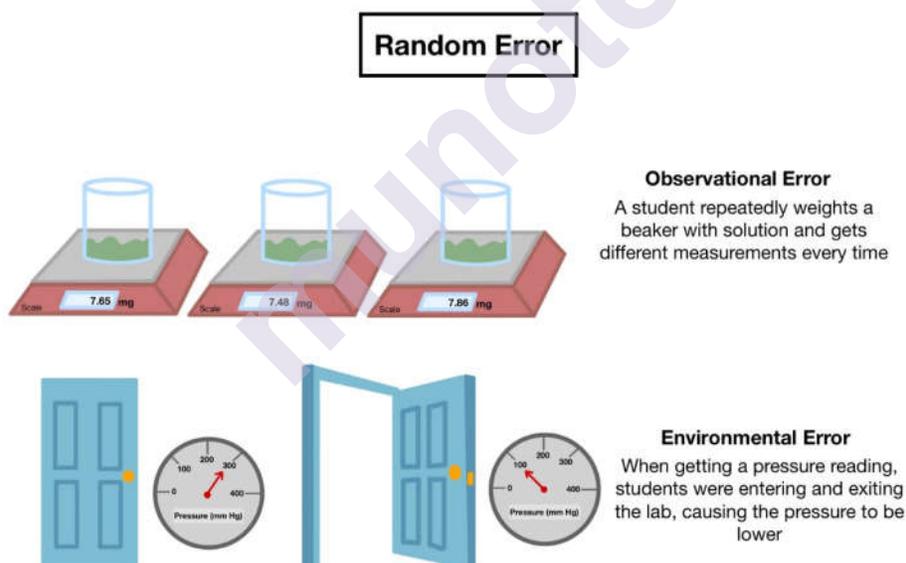
### C. Random Errors:

Random errors are the result of unpredictable changes. They are not like systematic errors; random errors can cause varied results. One moment a reading can be too high and the next moment the reading is simply too low. You'll be able to account for random errors by repeating your measurements. Taking repeated measurements permits you to use statistics to calculate the random error.

An error that is caused by unexpected changes within the climatic condition, such type of error is termed a random error. A random measurement error stems from fluctuation within the conditions among a system being measured that has nothing to do with the true signal being measured. These types of errors remain even after the removal of the systematic error. Hence such type of error is also known as residual error.

An example of random error is putting the same weight on an electronic scale many times and getting readings that change in an exceedingly random fashion from one reading to the next. The variations between these readings and also the actual weight correspond to the random error of the scale measurements. Random error (also known as unsystematic error, system noise, or random variation) has no pattern.

**There are two types of random errors**



**Image Source: - Caroline Monahan**

**1) Observational random error:** Random observational errors don't seem to be predictable. They fluctuate between being too high or too low. An example would be an instrument's reading unsteady/fluctuating. If you were to take the mid-point of the fluctuations, you'll be too high on one measurement but too low on the next. When the observer makes consistent observational mistakes (such as not reading the scale correctly and writing down values that are constantly too low or too high).

**2) Environmental random error:** Environmental errors are caused by the laboratory environment. An example can be a malfunctioning instrument. In my freshman chemistry lab, I had a pH meter that may not stay calibrated. After five minutes, the pH values would fluctuate erratically when unpredictable changes occur in the environment of the experiment (such as students repeatedly opening and closing the door when the pressure is being measured, causing fluctuations in the reading).

**Some common sources of random error include:**

- natural variations in real-world or experimental contexts.
- imprecise or unreliable measurement instruments.
- individual variations between participants or units.
- poorly controlled experimental procedures.

**Reducing random error**

Random error is almost always present in research, even in extremely controlled settings, whereas, you can't eradicate it, you will be able to reduce random error using the following subsequent strategies.

- a) Take repeated/continual measurements:** A simple way to increase precision is by taking repeated/continual measurements and using their average. For example, you might measure the wrist circumference of a participant three times and obtain slightly different lengths every time. Taking the mean of the three measurements, instead of using just one, brings you much closer to the true value.
- b) Increase sample size:** Large samples have less random error than small samples. That's as a result of the errors in different directions cancelling each other out more efficiently when you have more data points. Collecting data from a large sample increases precision and statistical power.
- c) Control variables:** In controlled experiments, you should carefully control any extraneous variables that could impact your measurements. This ought to be controlled for all participants so that you take away key sources of random error across the board.

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## **5.8 CRITERIA FOR GOOD MEASUREMENT:**

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In standard research, any score received by a measuring instrument is the total of both the 'true score', which is unknown, and the 'error' in the measurement process. If the error margins are low and reporting of results of the research are of high standards, no doubt the research will be fruitful. As per the opinion of Kimberlin & Winterstein, 2008 'If the measurement is very accurate then a researcher will find a true score'. The basis of good research is the trustworthiness (reliability and validity) of the data/information to make decisions; otherwise, a good decision cannot be made. Thatcher, 2010; Twycross & Shields, 2004 emphasized that in quantitative research a measurement can be reliable, but invalid; however, if a measurement is unreliable, then it cannot be valid.

Measurement criteria may be a system of metrics that defines what program and project success are and the way they should be measured significantly, the measurement criteria must be aligned with the program objectives and therefore the stakeholders' desires and expectations. The adequacy of scale is judged in an exceedingly manner on having a measuring of acceptable quality, the overall usefulness of the scale depends upon its validity, reliability, and sensitivity.

**These are mentioned below:**

**1) Validity:** A scale is said to be valid if it measures correctly what it is expected to measure. As we know attitudes are multifaceted, therefore single item scales are usually deficient in this criterion. In other words, an attitude scale is valid only when it is real -and correct: There are several differences.

**Types of validity as discussed below.**

**a) Content Validity:** This is also known as face validity. Here the contents of an attitude scale should cover all relevant facets of an issue that influence the respondent's attitude. Suppose we have a -scale to measure the job satisfaction of employees in, an organization. The scale, -covers various dimensions like nature of work, pay, security and superior. The scale, however, lacks content validity as it does not cover an important dimension like company policies and practices. This could happen because what dimensions to be included in a scale would depend on the judgment of the researcher which is likely to vary from individual to individual. Therefore, to avoid this, it would be better to approach a group of knowledgeable persons rather than leaving it to one person.

**b) Construct Validity:** It is known that it is not possible to measure attitude directly. It is inferred indirectly from the responses given by the respondents. Construct validity involves understanding the theoretical rationale underlying the obtained measurements. The content validity of an attitude can be assessed quantitatively by finding its correlation with measures of other constructs that one would expect to be strongly associated with the attitude and measures of constructs that would not be correlated to the attitude. A strong correlation of attitude with the construct is an example of convergent validity whereas a low correlation of attitude with the construct is an example of discriminating validity. A scale with construct validity should have both convergent and discriminating validity.

**c) Predictive Validity:** It involves the ability of a measured market phenomenon at one point in time to predict successfully another market phenomenon at another point in time. If the correlation between the two is high, the initial measure is said to have a high predictive, validity. An opinion questionnaire that forms the basis for correctly forecasting, the demand for a product has high predictive validity.

**2) Reliability:** A scale is said to be reliable. When it gives the same measurement under similar conditions. If a scale makes an equal error

every time, it would be reliable. However, such a scale cannot be valid as we know that the validity depends upon correct measurement. Reliability is achieved when the scale is free from erratic measurements. The following two methods are used for testing reliability. **Test-Retest Reliability:** It is concerned with how stable the ratings are when the scale is administered to the same group of persons at two different points of time. If there is a high correlation between two sets of scores (consistency), the test-retest reliability is very high. One should be cautious while using this method to test reliability. If the time difference between two sets of observations is long, the attitude may likely change. Further, if the time difference is too small, the respondents are likely to remember their earlier responses and therefore memory effect may distort the reliability test. There are no guidelines for determining what should be the ideal time interval between two observations to take care of these problems. A rule of thumb is to use the time interval between two to four weeks. **Split-Half Reliability:** It can be assessed only for multiple-item scales. Here the scale items are split randomly into two equal parts. At times splitting may be done by putting an even number of items on one side and an odd number on the other side. The correlation coefficient between respondents' total scores derived from two sets of items is computed. A high degree of correlation indicates a high split-half reliability of the scale.

**3) Sensitivity:** The sensitivity of a scale is closely related to its reliability. A scale can be able to discriminate between respondents who differ even slightly in terms of their attitude toward something. An essential of a rating scale is that it should have a sufficient range of numbers to help detection of fine variations in attitude.

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## 5.9 EXERCISE

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### Long Answer Questions:

- 1) Define 'measurement' in research. What are the different levels of measurement?
- 2) What are the various comparative scaling techniques?
- 3) What are the various non comparative scaling techniques?
- 4) What are the various sources of measurement of errors?
- 5) Explain the different sources of error in measurement.
- 6) Explain the criteria for good measurement.



# QUESTIONNAIRE DESIGN

## Unit Structure

6.0 Objectives

6.1 Questionnaire method

6.2 Types of Questionnaires

6.3 Process of Questionnaire Designing

6.4 Advantages and Disadvantages of Questionnaire Method

6.5 Sample Questionnaire

6.6 Self-Assessment Questions

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## 6.0 OBJECTIVES

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1. To understand the different methods to design the questionnaire.
2. To understand the step-by-step procedure used to construct the questionnaire.
3. To learn the usage of various types of questions during questionnaire design.
4. To study the benefits and drawbacks of different types of questionnaires.
5. To identify the content of the questions asked during questionnaire development in order to avoid bias and to get accurate responses.

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## 6.1 QUESTIONNAIRE METHOD

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In research studies, one of the most popular methods of data collection is through questionnaires. This method is used for conducting academic research, business research as well as research by the government. The questionnaire's purpose is to gather valuable information about the study by asking questions based on the hypothesis. This method is especially useful in instances when conducting interviews with a large group of people is impossible.

It consists of a set of questions which are arranged systematically and these questions are asked to respondents to obtain useful information related to the study. In this method, data can be gathered in a number of ways, including online, over the phone, on paper, or in person. If the data gathered from the questionnaire is accurate and unbiased, then it will help to draw an inference about the respondents. The questions in

the questionnaire should be simple to grasp because if the respondent does not understand the question, he may offer an incorrect response that will affect the data analysis.

The questionnaire approach is simple to use, and the results can be statistically analyzed. An adequate number of questions should be covered in the questionnaire. With this method, different categories of information can be gathered from a specific group of people. Before we conduct the main survey, it is advised to conduct a pilot study. This pilot study is very similar to the actual survey; it is done to understand the strengths and weaknesses of a questionnaire. Errors might occur during the questionnaire design, so it is important to conduct a pilot study for a small group of people so that modifications can be made to the questionnaire before it is floated to a large group of people. The pilot study aids in the detection and elimination of errors in the questionnaire.

### **Benefits of Questionnaire Method**

1. The main benefit of the questionnaire method is that it is cost-effective.
2. Different varieties of questions can be asked in the questionnaire method.
3. Questions can also be written in the local language.
4. Data can be gathered by sharing the questionnaire with local as well as global audiences.
5. When the questionnaire is made through an online platform, it reduces the time of data coding.
6. Questionnaires can be used to collect numeric (quantitative) or non-numeric (qualitative) data.
7. Since the researcher is not required to be present while the surveys are completed, data can be gathered swiftly.

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## **6.2 TYPES OF QUESTIONNAIRES**

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The following are the various types of questionnaires:

### **1. Online Questionnaire**

In an online questionnaire, questions can be prepared using an online portal and sent over an internet channel. The advantage of an online questionnaire is that it is not restricted by location. It may be delivered to responders from all over the world. Another benefit of an online questionnaire is that the respondent may respond to the questions at his or her convenience. When a questionnaire is delivered over an online channel, such as email, the return rate is low. This might occur if the respondent chooses to ignore the mail. In such cases, the researcher may decide to send respondents follow-up emails. To complete the online questionnaire, the responder must have an internet connection and be

educated and skilled in using the internet platform. It is a cost-effective method of getting responses to the questions. Through an online questionnaire, data can be gathered in real-time.

## **2. Telephone Questionnaire**

In a telephonic questionnaire, the researcher connects with a potential responder via telephone to get responses to the questions. When the study's sample size is small, a telephone questionnaire is the ideal option. The respondent might not feel comfortable responding to a large number of questions via telephone. Hence, this method is suitable when the number of questions is less. When compared to online questionnaires, telephone questionnaires have a higher response rate. The disadvantage of telephone questionnaires is that they are more expensive and time consuming than other approaches.

## **3. Paper Questionnaire**

The paper-based questionnaire is the most traditional technique, in which the questions are presented to potential responders on paper. Instead of having connection to the internet, this method needs the respondent to have access to a pen or pencil. Paper questionnaire are more expensive than other forms of questionnaire. The biggest downside using paper questionnaires is the danger of data loss, which might have a significant influence on the study. This method of Data collection is more suitable where the sample size is small.

## **4. Mail Questionnaire**

This approach was widely used in the early years since it was the simplest form of data collection. The researcher sends the questionnaire to the potential responder by mail, enclosed in an envelope. Since the questionnaire is in paper format, the respondent must be qualified to read and answer the questions. After completing the questionnaire, the respondent must mail it to the researcher. The respondent does not require access to technology for this method. This approach has the benefit of covering a vast geographic region, allowing respondents to reply at their convenience, and putting less pressure on respondents than a telephone questionnaire. The downside to this approach is that the responder is unable to clarify his queries, and the response rate is low.

### **Type of Questions**

#### **a) Open ended questions**

An open ended question allows the respondent to reply to the question in detail rather than just one word. The questions may begin with who, what, why, when, and so on in order to provoke a long conversation. This type of question allows the respondent to respond in whatever way they like. Open-ended questions provide more information, new insights, and the opportunity to probe. Example:

- a) What is the purpose of education?
- b) Why are you purchasing this product?
- c) What are your thoughts on your workplace's culture?

**b) Close ended questions**

Closed-ended questions require the respondent to choose between two or more alternatives. In this type of question, the respondent can make a quick decision since his options are limited. The main advantage of Close-ended questions over open-ended questions is that the responses can be easily coded. If the options provided for the question are insufficient, the researcher may include an open-ended question at the bottom of the questionnaire so that the respondent can provide extra information not covered by the alternatives. Examples:

- a) Do you enjoy drinking coffee?
  - I. Yes
  - II. No
  
- b) How old are you?
  - I. 18-25
  - II. 26-35
  - III. 36-45
  - IV. Above 45
  
- c) Which smart phone do you use?
  - I. Oppo
  - II. One Plus
  - III. Xiaomi
  - IV. Samsung
  - V. Other (please elaborate): \_\_\_\_\_

**c) Dichotomous Questions.**

A dichotomous question is a question that has just two possible responses, for example, male or female. When compared to other types of questions, dichotomous questions take less time to respond to. Another benefit of this type of question is that it is simple to code, analyse, and interpret. A dichotomous question allows respondents to make a quick, simple, and direct response. Example:

- a) Do you own a vehicle?
  - I. Yes
  - II. No
  
- b) Instagram is a social networking platform.
  - I. Agree
  - II. Disagree
  
- c) New Delhi is the capital of India.
  - I. True
  - II. False

## d) Likert Questions

In Likert scale questions, the respondent's attitude or opinion is usually measured using a five-to-seven-point scale. A question using a Likert scale determines if the respondent agrees or disagrees with the statement. While designing the Likert scale questions, symmetry is maintained by having an equal number of positive and negative questions. The middle option on the Likert scale is "neutral" or "neither agree nor disagree", and the responder picks this option when he is indecisive. Example:

### 5-point Likert Scale

a) I would recommend this product to others.

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

b) I enjoy my current job.

- (1) Strongly disagree
- (2) Disagree
- (3) Neither agree nor disagree
- (4) Agree
- (5) Strongly agree

### 7-point Likert Scale

a) I believe that putting in more effort at work will help me advance in my profession.

- (1) Strongly disagree
- (2) Disagree
- (3) Somewhat disagree
- (4) Neutral
- (5) Somewhat agree
- (6) Agree
- (7) Strongly agree

b) When a new task at work is assigned to me, I like to do it first.

- (1) Strongly disagree
- (2) Disagree

- (3) Somewhat disagree
- (4) Neither agree nor disagree
- (5) Somewhat agree
- (6) Agree
- (7) Strongly agree

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## **6.3 PROCESS OF QUESTIONNAIRE DESIGNING**

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The process of designing the questionnaire is the most crucial stage of the study. The questionnaire forms the centre of the study, and if there is an error in the questionnaire, it will have an impact on the analysis part and the conclusion part. Hence, the questions must be designed carefully and bias needs to be avoided. The respondent should be able to understand each and every question. Every question in the questionnaire should be simple for the respondent to read and comprehend. It is important to ensure that the number of questions asked is not more than what is required throughout the questionnaire design process. In addition, the questions should be able to extract precise responses.

### **Guidelines for developing an effective questionnaire**

#### **1. Length of the questions**

The length of the question is desired to be short and precise rather than long. If the question is excessively lengthy, the respondent may skip part of the question and provide an incorrect answer. In order to prevent this scenario, Oppenheim (1986) recommended that researchers stick to a rule of thumb of keeping questions under 20 words or one-line long.

#### **2. Sequence of the questions**

While sequencing the questions, in the beginning, the questions should be asked to establish a good rapport with the respondent. The initial questions should be general so that the respondent does not have to think too hard to answer them. The general questions are followed by specific questions designed to extract detailed information from the respondent and demand the respondent's thoughts, opinions, and judgements on a certain subject. The questionnaire should start with easy-to-answer questions and then go on to more challenging questions about sensitive topics. It is advised to avoid asking positive and negative questions about the same theme one after the other.

#### **3. Layout of the Questionnaire**

The following information should be provided in the questionnaire's introduction:

- The Title of the research.
- Introduction of the individual who is collecting the information.

- A concise summary and the purpose of the study.
- Guidelines for responding to the questions.

The questionnaire should be designed in such a way that answering the questions is made as simple as possible. It is vital to establish a rapport with the respondent in order to encourage them to answer the questions. The respondent must be assured that their response and identity will be treated confidentially. Each section of the questionnaire should have instructions so that the respondent can easily answer the questions.

#### **4. Wordings of the questions**

The wording selected when designing the questions will have an impact on the response. As a result, it is critical to carefully design each question because a minor modification in phrasing may result in a different response from the respondent. The question's wording should be chosen in such a manner that it expresses the same meaning to all respondents and is interpreted in the same way by all respondents. The question should not include more than one concept since the respondent may find it difficult to comprehend. It is recommended that the language be kept simple so that questions may be easily understood and accurate responses can be acquired.

#### **Designing the questionnaire using Google Forms**

There are several online tools for designing and developing questions. Google Forms is one such well-known tool with several features. A researcher can make each and every question mandatory to answer, and the sequence of questions for each respondent can also be changed. This will assist in avoiding bias while the respondent fills out the questionnaire. A Google form also allows researchers to make a questionnaire in sections, and it also has a feature to include images, upload documents, or capture the email address of the respondent. If the respondent does not answer a particular question in the questionnaire, it will create a blank space during data coding. In such a situation, this blank space can be given a neutral value during coding. In order to avoid the situation, all the questions can be made mandatory in the Google form, but care has to be taken to ensure that each and every question is easy to understand for the respondent. Designing the questionnaire and data collection through Google Forms is both cost-effective and time-saving.

#### **Preliminary testing of the Questionnaire**

The questionnaire survey is developed tentatively at first, and then, after a preliminary test, further modifications are made. The population selected for conducting the preliminary test or pilot study is the same one that will be used for the final study. A preliminary test is carried out to identify any flaws with the questionnaire so that

improvements may be made before carrying out the survey for the entire targeted population. This test assists researchers in identifying questions that respondents might either misinterpret or are unable to comprehend.

