---Monograph ---

# Research Methodology-Basics

Dr.Shiney Chib

April 10,2019.

**About the Author :**

Dr.Shiney Chib is working as Director & Research Head with Datta Meghe Institute of Management Studies, Nagpur. She is appointed as adjunct faculty with SEGI-University, Malaysia. She has been conferred with **'Distinguished Educator Award'** by 'Discovery Education Media', **'Rajiv Gandhi Excellence Award in the field of Education'** and '**Mahila Ratan Gold Medal for Academic Excellence'** and **'Eminent Educationist Award**'. She has also received '**Academic Excellence Award'** from NIPM Nagpur chapter. Eight students have been awarded PhD under her guidance. She has industrial experience of 11 years and 15 years of teaching experience. She has more than 100 publications, in the reputed journals, National and International conferences. She has guided 12 Ph.Ds and authored 4 books. She has participated and chaired the conferences held at Hamburg, Germany, Tokyo Japan and Hong Kong. She is a life member of NIPM, NHRD, All India Commerce Association, Lion's Club International.

# FOREWORD

We all agree that, research has its application in each and every field. Universities are giving utmost importance to Academic Research. This monograph is a bird's eye view on the Basics of Research Methodology. It explains the various concepts of Research Methodology in a very simple manner. Dr. Shiney Chib is a reputed faculty of Research Methodology, Consumer Behaviour , Business Analytics , having long years of experience in Industry as well as academia.

This is a Monograph, by a teacher who understands the difficulties the student's face, while learning the subject. It will also be helpful to the faculty teaching the subject.

I commend the author for bringing out the book in 'Research Methodology' area.

Mr. Anita Rao
Entrepreneur & Management Consultant.

# PREFACE

Research, is one the academic exercise carried out mostly by almost the people pursuing career in academic field. Even the curriculum of various programmes is having 'Research Methodology' as a subject. People find the subject, challenging looking to the technicalities involved in it. This Monograph is an effort to present the principles and concepts in a very simple manner.

*Explore the different arenas of Research….*

*Happy Researching…..*

**Shiney Chib, Ph.D.**

# ACKNOWLEDGMENTS

Words of gratitude to all the esteemed people, who directly or indirectly helped me in this assignment.

# CONTENTS

# Part I

# RESEARCH BASICS

# Part I

# RESEARCH BASICS

Research is defined as –

" the process of systematically obtaining accurate answers to significant and pertinent questions by the use of the scientific method of gathering and interpreting information."

--Clover & Basely

"a scientific undertaking which by means of logical and systematic techniques aims to,

- Discover new facts or verify and test old facts
- Analyse their sequences, interrelations and casual explanations
- Develop new scientific tools, concepts and theories which would facilitate reliable and valid study of human behaviour"---P.V.Young

## 1.1 OBJECTIVES OR PURPOSES OF RESEARCH



The objective or purpose of research are as follows:

- Research extends knowledge of human beings, social life and environment. Scientist and researches build up the wealth of knowledge through their research findings. They search answers to varies questions: What, Where, When, How and Why of various phenomena.
- Research brings the hidden information that might never be discovered fully during the ordinary course of life.
- Research helps in establishing generalization and general laws and contribute to theory building in various fields of knowledge like Law of Demand, theory of consumer behaviour, theories of motivation so on.
- Research verifies and tests existing facts and theories and thus helps in improving our knowledge and ability to handle situations and events.
- General laws developed through research may enable us to make reliable predictions of events yet to happen.

- It aims to analyse inter-relationships between variables and derive to casual explanations; and thus enables us to have a better understanding of the world in which we live.
- Applied research aims at finding solution to socio-economic problems, like social unrest, unemployment, poverty, health problems, human relation problems in organization so on.
- It aims at developing new tools, concepts, and theories for a better study of unknown phenomena.
- It aids in planning and thus contributes to national development.
- Analytical studies of internal and external environment of business and non-business organization provide factual data for rational decision making-formulation of strategies and policies. Studies of their operational problems contribute to an improvement in their performance.

## 1.2 IMPORTANCE OF RESEARCH

The importance of research is summarised as follows:

- Research extends the frontiers of knowledge.
- It brings the light information that is hidden.
- It establishes generalisations and general laws and contributes to theory building in various fields of knowledge.
- It verifies and test existing theories and help improving our knowledge and ability to handle situations and events.
- It enables us to make reliable predictions/forecasts of events yet to happen.
- It facilities analysis of inter-relation between variables and to derive casual explanations.
- Applied research/action research tries to find solutions to problems.
- It helps in developing new tools, devices, concepts, theories etc for a better study/understanding of unknown phenomena.
- It aids in planning.
- It helps in evaluation of polices and programmes.

- It aids rational decision-making.
- It provides basis for formulation of policies.
- It inculcates critical thinking and promotes the development of logical habits of thinking.
- The inventions and discoveries are the result of research only.
- The research for, research for innovations, new things, new facilities etc is contributing in a big way in the economic development in general and improving quality of human life in particular.

## 1.3 TYPES OF RESEARCH

Research may be classifies as follows:

According to Intent: Pure Research

Applied Research

Exploratory Research

Descriptive Research

Diagnostic Research

Evaluation Studies

Action Research

According to the methods of Study: Experimental Research

Analytical Study

Historical Study

Survey

According to the nature of the data: Quantitative Research

Qualitative Research



1 **PURE RESEARCH :** Pure research is also known as basic or fundamental research. It is undertaken out of intellectual curiosity. It is not necessarily problem oriented. It aims at extension of knowledge. It may lead to either discovery of new theory or refinement of an existing theory. The development of various sciences owes much to pure research. The findings of pure research enrich the storehouse of knowledge that can be drawn upon in the future to formulate significant practical researches. Pure research lays

the foundation for applied *research*. The findings of pure research formed the basis for innumerable scientific and technological inventions like steam engine, machines, automobiles, electronic gadgets etc. which have revolutionized and enriched our human life. Pure research offers solution to many practical problems, for example Maslow's theory of motivation serves as a guideline for formulating incentive schemes and approaches to motivating employees in organization.