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## 6.4 ADVANTAGES AND DISADVANTAGES OF QUESTIONNAIRE METHOD

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### Advantages

1. The questionnaire method enables researchers to gather a large amount of data with ease.
2. In this method, the researcher doesn't have to be present during surgery. The researcher may choose to send the questionnaire to the respondents via mail or social media platform and the respondent fills it out without monitoring. It eliminates the need for investigators to be trained.
3. Data can be gathered in an online format effortlessly.
4. This method is not limited to a specific region. Researchers may choose to send the questionnaire across the globe to a targeted group of people through online mode.
5. One of the major advantages of this method is that it is cost-effective.
6. Different varieties of questions can be asked in this method.
7. Questions can also be written in the local language.
8. If the questionnaire is created through an online platform, it reduces the time of coding the data.
9. The responder has adequate time to complete the questionnaire.
10. This method allows the researcher to ask the respondent personal questions, which is difficult to do during a face-to-face interview.

### Disadvantages

1. The respondent may not be truthful while answering the questions.
2. If the question is not designed properly, the respondent may find it difficult to interpret it.
3. If the number of questions is excessively high or the questions are unrelated to the study, the respondent may experience survey fatigue.
4. If the respondent doesn't read the complete question, he may give an inaccurate answer.
5. The response bias is difficult to detect.

6. The responder must be educated in order to complete the questionnaire.
7. The questions in this method are structured, and asking the same set of questions to various respondents may not match their profiles.
8. In comparison to the interview method, a questionnaire cannot completely capture a respondent's emotional responses.
9. It is impossible to tell whether the respondent really comprehended the question using this method.
10. This method gives respondents the option to modify their earlier answer if it conflicts with the subsequent responses.

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## 6.5 SAMPLE QUESTIONNAIRE

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### Questionnaire 1

This questionnaire is based on Facebook usage.

1. Your Name :
2. Your Age :
3. Gender :
  - Male
  - Female
  - Other
4. Education Qualification :
  - 10th
  - 12th
  - Graduation
  - Post-Graduation
  - Ph.D.
5. Occupation
  - I am working.
  - I have my own Business.
  - I am Student.
  - Others
6. Do you use Facebook?
  - Yes
  - No

7. What is your purpose for using Facebook?
  - To learn about other people's lives.
  - For entertainment.
  - To request help regarding personal or professional issues.
  - Searching for information.
  - Any other reason (Please elaborate) : \_\_\_\_\_
  
8. Apart from Facebook, what other social networking sites have you joined?
  - Instagram
  - Twitter
  - LinkedIn
  - Reddit
  
9. Why did you decide to join Facebook?
  - My friends requested me to join Facebook.
  - Due to advertisements.
  - To stay in touch with friends.
  - Any other reason (Please elaborate) : \_\_\_\_\_
  
10. How long have you been on Facebook?
  - <1 Year
  - 1-2 Years
  - 2-3 Years
  - >3 Years
  
11. How frequently do you use Facebook?
  - Daily
  - Weekly
  - Monthly
  - Quarterly

12. What is it about Facebook that you enjoy?

(Please note: 1- Minimum value and 5- Maximum value)

Features of Facebook	1	2	3	4	5
News Feed					
Sending someone a friend request.					
The wall where users' content is displayed.					
Sending messages to friends.					
Using groups for discussion.					
Availability of Likes and Reactions feature.					
Timeline feature which displays content according to year, month and date.					

13. Do you feel comfortable updating your profile or uploading a photo?

- Yes
- No
- Maybe

14. How likely are you to tell your friends about Facebook?

- Extremely likely
- Likely
- Neutral
- Unlikely
- Extremely unlikely

15. How frequently do you update your Facebook profile with new content?

- Once in a Day
- Once in a Week
- Once in a Month
- Once in a Year
- Never

16. Please rate your overall Facebook experience.

- Very Satisfied
- Satisfied
- Neutral
- Dissatisfied
- Very dissatisfied

### Questionnaire 2

This questionnaire is related to Mobile Service Provider.

1. Name: \_\_\_\_\_

2. Email ID: \_\_\_\_\_

3. Location: \_\_\_\_\_

4. Age: \_\_\_\_\_

5. Gender:

- Male
- Female
- Others

6. Occupation

- Student
- Working
- Looking for Job
- Own Business
- Home maker
- Others : \_\_\_\_\_

7. Monthly Salary

- Not applicable
- Less than 10,000/-
- 10,000-20,000/-
- 20,000-30,000/-
- More than 30,000/-

8. How long have you been using a mobile phone?

- Less than a year
- 2 Years
- 2-3 Years
- 3-4 Years
- More than 4 Years

9. Which mobile service provider do you use?

- Reliance Jio
- Airtel
- Idea
- BSNL
- Other (please specify): \_\_\_\_\_

10. How long have you been using the mobile service provider mentioned above?

- Less than a year
- 2 Years
- 2-3 Years
- 3-4 Years
- More than 4 Years

11. Please specify what type of connection you are using.

- Pre-paid
- Post-paid
- Other (please specify): \_\_\_\_\_

12. Rate the following services provided by your mobile service provider.

(Please note: 1- Minimum value and 5- Maximum value)

Services	1	2	3	4	5
Calling					
Internet					
SMS					
International Call					
Subscriptions to Apps					
Caller tune					

13. What aspects do you consider while choosing a mobile service provider?

- Data plans
- 4G availability
- Good Service
- Network availability
- The Quality of Audio and Video Calls
- Other (please specify): \_\_\_\_\_

14. Have you ported your number to the current mobile service provider?

- Yes
- No

15. How satisfied are you with your current mobile service provider?

- Very Satisfied
- Satisfied
- Neutral
- Dissatisfied
- Very dissatisfied

16. Would you recommend switching to your mobile service provider to a friend, family member, or co-worker?

- Very unlikely
- Somewhat unlikely
- Neither likely nor unlikely
- Somewhat likely
- Very likely

17. Please specify your mobile network.

- 2G
- 3G
- 4G
- Others

18. What do u like the most about your mobile service provider?

- Internet Speed
- Audio call quality
- Affordable price
- Network availability in your area
- Excellent service

### **Questionnaire 3**

This questionnaire is based on consumer behaviour towards online shopping. The questions are asked to capture the following variables:

Attitude, Perceived Usefulness, Perceived ease of use, and Buying Intention.

Question nos. 1 to 8 are demographic questions which are asked to understand the background of the respondents. Question nos. 9 to 24 are asked to capture the four variables of the study.

1. Name:
2. Email Id:
3. Contact Number:
4. Your age:
  - Under 19
  - 19-25
  - 26-35
  - 36-50
  - 50+
5. Your marital status :
  - Single
  - Married
  - Divorced
  - Others
6. Gender:
  - Male
  - Female
  - Other
7. What is your highest level of education?
  - Prefer not to say
  - Bachelor's Degree
  - Master's Degree
  - Ph.D.
8. Please specify your location
  - Mumbai
  - Bangalore
  - Delhi
  - Pune
  
  - Any other location (Please specify) : \_\_\_\_\_

Attitude

9. I think online shopping is more effective than offline shopping.
  - Strongly Agree
  - Agree
  - Neutral
  - Disagree
  - Strongly Disagree

10. I prefer online shopping for purchasing household products.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

11. I feel online shopping saves time.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

12. Online buying is quite beneficial.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

Perceived Usefulness

13. I believe online shopping doesn't require a lot of mental effort.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

14. Online shopping is more useful as it saves time and money.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

15. I believe online shopping provides more information about the product.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

16. Shopping online increases my ability to purchase the product I want.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

17. I think shopping online makes it easier for me to purchase products.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

18. My search is more effective when I shop online.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

19. I feel shopping products online is easy for me.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

20. I feel I have no problem using internet for shopping.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

#### Buying Intention

21. I would purchase products online.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

22. I intend to use the internet to make a purchase decision towards a product.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

23. I am willing to purchase a product through the internet rather than the offline mode.
- Strongly Agree
  - Agree
  - Neutral
  - Disagree
  - Strongly Disagree
24. In the near future, I plan to purchase the product online.
- Strongly Agree
  - Agree
  - Neutral
  - Disagree
  - Strongly Disagree
  -

---

## **6.6 SELF ASSESSMENT QUESTIONS**

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1. What is a questionnaire?
2. What are the steps involved in designing the questionnaire?
3. Which rules must be followed while constructing the questionnaire?
4. How would you create a questionnaire to measure consumer satisfaction towards banking services?
5. What are advantages and disadvantages of questionnaires method?
6. Write a short note on types of questions.
7. Distinguish between open ended questions and close ended questions.
8. What is preliminary testing of the Questionnaire?
9. Distinguish between 5 point and 7 point Likert scale with example.
10. Write a short note on benefits of Questionnaire method.



## SAMPLING AND DATA PROCESSING

### Unit Structure

- 7.0 Objectives
- 7.1 Introduction
- 7.2 Sampling Concepts
- 7.3 Sampling Design
- 7.4 Sample Size
- 7.5 Sampling Methods
- 7.6 Editing and Coding of Data
- 7.7 Classification and Tabulation of Data
- 7.8 Summary
- 7.9 Self Assessment Questions

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### 7.0 OBJECTIVES

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After analyzing this module, you should be able to:

- Understand the meaning and nature of sampling concepts
- How to design a sample for the research
- Importance of correct sample size
- Understand the significance of sampling methods
- Selection of right sampling method
- Knowledge about editing and coding of data
- Knowledge about classification and tabulation of data

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### 7.1 INTRODUCTION

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In most of the research projects, the responses by the respondents determine the accuracy and relevance of research. Sample helps to collect the vital information. Today's world is highly dynamic. Any study is expected to be completed in a short time to maintain the relevance of situations and characteristics before it gets changed. The technique through which a sample is selected is crucial. Sampling helps to collect relevant information more quickly.

Selection of participants is an important process. The way we select participants will determine the population. It will determine the population to which we may generalize the findings of the research. If the job is done poorly at the sampling stage of the process of research, the integrity and the relevance of the whole research is at risk.

A sample is a small version of a larger group. The size of the sample plays an important role in research. Sample is a group of people taken from a large group for the measurement of the findings of the research. The following factors are important while determining the size of the sample -

1. Nature of the universe
2. Nature of the study
3. Availability of time
4. Financial availability and options
5. Standard of accuracy and reliability
6. Size of the questionnaire
7. Method of sampling
8. Types of sampling

A sample will not be considered representative due to wrong stratification, small size, non-random, wrong selection of the population, purposive selection etc.

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## 7.2 SAMPLING CONCEPTS

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It is not possible to survey the population. Cost and time are some important elements. With the help of sampling, the objective of covering people in research can be achieved. Sampling is the process of selecting units from a population of the universe. In the first place, the major question that motivates sampling is generalization. For better understanding, let's have a look into the various important concepts of sampling -

### 01. Sampling

Sampling is a technique through which the predetermined number of observations are taken from a large population for the purpose of research. This technique is used in statistical analysis. It is an act of selecting a representative from the population for determining the features of the whole population.

### 02. Population or Universe

The population or universe represents the entire aggregation of items from which samples can be selected for the research. It represents the entire group which is the focus of the study.

**03. Sampling size**

A sampling size consists of the various units taken for the research in numbers from the whole population to conduct research. It is usually represented by “n”.

**04. Sample Design**

Sample design represents a definite plan for obtaining a sample from a given population. A sample design can be described by sampling methods and estimators.

**05. Sampling Methods**

Sampling methods refers to the procedures by which some elements of the population are included in the sample for conducting research.

**06. Estimator**

For calculating sample statistics, the estimation process is used. This process is called the estimator. Different estimators are used for different sampling.

**07. Sampling Frame**

It is the list of items from which the sample may be drawn.

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**7.3 SAMPLING DESIGN**


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Sample design represents a definite plan for obtaining a sample from a given population. A sample design can be described by sampling methods and estimators. Sampling methods refers to the procedures by which some elements of the population are included in the sample for conducting research. For calculating sample statistics, the estimation process is used. This process is called the estimator. Different estimators are used for different sampling.

It is a definite plan for obtaining a sample from a given population. The design gives meaning and direction to the research. The best design depends on the objectives and the resources available for the research. Many factors guide the choice of sample design. To get a desired level of accuracy and precision in research, a researcher might select the most appropriate design for selecting a sample.

**7.3.1 Features of Good Sample Design**

The following can be considered as the features of good sampling design -

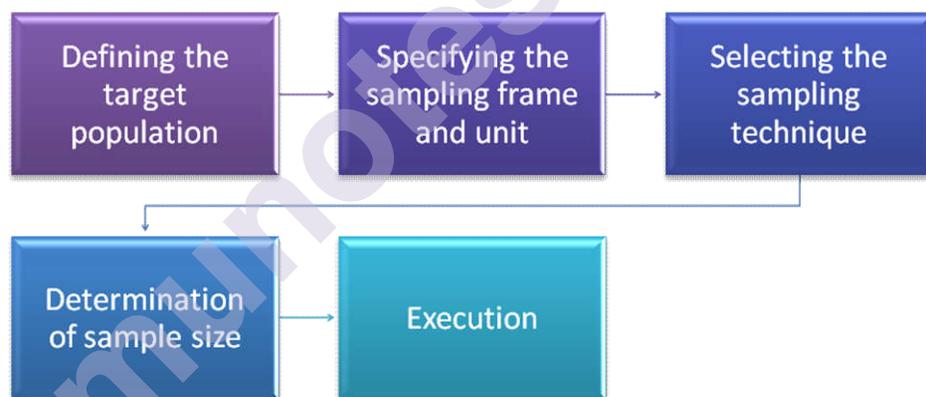
01. Systematic bias can be controlled in a better way through proper sampling design.
02. The sampling design must represent the research objectives for which a sampling technique is going to be used.

03. It must be designed in such a way which results in a small sampling error.
04. In the context of funds, the sample design must be viable.
05. It must give the results of the sample study.
06. It must result in a truly representative sample.

With the help of sampling design, a large number of units can be studied. A good sampling design also saves time, energy and money for the researcher. The sampling design involves some important steps which starts from defining the target population to executing the sampling process. A sampling error pops up when the process is not well defined or executed.

### 7.3.2 STEPS IN SAMPLING DESIGN

Sampling represents the segment of the population that is selected for the purpose of investigation for research. The process of designing a sample should be planned and well executed properly. The following are the steps involves in sampling design -



**Fig. 7.1: Steps in Sampling Design**

#### 01. Defining the Target Population

The first step in sampling design is defining the population of interest. In terms of sampling unit and time, the population for the sample can be defined. The population or universe should be selected by keeping in view the objectives of the research study. The right selection of population reduces the probability of selecting wrong respondents who are not beneficial for research. The definition of the population for the research must be cleared and corrected.

#### 02. Specifying the Sampling Frame and Unit

After defining the population for the research, a researcher should select and decide on the sampling frame. Sampling frame is the list of items from which the sample may be drawn. A sampling error pops up when the

sampling frame is not clearly specified. When the sampling frame does not represent the total population, the chances of sampling frame error may arise.

Sampling unit contains a single element or a group of elements from which a sample may be drawn or selected. It is a basic unit containing a single element or group of elements of the population. The population to be sampled is a sampling unit. The units can be in the form of geographical, demographic, construction, groups or individual units suitable for the research.

### **03. Selecting the Sampling Technique**

After specifying the sampling frame and unit, the selection of sampling techniques is considered as the fourth step. The technique shows the way in which the samples are to be drawn. It is a very important step of the research process. Using an appropriate technique for selecting a sample can generalize the results of the research in a better way. The choice of the sampling technique depends upon the research objectives, financial resources, time availability and the nature of the problem.

There are essentially two types of sampling methods -

- Probability Sampling Methods
- Non-probability Sampling Methods

### **04. Determination of Sample Size**

A sampling size consists of the various units taken for the research in numbers from the whole population to conduct research. It is usually represented by “n”. It plays a crucial role in the sampling design. The calculation of sample size is a simple procedure. Due to errors, the estimation may not come exactly. Type I error and Type II error are some of the ingredients in a sample size calculation.

### **05. Execution - Selecting the sample**

The final step in the sampling design is selecting the sample. For the smooth implementation of the whole process, it is necessary that the interviewers should follow the outline for the smooth functioning and implementation of the research. The execution step involves implementing the whole process to draw a sample. The sample which is required for the research is drawn in the final step of the research design.

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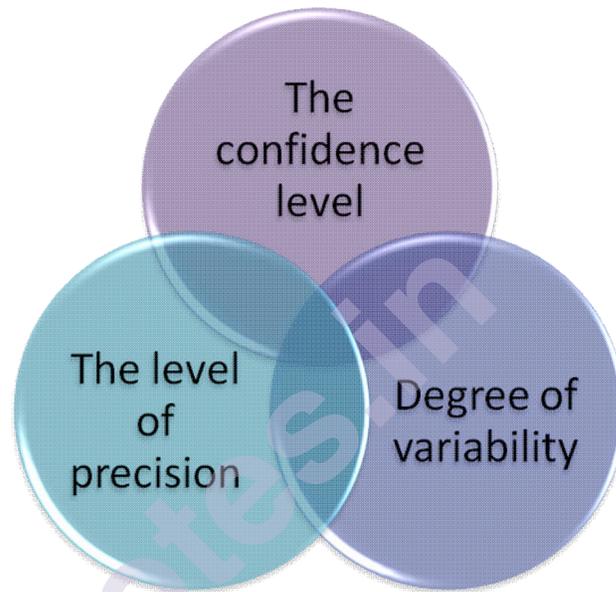
## **7.4 SAMPLE SIZE**

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A sample size is a part of the total population which is drawn for the purpose of conducting research. A sampling size consists of the various units taken for the research in numbers from the whole population to conduct research. It is usually represented by “n”. Determination of sample size plays an important role in the sampling process. There are various methods through which a sample size can be determined.

In the case of probability sampling, the sample size is determined with the help of formulas. The acceptable error and level of confidence are specified. In the case of non-probability sampling, many factors like budget allocation, analysis of subgroups, and number of variables are some important things to be considered while determining the sample size.

The sample size involves the study of the purpose of the research and the size of the population. Along with these, the following criteria is also used to determine the sample size -



**Fig. 7.2: Sample Size Criteria**

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## 7.5 SAMPLING METHODS

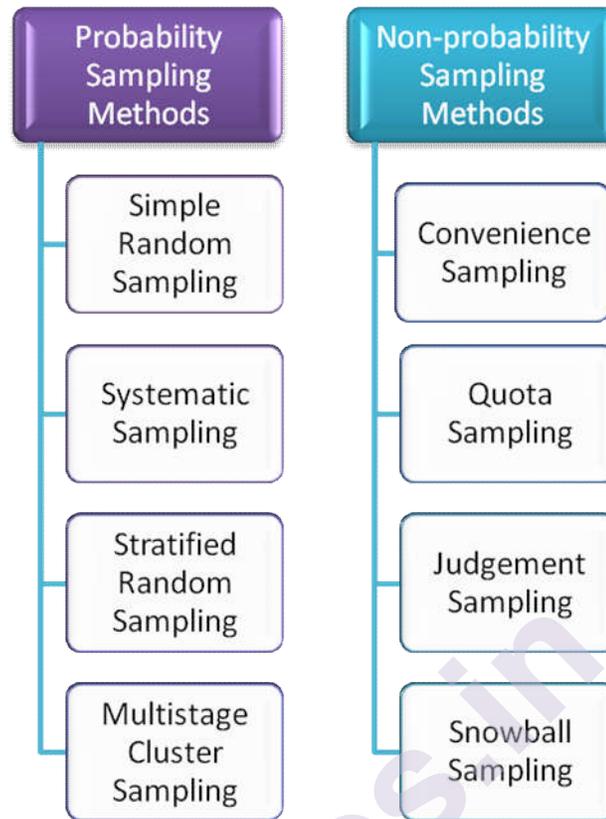
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Sampling methods refers to the procedures by which some elements of the population are included in the sample for conducting research. . The technique shows the way in which the samples are to be drawn. It is a very important step of the research process. Using an appropriate technique for selecting a sample can generalize the results of the research in a better way. The choice of the sampling technique depends upon the research objectives, financial resources, time availability and the nature of the problem.

There are essentially two types of sampling methods -

01. Probability Sampling Methods

02. Non-probability Sampling Methods



**Fig. 7.3: Methods of Sampling**

### 01. Probability Sampling

In probability sampling, each element of population has a chance of being chosen for the sample. In this technique of sampling, every member of the population has a probability of being included in the sample. The probability of getting chosen is an important feature of probability sampling.

The approach of probability sampling is quite desirable as there are chances for elements of being included in the sample. The following are the techniques of probability sampling -

#### (i) Simple Random Sampling

A simple random sampling is a technique where each element in the target population is randomly selected to form a sample. In this technique, every element from the target population has an equal probability of inclusion in the sample. This technique is suitable when the size of the target population is small.

#### (ii) Systematic Sampling

Systematic sampling is often used as a substitute for simple random sampling. The selection of the elements from the target population is systematic. Except for the first element, the selection is on the basis of a systematic approach and it is not random in nature like simple random

sampling. It involves the selection of every kth element. The selection is done from a sampling frame. 'K' represents the skip interval.

### **(iii) Stratified Random Sampling**

Before sampling, the process of grouping the members of the population in a similar feature group is known as stratification. In this technique, the elements of the population are divided into small subgroups. The division of the group is based on the similarity. After stratification, the elements are randomly selected from each of these strata. The elements within the group are homogeneous and heterogeneous among the group formed.

### **(iv) Cluster Sampling**

In this technique, the population is grouped into various clusters and the few clusters are selected for the study. The use of this technique is suitable for the studies which cover geographical areas. A researcher can choose, one level or multilevel cluster sampling.

## **02. Non-probability Sampling**

Non-probability sampling is also known as purposive sampling. The elements in this technique are selected on the basis of factors. There is no chance of getting selected randomly. The selection of the element is purposive and based on some factors. Quota sampling, convenience sampling, judgment sampling and snowball sampling are few examples of non-probability sampling.

### **(i) Quota Sampling**

Quota sampling is a technique through which the number of respondents that are to be drawn from each of several categories is mentioned and specified in advance. The final selection of the respondents is left to the researcher. The process proceeds until the quota for each category is filled.

### **(ii) Convenience Sampling**

As the name suggests, convenience sampling is based on the ease and convenience of the researcher to further carry research. Based on the easy availability and accessibility when the researcher selects the units from the population to draw samples, it is known as convenience sampling. In convenience sampling, there is no set criteria for selecting the sample. It depends upon the ease and accessibility of the researcher.

### **(iii) Judgment Sampling**

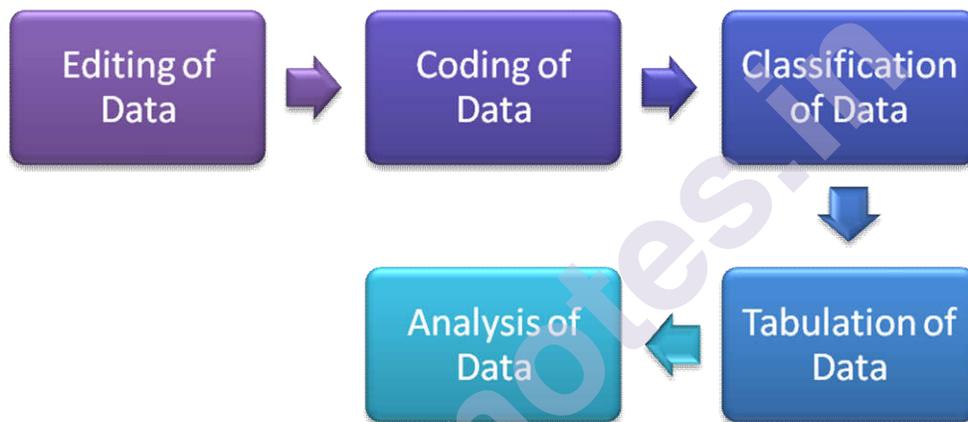
Judgment sampling is a technique through which an experienced researcher selects the units from the population based on the judgment for their research. The sample units are selected based on the population's parameters.

#### (iv) Snowball Sampling

Snowball sampling involves the selection of additional respondents. The technique of snowballing is used on rare populations or low incidence populations. The process of sampling under this technique is based on the chain of referrals.

### 7.6 EDITING AND CODING OF DATA

After the process of data collection, the data which is collected needs to be edited. The data for the research can be obtained through schedules, interviews, questionnaire, observations or through secondary sources like books, journals, websites, published data and reports etc. the following process is adopted while preparing the data -



**Fig. 7.4 Process of Data Preparation**

#### 01. Data Editing

Data Editing is the first step. It is a focal point in the preparation of statistics. The goal of data editing is to improve the quality of the information. When the responses are collected through open-ended questions of questionnaires, unstructured observations and interviews, the editing of data is required. The information must be coded systematically. Lack of clarity or goal at first stage will result later in confusion and goal deviation.

The following are the reasons which advocates the need for data editing -

01. It provides consistency.
02. It provides uniformity to the whole process.
03. It provides completeness.
04. It ensures accuracy of the data.

## 02. Data Coding

Coding is the development and use of a language. The language will be used to transfer data. The coding plays a vital role in transferring data from the instrument which was used in the process of data collection. Coding is the process of mixing the data with a code label to easily retrieve at a later stage for further comparison, interpretation and analysis.

The codes can be based on topics, ideas, concepts, themes, phrases, terms and keywords. The codes are given the relevant names that provide an indication of the idea or concept. Researchers have some codes already in mind and are also looking for other ideas to draw something from the data.

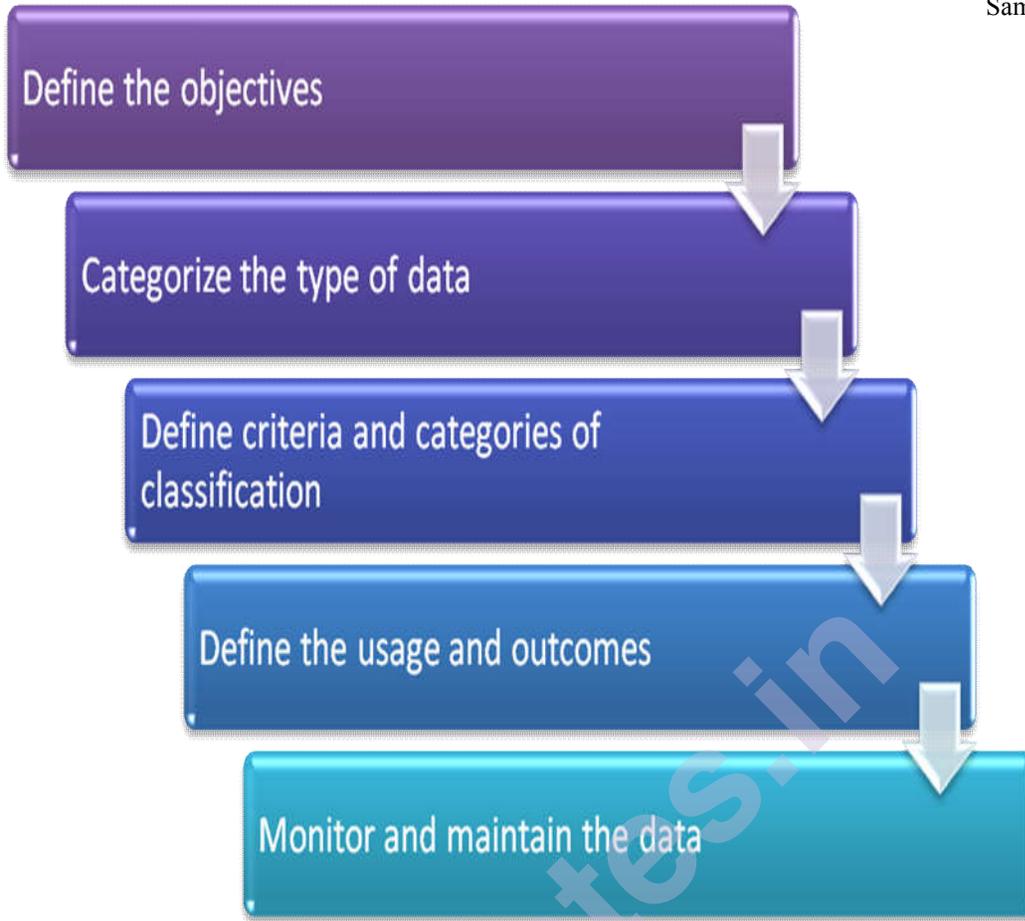
The following questions are important or suggested to ask about the data for coding -

1. What is happening/going on?
2. What is the person's behavior saying?
3. How can the actions be taken for granted?
4. What are people doing?

## 03. Classification of Data

Data classification is an act of organizing data by relevant categories to purposely use it for research analysis. The data is classified on the basis of characteristics, level of sensitivity and impact of the study. The classification of data helps to determine the relevant and irrelevant data. The relevant data is used for further research.

The data should be classified into three categories - Restricted Data, Private data and Public data. Restricted data is one which cannot be disclosed or altered. Private data is data which has a moderate level of risk. A reasonable level of security controls should be applied to private data. The public data is published and available for all. It can be easily accessible for all. Some level of control is required to prevent unauthorized alteration.



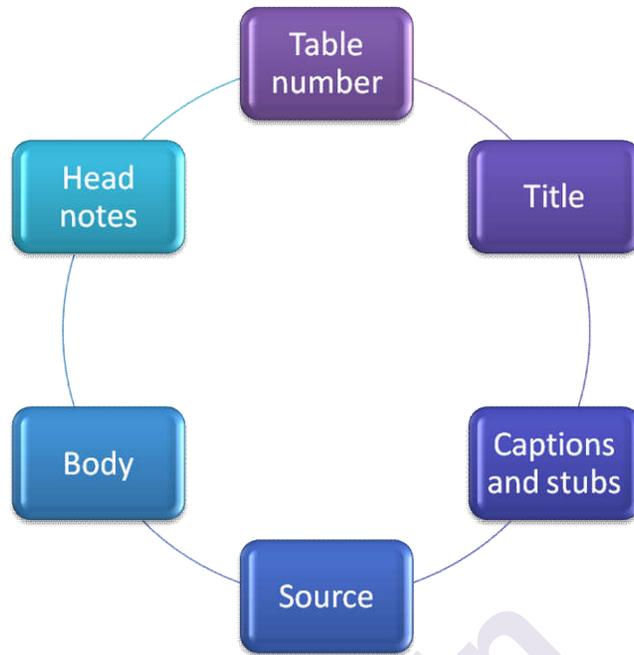
**Fig. 7.5: Process of Data Classification**

#### **04. Tabulation of Data**

Tabulation of data means systematic arrangement of data in rows and columns. Tabulation is a layout of the data in tabulated form to show with the help of different rows and columns. Tabulation of data is a systematic process of showing the data in terms of figures to analyze. When the data are tabulated for one characteristic, it is said to be simple tabulation. While, the data is tabulated according to the two characteristics, it is said to be double tabulation.

When the data is tabulated on the basis of multiple characteristics, it is said to be multiple or complex tabulation. The main purpose of data tabulation is to simplify the presentation. With the help of tabulated data, data can easily be understood.

Preparation of tables is an art. For tabulating data, this art is required to a researcher for handling and presenting data. The preparation of table involves general principles -

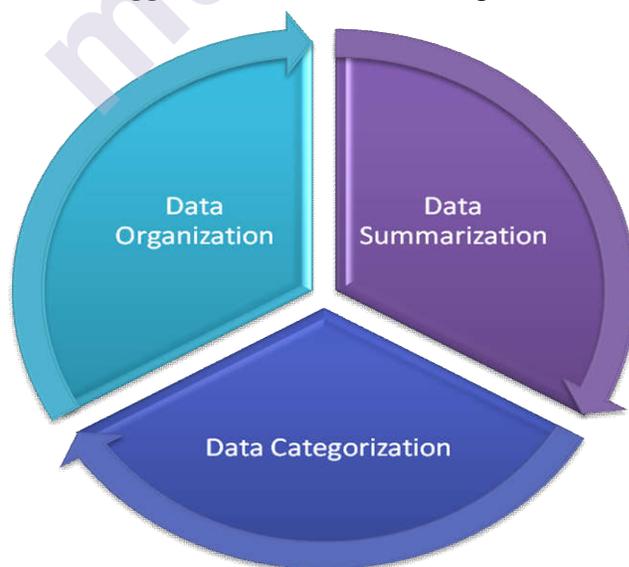


**Fig.7.6: General Principles of Tabulation of Data**

### 05. Analysis of Data

Data analysis is an important step of the research process. It is the process of applying techniques to describe, condense and evaluate data. Data integrity is an important part of data analysis. Data analysis is the process through which data is collected, modeled and analyzed data that supports decision making.

It involves the process of organization, summarization and categorization of data. It is defined as a process of cleaning, modeling and transforming data to support the decision making and findings related to research.



**Fig.7.6: Process of Data Analysis**

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## 7.8 SUMMARY

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- Sampling is a technique through which the predetermined number of observations are taken from a large population for the purpose of research. This technique is used in statistical analysis. It is an act of selecting a representative form the population for determining the features of the whole population.
- The population or universe represents the entire aggregation of items from which samples can be selected for the research. It represents the entire group which is the focus of the study.
- Sample design represents a definite plan for obtaining a sample from a given population. A sample design can be described by sampling methods and estimators. Sampling methods refers to the procedures by which some elements of the population are included in the sample for conducting research. For calculating sample statistics, the estimation process is used. This process is called the estimator. Different estimators are used for different sampling.
- Sampling represents the segment of the population that is selected for the purpose of investigation for research. The process of designing a sample should be planned and well executed properly.
- A sample size is a part of the total population which is drawn for the purpose of conducting research. A sampling size consists of the various units taken for the research in numbers from the whole population to conduct research. It is usually represented by “n”. Determination of sample size plays an important role in the sampling process. There are various methods through which a sample size can be determined.
- Sampling methods refers to the procedures by which some elements of the population are included in the sample for conducting research. . The technique shows the way in which the samples are to be drawn. It is a very important step of the research process.
- After the process of data collection, the data which is collected needs to be edited. The data for the research can be obtained through schedules, interviews, questionnaires, observations or through secondary sources like books, journals, websites, published data and reports etc.
- The goal of data editing is to improve the quality of the information. When the responses are collected through open-ended questions of questionnaires, unstructured observations and interviews, the editing of data is required. Coding is the process of mixing the data with a code label to easily retrieve at a later stage for further comparison., interpretation and analysis.

- Data classification is an act of organizing data by relevant categories to purposely use it for research analysis. The data is classified on the basis of characteristics, level of sensitivity and impact of the study.
- Tabulation of data means systematic arrangement of data in rows and columns. Tabulation is a layout of the data in tabulated form to show with the help of different rows and columns. Tabulation of data is a systematic process of showing the data in terms of figures to analyze.
- Data analysis involves the process of organization, summarization and categorization of data. It is defined as a process of cleaning, modeling and transforming data to support the decision making and findings related to research.

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## 7.9 SELF ASSESSMENT QUESTIONS

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### Section A - Descriptive Questions

01. What is the meaning of sample? Explain the process of designing a sample.
02. Explain the importance of techniques of research by keeping in view its relevance in social and scientific research.
03. Describe the various steps in the sampling process.
04. Distinguish between probability sampling and non-probability sampling.
05. What is data editing and coding? Explain its relevance in research.
06. Why is data editing considered as a focal point of research? Support your answer with the help of a few examples.
07. What is coding? Explain the process of coding.
08. What do you mean data classification? Why is data integrity important in data classification?
09. Describe this statement - “Data editing, coding, classification, tabulation and analysis are important elements of processing of data”.

### Section B - Multiple Choice Questions

01. Which of the following is not a type of non-probability sampling?
  - a) Quota sampling
  - b) Convenience sampling
  - c) Snowball sampling
  - d) Stratified random sampling

02. Among these, which sampling is based on equal probability?
- (a) Simple random sampling
  - (b) Stratified random sampling
  - (c) Systematic sampling
  - (d) Probability sampling
03. The distribution that is formed by all possible values of a statistics is known as:
- (a) Hyper geometric distribution
  - (b) Normal distribution
  - (c) Sampling distribution
  - (d) Binomial distribution
04. Of the following sampling methods, which is a probability method?
- a) Judgment
  - b) Quota
  - c) Simple random
  - d) Convenience
05. Sample is a representative unit of the population. Is this statement true or false?
- a) True
  - a) False
06. What are the various classifications of sampling?
- a) Random and purposive
  - b) Stratified and cluster
  - c) Probability and non-probability
  - d) Multi-stage and sequential



## UNIVARIATE AND BIVARIATE ANALYSIS OF DATA

### Unit Structure

- 8.0 Objectives
- 8.1 Introduction
- 8.2 Descriptive vs Inferential Analysis
- 8.3 Descriptive Analysis of Univariate data
- 8.4 Nominal Scale
- 8.5 Ordinal Scale
- 8.6 Measures of Central Tendency
- 8.7 Measures of Dispersion
- 8.8 Descriptive Analysis of Bivariate data
- 8.9 Summary
- 8.10 Self Assessment Questions

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### 8.0 OBJECTIVES

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After studying this module, you should be able to:

- Concepts of univariate and bivariate analysis
- Know about the descriptive and inferential analysis
- How to do descriptive analysis of univariate data
- Knowledge about nominal and ordinal scale
- Understand the meaning and application of measures of central tendency and dispersion
- How to do descriptive analysis of bivariate data
- Difference between univariate and bivariate analysis

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### 8.1 INTRODUCTION

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Research is defined as the creation of new knowledge. From problem statements to conclude the research, each and every step plays an important role. The most critical and essential pillar of the whole process is

data analysis. Data analysis is the process through which data is collected, modeled and analyzed data that supports decision making.

Data analysis is an important step of the research process. It is the process of applying techniques to describe, condense and evaluate data. Data integrity is an important part of data analysis. It involves the process of organization, summarization and categorization of data. It is defined as a process of cleaning, modeling and transforming data to support the decision making and findings related to research.



**Fig. 8.1: Process of Data Analysis**

Data analysis involves the application of raw data into categories with the help of coding and tabulation. For the further analysis, the irrelevant data is removed to conduct the further research on the basis of relevant data. The purpose of data analysis is to classify the raw data into some usable categories. The data transformation and coding, editing, tabulation and statistical inferences are some important elements of data analysis.

Transforming data is an important step. Coding is the process of mixing the data with a code label to easily retrieve at a later stage for further comparison, interpretation and analysis. The codes can be based on topics, ideas, concepts, themes, phrases, terms and keywords. The codes are given the relevant names that provide an indication of the idea or concept. Researchers have some codes already in mind and are also looking for other ideas to draw something from the data.

Data editing is a focal point in the preparation of statistics. The goal of data editing is to improve the quality of the information. When the responses are collected through open-ended questions of questionnaires, unstructured observations and interviews, the editing of data is required. Tabulation of data means systematic arrangement of data in rows and columns. Tabulation is a layout of the data in tabulated form to show with the help of different rows and columns. Tabulation of data is a systematic process of showing the data in terms of figures to analyze.