2. **APPLIED RESEARCH :** Applied research is carried out in life to find solution to a real-life problem requiring an action or policy decision. It is thus problem oriented and action directed. It seeks an immediate and practical result example marketing research carried on for developing a new market of for studying the post purchase experience of customers. Applied research may aid in conceptual clarification. It helps to integrate the previously existing theories and may help in giving new dimensions to it.

3. **EXPLORATORY RESEARCH / FORMULATIVE RESEARCH :** Exploratory research is preliminary study of an unfamiliar problem about which the researcher has little knowledge. It is similar to a doctor's initial investigation of a patient suffering from an unfamiliar malady for getting some clues for identifying it.

Purpose of exploratory study may be:

To generate new ideas

To increase the researcher's familiarity with the problem

To make a precise formulation of the problem

To gather information for clarifying concepts

To determine whether it is feasible to attempt the study.

4 **DESCRIPTIVE RESEARCH :** Descriptive study is a fact-finding investigation with adequate interpretation. It is the simplest type of research. It is more specific than an exploratory study, as it has focus on particular aspects or dimensions of the problem studied. It is designed to gather descriptive information and provides information for formulating more sophisticated studies. Data are collected by using one or more appropriate methods: observation, interviewing and mail questionnaire. A descriptive study aims at identifying various characteristics of a community or institution or problem under study, but it does not deal with testing of proposition or hypothesis.

5 **DIAGNOSTIC STUDY :** It focus on discovering what is happening, why is it happening and what can be done about it. It aims at identifying the causes of a problem and the possible solution for it. It involves prior knowledge of the

problem, its thorough formulation, clear-cut definition of the given population, adequate methods for collecting accurate information, precise measurement of variables, statistical analysis and test of significance. The aim *is* to obtain complete and accurate information about a given situation/phenomenon.

6 **EVALUATION STUDIES :** Evaluation study is one type of applied research. It is made for assessing the effectiveness of social or economic programmes implemented or for assessing the impact of developmental projects on the development of the project area. Evaluation research is thus, directed to assess or appraise the quality and quantity of an activity and its performance and to specify its attributes and conditions required for it success. It is also concerned with change over time.

7 **ACTION RESEARCH :** Action research is a type of evaluation study. It is a concurrent evaluation study of an action programme launched for solving a problem for improving an existing situation. It includes the following steps:

- Diagnosis
- Sharing of diagnostic information.
- Planning: developing change programme.
- Initiations of organizational change.
- Implementation of participation and communication process.
- Post experimental evaluation.



8 **EXPERIMENTAL RESEARCH :** Experimental research is designed to assess the effects of particular variables on a phenomenon by keeping other variables constant or controlled. It aims at determining whether and in what manner variables are related to each other. The factor which is influenced by other factors is called a dependent variable and the other factors, which influence it are known as independent variables. The nature of relationship between independent variables and dependent variables is perceived and stated in the form of casual hypothesis. A closely controlled procedure is adopted to test them.

9 **ANALYTICAL STUDY OR STATISTICAL METHOD :** Analytical study is a system of procedures and techniques of analysis applied to quantative data. It may consist of a system of mathematical models or statistical techniques applicable to numerical data. Hence it is also called as Statistical Method. This study aims at testing hypothesis and specifying and interpreting relationships. It concentrates on analyzing data in depth and examining relationships from various angles by bringing in as many relevant variables as possible in the

analysis of plan. This method is extensively used in business and other fields in which quantative numerical data are generated. It is used for measuring variables, comparing groups and examining association between factors.

10 **HISTORICAL RESEARCH :** Historical research is a study of past records and other information sources with a view to reconstructing the origin and development of an institution or a movement or a system and discovering the trends in the past. Its objective is to draw explanation and generalization from the past trends in order to understand the present and to anticipate the future. It enables us to grasp our relationship with the past and to plan more intelligently for the future. The past contains the key to the present and the present influences the future. It includes the following steps:

- Feasibility of the study should be examined.
- Selection of the problem
- Data collection
- Analysis of data
- Interpretation



11 **QUANTITATIVE RESEARCH :** Quantitative research is based on quantitative data. The phenomena under study can be measured in terms of some quantity or amount. For example sales can be measured in terms of rupees. Quantitative research attempts precise measurement of something.

12 **QUALITATIVE RESEARCH :** Qualitative research is based on attributes. An attribute is a quality or characteristic which cannot be precisely measured, but whose presence or absence can be identified and counted. Qualitative research aims at discovering the underlying motives, desires, opinions, preferences etc. Using in depth interviews, direct observation, content analysis etc. Qualitative research in practice is a very difficult job.

## 1.4 RESEARCH PROCESS

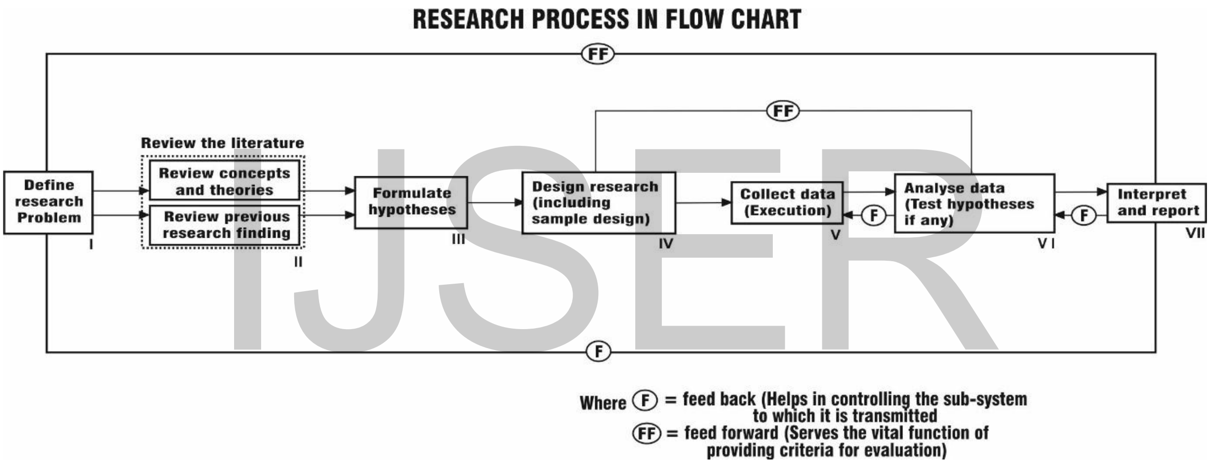
Research process consist of series of actions or steps necessary to effectively carry out research and the desired sequencing of these steps.

According to Nachmias, the research process has seven stages as follows:

- Identification & selection of the research problem.
- Choice of a theoretical framework for the research problem.
- Formulation of the research problem.

- Design of the experiment or inquiry.
- Definition and measurement of variables.
- Sampling procedures.
- Tools and techniques for gathering data.
- Coding, editing and processing of data.
- Analysis of the data
- Reporting research

- *Reporting research*




*Source : Research Methodology, C.R.Kothari, New Age International Publishers (second revised edition), Pg. 11, Fig. 1.1*

These steps are not mutually exclusive, neither they are separate and distinct. They do not necessarily follow each other in any special order.

Research process may adopt the following steps :

- ➢ *Identifying and stating the management problem and problem area*
- ➢ *Planning the project in such a way that the observation empirically demonstrates the probability or non probability of the relationship between the phenomena*
- ➢ *Formulating the hypothesis*
- ➢ *Crystallizing, the objectives, purposes, rationale, scope and expected limitation of the research*

- *Planning to formulate the research project, identifying the resources, including financial and human resources.*
- *Identifying the types of data to be collected and its sources*
- *Specifying the methods of data collection and analysis*
- *Estimating the expected result and comparing it with the company's expectation for problem saving and decision making*
- *Finalizing a systematic scheme for proceeding with the project including sampling, survey analytical frame work and report writing.*

## 1.5 RESEARCH DESIGN

Research design is a purposeful scheme of action proposed to be carried out in a sequence during the process of research focusing on the management problem to be tackled. It must be a scheme for problem solving through proper analysis, for which a systematic arrangement of managerial efforts of investigate the problem is necessary. It defines the task of a researcher from identifying a managerial problem and problem area to report writing with the help of collection, tabulation, analysing and interpretation of data.



**STAGES**

For the systematic presentation, the process of research may be

classified under stages –

- *Primary Stage*
- *Secondary Stage*
- *Tertiary Stage*

The Primary Stage includes :

- *Observation*
- *Interest*
- *Crystallization & identification of research problem*
- *Formulation of hypothesis*
- *Primary synopsis*

- *Conceptual clarity*
- *Documentation*
- *Preparation of Bibliography and*
- *Research designs*

The secondary stage includes :

- *Project Planning*
- *Project formulation*
- *Questionnaire preparation*
- *Investigation and data collection*
- *Preparation of final synopsis*
- *Compilation of data*
- *Classification*
- *Tabulation & presentation of data*
- *Experimentation*
- *Analysis*
- *Testing of Hypothesis and*
- *Interpretation*



The tertiary stage includes *:*

- *Report writing*
- *Observation, suggestions and conclusions.*

"A research design is the arrangement of conditions for collections and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure." In fact, the research design is the conceptual structure within which research is conducted; it constitutes the blueprint for the collections, measurement and analysis of data. As such the design includes an outline of what the researcher will do from writing the hypothesis and its operational implications to the final analysis of data. More explicitly, the design decisions happen to be in respects of:

*(i)* *What is the study about ?*

*(ii)* *Why is the study being made ?*

*(iii)* *Where will the study be carried out ?*

*(iv)* *What type of data is required ?*

*(v)* *Where can the required data be found ?*

*(vi)* *What periods of time will the study include ?*

*(vii)* *What will be the sample design ?*

*(viii)* *What techniques of data collections will be used ?*

*(ix)* *How will the data be analysed ?*

*(x)* *In what style will the report be prepared ?*



*****

# Part II

# VARIABLES

# Part II

# VARIABLES

- Independent Variable – something that is changed by the scientist
  - What is tested
  - What is manipulated
- Dependent Variable – something that might be affected by the change in the independent variable
  - What is observed
  - What is measured
  - The data collected during the investigation
- Controlled Variable – a variable that is not changed
  - Also called constants
  - Allow for a "fair test"

**Example 1: Identify the variables in this investigation.** Students of different ages were given the same jigsaw puzzle to put together. They were timed to see how long it took to finish the puzzle.

**Independent Variable**: Ages of the students

- Different ages were tested by the scientist

**Dependent Variable**: The time it to put the puzzle together

- The time was observed and measured by the scientist

**Controlled Variable:** Same puzzle

- All of the participants were tested with the same puzzle.
- It would not have been a fair test if some had an easy 30 piece puzzle and some had a harder 500 piece puzzle.

**Example 2: Identify the variables in this investigation.** The higher the temperature of water, the faster an egg will boil.

- Independent variable – temperature of water
- Dependent variable – time to cook an egg
- Controlled variable – type of egg

**Example 3: Identify the variables in this investigation.** The temperature of water was measured at different depths of a pond.

- Independent variable – depth of the water
- Dependent variable – temperature
- Controlled variable – thermometer

# Part III

# SAMPLING

# Part III

# SAMPLING

The first and foremost task in carrying out a survey is to select the sample. Sample selection is undertaken for practical impossibility to survey the population. By applying rationality in selection of samples, we generalize the findings of our research. There are different types of sampling. We may categories those in three major heads as follows:

1. Random Sampling
2. Purposive Sampling
3. Stratified Sampling

## 3.1 OBJECTIVES OF SAMPLING

Main objectives are as follows :

1 To obtain information about the population on the basis of sample drawn from such population
2 To set up limits of accuracy of the estimates of the population parameters completed on the basis of sample statistic.
3 To test the significance about the population characteristics on the basis of sample statistic.

Apart from the above sampling procedures, there are other types of sampling like:

- Quota sampling (a special type of stratified sampling).
- Multi-stage sampling (where samples are selected from a very large area).
- Convenience sampling (where population is not clearly defined and complete source of list is not available).
- Self selected sampling, etc.

After deciding over the samples to be surveyed, the next task is to go ahead with the survey matter.