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## 8.2 DESCRIPTIVE VS. INFERENCE ANALYSIS

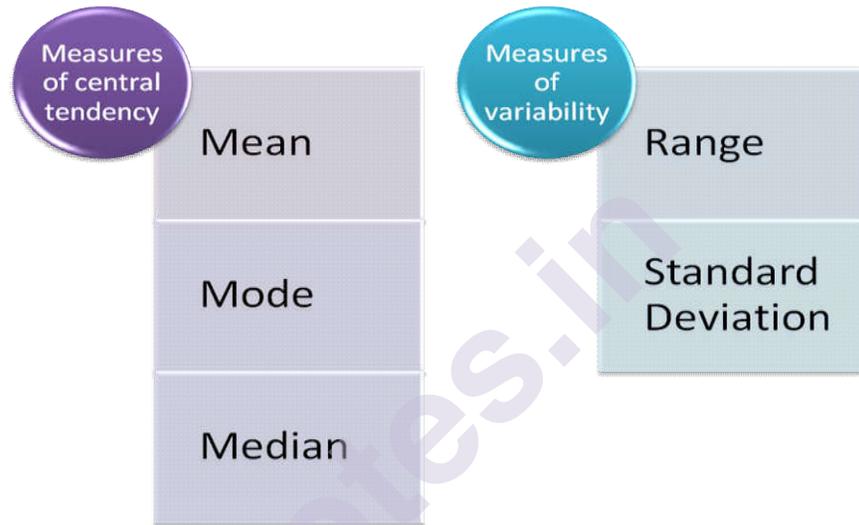
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### 8.2.1 Descriptive Analysis

Descriptive analysis is also referred to as one dimensional analysis. The act of organizing, analyzing and presenting data in a meaningful way is descriptive analysis. It involves the study of the distribution of one

variable. The analysis may be based on the one variable, two variable or multi variable. Under study, descriptive analysis helps to describe, show and summarize data. With the help of this analysis, the profile of the various companies, departments, organizations etc. can be taken for further study.

The descriptive analysis helps to describe a situation. Measures of central tendency like mean, median and mode and measures of variability like range and standard deviation are the types of descriptive analysis.



**Fig. 8.2: Types of Descriptive Analysis**

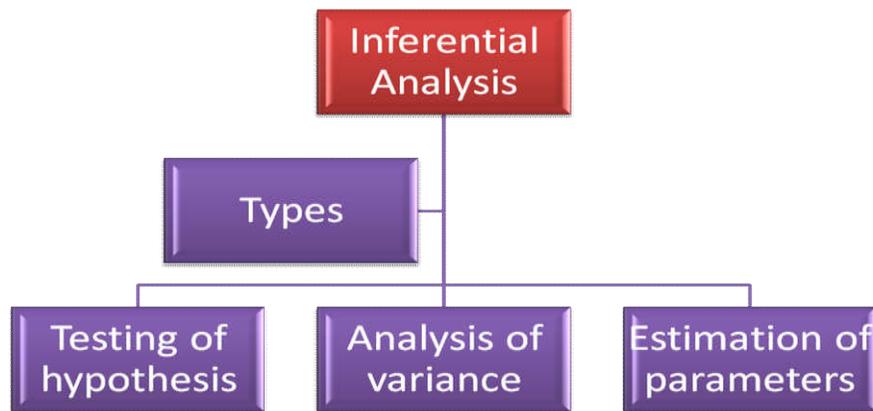
### 8.2.2 Inferential Analysis

Inferential analysis helps to compare, test and predict data. This analysis allows researchers to begin making inferences as the name suggests about the hypothesis based on the data collected for the research. It involves tests of significance for the testing of the hypothesis. A researcher can draw inferences and come to conclusions about the population at large with the help of inferential analysis.

With the help of this analysis, the data validity can be determined which can further lead to draw some conclusions. Inferential analysis takes an active part and helps in the interpretation of data. It involves the analysis of a random sample of data which is taken from the population. Further, it helps to describe and make inferences about the population.

The main purpose of this analysis is to draw conclusions from a sample. Later, to generalize them to the population. With the help of probability theory, it determines the probability of the characteristics of the sample which can be generalized on the whole population.

Hypothesis testing, analysis of variance, estimation of parameters are some methodologies of inferential analysis.



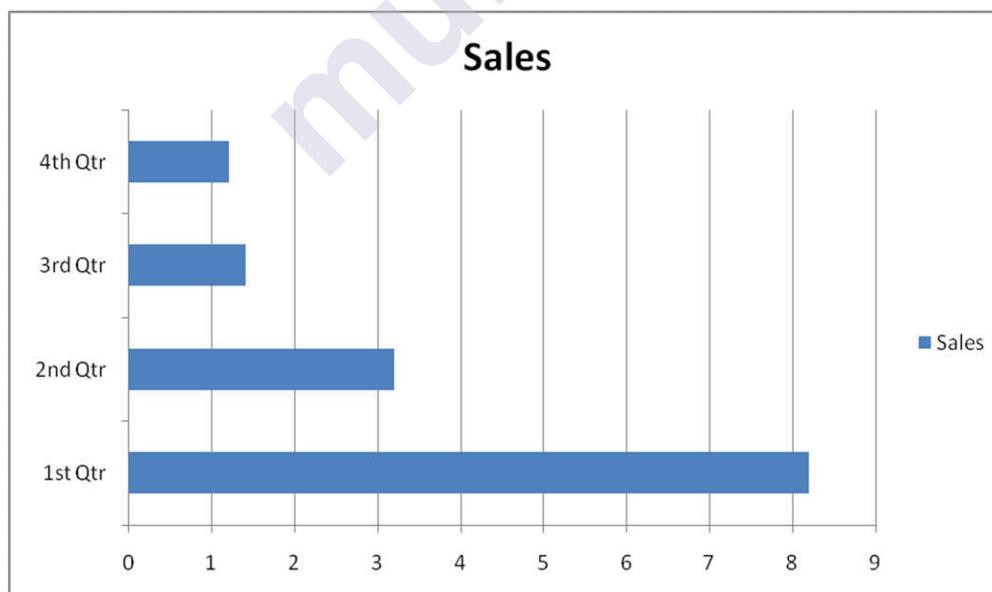
**Fig. 8.3: Types of Inferential Analysis**

### **8.3 DESCRIPTIVE ANALYSIS OF UNIVARIATE DATA**

As mentioned earlier, descriptive analysis helps to describe, show and summarize data. Univariate data means your data has only one variable. It is the most basic form of statistical data analysis technique. The descriptive analysis of univariate data is used when the data contains only one variable and it does not deal with the cause and effect relationship.

The main purpose of descriptive analysis of univariate data is to simply describe the data to find the patterns within the data. With the help of central tendency, dispersion, range, variance etc. the patterns can be described found in univariate data. Several options can be used for describing data for univariate data -

- Bar charts (Graph with rectangular bars)



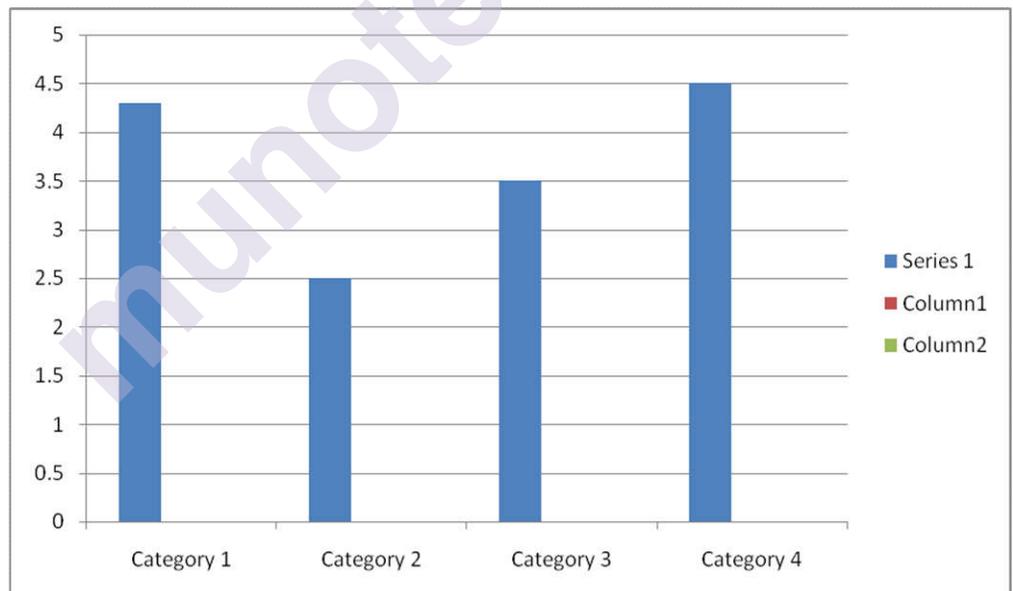
**Fig. 8.4: Bar Graphs**

- Frequency distribution table (It tells how often something happened)

Number of Products (x)	Tally	Frequency (f)

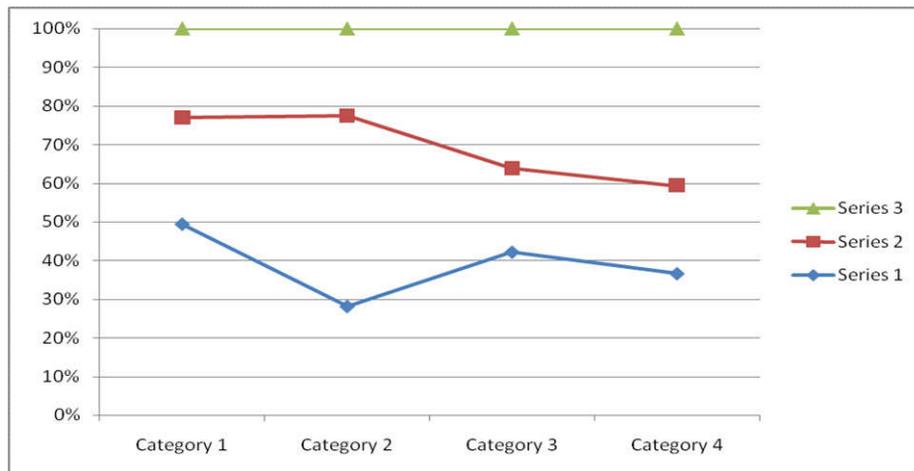
**Fig. 8.5: Frequency Distribution Tables**

- Histogram (Way to display counts of data)



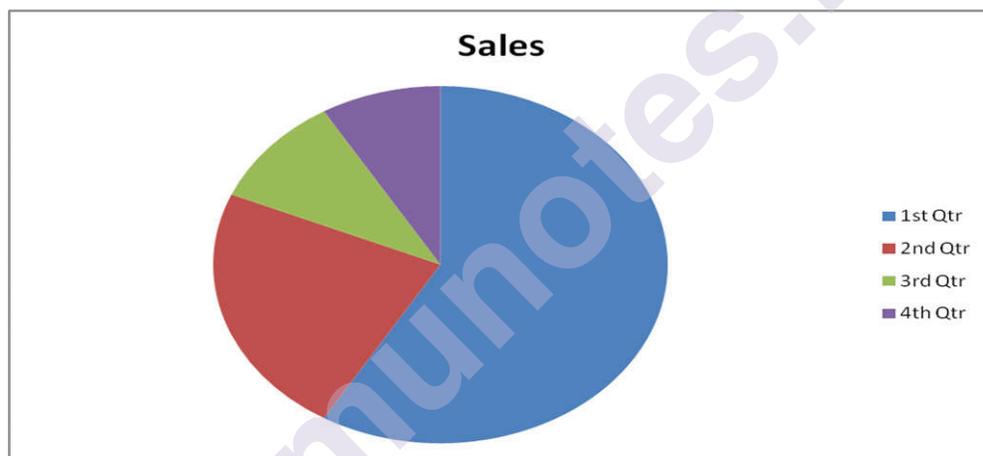
**Fig. 8.6 : Histogram**

- Frequency Polygon (can be used to compare sets of data)



**Fig. 8.7: Frequency Polygon**

- Pie Chart (It displays data in a circular graph)



**Fig. 8.8: Pie Chart**

## 8.4 NOMINAL SCALE

The name of this scale is derived from the Latin word ‘Nomen’ which means name. The numbers on the nominal scale don’t have values. A nominal scale can have both qualitative variables and quantitative variables. It is a scale of measurement. The scale is used to assign events or objects into discrete categories. The use of numeric value or categories ranked by class is not required in this type of scale. This scale is considered as the most basic form of measurement. The scale uses tags or labels to associate value with the rank. It differentiated items. The scale deals with non-numeric attributes.

Nominal scales are used to categorize and evaluate data in many fields. An example of nominal scale is -

Que. 1 What is your occupation?

- Business
- Service
- Professional
- Other

Que. 2 What is your gender?

- Male
- Female
- Transgender

#### **8.4.1 Analysis of Nominal scale data with only one possible response and two possible responses**

Nominal scales are qualitative in nature. The numbers which are assigned to the attributes have no numerical values. This makes the analysis confusing. There is no arithmetic computation and no numerical value can be assigned to the data obtained through this scale.

With the help of Mode and Percentage, the analysis of nominal scale data can be performed. Equality or set membership can be used to analyze nominal data. The qualities of the attribute can be put in order. Ranking the variables is meaningless.

For the graphical representation of the data, Pie charts and Bar charts can be used for the analysis of nominal data. Pie chart to represent the percentage value of your findings and Bar chart to represent the frequency of the categories according to the responses.

To assess the nominal data, two categories can be used - The Matched sample and the Unmatched sample. In the Matched sample, the data with similar characteristics are paired together. While in an unmatched sample, the random pairs are chosen for the purpose of analysis.

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### **8.5 ORDINAL SCALE**

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The term 'ordinal' means order. It includes the type of statistical data where variables are in rank or order. There is no degree of difference between categories. The scale places variables in order and permits to measure the value at lower or higher in scale. Ordinal scale is the second level of measurement. The data can be grouped, named or ranked with the help of this scale.

The ordinal scale shows the relative rank of variables. The non-numeric attributes like happiness, health, sadness can be measured with the help of ordinal scale. It helps to identify the rank of variables. The degree of agreement or disagreement can be analyzed with the help of this scale.

An example of ordinal scale is

01. How satisfied are you with our services?

- 1- Totally Satisfied
- 2- Satisfied
- 3- Neutral
- 4- Dissatisfied
- 5- Totally Dissatisfied

How happy are you with the performance of the product?

- 1- Very Unhappy
- 2- Unhappy
- 3- Neutral
- 4- Unhappy
- 5- Very Unhappy

### 8.5.1 Analysis of Ordinal Scaled Questions

The analysis of the ordinal scale questions can be done with the help of ranking the data. With the help of rating surveys, the impact can be assessed. Use of Likert scale is found to be very convenient and famous in ordinal scale. The Likert scale is a variant of the ordinal scale that is used to calculate satisfaction level.

The example of Likert Scale is -

Que. How satisfied are you with our products?

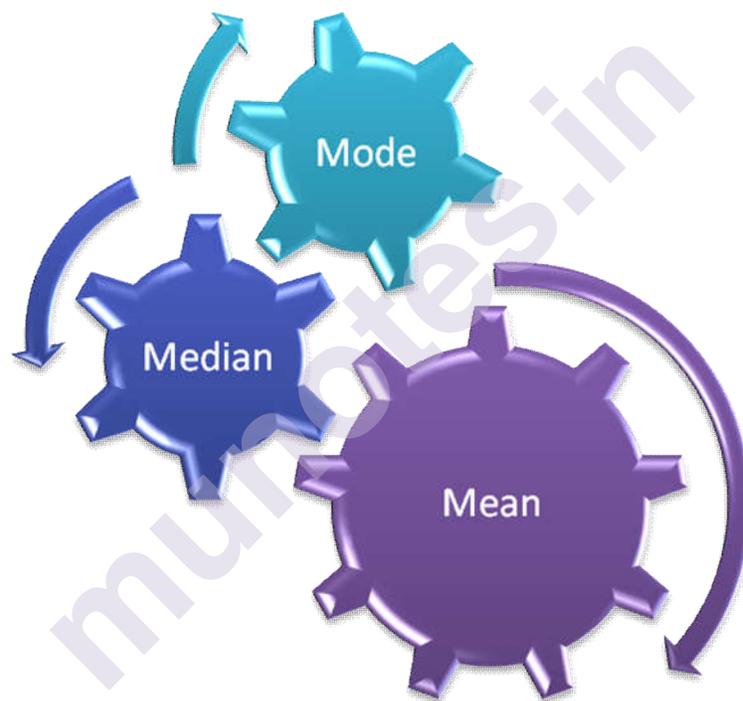
- 4- Strongly Agree
- 3- Agree
- 2- Neutral
- 1- Disagree
- 0- Strongly Disagree

Positional measures like Median and Percentile are considered as appropriate methods for ordinal scale. Classification method is also used for measuring the data collected through ordinal scale. The classification process includes the segmentation of data so that each observation is similar to the other. After classification, dispersion is measured and minimized in each group to maximize the results of classification.

## 8.6 MEASURES OF CENTRAL TENDENCY

A measure of central tendency attempts to describe a whole set of data with a single value that represents the middle or center of its distribution. It is an attempt to describe a set of data by analyzing and identifying the central position within the set of data. There are three main measures of central tendency. Out of these three, Mean or Average is the most familiar one as compared to median and mode.

These measures explain a different position of the central value in the distribution. In the distribution, the central tendency aims to provide an accurate description of the entire data. It also helps to ascertain how to calculate them and under what conditions they are most convenient and appropriate to be used.



**Fig. 8.9: Measures of Central Tendency**

### 01. Mean

The mean or average is the most popular measure of central tendency. Mean can be used with both discrete and continuous data, although its use is most often with continuous data.. We can simply add all the values in a data set and divide it by the total number of values to calculate the mean. The formula of mean This formula is usually written in a slightly different manner using the Greek capital letter,  $\Sigma$ , pronounced "sigma", which means "sum of...":

$$\bar{X} = \frac{\sum X}{N}$$

Some other measures of mean used to find the central tendency are as follows:

- Geometric Mean
- Harmonic Mean
- Weighted Mean

## 02. Median

Median represents the middle value. It is the *middle value* in distribution when the values are arranged in ascending or descending order. It divides the distribution in half. In simple words, we can say that median is the middle score for a set of data that has been arranged in order of magnitude. Median when 'n' is odd and when 'n' is even can be calculated with the help of this formulas,

**Median**

n is odd,  

$$\text{Median} = \left(\frac{n+1}{2}\right)^{\text{th}} \text{ observation}$$

n is even,  

$$\text{Median} = \frac{\left(\frac{n}{2}\right)^{\text{th}} + \left(\frac{n}{2} + 1\right)^{\text{th}} \text{ observation}}{2}$$

## 03. Mode

Mode represents the most frequent values. It represents the frequently occurring value in the dataset. Mode represents the most common value. The most frequent value in the given dataset is considered as mode. It is the most commonly occurring value in a distribution. Over the median and the mean, the mode has an advantage as it can be found for both numerical and categorical (non-numerical) data.