Survey may be carried out either by directly interviewing the samples or by sending questionnaire to the samples or by mere observation of the characteristics of samples. We have discussed these in earlier chapter.

## 3.2 THE SAMPLING PROCESS

There are seven steps involved in this process.

**Step 1 : Define the population:** It is the aggregate of all elements, usually defined prior to the selection of the sample. The population is said to be completely defined if at least the following terms are specified:

i. Elements
ii. Sampling Units
iii. Extent
iv. Time

For example, for monitoring the sales of our product, the population might be

- Element – Our Product.
- Sampling Units – Retail outlets, super markets.
- Extent – Mumbai.
- Time – December 1-31st ,2009

**Step 2 : Identify the sampling frame**: The sampling frame should be so selected which consists of almost all the sampling units. Though it is not possible to have one-to-one correspondence between frame units and sampling units, however, we should choose a sampling frame which yields unbiased estimates with a variance as low as possible. Popularly known sampling frame are :

Census reports, electoral registers, lists of member units of trade and industry associations, lists of members of professional bodies, lists of dwelling units maintained by local bodies, returns from an earlier survey and large scale maps etc.

**Step 3: Specify the sampling unit**: The sampling unit is the basic unit containing the elements of the target population.

**Step 4: Specify the sampling method**: The sampling method indicates how the sample units are selected. The most important decision in this regard is to determine which of the two-probability or non-probability samples is to be chosen.

**Step 5: Determine the sample size (n):** The decision about the number of elements to be chosen, i.e., number of observations in each sample (n) of the target population.

**Step 6: Specify the sampling plan**: This means that one should indicate, how decisions made so far are to be implemented. All expected pertinent issues in a sampling survey must be answered by the sampling plan.

**Step 7: Select the sample:** This is the final step in the sampling process. A good deal of field work and office work is introduced in the actual selection of the sample elements. However it depends mainly upon the sampling plan and the sample size required.



## 3.3 CHARACTERISTICS OF IDEAL SAMPLING

To adopt appropriate and unbiased sampling techniques, a researcher has to maintain certain qualities of sampling techniques. They are as follows:

- **Representativeness**: An ideal sample is the sample which represents the characteristics of entire population. Thus the selection procedure for sampling should be such that the sample selected has all those qualities and features which the entire population possess.
- **Independence**: The second quality required in sampling techniques is that all possible samples which can be selected should be independent of each other. This helps to make an unbiased selection of samples where selection of one unit of population does not depend upon that of another unit.
- **Adequacy**: The number of units in a sample, that is sample size, selected from the population should not be too less as this would result in failure to capture the diversity of population. At the same time, it should not be too

large. It should be just sufficient to enable a researcher to derive a correct conclusion about population based on his sample.

- **Homogeneity**: To make a sample scientific , the element or unit selected within the sample should be identical with another element or unit of that sample.

## *3.4* TYPES OF SAMPLING

There are basically two types of sampling methods:

- **Probability Sampling Method**

The probability or chance of every unit in the population being included in the sample is known.

**Probability Sampling Methods**

The major sampling methods under probability sampling are:

**Simple Random Sampling:** Simple Random Sampling is the simplest type of sampling, in which we draw a sample of size (n) in such a way that each of the 'N' members of the population has the same chance of being included in the sample. A sample selected in this way is called a simple random sample.



**Systematic Sampling:** The systematic sampling also employs the principle of Random Sampling. However, in this method of sample, selection of a unit depends upon the selection of a preceding unit in contrast to simple Random Sampling. Where the selection of a unit is independent of each other. Systematic Random Sampling in this sense is called quasi-random-sampling.

**Stratified Random Sampling:** Another useful type of sampling procedure is called stratified random sampling. In this procedure, the members of the population are first assigned to strata or groups, on the basis of some characteristic and a simple random sample is drawn from each stratum. The individuals in all the samples taken together constitute the sample from the population as a whole.

**Cluster Sampling :**In the probability sampling methods, we have seen that each item in the sample is chosen one at a time from the complete list of universe elements. However, it would be more expedient to select entire groups or clusters at random. Let us take, for example, a residential colony comprising 15 Blocks : A to O. Let us treat each block as a cluster and then select 3 (say) blocks (cluster) out of 15 blocks at random and then collect information from all families residing in these 3 blocks (clusters).

- ❖ **Non-probability Sampling Methods**

Though the probability samples give an unbiased sample and the parameters used for the study can be tested for a given confidence internally, still non-probability sampling finds frequent use in many situations because of difficult conditions such as frame (list of all sampling units), time and cost involved. Major Non-probability sampling methods are discussed below.

- **Convenience Sampling** : As the name implies, the selection of the sample is left to the researcher who is to select the sample. The researcher normally interviews persons in groups at some retail outlet, supermarket or may stand at a prominent point and interview the persons who happen to be there. This type of sampling is also called 'accidental sampling' as the respondents in the sample are included merely because of their presence on the spot.
- **Judgement Sampling**: In judgement sampling, the judgement or opinion of some experts forms the basis of the sampling method. It is expected that these samples would be better as the experts are supposed to know the population.
- **Snowball sampling**: The sampling technique involves the selection of additional respondents based on the referral of initial respondents is known as snowball sampling. This sampling technique is often used when the population is rarely found and not easily accessible. Hence the sampling depends upon the chain system of referrals

- **Quota Sampling** : This is the most frequently used non-probability sampling method and is used when. Employing Stratification: i.e., age, sex, income, family etc. More often compound stratification is used in groups with sex.

## 3.5 SAMPLING ERRORS

Sampling errors are those which arise due to drawing of faulty inferences about the population based on the results obtained from the samples. In other words, it is the difference between the results which would have obtained if the entire population was taken for such a study and the results obtained from the samples drawn from it. The sampling error would be smallest if the sample size is large in relation to the population and vice versa.

*****

# Part IV

# SCALING

# Part IV

# SCALING

## 4.1 MEANING OF SCALING

Scaling describes the procedures of assigning numbers to various degrees of opinion, attitude and other concepts. This can be done in two ways viz.,

1 Making a judgement about some characteristic of an individual and then placing him directly on a scale that has been defined in terms of that characteristic and

2 Constructing questionnaires in such a way that the score of individual's responses assigns him a place on a scale.

Summated scales (or Likert-type scales) are developed by utilizing the item analysis approach wherein a particular item is evaluated on the basis of how well it discriminates between those persons whose total score is high and those whose score is low. Those items or statements that best meet this sort of discrimination test are included in the final instrument.

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

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

**(i) strongly agree, (ii) agree, (iii) undecided, (iv) disagree, (v) strongly disagree.**

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

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

Each point on the scale carries a score. Response indicating the least favourable degree of job satisfaction is given the least score (say 1) and the most favourable is given the highest score (say 5).

## 4.2 MEASUREMENT SCALES



From what has been stated above, we can write that scales of measurement can be considered in terms of their mathematical properties. The most widely used classification of measurement scales are:

(a) Nominal scale;

(b) Ordinal scale;

(c) Interval scale; and

(d) Ratio scale.

(a) **Nominal scale** : Nominal scale is simply a system of assigning number symbols to events in order to label them. Nominal scales provide convenient ways of keeping track of people, objects and events. One cannot do much with the numbers involved. There is no generally used measure of dispersion for nominal scales. Chi-square test is the most common test of statistical significance that can be utilized, and for the measures of correlation, the contingency coefficient can be worked out. Nominal scale is the least powerful level of measurement. It indicates no order or distance relationship and has no arithmetic origin. A nominal scale simply describes differences between things by assigning them to categories. Nominal data are, thus, counted data. The scale wastes any information that we may have about varying degrees of attitude, skills, understandings, etc. In spite of all this, nominal scales are still very useful and are widely used in surveys and other ex-post-facto research when data are being classified by major sub-groups of the population.

(b) **Ordinal scale**: The lowest level of the ordered scale that is commonly used is the ordinal scale. The ordinal scale places events in order, but there is no attempt to make the intervals of the scale equal in terms of some rule. Rank orders represent ordinal scales and are frequently used in research relating to qualitative phenomena. A student's rank in his graduation class involves the use of an ordinal scale. For instance, if Tina's position in his class is 10 and Reena's position is 40, it cannot be said that Reena's position is four times as good as that of Tina's. The statement would make no sense at all. Ordinal scales only permit the ranking of items from highest to lowest. Ordinal measures have no absolute values, and the real differences between adjacent ranks may not be equal. All that can be said is that one person is higher or lower on the scale than another, but more precise comparisons cannot be made.

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

(c) **Interval scale** : In the case of interval scale, the intervals are adjusted in terms of some rule that has been established as a basis for making the units equal. The units are equal only in so far as one accepts the assumptions on which the rule is based. Interval scales can have an arbitrary zero, but it is not possible to determine for them what may be called an absolute zero or the unique origin. The primary limitation of the interval scale is the lack of a true zero; it does not have the capacity to measure the complete absence of a trait or characteristic. The Fahrenheit scale is an example of an interval scale and shows similarities in what one can and cannot do with it. One can say that an increase in temperature from $30^{o}$ to $40^{o}$ involves the same increase in temperature as an increase from $60^{o}$ to $70^{o}$, but one cannot say that the temperature of $60^{o}$ is twice as warm as the temperature of $30^{o}$ because both numbers are dependent on the fact that the zero on the scale is set arbitrarily at the temperature of the freezing point of water. The ratio of the two temperatures, $30^{0}$ and $60^{o}$, means nothing because zero is an arbitrary point.

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

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

"Reetu." The ratio involved does have significance and facilitates a kind of comparison which is not possible in case of an interval scale.

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

*****

# Part V

# DATA COLLECTION

# Part V

# DATA COLLECTION

The data serve as the bases or raw materials for analysis. Without an analysis of factual data, no specific inferences can be drawn on the questions under study. Inferences based on imagination or guess work cannot provide correct answers to research questions. The relevance, adequacy and reliability of data determine the quality of the findings of a study. Data form the basis for testing the hypotheses formulated in a study. Data also provide the facts and figures required for constructing measurement scales and tables, which are analysed with statistical techniques. Inferences on the results of statistical analysis and tests of significance provide the answers to research questions. Thus, the scientific process of measurements, analysis, testing and inferences depends on the availability of relevant data and their accuracy. Hence, the importance of data for any research study.



## 5.1 SOURCES OF DATA

The sources of data may be classified into

**(a) Primary sources** and

**(b) Secondary sources.**

### Primary Sources

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

**Secondary Sources**

These are sources containing data which have been collected and compiled for another purpose. The secondary sources consists of readily available compendia and already compiled statistical statements and reports whose data may be used by researches for their studies, e.g. census reports, annual reports and financial statements of companies, Statistical statements, Reports of Government Department, Annual Reports on currency and finance published by the Reserve Bank of India, etc.

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



## 5.2 DATA COLLECTION PROCEDURE FOR PRIMARY DATA

❖ **Planning the study**

Since the quality of results gained from statistical data depends upon the quality of information collected, it is important that a sound investigative process be established to ensure that the data is highly representative and unbiased. This requires a high degree of skill and also certain precautionary measures may have to be taken.

❖ **Modes of Data Collection**

There are basically three widely used methods for collection of primary data:

- Observation
- Experimentation
- Questionnaire
- Interviewing
- Case Study Method

### Construction of a Questionnaire

When information is to be collected by asking questions to people who may have the desired data, a standardized form called questionnaire is prepared. The questionnaire has a list of questions to be asked and spaces in which the respondents record the answers. Each question is worded exactly as it is to be asked. Also, the questions are listed in a established sequence.

Questionnaire construction is discussed below in nine steps. These steps may vary in importance in individual projects, but each one must be thought through. The nine steps are:

i. Decide what information is wanted.
ii. Decide what type of questionnaire (personal interview, mail telephone) to use.
iii. Decide on the content of individual questions.
iv. Decide on the type of question (open, multiple choice, dichotomous) to use.
v. Decide on the wording of the questions.
vi. Decide on question sequence.
vii. Decide on lay out and method of reproduction of questionnaire.
viii. Make a preliminary draft and pre-test it.