Mode can be calculated as,

$$\text{Mode} = l + \left(\frac{f_1 - f_0}{2f_1 - f_0 - f_2}\right) \times h$$

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## 8.7 MEASURES OF DISPERSION

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Dispersion is a statistical term. The term 'Dispersion' is used to describe the extent to which data is scattered. Measures of dispersion help to describe the variability in data. There are certain types of measures that

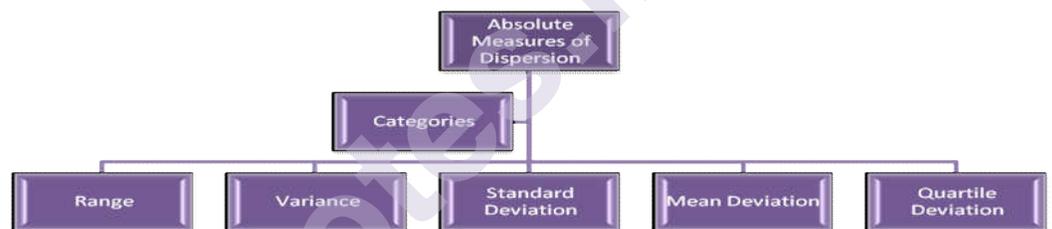
are used to quantify the dispersion of data. Measures of dispersion help to interpret the variability of data. It helps to understand how homogeneous or heterogeneous the data is.

There are two main types of dispersion methods in statistics which are:

- Absolute Measure of Dispersion
- Relative Measure of Dispersion

### 01. Absolute Measure of Dispersion

The method expresses the variations in terms of the average of deviations of observations like standard or mean deviations. It contains the same unit as the original data set. The absolute method of dispersion measures usually expresses variations in a data set with respect to the average of the deviations of the observations. The most commonly used absolute measures of deviation are listed below -



**Fig. 8.10: Categories of Absolute Measures of Dispersion**

#### 01. Range

The range can be defined as the difference between the maximum value and the minimum value. The difference shows the range between the minimum value and maximum value. Range is the difference between the maximum value and the minimum value given in a data set.

#### 02. Variance

Variance checks the spread of the data about the mean. Variance is known as the average squared deviation from the mean of the given data set.

#### 03. Mean Deviation

The central points of mean deviation could be mean, median or mode. It gives the average of the data's absolute deviation about the central points. In this way, the Mean Deviation is calculated -

1. Calculate the average of the observations
2. Calculate the difference of each observation from the mean
3. Average all the deviations.

#### 04. Standard Deviation

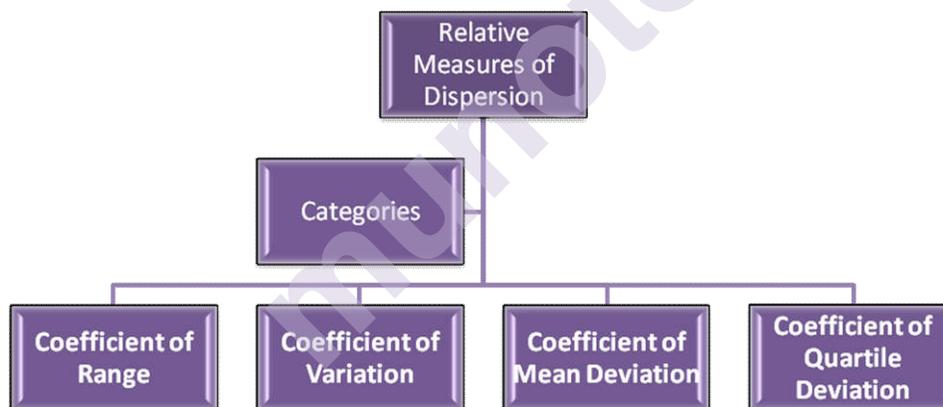
Standard deviation measures the differences in the values about the mean. It measures the variation of the data about the mean. The square root of the variance gives the standard deviation. In simple words, the square root of the variance is known as the standard deviation.

#### 05. Quartile Deviation

The quartiles are values that divide a list of numbers into quarters. The quartile deviation is half of the distance between the third and the first quartile. It can be defined as half of the difference between the third quartile and the first quartile in a given data set.

### 02. Relative Measures of Dispersion

**Relative Measures of Dispersion measure compares values without units. They are used to compare the distribution of two or more data sets. When the data of separate sheets have different units and their comparison needs to be done, the use of relative measures takes place. The relative measures of dispersion are expressed in the form of ratios and percentages. Let's have a look at this diagram which shows the various measures of relative measures of dispersion -**



**Fig. 8.11 Categories of Relative Measures of Dispersion**

#### 01. Coefficient of Range

The Coefficient of Range is the ratio of the difference between the highest and lowest value in a data set to the sum of the highest and lowest value.

#### 02. Coefficient of Variation

The Coefficient of Variation is the ratio of the standard deviation to the mean of the data set. It is expressed in the form of a percentage.

### 03. Coefficient of Mean Deviation

The Coefficient of Mean Deviation is defined as the ratio of the mean deviation to the value of the central point from which it is calculated.

### 04. Coefficient of Quartile Deviation

The Coefficient of Quartile Deviation is the ratio of the difference between the third quartile and the first quartile to the sum of the third and first quartiles.

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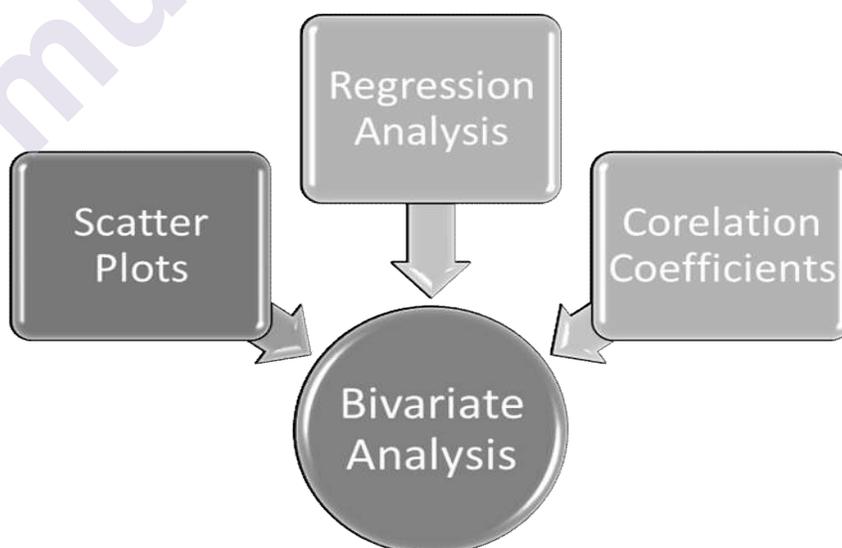
## 8.8 DESCRIPTIVE ANALYSIS OF BIVARIATE DATA

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Univariate analysis is the analysis of one variable. In Bivariate analysis, the analysis of exactly two variables takes place. Multivariate analysis is the analysis of more than two variables. Bivariate analysis means analysis of bivariate or analysis of two variables used to find out if there is a relationship between two sets of values. It usually involves the variables X and Y. It is one of the simplest methods of ascertaining two variables.

In this statistical analysis, the two variables are observed. One variable is dependent while the other is independent. As mentioned earlier, it usually involves the variables X and Y. In order to conclude the impact and cause of study involving two variables, this analysis is used. The study of bivariate studies explores the relationship of two variables. The study is stated to be an analysis of any concurrent relation between two variables or attributes.

The following are the types of Bivariate analysis -



**Fig. 8.12: Types of Bivariate Analysis**

### 01. Scatter Plots

Scatter plots give a visual idea of the pattern that the variables follow. The dots in the scatter plots represent the values for two different numeric variables.

### 02. Regression Analysis

The Regression Analysis allows the researcher to examine the relationship between two or more variables of interest.

### 03. Correlation Coefficient

Correlation Coefficient measures the relationship between the two variables. It is used to measure how strong a relationship is between two variables. Correlation coefficient formulas are used to find how strong a relationship is between data. The formulas return a value between -1 and 1, where:

- 1 indicates a strong positive relationship.
- -1 indicates a strong negative relationship.
- A result of zero indicates no relationship at all.

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## 8.9 SUMMARY

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- Data analysis is an important step of the research process. It is the process of applying techniques to describe, condense and evaluate data. Data integrity is an important part of data analysis. It involves the process of organization, summarization and categorization of data. It is defined as a process of cleaning, modeling and transforming data to support the decision making and findings related to research.
- Descriptive analysis is also referred to as one dimensional analysis. The act of organizing, analyzing and presenting data in a meaningful way is descriptive analysis. It involves the study of the distribution of one variable. The analysis may be based on the one variable, two variable or multi variable.
- Inferential analysis helps to compare, test and predict data. This analysis allows researchers to begin making inferences as the name suggests about the hypothesis based on the data collected for the research. It involves tests of significance for the testing of the hypothesis.
- Univariate data means your data has only one variable. It is the most basic form of statistical data analysis technique. The descriptive analysis of univariate data is used when the data contains only one variable and it does not deal with the cause and effect relationship.

- A nominal scale can have both qualitative variables and quantitative variables. It is a scale of measurement. The scale is used to assign events or objects into discrete categories. The use of numeric value or categories ranked by class is not required in this type of scale.
- The ordinal scale shows the relative rank of variables. The non-numeric attributes like happiness, health, sadness can be measured with the help of ordinal scale. It helps to identify the rank of variables. The degree of agreement or disagreement can be analyzed with the help of this scale.
- A measure of central tendency attempts to describe a whole set of data with a single value that represents the middle or center of its distribution. It is an attempt to describe a set of data by analyzing and identifying the central position within the set of data.
- Measures of dispersion help to describe the variability in data. There are certain types of measures that are used to quantify the dispersion of data. Measures of dispersion help to interpret the variability of data. It helps to understand how homogeneous or heterogeneous the data is.
- Bivariate analysis means analysis of bivariate or analysis of two variables used to find out if there is a relationship between two sets of values. It usually involves the variables X and Y. It is one of the simplest methods of ascertaining two variables.

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## 8.10 SELF ASSESSMENT QUESTIONS

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### Section A - Descriptive Questions

01. Explain the Univariate and Bivariate Analysis of Data.
02. What is descriptive analysis and inferential analysis? Explain its various types.
03. Elaborate the descriptive analysis of univariate data. Also explain the several options that can be used for describing data for univariate data.
04. What is the nominal scale? How are nominal scales used to categorize and evaluate data in many fields?
05. What is the ordinal scale? How can analysis of the ordinal scale questions be done?
06. What is the measure of central tendency? Explain the various measures of central tendency.
07. What are Measures of Dispersion? Explain the types of dispersion methods.
08. Describe the various types of analysis of bivariate.

**Section B - Multiple Choice Questions**

01. For which type of measurement, the coefficient of variation can be computed?
  - a) Nominal Scale
  - b) Ordinal Scale
  - c) Interval Scale
  - d) Ratio Scale
  
02. Which of the following are types of correlation?
  - a. Positive and Negative
  - b. Simple, Partial and Multiple
  - c. Linear and Nonlinear
  - d. All of the above
  
03. The original hypothesis is known as \_\_\_\_\_.
  - a. Alternate hypothesis
  - b. Null hypothesis
  - c. Both a and b are incorrect
  - d. Both a and b are correct
  
04. Which of the following statements is true for correlation analysis?
  - a. It is a bivariate analysis
  - b. It is a multivariate analysis
  - c. It is a univariate analysis
  - d. Both a and c
  
05. Which of the following techniques is an analysis of the relationship between two variables to help provide the prediction mechanism?
  - a. Standard error
  - b. Correlation
  - c. Regression
  - d. None of the above



## TESTING OF HYPOTHESES, CHI-SQUARE ANALYSIS & ANALYSIS OF VARIANCE (ANOVA)

### Unit Structure

9.0 Objectives

9.1 Hypothesis Testing:

9.2 Chi-Square Test

9.3 Analysis of Variance (ANOVA)

9.4 Self Assessment Questions

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### 9.0 OBJECTIVES

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1. Define null hypothesis, alternative hypothesis, level of significance, test statistic.
2. Distinguish between a one-tailed and a two-tailed test.
3. Formulate statistical hypothesis for testing.
4. To determine whether the difference between the observed and expected values is statistically significant using Chi- Square test.
5. To know and apply the one way & two-way ANOVA and interpret the results.

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### 9.1 HYPOTHESIS TESTING:

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#### 9.1.1 Introduction

In Quantitative research, a researcher is trying to answer a question set by him/her. hypothesis testing is a process of evaluating the research question. The main idea of hypothesis testing is to prove or disprove research questions. Hypothesis testing is termed significant testing.

Researchers need to state Null and alternative hypothesis to use hypothesis testing.

Statistical hypothesis is a statement that is based on experience and is believed to be proved i.e. known as the null hypothesis and the burden of justification is with an alternating hypothesis. A statistical hypothesis is an

assumption made regarding the distribution of one or more population characteristics.

Let's see some statements,

- i) One-day cricket matches are not good for cricketers.
- ii) There is a vast difference in the performance of players in ODI and Test matches.
- iii) The mobile phone is not good for the health of users.
- iv) The life of individual decreases with the use of the mobile phone.

Statements ii) and iv) are statistical hypothesis as they are based on population characteristic, and statement i) and iii) are simple hypothesis.

### 9.1.2 Null Hypothesis

The null hypothesis is the hypothesis that there is no relation between two or more variables. The null hypothesis can be disproved, and rejected by researchers. It is denoted by  $H_0$  (H-zero).

A statistical hypothesis in which there is no significant difference between the set of variables is a null hypothesis.

### 9.1.3 Alternative Hypothesis

A statistical hypothesis, which states that there is a significant difference between the set of variables, is an alternative hypothesis. A hypothesis other than the null hypothesis is an alternative. It is denoted by  $H_1$  (H-one). In other words, an alternative hypothesis is a contradictory statement to the null hypothesis.

Rejection of null hypothesis means that it is false but the decision of accepting  $H_0$  does not mean that it is true and therefore when we set the hypothesis, we write the statement in the null hypothesis that we want to reject.

As long as there is no contradiction, we retain  $H_0$  but, when we have some observation contradicting  $H_0$  we could expect that  $H_1$  is valid. So therefore  $H_0$  has benefit of doubt but  $H_1$  has burden of justification.

The researcher aims to prove an alternative hypothesis but in an indirect way. When the null hypothesis gets rejected the same time alternative hypothesis gets accepted. They are mutually exclusive and exhaustive.

### 9.1.4 Errors in Hypothesis Testing

Hypothesis testing may lead to two types of errors. Type I error and type II error.

Type I error: When the null hypothesis is true and the researcher rejects it, a type I error occurs. The probability of committing a type I error is called the significance level.

Type II error: When the null hypothesis is false and the researcher fails to reject it, a type II error occurs. The probability of committing a type II error is called the power of the test.

Decision ↓	$H_0$ (True)	$H_0$ (False)
Accept $H_0$	Correct decision	Type II error
Reject $H_0$	Type I error	Correct decision

The type I error is usually pre-defined.

If the type I error is fixed at 10 percent, it means that there are about 10 chances in 100 that we will reject  $H_0$  when  $H_0$  is true. If a type I error is fixed at a lower level, then it can be controlled.

For example, if we fix type I error at 5 percent, we will say that the maximum probability of committing a Type I error would only be 0.05.

With a fixed sample size,  $n$ , the probability of committing Type II error increases, when we try to reduce Type I error, simultaneously we cannot reduce both types of errors.

### 9.1.5 Types of Hypothesis Testing

1) Parametric Tests

2) Non-parametric Tests

1) Parametric Tests: It is a statistical test that depends on an assumption about the distribution of the data, that the data are normally distributed. In the case of a normal distribution of a population, these features are known as parameters.

Parametric analysis can only be used on quantitative data, as only quantitative data can have a normal distribution.

Parametric tests generate more information about the whole population as compared to non-parametric tests.

2) Non-parametric Tests: There is no need for any particular distribution for the data in the non-parametric tests of the null hypothesis. Even though quantitative data is not normally distributed or data is of any kind, non-parametric tests can be used.

Parametric tests should be used to find differences between the study groups if they exist. Hence, the Normal distribution of data plays an important role in hypothesis testing.

To carry out the parametric analysis, non-normally distributed data should transform into normally distributed data. Logarithmic transformation is the most commonly used method. Sample size and normal distribution of data are the main factors in hypothesis testing. For small-size data, non-parametric tests are used. Parametric tests can be used for large-size data, as large-size data will be more normally distributed and variation will be less.

### 9.1.6 Steps for Testing Hypothesis:

- 1) Setting up the hypothesis: This means that making a formal and clear statements of the null and alternating hypothesis.
- 2) Selecting the level of significance: significance level should be specified in advance as hypothesis are tested on pre-defined significance level. Generally, 5% or 1% level is used for testing.
- 3) Test Statistic: Hypothesis will be tested using formulae of test statistics for mean, proportion and variance.
- 4) Critical value: we obtain critical value using test statistic, level of significance ( $\alpha$ ) and the type of test (one-tailed or two-tailed).
- 5) Decision making: decision of rejection or not rejection of null hypothesis will be made after comparison of value of test statistic and critical value.

Null hypothesis will be rejected when

- a) Value of test statistic < lower critical value or Value of test statistic > lower critical value, in case of two-tailed test.
- b) Value of test statistic < critical value, in case of left-tailed test.
- c) Value of test statistic > critical value, in case of right-tailed test.

### 9.1.7 Hypothesis testing for Mean:

Here we test, whether population mean and hypothesized mean are same of different. Let,  $\mu_0$  be the hypothesized mean, we may test any of the following:

- (i)  $H_0: \mu = \mu_0$  against  $H_1: \mu \neq \mu_0$
- (ii)  $H_0: \mu = \mu_0$  against  $H_1: \mu > \mu_0$  or  $H_0: \mu \leq \mu_0$  against  $H_1: \mu > \mu_0$
- (iii)  $H_0: \mu = \mu_0$  against  $H_1: \mu < \mu_0$  or  $H_0: \mu \geq \mu_0$  against  $H_1: \mu < \mu_0$

#### a) S.D. is given

Test statistic is given by

$Z_c = \frac{\bar{x} - \mu_0}{\sigma / \sqrt{n}}$  here  $\bar{x}$  : sample mean,  $\sigma$  : standard deviation of population and  $n$  : sample size

**b) S.D. is not given**

Test statistic is given by

$$T_c = \frac{\bar{x} - \mu_0}{\frac{\sigma}{\sqrt{n}}} \quad \text{where } \sigma = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})^2}$$

here  $\bar{x}$  : sample mean,  $\sigma$  : standard deviation of population and  $n$  : sample size

**Example:**

Ten employees are selected from a firm and their weights are found to be, in kgs., 50, 52, 52, 53, 55, 56, 57, 58, 58 and 59. At 5% level of significance, check whether previous average weight i.e. 54 kg is equals current average weight or not.

Solution:

Here we want to test  $H_0: \mu = \mu_0$  against  $H_1: \mu \neq \mu_0$ , we have to check it is changed or not, hence it is two tailed test.

Here,

$H_0$  = average weight is not changed.

$H_1$  = average weight is changed.

Also, S.D. is not given.

We calculate mean, S.D. for given data.

x	x-x̄	(x-x̄) <sup>2</sup>
50	-5	25
52	-3	9
52	-3	9
53	-2	4
55	0	0
56	1	1
57	2	4
58	3	9
58	3	9
59	4	16
<b>550</b>		<b>86</b>

$$n = 10, \bar{x} = 55$$

$$\sigma = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})^2} = \sqrt{\frac{1}{9}(86)} = 3.0912$$

Test statistic is

$$T_c = \frac{\bar{x} - \mu_0}{\frac{\sigma}{\sqrt{n}}} = \frac{55 - 54}{3.0912/\sqrt{10}} = 1.022$$

Now, we calculate critical value with d.f. = (n-1) = 9 and significance level = 0.05

From student's t-distribution table we get

Critical value = 2.262

Here value of test statistic < critical value

So, we reject null hypothesis i.e. we reject 'average weight is not changed'.