Revise and prepare the final questionnaire.

## 5.3 TECHNIQUE OF DEVELOPING MEASUREMENT TOOLS

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

(a) Concept development;

(b) Specification of concept dimensions;

(c) Selection of indicators; and

(d) Formation of index.

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

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

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

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

## Attitude

Attitude is the mental state of an individual which makes him to act or respond for or against objects, situations, etc., with which his/her vested feelings of interest, liking, desire and so on, are directly or indirectly linked or associated. Attitudes are different from knowledge in a sense that attitudes are emotion-laden. Knowledge reinforces attitudes and reinforced attitudes in the long run reinforce individual and group behavior. Hence, attitude is neither behavior nor cause of behavior but it relates to an intervening pre-disposition or a frame of reference which influences the behavior of an individual.

## Attitude Survey

To recruit a new incumbent and to evaluate human relations in factories, industries and different organizations, attitude survey is indispensable. The study of attitude is also important in designing a training programme which is a core HRD function. Attitude surveys focus on feelings and motives of the employees' opinions about their working environments. There are three basic purposes for conducting attitude surveys:

1 To compare results with other survey results.
2 To measure the effect of change that occurs.
3 To determine the nature and extent of employee feelings regarding specific organizational issues and the organization in general.

Usually attitude surveys are carried out by interviewing a person with a structure close ended questionnaire. The skill of the interviewer is all important here for correct measurement of attitude. While framing the questionnaire, the interviewer should be cautious as simple opinion-laden questionnaire items will not depict the attitude of the interviewee. What is important is to put value laden questionnaire items, use of behaviourally anchored statements, asking the respondents to rank any myth statements, etc. a simple list of such myth statements and value-laden questionnaire items is given below:

**Sample Questionnaire Items for Attitude Measurement**

Do you think that expenditure on training is wasteful? (Give your answer selecting any one from the given alternatives).

To a large extent

To some extent

To a very little extent

Not to all

## 5.4 SCALING

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



*****

# Part VI

# DATA PROCESSING

# Part VI

# DATA PROCESSING

The various steps in processing of data may be stated as:

(a) Identifying the data structures

(b) Editing the data

(c) Coding and classifying the data

(d) Transcriptions of data

(e) Tabulation of data.

*****

# Part VII

# STATISTICS IN RESEARCH

# Part VII

# STATISTICS IN RESEARCH

The role of statistics in research is to function as a tool in designing research, analyzing its data and drawing conclusions there from. Most research studies result in a large volume of raw data which must be suitably reduced so that the same can be read easily and can be used for further analysis. Classification and tabulation, as stated earlier, achieve this objective to some extent, but we have to go a step further and develop certain indices or measures to summarise the collected/classified data. Only after this we can adopt the process of generalization from small groups (i.e., samples) to population. If fact, there are two major areas of statistics viz., **descriptive statistics** and **inferential statistics.** Descriptive statistics concern the development of certain indices from the raw data, whereas inferential statistics concern with the process of generalization.



Inferential statistics are also known as sampling statistics and are mainly concerned with two major type of problems : (i) the estimation of population parameters, and (ii) the testing of statistical hypotheses.

The important statistical measures that are used to summarise the survey/research data are:

1 Measures of central tendency or statistical averages;
2 Measures of dispersion;
3 Measures of asymmetry (skewness);
4 Measures of relationship; and
5 Other measures.

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

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

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

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

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

## 7.1 MEASURES OF CENTRAL TENDENCY

Measures of central tendency (or statistical averages) tell us the point about which items have a tendency to cluster. Such a measure is considered as the most representative figure for the entire mass of data. Measure of central tendency is also known as statistical average. **Mean** is the simplest measurement of central tendency and is a widely used measure**. Median** is the value of the middle item of series when it is arranged in ascending or descending order of magnitude. It divides the series into two halves; in one half all items are less than median, whereas in the other half all items are less than median, whereas in the other half all items have values higher than median. **Mode** is the most commonly or frequently occurring value in a series. In general, mode is the size of the item which has the maximum frequency, but at items such an item may not be mode on account of the effect of the frequencies of the neighbouring items.

## 7.2 MEASURES OF DISPERSION

An averages can represent a series only as best as a single figure can, but it certainly cannot reveal the entire story of any phenomenon under study. Especially it fails to give any idea about the scatter of the values of items of a variable in the series around the true value of average. In order to measure this scatter, statistical devices called measures of dispersion are calculated. Important measures of dispersion are (a**) range**, (b) **mean deviation**, and (c) **standard deviation**.

**Range** is the simplest possible measures of dispersion and is defined as the difference between the values of the extreme items of a series. Thus,

Range = (Highest value of an item in a series) – (Lowest value of an item in a series)



Mean deviation is the average of difference of the values of items from some average of the series. Such a difference is technically described as deviation. In calculating mean deviation we ignore the minus sign of deviations while taking their total for obtaining the mean deviation. When mean deviation is divided by the average used in finding out the mean deviation itself, the resulting quantity is described as the coefficient of mean deviation. Mean deviation and its coefficient are used in statistical studies for judging the variability.

**Standard deviation** is most widely used measure of dispersion of a series and is commonly denoted by the symbol **'σ' (pronounced as sigma).** Standard deviation is defined as the square-root of the average of squares of deviations, when such deviations for the values of individual items in a series are obtained from the arithmetic average. When we divide the standard deviation by the arithmetic average of the series, the resulting quantity is known as coefficient of standard deviation which happens to be a relative measure and is often used for comparing with similar measure of other series. When this coefficient of standard deviation is multiplied by 100, the resulting figure is known as coefficient of variation. Sometimes, we work out the square of standard deviation, known as variance, which is frequently used in the context of analysis of variation. The standard deviation (along with several related measures like variance, coefficient of variation, etc.) is used mostly in research studies and is regarded as a very satisfactory measure of dispersion in a series. It is amenable to mathematical manipulation because the algebraic signs are not ignored in its calculation (as we ignore in case of mean deviation). It is less affected by fluctuations of sampling. These advantages make standard deviation and its coefficient a very popular measure of the scatteredness of a series. It is popularly used in the context of estimation and testing of hypotheses.