Therefore, conclusion is average weight is changed from 54.

### 9.1.8 Hypothesis testing for Difference of Two Mean:

Here we test, whether population means of two samples are same or different. These population samples may be drawn from different populations. Let,  $x_1, x_2, \dots, x_n$  be sample drawn from one population with population mean  $\mu_x$  and population variance  $\sigma_x^2$  and  $y_1, y_2, \dots, y_m$  be sample drawn from another population with population mean  $\mu_y$  and population variance  $\sigma_y^2$ .

We may test any of the following:

- (i)  $H_0: \mu_x = \mu_y$  against  $H_1: \mu_x \neq \mu_y$
- (ii)  $H_0: \mu_x = \mu_y$  against  $H_1: \mu_x > \mu_y$  or  $H_0: \mu_x \leq \mu_y$  against  $H_1: \mu_x > \mu_y$
- (iii)  $H_0: \mu_x = \mu_y$  against  $H_1: \mu_x < \mu_y$  or  $H_0: \mu_x \geq \mu_y$  against  $H_1: \mu_x < \mu_y$

Let us see, different situations and test statistic under each situation:

- c) Both samples are independent of each other both population variances are known.

Let,  $\bar{x}, \bar{y}$  be sample means and  $\sigma_x^2, \sigma_y^2$  be variances of two samples with sample size  $n, m$  from two populations respectively.

Test statistic is given by

$$Z_c = \frac{\bar{x} - \bar{y}}{\sqrt{\frac{\sigma_x^2}{n} + \frac{\sigma_y^2}{m}}}$$

This test is also known as Z-test.

- d) Both samples are independent of each other both population variances are not known.

When population variances are unknown, student's t-test to be used. Student's t-test with  $m + n - 2$  degree of freedom has two conditions viz. both populations have normal distribution and their variances are equal.

Unknown variances are calculated by pooled sample variance given by

$$s^2 = \frac{1}{m + n - 2} \left[ \sum_{i=1}^n (x_i - \bar{x})^2 + \sum_{j=1}^m (y_j - \bar{y})^2 \right]$$

Test statistic is given by

$$T_c = \frac{\bar{x} - \bar{y}}{s \sqrt{\frac{1}{n} + \frac{1}{m}}}$$

- e) Both samples are related.  
Two samples are related means they are paired observations. So, clearly  $n = m$ . Here we use t-distribution with  $n - 1$  degree of

freedom (d.f.). Test statistic is  $T_c = \frac{\bar{d}}{s_d \sqrt{n}}$

where,  $d_i = x_i - y_i$  ( $i = 1, 2, \dots, n$ ),

$$\bar{d} = \frac{1}{n} \sum_{i=1}^n d_i \&$$

$$s_d = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (d_i - \bar{d})^2}$$

### Example:

In a survey of daily wages of workers, 400 workers are chosen at random in a company ABC. Their average daily wages are Rs. 250 with standard deviation of Rs.40. For 400 workers chosen from some other company XYZ, the average daily wages are Rs.220 with standard deviation of Rs.55. Are the average daily wages of workers in both companies same? Test at 5% level of significance.

### Solution;

Here we wish to test  $H_0: \mu_x = \mu_y$  against  $H_1: \mu_x \neq \mu_y$ , we have to check it is same or not, hence it is two tailed test.

Let,

$H_0$  = average daily wages of workers in both companies are not same

$H_1$  = average daily wages of workers in both companies are same

Given that,

$$n = 400, \bar{x} = 250, \sigma_x = 40, m = 400, \bar{y} = 220, \sigma_y = 55$$

Test statistic is

$$Z_c = \frac{\bar{x} - \bar{y}}{\sqrt{\frac{\sigma_x^2}{n} + \frac{\sigma_y^2}{m}}} = \frac{250 - 220}{\sqrt{\frac{(40)^2}{400} + \frac{(55)^2}{400}}} = 8.822575$$

Now we find critical value at 5% significance level and d.f.= 400 (infinity)

Critical values = -1.96 and 1.96 for two tailed test.

Since, calculated test statistic > Critical value

Therefore, we reject the null hypothesis and conclusion is daily wages of workers are same in both companies.

### 9.1.9 Hypothesis testing for Proportion:

Population has two mutually exclusive and exhaustive classes or groups based on certain attributes. One class possesses that attribute and another class not possesses that attribute. Here, population proportion is the parameter.

We may test any of the following:

- (i)  $H_0: \pi \leq \pi_0, H_1: \pi > \pi_0$  (right tail test)
- (ii)  $H_0: \pi \geq \pi_0, H_1: \pi < \pi_0$  (left tail test)
- (iii)  $H_0: \pi = \pi_0, H_1: \pi \neq \pi_0$  (two tail test)

Test statistic is given by

$$Z_c = \frac{p - \pi_0}{\sqrt{\frac{\pi_0(1 - \pi_0)}{n}}}$$

here  $p$  : sample proportion and  $n$  : sample size

Example:

A sample of 500 persons selected at random from a large city gives the results that 53% males are employed. Is there reason to doubt the hypothesis that males and females are in equal numbers in employment sector? Use 1% level of significance.

**Solution:**

We wish to test,  $H_0: \pi = 0.50$  against  $H_1: \pi > 0.50$  (right tailed test)

Given that,

Sample proportion = 0.53

Sample size = 500

$$Z_c = \frac{p - \pi_0}{\sqrt{\frac{\pi_0(1 - \pi_0)}{n}}} = \frac{0.53 - 0.50}{\sqrt{\frac{0.5(0.5)}{500}}} = 1.341641$$

Critical value with 0.01 significance level is 2.326

Since, test statistic < critical value

So null hypothesis not rejected. So number of male and females are same in employment sector.

**9.1.10 Hypothesis testing for Difference of Two Proportions:**

Here we compare two population proportions  $\pi_1$  and  $\pi_2$  with sample proportions  $p_1$  and  $p_2$  taken from two independent samples (large enough, >30) drawn from each population respectively.

We may test any of the following:

- (i)  $H_0: \pi_1 = \pi_2$  against  $H_1: \pi_1 \neq \pi_2$
- (ii)  $H_0: \pi_1 = \pi_2$  against  $H_1: \pi_1 > \pi_2$  or  $H_0: \pi_1 \leq \pi_2$  against  $H_1: \pi_1 > \pi_2$
- (iii)  $H_0: \pi_1 = \pi_2$  against  $H_1: \pi_1 < \pi_2$  or  $H_0: \pi_1 \geq \pi_2$  against  $H_1: \pi_1 < \pi_2$

The test statistic is  $Z_c = \frac{p_1 - p_2}{\sqrt{\bar{\pi}(1 - \bar{\pi})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$  where,  $\bar{\pi} = \frac{n_1 p_1 + n_2 p_2}{n_1 + n_2}$

Example: There are 100 students in a university college and in the whole university, inclusive of this college, the number of students is 2000. In a random sample study 20 were found smokers in the college and the proportion of smokers in the university is 0.05. Is there a significant difference between the proportion of smokers in the college and university? Test at 5 per cent level.

**Solution:**

Let  $H_0: \bar{p} = p$  (there is no difference between sample proportion and population proportion)

and  $H_1: \bar{p} \neq p$  (there is difference between the two proportions)

and on the basis of the given information, the test statistic  $z$  can be worked out as under:

$$Z_c = \frac{P_1 - P_2}{\sqrt{\bar{\pi}(1 - \bar{\pi})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} = \frac{0.2 - 0.05}{\sqrt{0.05(0.95)\left(\frac{1}{100} + \frac{1}{2000}\right)}} = \frac{0.150}{0.021} = 7.143$$

As the  $H_1$  is two-sided, we shall determine the rejection regions applying two-tailed test at 5 percent level and the same works out to as under, using normal curve area table:

$$R : |z| > 1.96$$

The observed value of  $z$  is 7.143 which is in the rejection region and as such we reject  $H_0$  and conclude that there is a significant difference between the proportion of smokers in the college and university.

## 9.2 CHI-SQUARE TEST

### 9.2.1 Introduction

A confidence interval of the unknown population variance is estimated by using the Chi-Square distribution. Here we use non-parametric tests which are not based on any parameter like mean, variance, proportion, etc. with the help of Chi-Square distribution.

These non-parametric tests are a) Test for equality of more than two population proportions. b) Test for independence of variable c) test for the goodness of fit

### 9.2.2 Test for equality of more than two population proportions.

Example: A food industry wishes to test if the proportion of its customers in three age groups are the same or not.

Industry conducts a sample survey of 1000 people in each age group and find that there are 400, 450 and 300 customers in the sample in three different age(in yrs.) groups (15-25, 25 - 40 and above 40).

Here, we wish to test

$H_0$  = proportion of its customers in three age groups are same.

$H_1$  = proportion of its customers in three age groups are not same.

Age group (yrs.) →	15 - 25	25 - 40	Above 40
Like	400	450	300
Dislike	600	550	700

The above table shows the number of individuals in respective age groups who like or dislike products of that food industry.

Test statistics Chi-square is,

$$\chi_c^2 = \frac{[O_{ij} - E_{ij}]^2}{E_{ij}}$$

Where,

$O_{ij}$  = Observed frequency of the ith row and jth column

$E_{ij}$  = Expected frequency of ith row and jth column

$$= \frac{[\text{corresponding row total} \times \text{corresponding column total}]}{\text{Grand Total}}$$

For contingency table having r-rows and c- columns,  $\chi_c^2$  follows chi-Square distribution with  $(r - 1) \times (c - 1)$  degree of freedom with three conditions

- (1) each cell has an expected frequency of at least 5
- (2) total sample size is at least 50
- (3)  $\sum O_{ij} = \sum E_{ij}$

For the above example,

Age group (yrs.) →	15 - 25	25 - 40	Above 40
Like	$O_{11} = 400$ $E_{11} = 383.33$	$O_{12} = 450$ $E_{12} = 383.33$	$O_{13} = 300$ $E_{13} = 383.33$
Dislike	$O_{21} = 600$ $E_{21} = 616.66$	$O_{22} = 550$ $E_{22} = 616.66$	$O_{23} = 700$ $E_{23} = 616.66$

$$\begin{aligned} \chi_c^2 &= \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \\ &= \frac{(400 - 383.33)^2}{383.33} + \frac{(450 - 383.33)^2}{383.33} + \frac{(300 - 383.33)^2}{383.33} + \frac{(600 - 616.66)^2}{616.66} + \frac{(550 - 616.66)^2}{616.66} + \frac{(700 - 616.66)^2}{616.66} \\ &= 49.354183 \end{aligned}$$

We then compare the test statistic to the critical Chi-square value.

Here we set alpha value = 0.05 (i.e. 5%) and the degrees of freedom =  $(2-1)(3-1) = 2$

For d.f. 2 and 5% significance level critical value is 5.991

Since  $\chi_c^2 > \chi_{cc}^2$

Therefore, we reject the null hypothesis  $H_0$  at a 5% significance level and conclude that the Subject and mode of learning are not independent.

### 9.2.3 Test for the independence of variable

The Chi-square **test of independence** is a statistical hypothesis test used to determine whether two categorical or nominal variables are likely to be related or not. This test does not measure the degree of relationship between two attributes. If the calculated value of  $\chi^2$  is less than the table value at a certain level of significance for a given degree of freedom, we conclude that the null hypothesis is rejected.

#### Example:

Consider the data for 500 students at college. For each student, we know the subject and mode of learning, whether online or on campus.

Our variables are the subject and whether online or on-campus learning. Both variables are categorical.

The last requirement is at least five expected values for each combination of the two variables. To confirm this, we need to know the total counts for each subject learned and the total counts for whether online or on-campus learning.

Here we wish to test,

$H_0$  = 'subject' and 'mode of learning' are independent.

$H_1$  = 'subject' and 'mode of learning' are not independent.

Subject learned	Online	On-campus
Mathematics	60	75
Communication Skills	85	95
History	90	30
Information Technology	45	20

To find expected counts for each subject-mode of learning combination, we first need the row and column totals, which are shown below:

Contingency table for subject-mode of learning combination with row and column totals

<b>Subject learned</b>	<b>Online</b>	<b>On-campus</b>	<b>Row totals</b>
<b>Mathematics</b>	60	75	135
<b>Communication Skills</b>	85	95	180
<b>History</b>	90	30	120
<b>Information Technology</b>	45	20	65
<b>Column totals</b>	<b>280</b>	<b>220</b>	<b>GRAND TOTAL = 500</b>

Here are the actual and expected counts for each subject-mode of learning combination. In each cell below, the expected count appears in **bold** below the actual count. The expected counts are rounded to the nearest whole number.

Expected frequency of any cell =  $[(\text{Row total for the row of that cell}) * (\text{Column total for the column of that cell})] / (\text{Grand Total})$

Contingency table for subject-mode of learning combination showing actual count vs. expected count

<b>Subject learned</b>	<b>Online</b>	<b>On-campus</b>	<b>Row totals</b>
<b>Mathematics</b>	60 <b>76</b>	75 <b>59</b>	135
<b>Communication Skills</b>	85 <b>101</b>	95 <b>79</b>	180
<b>History</b>	90 <b>67</b>	30 <b>53</b>	120
<b>Information Technology</b>	45 <b>36</b>	20 <b>29</b>	65
<b>Column totals</b>	<b>280</b>	<b>220</b>	<b>GRAND TOTAL = 500</b>

The expected counts use the row and column totals. If we look at each of the cells, we can see that some expected counts are close to the actual counts but most are not. If there is no relationship between the subject learned and the mode of learning, the actual and expected counts will be similar. If there is a relationship, the actual and expected counts will be different.

Lastly, to get our test statistic,

$$\chi_c^2 = \sum \left[ \frac{(O-E)^2}{E} \right]$$

$$= 3.29+3.52+5.81+6.21+12.65+13.52+9.68+10.35=65.03$$

We then compare the test statistic to the critical Chi-square value.

Here we set alpha value = 0.05 (i.e. 5%) and the degrees of freedom= (4-1)(2-1) = 3

For d.f. 3 and 5% significance level critical value is 7.815.

Since  $\chi_c^2 > \chi_{\alpha}^2$

Therefore, we reject the null hypothesis  $H_0$  at a 5% significance level and conclude that the Subject and mode of learning are not independent.

#### 9.2.4 Test for the goodness of fit

The Chi-square **goodness of fit** test checks whether your sample data is likely to be from a specific theoretical distribution. We have a set of data values and an idea about how the data values are distributed. The test gives us a way to decide if the data values have a “good enough” fit to our idea, or if our idea is questionable.

Conditions for continuity of  $\chi^2$  test i.e. for the validity of  $\chi^2$  test of goodness of fit between theory and experiment the following conditions must be satisfied

- 1) Sample observations are drawn independently
- 2)  $\sum O_{ij} = \sum E_{ij}$  for all i, j
- 3) Total frequency should be very large i.e. at least 50
- 4) No theoretical cell frequency should be less than 5

#### *Example:*

We collect a random sample of five boxes. Each box has 60 pens and four colors. We hypothesize that the proportions of the four colors in each box are the same.

$H_0$  = proportion of the four colors in each box is the same.

$H_1$  = proportion of the four colors in each box is not the same.

We have a simple random sample of 5 boxes of pens. Our categorical variable is the color of the pen. We have the count of each color in 5 boxes of pens.

Each bag has 60 pens. Each box has four colors of pens. We expect to have equal numbers for each color. This means we expect  $60 / 4 = 15$  pens of each color from each box.

For 5 boxes in our sample, we expect  $5 \times 15 = 75$  pens of each color. This is more than the requirement of five expected values in each category.

Expected frequency of any cell =

$$\frac{[(\text{Row total for the row of that cell}) \times (\text{Column total for the column of that cell})]}{(\text{Grand Total})}$$

Color	Number of Pens (05 bags)	Expected Number of pens	Observed – Expected	Squared Difference	Squared Difference / Expected Number
Red	70	75	5	25	$25 / 75 = 0.33$
Blue	65	75	10	100	$100 / 75 = 1.33$
Black	70	75	5	25	$25 / 75 = 0.33$
Green	95	75	20	400	$400 / 75 = 5.33$
Total	300	300	–	–	7.32

Finally, we calculate the test statistic = 7.32

We then compare the test statistic to the critical Chi-square value.

Here we set alpha value = 0.05 (i.e. 5%) and the degrees of freedom =  $(4-1)(4-1) = 9$

For d.f. 9 and 5% significance level critical value is 16.919

Since  $\chi_c^2 < \chi_{\alpha}^2$

Therefore, we accept the null hypothesis  $H_0$  at a 5% significance level and conclude that proportion of the four colors in each box may be the same.

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## 9.3 ANALYSIS OF VARIANCE (ANOVA)

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### 9.3.1 Introduction

ANOVA was developed and practiced by Professor R. A. Fisher later on professor Snedecor and many others contributed in development of ANOVA. The difference between different groups of data for homogeneity is tested by using ANOVA techniques.

“The essence of ANOVA is that the total amount of variation in a set of data is broken down into two types, that amount which can be attributed to chance and amount which can be contributed to specified causes.” There may be variation between samples and also within sample items.

To compare more than two populations, ANOVA plays an important role. To compare yield of crop from different types of soils, to compare diet habits of people from different age groups, etc. In such cases, one generally does not want to consider all possible combinations of two populations at a time for that would require a large number of tests before we would be able to arrive at a decision. This testing requires lots of money and time, even after these tests some relationship between population or attributes remains unidentified. Through this technique one can explain whether various varieties soils or age groups etc differ significantly so that a policy decision could be taken accordingly.

In general ANOVA technique helps to investigate any number of factors which are hypothesized or said to influence the dependent variable.

Also, the differences amongst various categories within each of these factors be investigated by this technique.

If we take only one factor and investigate the differences amongst its various categories having numerous possible values, we are said to use one-way ANOVA and in case we investigate two factors at the same time, then we use two-way ANOVA.

The basic principle of ANOVA is to test differences among the means of the populations examining the amount of variation within each of these samples, relative to the amount of variation between the samples. The total variance in the joint sample is partitioned into two parts (a) between samples variance, and (b) within samples variance. Between samples variance is due to different treatments, while within samples variance is due to the random unexplained disturbance.

Test statistic is defined as

$$F_c = \frac{\text{between sample variance}}{\text{within sample variance}}$$

Using this method, we wish to test

**H<sub>0</sub>** : all population means are the same (i.e., effects of all treatments are the same)

$H_1$  : all population means are not the same (i.e., effects of all treatments are not the same)

When the effects of all the treatments will be different, between samples variance will be large. In such cases calculated  $F_c$  will be large and hence we reject null hypothesis. Therefore, ANOVA is right tailed test.