## 7.3 MEASURES OF ASYMMETRY (SKEWNESS)

When the distribution of item in a series happens to be perfectly symmetrical, we then have the following type of curve for the distribution: Such a curve is technically described as a normal curve and the relating distribution as normal distribution. Such a curve is perfectly bell shaped curve in which case the value of or M or Z is just the same and skewness is altogether absent. But if the curve is distorted (whether on the right side or on the left side), we have asymmetrical distribution which indicates that there is skewness. If the curve is distorted on the right side, we have positive skewness but when the curve is distorted towards left, we have negative skewness . skEwness is, thus, a measure of asymmetry and shows the manner in which the items are clustered around the average. In a symmetrical distribution, the items show a perfect balance on either side of the mode, but in a skew distribution the balance is thrown to one series. The difference between the mean, median or the mode provides an easy way of expressing skewness in a series. In case of positive skewness, we have $Z < M > X$ and in case of negative skewness we have $X < M < Z$.

## 7.4 MEASURES OF RELATIONSHIP

So far we have dealt with those statistical measures that we use in context of **univariate** population i.e., the population consisting of measurement of only **one variable**. But if we have the data on **two variables,** we are said to have a **bivariate** population and if the data happen to be on **more than two variables**, the population is known as **multivariate population**.

Does there exist association or correlation between the two (or more) variables? If yes, of what degree? Is there any cause and effect relationship between the two variables in case of the bivariate population or between one variable on one side and two or more variables on the other side in case of multivariate population? If yes, of what degree and in which direction? The first question is answered by the use of correlation technique and the second question by the technique of regression. There are several methods of applying the two techniques, but the important ones are as under:



In case of bivariate population : Correlation can be studied through (a) cross tabulation; (b) Charles Spearman's coefficient of correlation; (c) Karl Pearson's coefficient of correlation; whereas cause and effect relationship can be studied through simple regression equations.

In case of multivariate population : Correlation can be studied through (a) coefficient of multiple correlation; (b) coefficient of partial correlation; whereas cause and effect relationship can be studied through multiple regression equations.

**Cross tabulation** approach is especially useful when the data are in **nominal form**. Under it we classify each variable into two or more categories and then cross classify the variables in these sub-categories. Then we look for interactions between them which may be symmetrical, reciprocal or asymmetrical. A symmetrical relationship is one in which the two variables vary together, but we assume that neither variable is due to the other. A reciprocal relationship exists when the two variables mutually influence or reinforce each other. Asymmetrical relationship is said to exist if one variable (the independent variable) is responsible for another variable (the dependent variable). The cross classification procedure begins with a two-way table which indicates whether there is or there is not an interrelationship between the variables. This sort of analysis can be further elaborated in which case a third factor is introduced into the association through cross-classifying the three variables. By doing so we find conditional relationship in which factor x appears to affect factor Y only when factor Z is held constant. The correlation, if any, found through this approach is not considered a very powerful form of statistical correlation and accordingly we use some other methods when data happen to be either ordinal or interval or ration data.

Charles Spearman's coefficient of correlation (or rank correlation) is the technique of determining the degree of correlation between two variables in case of ordinal data where ranks are given to the different values of the variables. The main objective of this coefficient is to determine the extent to which the two sets of ranking are similar or dissimilar. As rank correlation is a non-parametric technique for measuring relationship between paired observations of two variables when data are in the ranked form.

Karl Pearson's coefficient of correlation (or simple correlation) is the most widely used method of measuring the degree of relationship between two variables. This coefficient assumes the following:

i) That there is linear relationship between the two variables;
ii) That the two variables are casually related which means that one of the variables is independent and the other one is dependent; and
iii) A large number of independent causes are operating in both variables so as to produce a normal distribution.

The value of 'r' lies between ± 1. Positive values of r indicate positive correlation between the two variables (i.e., changes in both variables take place in the statement direction), whereas negative values of 'r'. indicate negative correlation i.e., changes in the two variables taking place in the opposite directions. A zero value of 'r' indicates that there is no association between the two variables.

## 7.5 SIMPLE REGRESSION ANALYSIS

Regression is the determination of a statistical relationship between two or more variables. In simple regression, we have only two variables, one variable (defined as independent) is the cause of the behavior of another one (defined as dependent variable). Regression can only interpret what exists physically i.e., there must be a physical way in which independent variable X can affect dependent variable Y.

## 7.6 MULTIPLE CORRELATION AND REGRESSION

When there are two or more than two independent variables, the analysis concerning relationship is known as multiple correlation and the equation describing such relationship as the multiple regression equation. We here explain multiple correlation and regression taking only two independent variables and one dependent variable.

## 7.7 PARTIAL CORRELATION

Partial correlation measures separately the relationship between two variables in such a way that the effects of other related variables are eliminated. In other words, in partial correlation analysis, we aim at measuring the relation between a dependent variable and a particular independent variable by holding all other variables constant. Thus, each partial coefficient of correlation measures the effect of its independent variable on the dependent variable.

*****

# Part VIII

# HYPOTHESIS

# Part VIII

# HYPOTHESIS

Hypothesis, means a mere assumption or some supposition to be proved or disproved. hypothesis may be defined as a proposition or a set of proposition set forth as an 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 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.



## 8.1 BASIC CONCEPTS CONCERNING TESTING OF HYPOTHESES

Basic concepts in the context of testing of hypotheses need to be explained.

a) **Null hypothesis and alternative hypothesis:** In the context of statistical analysis, we often talk about null hypothesis and alternative hypothesis. If we are to compare method A with method B about its superiority and if we proceed on the assumption that both methods are equally good, then this assumption is termed as the null hypothesis. As against this, we may think that the method A is superior or the method B is inferior, we are then stating what is termed as alternative hypothesis. The null hypothesis is generally symbolized as $H_0$ and the alternative hypothesis as $H_a$. Suppose we want to test the hypothesis that the population mean ($\mu$) is equal to the hypothesized mean ($\mu\ H_0$) = 100.