### 9.3.2 ONE WAY ANOVA:

Calculation Steps:

For  $k$  samples, having  $n_1, n_2, \dots, n_k$  number of items respectively,  
 $n = n_1 + n_2 + \dots + n_k$

1) calculate mean of each sample

i.e. calculate  $\bar{x}_1, \bar{x}_2, \dots, \bar{x}_k$

2) calculate mean of the sample means

i.e. calculate  $\bar{\bar{x}} = \frac{\bar{x}_1 + \bar{x}_2 + \dots + \bar{x}_k}{k}$

3) calculate sum of squares for variance between the samples or SS between

$$SS \text{ between} = n_1(\bar{x}_1 - \bar{\bar{x}})^2 + n_2(\bar{x}_2 - \bar{\bar{x}})^2 + \dots + n_k(\bar{x}_k - \bar{\bar{x}})^2$$

4) calculate mean square between samples

MS between =  $\frac{SS \text{ between}}{k-1}$  where,  $k-1$  is degree of freedom between samples

5) calculate sum of squares for variance within samples

$$SS \text{ within} = \sum (x_{1i} - \bar{x}_1)^2 + \sum (x_{2i} - \bar{x}_2)^2 + \dots + \sum (x_{ki} - \bar{x}_k)^2 \quad \text{for } i = 1, 2, 3, \dots$$

6) calculate mean square within samples

MS within =  $\frac{SS \text{ within}}{n-k}$  where,  $n-k$  is degree of freedom within samples

7) calculate sum of squares of deviations for total variance

$$SS \text{ for total variance} = \sum (x_{ij} - \bar{\bar{x}})^2 \quad i = 1, 2, \dots \text{ and } j = 1, 2, \dots$$

Also

SS for total variance = SS between + SS within

and d.f. for total variance = d.f. for between + d.f. for within

$$= (k-1) + (n-k) = n-1$$

8) finally, calculate test statistic

$$F - \text{ratio} = \frac{MS \text{ between}}{MS \text{ within}}$$

9) calculate Critical value from F-distribution table.

Critical value = F-distribution (d.f. for between, d.f for within)

here,  $v_1 = \text{d.f. for between}$  ,  $v_2 = \text{d.f for within}$

10) conclusion

Now we can decide whether to reject or not reject the null hypothesis.

### 9.3.3 TWO WAY ANOVA:

Two-way ANOVA technique is used when the data are classified with respect to two factors.

For example, the agricultural yield may be classified with respect to different varieties of seeds and also with respect to different varieties of fertilizers used. A business firm may have its sales data classified with respect to different salesmen and also with respect to sales in different regions. In a factory, the various units of a product produced during a certain period may be classified with respect to different varieties of machines used and also with respect to different situation of weather. Such a two-way design may have repeated measurements of each factor or may not have repeated values. The ANOVA technique is little different in case of repeated measurements where we also compute the interaction variation.

#### 9.3.3.1 One Observation per Cell:

We have to calculate this residual or error variation by subtraction, once we have calculated (just on the same lines as we did in the case of one-way ANOVA) the sum of squares for total variance and for variance between varieties of one treatment as also for variance between varieties of the other treatment.

Calculation Steps:

1) Calculate T = total of the values of individual items in all the samples.

2) Calculate Correction factor  $= \frac{(T)^2}{n}$

3) Calculate sum of squares of deviations for total variance or total SS

$$\text{Total SS} = \sum x_{ij}^2 - \frac{(T)^2}{n}$$

4) Take the total of different columns and then obtain the square of each column total and divide such squared values of each column by the number of items in the concerning column and take the total of the result thus obtained. Finally, subtract the correction factor from this total to

obtain the sum of squares of deviations for variance between columns or (SS between columns).

$$\text{SS between columns} = \frac{\sum(T_j)^2}{n_j} - \frac{(T)^2}{n}$$

5) Take the total of different rows and then obtain the square of each row total and divide such squared values of each row by the number of items in the corresponding row and take the total of the result thus obtained. Finally, subtract the correction factor from this total to obtain the sum of squares of deviations for variance between rows (or SS between rows).

$$\text{SS between rows} = \frac{\sum(T_i)^2}{n_i} - \frac{(T)^2}{n}$$

6) Calculate Sum of squares of deviations for residual or error variance

SS for residual or error variance = Total SS – (SS between columns + SS between rows)

7) Calculate Degrees of freedom (d.f.)

d.f. for total variance = (c. r – 1)

d.f. for variance between columns = (c – 1)

d.f. for variance between rows = (r – 1)

d.f. for residual variance = (c – 1) (r – 1)

where c = number of columns and r = number of rows

8) Calculate Mean squares

$$\text{MS between columns} = \frac{\text{SS between columns}}{(c-1)}$$

$$\text{MS between rows} = \frac{\text{SS between rows}}{(r-1)}$$

$$\text{MS for residual or error} = \frac{\text{SS for residual or error}}{(c-1)(r-1)}$$

here we wish to test

a)  $H_{0c}$ : the varieties of first factor have the same effect

Against

$H_{1c}$  : the varieties of first factor are significantly different

The test statistic is

$$F_c = \frac{\text{MS between columns}}{\text{MS residuals}}$$

It follows F distribution with  $((c-1), (c-1)(r-1))$  d.f.

- b)  $H_{0c}$ : the varieties of second factor have the same effect  
 Against  
 $H_{1c}$ : the varieties of second factor are significantly different  
 The test statistic is  

$$F_R = \frac{\text{MS between rows}}{\text{MS residuals}}$$
 It follows F distribution with  $((r - 1), (c - 1)(r - 1))$  d.f.

**Example:**

The following table gives the monthly sales (in thousand rupees) of a certain firm in three states by its four salesmen:

States	Salesmen				Total
	A	B	C	D	
X	5	4	4	7	20
Y	7	8	5	4	24
Z	9	6	6	7	28
Total	21	18	15	18	72

Calculate F-coefficients and state whether the difference between sales affected by the four salesmen and difference between sales affected in three States are significant.

**Solution:**

Here no. of rows (r) = 3, no. of columns(c) = 4, total no. of observations (n) = 12

Sum of all observations = T = 72

$$\text{Correction factor} = \frac{(T)^2}{n} = \frac{(72)^2}{12} = \frac{5184}{12} = 432$$

Total SS =

$$\sum x_{ij}^2 - \frac{(T)^2}{n} = (5^2 + 4^2 + 4^2 + 7^2 + 7^2 + 8^2 + 5^2 + 4^2 + 9^2 + 6^2 + 6^2 + 7^2) - 432$$

$$= 462 - 432 = 30$$

SS between columns =

$$\frac{\sum (T_j)^2}{n_j} - \frac{(T)^2}{n} = \left[ \frac{(21)^2}{3} + \frac{(18)^2}{3} + \frac{(15)^2}{3} + \frac{(18)^2}{3} \right] - 432$$

$$= 438 - 432 = 6$$

$$\text{SS between rows} = \frac{\sum(T_i)^2}{n_i} - \frac{(T)^2}{n} = \left[ \frac{(20)^2}{4} + \frac{(24)^2}{4} + \frac{(28)^2}{4} \right] - 432$$

$$= 440 - 432 = 8$$

SS for residual or error variance = Total SS – (SS between columns + SS between rows)

$$= 30 - (8+6) = 16$$

$$\text{d.f. for total variance} = (c \cdot r - 1) = (4)(2) = 8$$

$$\text{d.f. for variance between columns} = (c - 1) = 3$$

$$\text{d.f. for variance between rows} = (r - 1) = 2$$

$$\text{d.f. for residual variance} = (c - 1)(r - 1) = (3)(2) = 6$$

$$\text{MS between columns} = \frac{\text{SS between columns}}{(c - 1)} = \frac{6}{3} = 2$$

$$\text{MS between rows} = \frac{\text{SS between rows}}{(r - 1)} = \frac{8}{2} = 4$$

$$\text{MS for residual or error} = \frac{\text{SS for residual or error}}{(c - 1)(r - 1)} = \frac{16}{(3)(2)}$$

$$= 2.66667$$

$$F_c = \frac{\text{MS between columns}}{\text{MS residuals}} = \frac{2}{2.66} = 0.75$$

It follows F distribution with  $((c - 1), (c - 1)(r - 1))$  d.f. i.e. with d.f. = (3, 6)

Critical value = 4.76

$$F_R = \frac{\text{MS between rows}}{\text{MS residuals}} = \frac{4}{2.66} = 1.5$$

It follows F distribution with  $((r - 1), (c - 1)(r - 1))$  d.f. i.e. with d.f. = (2, 6)

Critical value = 5.14

From the above calculation we find that, the difference between sales affected by the four salesmen and difference between sales affected in three States are insignificant, since F-ratio's are less than table values at 5% significance level.

### 9.3.3.2 More than One Observation per Cell:

We can obtain a separate independent measure of inherent or smallest variations with repeated measurements for all of the categories using two way ANOVA. For this measure we can calculate the sum of squares and

degrees of freedom in the same way as we had worked out the sum of squares for variance within samples in the case of one-way ANOVA. Total SS, SS between columns and SS between rows can also be calculated as stated above. We then find left-over sums of squares and left-over degrees of freedom which are used for what is known as 'interaction variation' (Interaction is the measure of inter relationship among the two different classifications).

**Example:**

Is the interaction variation significant in case of the following information concerning mileage based on different brands of gasoline and cars?

		Brands of gasoline				Total
		W	X	Y	Z	
cars	A	13	12	12	11	93
		11	10	11	13	
	B	12	10	11	9	88
		13	11	12	10	
	C	14	11	13	10	93
		13	10	14	8	
Total		76	64	73	61	274

Here c=4, r = 3, T = 274, n= 24

$$\text{Correction factor} = \frac{(274)^2}{24} = 3128.167$$

$$\text{Total SS} = 3184 - 3128.167 = 55.83$$

SS between columns (brands of gasoline) =

$$\left[ \frac{(76)^2}{6} + \frac{(64)^2}{6} + \frac{(73)^2}{6} + \frac{(61)^2}{6} \right] - 3128.167$$

$$= 3153.667 - 3128.167 = 25.5$$

$$\text{SS between rows (Cars)} = \left[ \frac{(93)^2}{8} + \frac{(88)^2}{8} + \frac{(93)^2}{8} \right] - 3128.167$$

$$= 3130.25 - 3128.167 = 2.08$$

SS within samples (error)=

$$\begin{aligned} & (13 - 12)^2 + (11 - 12)^2 + (12 - 12.5)^2 + (13 - 12.5)^2 + \\ & (14 - 13.5)^2 + (13 - 13.5)^2 + (12 - 11)^2 + (10 - 11)^2 + (10 - \\ & 10.5)^2 + (11 - 10.5)^2 + (11 - 10.5)^2 + (10 - 10.5)^2 + (12 - \\ & 11.5)^2 + (11 - 11.5)^2 + (11 - 11.5)^2 + (12 - 11.5)^2 + (13 - \\ & 13.5)^2 + (14 - 13.5)^2 + (11 - 12)^2 + (13 - 12)^2 + (9 - 9.5)^2 + \\ & (10 - 9.5)^2 + (10 - 9)^2 + (8 - 9)^2 \end{aligned}$$

$$= 12$$

SS for interaction variation

= Total SS - (SS between columns + SS between rows + SS within samples)

$$= 55.83 - (25.5 + 2.08 + 12) = 16.25$$

d.f. for variance between columns =  $(c - 1) = 3$

d.f. for variance between rows =  $(r - 1) = 2$

d.f. for interaction =  $(c - 1)(r - 1) = (3)(2) = 6$

d.f. for within samples(error)

=  $(n-1) - \text{d.f. for variance between columns} - \text{d.f. for variance between rows} - \text{d.f. for interaction} = 23 - 3 - 2 - 6 = 12$

$$\text{MS between columns} = \frac{\text{SS between columns}}{(c - 1)} = \frac{25.5}{3} = 8.5$$

$$\text{MS between rows} = \frac{\text{SS between rows}}{(r - 1)} = \frac{2.08}{2} = 1.04$$

$$\text{MS interaction} = \frac{\text{SS for interaction}}{(c - 1)(r - 1)} = \frac{16.25}{(3)(2)} = 2.70$$

$$\text{MS within samples (error)} = \frac{\text{SS within samples}}{\text{d.f. for within samples}} = \frac{12}{12} = 1$$

$$F_C = \frac{\text{MS between columns}}{\text{MS within samples}} = \frac{8.5}{1} = 8.5$$

It follows F distribution with  $((c - 1), \text{d.f. for within sample})$  d.f. i.e. with d.f. = (3, 12)

Critical value = 3.49

$$F_R = \frac{\text{MS between rows}}{\text{MS within samples}} = \frac{1.04}{1} = 1.04$$

It follows F distribution with  $((r - 1), \text{d.f. for within sample})$  d.f. i.e. with d.f. = (2, 12)

Critical value = 3.88

$$F_1 = \frac{\text{MS Interaction}}{\text{MS within samples}} = \frac{2.70}{1} = 2.70$$

It follows F distribution with  $((r - 1)(c - 1), \text{d.f for within sample})$  d.f. i.e. with d.f. = (6, 12)

Critical value = 3

Since  $F_1 >$  critical value, interaction term is significant at 5% significant level.

## 9.4 SELF ASSESSMENT QUESTIONS

- 1) In a test given to two groups of students, the marks obtained were as follows:

First Group	18	20	36	50	49	36	34	49	41
Second Group	29	28	26	35	30	44	46		

Examine the significance of difference between mean marks obtained by students of the above two groups. Test at five per cent level of significance.

- 2) Ten young recruits were put through a strenuous physical training program by the army. Their weights

(in kg) were recorded before and after with the following results:

Recruit	1	2	3	4	5	6	7	8	9	10
Weight before	127	195	162	170	143	205	168	175	197	136
Weight after	135	200	160	182	147	200	172	186	194	141

Using 5% level of significance, should we conclude that the program affects the average weight of young recruits?

- 3) Suppose that a public corporation has agreed to advertise through a local newspaper if it can be established that the newspaper circulation reaches more than 60% of the corporation's customers. What  $H_0$  and  $H_a$  should be established for this problem while deciding on the basis of a sample of customers whether or not the corporation should advertise in the local newspaper? If a sample of size 100 is collected and 1% level of significance is taken, what is the critical value for making a decision whether or not to advertise? Would it make any difference if we take a sample of 25 in place of 100 for our purpose? If so, explain.

4) The means of the random samples of sizes 9 and 7 are 196.42 and 198.42 respectively. The sums of the squares of the deviations from the mean are 26.94 and 18.73 respectively. Can the samples be constituted to have been drawn from the same normal population? Use 5% level of significance.

5) A farmer grows crops on two fields A and B. On A he puts Rs. 10 worth of manure per acre and on B Rs 20worth. The net returns per acre exclusive of the cost of manure on the two fields in the five years are:

Year	1	2	3	4	5
Field A, Rs per acre	34	28	42	37	44
Field B, Rs per acre	36	33	48	38	50

Other things being equal, discuss the question whether it is likely to pay the farmer to continue the more expensive dressing. Test at 5% level of significance.

6) A die is thrown 132 times with following results:

Number turned up	1	2	3	4	5	6
Frequency	16	20	25	14	29	28

Is the die unbiased?

7) The table given below shows the data obtained during outbreak of smallpox:

	Attacked	Not attacked	Total
Vaccinated	31	469	500
Not vaccinated	185	1315	1500
Total	216	1784	2000

Test the effectiveness of vaccination in preventing the attack from smallpox. Test your result

with the help of  $\chi^2$  at 5 per cent level of significance.

8) The following information is obtained concerning an investigation of 50 ordinary shops of small size:

	Shops		Total
	In towns	In villages	
Run by men	17	18	35
Run by women	3	12	15
Total	20	30	50

Can it be inferred that shops run by women are relatively more in villages than in towns? Use  $\chi^2$  test.

9) Set up ANOVA table for the following information relating to three drugs testing to judge the effectiveness in reducing blood pressure for three different groups of people:

**Amount of Blood Pressure Reduction in Millimeters of Mercury**

		Drugs		
		X	Y	Z
Group of people	A	14	10	11
		15	9	11
	B	12	7	10
		11	8	11
	C	10	11	8
		11	11	7

Do the drugs act differently?

Are the different groups of people affected differently?

Is the interaction term significant?

Answer the above questions taking a significant level of 5%.

10) Set up an analysis of variance table for the following per acre production data for three varieties of wheat, each grown on 4 plots and state if the variety differences are significant.

Plot of land	Per acre production data		
	Variety of wheat		
	A	B	C
1	6	5	5
2	7	5	4
3	3	3	3
4	8	7	4



## RESEARCH REPORT

### Unit Structure

- 10.0 Objectives
- 10.1 Introduction
- 10.2 Types of research reports – Brief reports and Detailed reports
- 10.3 Report writing
- 10.4 Report writing: Formulation rules for writing the report
- 10.5 Guidelines for presenting tabular data
- 10.6 Guidelines for visual Representations
- 10.7 Meaning of Research Ethics
- 10.8 Client's Ethical code
- 10.9 Researcher's Ethical code
- 10.10 Ethical Codes related to respondents
- 10.11 Responsibility of ethics in research
- 10.12 Self-Assessment Questions

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### 10.0 OBJECTIVES

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1. To understand purpose of writing a research report.
2. To study different types of research report and rules for writing the report.
3. Exploring key features of research report.
4. Understanding guidelines to represent data in report.
5. Studying ethical code related to client, researcher and respondents.

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### 10.1 INTRODUCTION

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A research report is a well-executed document that outlines the processes, data, and findings of an investigation in a systematic way. It is a document that serves as a first-hand account of the research process and study, and it is usually considered an accurate source of information.

A research report can be considered as a summary of the research process that clearly highlights findings, recommendations, and other important

details. Reading a well-written research report should provide you with all the information you need about the core areas of the research process.

Report writing is one of the most important activities of the entire process of conducting a research study. It is through this report that the researcher is able to convey in writing the explanations to the following factors.

- The objective of the research study.
- Method of the research study
- Observations of the research study.
- Resources used in the research.

It is through this report that the researcher is able to emphasize his contribution to the research topic and the knowledge gathered during the entire process. Hence the report should reflect the knowledge and expertise in the area of his research, logical and analytical skills, creativity in terms of report designing and presentation etc. Research is an activity where process and outcome is open to public scrutiny and analysis.

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## **10.2 TYPES OF RESEARCH REPORTS**

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### **Types of Research Report**

Depending on its intended audience, the research report may be either technical, popular, brief or detail.

#### **Technical Report**

The technical report is generally intended for other researcher or for research managers. The report should enable another researcher to be critic of methodology, check calculations and accuracy and to follow everything which is done on a step by step basis. A brief definition of all the technical term should be given.

#### **The popular Report**

The popular report is more for a more general audience, one that is not familiar with the details of research methods and terminology. Compared to the technical report, the presentation will be a bit livelier with increased attention to headlines, flow diagrams, charts, tables and occasional summaries for the purpose of stressing major points.

#### **Brief Reports**

Brief reports are to the point reports that are usually suitable for the presentation of previously published research. Brief reports are similar to original research as they follow the same format and guidelines, but are designed for small-scale research or research that is in early stages of development. These may include preliminary studies that utilize a simple research design or a small sample size and that have produced limited raw data and initial findings that may need further investigation.

## Detailed Reports

A detailed report is a report where each and every detail is mentioned in the report in terms of primary analysis, right until the last stages of analysis and conclusion. It is a very comprehensive report containing all the possible information related and relevant to the study. The researcher must it a point to cover all aspects of the study through this kind of report.

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### 10.3 REPORT WRITING

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It is one of the most important activities of conducting a research study. After the researcher has performed the complete study, it is important to record its findings in a systematic manner that can be used repeatedly for multiple purposes. Hence the report writing activity has gained much importance for this objective.

#### a) Guidelines for writing a report

There are certain points to be kept in mind while writing a research report.

**The Audience:** The report should be clear to the readers with familiar words and terms that can be understood by the audience. The technical terms should be defined clearly. To make the report easily understandable, the researcher must use percentages, rounded off figures, ranks or ratios. The researcher must also must put the exact data in a tabular form for better analysis of the report. They must use charts, graphs, pictures etc. wherever they help clarify and explain the accurate presentation of data.

**Information:** The research report is designed to communicate information to its readers in order to aid decision making or any other purpose. Hence it is important to make sure that the report clearly relates the research findings to the objectives of the research which was conducted.

**Concise and Complete:** Knowing what to leave out and to put only the required information can be very tricky sometimes. The researcher needs to make sure that all the information is being presented in the report in an accurate and concise manner. It is also important to note that the information is complete and presented with all the information gathered.

#### b) Steps in writing a Report

The method of carrying out the study, assembling of data and compiling of a report should be carried on in the following ways.

1. **Preparation:** The researcher needs to prepare mentally for the task of report writing. He needs to accurately understand the purpose of his report and its objectives as defined in the purpose of the research mentioned in the primary stages.

2. **Gathering Information:** This is the stage of gathering information. Collection of data such as facts, figures ideas etc. about the subject by

whatever means and resources available. Some of the means used in gathering the information are

- a. **By Observation:** By looking at situations, incidences, people and their behaviour etc, we can record these sequences in detail and collect relevant data.
- b. **By Reading:** We can collect information by reading the published work of other researchers on similar issues, factual documentation produced, documentation of professional bodies will provide enough information related to the subject.
- c. **By Interviews:** interviews can be formal or informal depending upon their nature and the person being interviewed. A lot of data can be collected this way.
- d. **By Discussion:** focus groups and brainstorming sessions are a great source of gathering data for research and the same can be used further.
- e. **By Surveys:** Surveys can be carried out to assess customer opinion and reactions. These are also useful in understanding people's attitudes. Questionnaires are useful instruments in carrying out surveys and collecting the data required for research purposes.

Other methods of data collection are secondary sources, enquiries, experiment

3. **Sorting, selecting, arranging and recording the material:** After assembling all the material, the researcher must check to ensure that he is in possession of all supporting documents for all his arguments. Data should be arranged in logical sequence, start to finish, ensuring a natural flow.

4. **Writing the Introduction:** The introduction provides the background along with the purpose of the study and other overall information of the entire research report.

5. **Recording Inferences:** recording inferences facilitates in understanding the quality of investigations and gauge the success of work. Hence inferences should form an important part of the research report.

6. **Writing Recommendation**

7. **Preparing the report presentation**

8. **Typing the report**

c) **Structure of a Report:**

The format of a report varies as per the type and purpose of the research study. However, there are general guidelines in the form of a format that

could be modified in a suitable manner as per the requirements of the researcher.

### **It comprises of the following parts**

- Preliminary section
- Main Body of the report
- Concluding section

### **Preliminary Section**

1. **Title Page:** The title page covers the title of the project. Along with other information like name of the researcher, name of the Institute or organisation that he is associated with. It also mentions any assigned guide or faculty if applicable.
2. **Index of Contents:** The index includes information of the content covered in the entire research report along with their corresponding page numbers.
3. **Executive Summary:** The summary elaborates about the title of the project in brief, bringing out the background and objective of the study. It also aims to bring out the conclusion drawn from the study conducted in a short and concise manner.

### **Main Body of the report**

This is the main part of the research report and contains the entire research process. It comprises of Introduction, methodology of conducting study, analysis etc,

#### **Introduction**

This section contains the reason and intent of the research conducted. The reasons that led to the conduct of the study.

#### **Literature Review**

This part of the body helps to put the research into a background context and aims to explain its importance. Books and articles which relate directly to the research topic is mentioned in this section. Previously published information is also addressed and referenced in the literature review section.

#### **Methodology**

Methodology deals with the methods and principles used in the research. In the methodology chapter, method/s used for the research and why the researcher thought they were the appropriate methods, are explained. The researcher, for example, may depend mostly upon secondary data or might have collected his own data. He should explain the method of data collection, materials used, subjects interviewed, or places visited. He must

give a detailed account of how and when the research was carried out and explain why he used the particular method/s, rather than other methods.

### **Results**

The researcher must record his findings and give a clear presentation of his results. He must be able to show the essential data and calculations too. The researcher may use tables, graphs and figures in order to present his findings in an appropriate manner.

### **Discussion**

The researcher must interpret his results. He must be able to analyse his data and how do they compare with those of others who have done similar research in this area. The accuracy of his measurements/results should be discussed and deficiencies, if any, in the research design should be mentioned.

### **Conclusion**

The researcher must summarize briefly the main conclusions which were discussed under “Results.” Was the researcher able to answer some or all of the questions which were raised in his aims and objectives? The researcher must not be tempted to draw conclusions which are not backed up by supporting evidence. He must also make a note of any deviation/s from expected results and any failure to achieve all that he had intended to prior to the findings.

### **Recommendations**

The researcher must make his recommendations, if required. The suggestions for action and further research should be given as found appropriate by him.

### **Concluding Section**

#### **Reference**

The reference contains the names of authors, books, articles etc. publications, websites’ addresses, used specifically in the report.

#### **Acknowledgements**

The researcher must acknowledge the type of guidance or use of resources in the overall conduct of the study or a specific part like conducting the survey or use of any technical machines, computers etc. that supported facilitation in the collection of data. The researcher must also mention any guidance or assistance received from persons with regards to his research study.

The appendices include the data collected, the detailed analysis and tables/ graphs/ charts etc. the appendices are to be numbered according to the order in which these are referred in the text

**d) Interpretations of Results and Suggested Recommendations**

This section provides a detailed summary of the study's findings. The study's findings must be transformed into a business action plan, which demands the researcher's ability to interpret the findings and simplify the data so that it is easily comprehended by the reader. The results of the study should be supported by data from previous studies. The suggestions section should provide recommendations to decision makers based on the study's results. Since the recommendations will be converted into an action plan, it is essential that they are practical and realistic.

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**10.4 REPORT WRITING: FORMULATION RULES FOR WRITING THE REPORT**

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1. Report must be written in paragraph, which will make it easy for narration. This will aid in the organization of sentences that centre around a specific central idea. Also, by linking one sentence to the next, continuity must be preserved.
2. While writing a report present tense must be used. For example, instead of saying "The respondents were using product X" say "The respondents use product X".
3. Wherever necessary, appropriate headings and subheadings must be provided.
4. The report must be long enough to cover the subject yet brief enough to hold the reader's interest.
5. While writing the report, use of technical jargon should be kept to a minimum, and grammatical mistakes should be avoided. It is critical to ensure that the report is clear and easy to understand for the reader.
6. To highlight key findings from the study, numerical data should be presented in tabular format so that the reader may easily locate relevant information in less time.
7. While writing the report, the respondent's identity should be kept confidential.
8. Any assumptions made by the researcher when writing the report should be clearly stated.

## **10.5 GUIDELINES FOR PRESENTING TABULAR DATA**

Tables are the most effective way to represent numerical data. With the help of a table, even complex and extensive data can be easily comprehended. When numerical data is presented in tabular form, the reader has quick access to information and is able to compare important data more easily. For example, if the revenues and sales growth of a certain firm need to be compared over the course of ten years, tabular data can help. When displaying data in tabular form, the following guidelines must be followed-

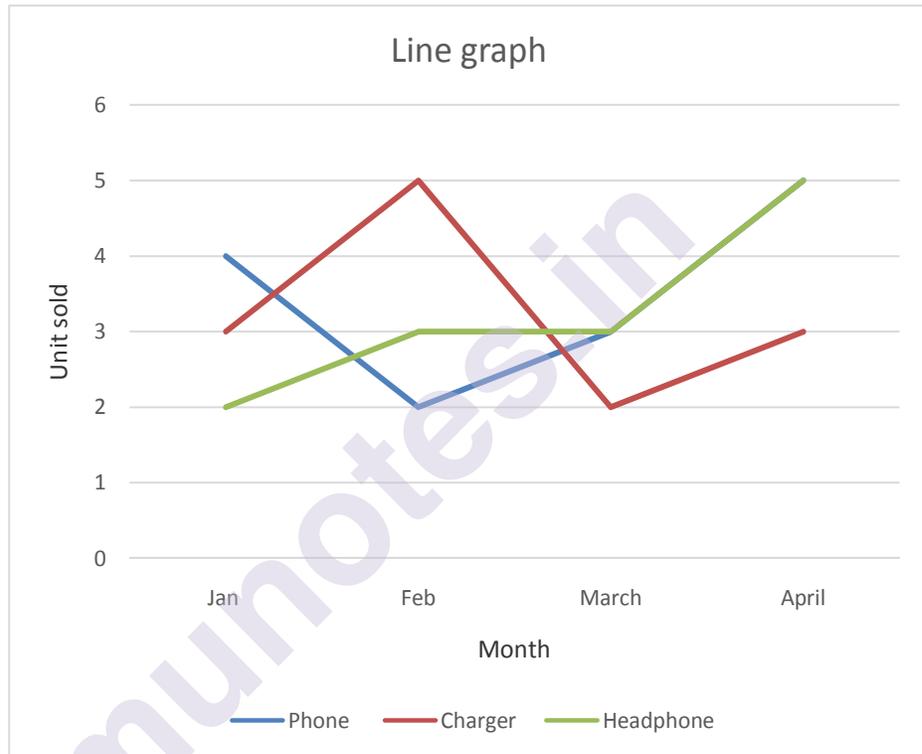
1. The table must have a title that is both brief and informative.
2. Tables should be numbered sequentially; these numbers are often Arabic numbers.
3. The information mentioned in the table should have unit.
4. A column heading should be placed at the top of each column, and a row heading should be placed on the left border of the table for each row.
5. The row or column subheading should be given if the rows or columns are grouped together.
6. Any assumptions or definitions required to interpret the data should be mentioned in the table's footnotes.
7. If the data was gathered from a secondary source, the source should be cited in the footnote.

Sr. No	Company	Profit (Rs, millions)	Sales (Rs, millions)	Year
1	A	56	50	2022
2	A	90	86	2021
3	A	70	88	2020
4	B	60	54	2022
5	B	70	68	2021
6	B	89	89	2020
7	C	100	96	2022
8	C	120	110	2021
9	C	100	84	2020

## 10.6 GUIDELINES FOR VISUAL REPRESENTATIONS

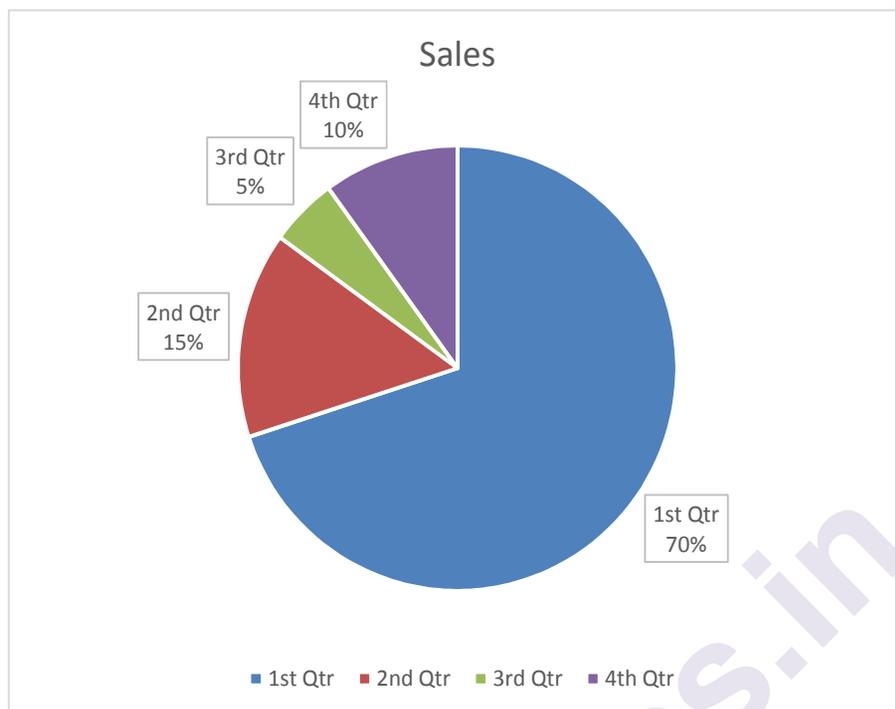
Numerical data can be readily converted into visual form using computer software like SPSS and MS-Excel. With the use of graphics, visual aids assist in the quick comprehension of data. Visual data representations include less information than tabular data representations, but they are easier to read and retain. Line Chart, Pie chart, Bar chart, Column chart, Pie chart and Scatter chart are the most widely used graphics for representing visual data.

### a) Guidelines for Line Chart



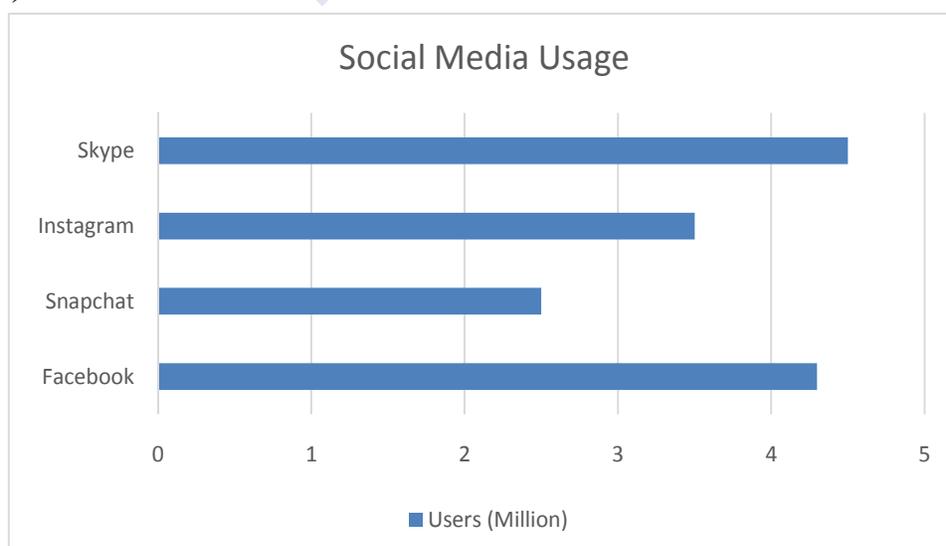
The primary goal of a line chart is to identify a trend or pattern over time. On the x axis of a line graph, the time unit or independent variable should be placed. When more than one line is present, the individual lines should be of distinct type and colour. The maximum number of lines in a line graph must be five or less. The zero base line should be included in the line graph

**b) Guidelines for Pie Chart**



A pie chart is used to show a cross section of an area. Each portion or slice reflects the ratio of that section to the total area. The total of all the data for a pie chart should equal 100%. The percentage of each area should be presented within or above the segment, making it easier to read. The pie chart should be ordered clockwise from largest to smallest slice. The largest slice should be positioned at 12 o'clock. The largest slice must be coloured light, while the smallest slice must be coloured dark. A pie chart should have a maximum of 5 slices; if the number surpasses 5, another type of chart can be used.

**c) Guidelines for Bar Chart**



Data is organised in columns or rows in a bar chart, which allows for comparison of individual items. When the pattern is both negative and positive on the same chart, horizontal bars are recommended. Vertical bars are preferred over horizontal bars when the elements are time-related. The axis of a bar chart should start at zero to make the data easier to understand. The distance between each column should be half its width. In a bar chart, the columns should be ordered in a meaningful sequence, such as ascending, descending, or chronological order.

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## **10.7 MEANING OF RESEARCH ETHICS**

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Misconduct in research can take place in two areas: research authenticity and publication ethics. Ethics in research distinguishes between permitted and undesirable behaviour by setting standards for conducting appropriate research. According to Rowely (2004), performing ethical research involves maintaining confidentiality and anonymity while also being transparent about the process followed while conducting the study. Ethics in research has guidelines in place to ensure that no one is harmed as a result of study.

In the case of business research, it is suggested that the study be conducted according to a standard procedure. Since business research comprises a variety of processes such as Problem definition, Research Design, Data gathering, Analysis, and Reporting, a protocol must be followed at each stage of the process. Every organization has its own set of rules for doing research, which are documented. International organizations such as the Council of American Survey Research Organizations (CASRO), Social Research Association (SRA) and American Psychological Association (APA) have detailed codes of conduct for doing research.

The following are the three stakeholders in any research project:

- Sponsoring client.
- The researcher himself.
- The respondent from whom information will be gathered.

Since each stakeholder has diverse motivations and concerns, ethical rules for each should be distinct.

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## **10.8 CLIENT'S ETHICAL CODE**

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When conducting research for a business client, a specific code of ethics must be followed. It must be assured that the client does not interfere with the process or influence the outcome of the research in a certain direction for his own benefit or hidden goal. The literature review may propose that research be conducted on a certain group of individuals, while the client may insist that the researcher undertake the research on a specific group of people based on his own assumptions.

It has been observed that small enterprises would request a proposal from a research organization in order to find a solution to a specific problem they are having. They analyse the research methodology after receiving the proposal and conduct the same study with the assistance of an internal

team at a minimal cost. They refuse to pay the research agencies as the proposal is at initial stage. The researcher is the key person between the client and the respondents, and he is responsible of doing quality checks at each stage of the study and maintaining professionalism. It is the researcher's obligation to ensure that the study does not hurt the sentiments of anyone involved in it.

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## **10.9 RESEARCHER'S ETHICAL CODE**

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The researcher must follow a standard procedure when performing the study, and quality checks must be performed at each stage. The researcher must select the appropriate methodology for the study. Since the client may not be aware of validity of the results, the researcher must be transparent with him about the significance of the result.

It is the researcher's responsibility to maintain the client's confidence and privacy. Without the client's approval, the researcher must never disclose the name of the company or any other information regarding the study. For example, if the client wants to conduct a research to determine its product's market positioning in comparison to a competitor, it's critical to ensure that the client's company name is not revealed in order to avoid skewed results. The researcher must not disclose the reason for doing the study. For example, if the research is about a new product and if the purpose is revealed, the competitor may adapt the idea into a new prototype. The study findings should be kept private until they are turned into a business action plan. The study's findings being made public might have a significant influence on the action plan.

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## **10.10 ETHICAL CODES RELATED TO RESPONDENTS**

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The responder is the individual from whom the data must be collected, hence it must be ensured that the respondent is not treated unethically. The respondent's privacy must be protected, and the procedures used to conduct the research must not be harmful to the respondent's sentiments. Prior to performing the study, the purpose of the study and the sort of information that will be collected should be clearly stated to the respondent. During the data gathering process, the researcher should avoid influencing or forcing the responder. Before asking for any sensitive information, the researcher should establish rapport with the respondent and allow them some time to respond. If the responder is a part in an experimental research, such as the testing of a new product, the respondent should be given thorough information about the study's methodology and the risks involved. After the researcher has clearly described the study's goal, process, and expected outcome to the responder, it is advised that the two of them sign a written agreement.

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## **10.11 RESPONSIBILITY OF ETHICS IN RESEARCH**

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The purpose of research ethics is to develop standard methods for doing research and to provide care for participants involved in the study. While conducting the study, all researchers must seek to adhere to basic ethical

norms. In research, ethics assures that all communication regarding the approach, methodology, analysis, and results is transparent and truthful, and that no data are fabricated. Research ethics ensures that the process or outcome is not impacted by extraneous variables such as personal interests, preventing bias at any stage. It ensures that all agreements are adhered and that any confidential agreements established with the responder or customer are maintained. Ethical guidelines ensure that the researcher does not copy the information and if the researcher cites a source, credit is given. The ethical standards also ensure that the research process does not harm society.

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### **10.12 SELF ASSESSMENT QUESTIONS**

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1. Write a short note on characteristics of research report.
2. What are the different methods in which a research work can be reported?
3. Describe the layout of a research report.
4. What are the guidelines for visual representation of data of research result?
5. Distinguish between brief report and detailed report.
6. What is Research ethics and why is it important?
7. Write short notes on the following-
  - a. Client's Ethical code.
  - b. Researcher's Ethical code.
  - c. Ethical Codes related to respondents.