Then we would say that the null hypothesis is that the population mean is equal to the hypothesized mean 100 and symbolically we can express as:

$H_0 : \mu = \mu H_0 = 100$

If our sample results do not support this null hypothesis, we should conclude that something else is true. What we conclude rejecting the null hypothesis is known as alternative hypothesis. In other words, the set of alternatives to the null hypothesis is referred to as the alternative hypothesis. If we accept $H_0$, then we are rejecting $H_a$ and if we reject $H_0$, then we are accepting $H_a$. for $H_0 : \mu = \mu H_0 = 100$, we may consider three possible alternative hypotheses as follows:

| **Alternative hypothesis** | **To be read as follows** |
|---|---|
| $H_a : \mu \neq \mu H_0$ | (The alternative hypothesis is that the population mean is not equal to 100 i.e., it may be more or less than 100) |
| $H_a : \mu > \mu H_0$ | (The alternative hypothesis is that the population mean is greater than 100) |
| $H_a : \mu < \mu H_0$ | (The alternative hypothesis is that the population mean is less than 100) |



The null hypothesis and the alternative hypothesis are chosen before the sample is drawn (the researcher must avoid the error of deriving hypotheses from the data that he collects and then testing the hypotheses from the same data). In the choice of null hypothesis, the following considerations are usually kept in view:

a) Alternative hypothesis is usually the one which one wishes to prove and the null hypothesis is the one which one wishes to disprove. Thus, a null hypothesis represents the hypothesis we are trying to reject, and alternative hypothesis represents all other possibilities.

b) If the rejection of a certain hypothesis when it is actually true involves great risk, it is taken as null hypothesis because then the probability of rejecting it when it is true is $\alpha$ (the level of significance) which is chosen very small.

c) Null hypothesis should always be specific hypothesis i.e., it should not state about or approximately a certain value.

Generally, in hypothesis testing we proceed on the basis of null hypothesis, keeping the alternative hypothesis in view. Why so? The answer is that on the assumption that null hypothesis is true, one can assign the probabilities to different possible sample results, but this cannot be done if we proceed with the alternative hypothesis. Hence the use of null hypothesis (at times also known as statistical hypothesis) is quite frequent.



**(b) The level of significance**: This is a very important concept in the context of hypothesis testing. It is always some percentage (usually 5%) which should be chosen with great care, thought and reason. In case we take the significance level at 5 per cent, then this implies that $H_0$ will be rejected when the sampling result (i.e., observed evidence) has a less than 0.05 probability of occurring if $H_0$ is true. In other words, the 5 per cent level of significance means that researcher is willing to take as much as a 5 per cent risk of rejecting the null hypothesis when it ($H_0$) happens to be true. Thus the significance level is the maximum value of the probability of rejecting $H_0$ when it is true and is usually determined in advance before testing the hypothesis.

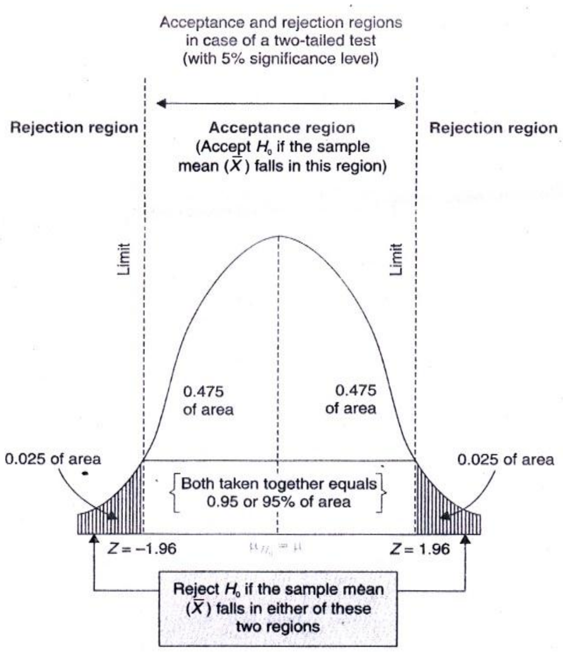
**(c) Decision rule or test of hypothesis**: Given a hypothesis $H_0$ and an alternative hypothesis $H_a$, we make a rule which is known as decision rule according to which we accept $H_0$ (i.e., accept $H_a$). for instance, if ($H_0$ is that a certain lot is good (there are very few defective items in it) against $H_a$) that the lot is not good (there are too many defective items in it), then we must decide the number of items to be tested and the criterion for accepting or rejecting the hypothesis. We might test 10 items in the lot and plan our decision saying that if there are none or only 1 defective item among the 10, we will accept $H_0$ otherwise we will reject $H_0$ (or accept $H_a$). this sort of basis is known as decision rule.

**(d) Type I and Type II errors**: In the context of testing of hypotheses, there are basically two types of errors we can make. We may reject $H_0$ when $H_0$ is true and we may accept $H_0$ when in fact $H_0$ is not true. the former is known as Type I error and the latter as Type II error. In other words, Type I error means rejection of hypothesis which should have been accepted and Type II error means accepting the hypothesis which should have been rejected. Type I error is denoted by $\alpha$ (alpha) known as $\alpha$ error, also called the level of significance of test; and Type II error is denoted by $\beta$ (beta) known as $\beta$ error. In a tabular form the said two errors can be presented as follows:



| | Decision | |
|---|---|---|
| | Accept $H_0$ | Reject $H_0$ |
| $H_0$ (true) | Correct decision | Type I error ($\alpha$ error) |
| $H_0$ (false) | Type II error ($\beta$ error) | Correct decision |

**Two-tailed and One tailed tests:** In the context of hypothesis testing, these two terms are quite important and must be clearly understood. A two-tailed test rejects the null hypothesis if, say, the sample mean is significantly higher or lower than the hypothesized value of the mean of the population. Such a test is appropriate when the null hypothesis is some specified value and the alternative hypothesis is a value not equal to the specified value of the null hypothesis. Symbolically, the two-tailed test is appropriate when we have $H_0 : \mu = \mu H_0$ and $H_a : \mu \neq \mu H_0$ which may mean $\mu > \mu H_0$ or $\mu < \mu H_0$ . thus, in a two-tailed test, there are two rejection regions, one on each tail of the curve which can be illustrated as under:

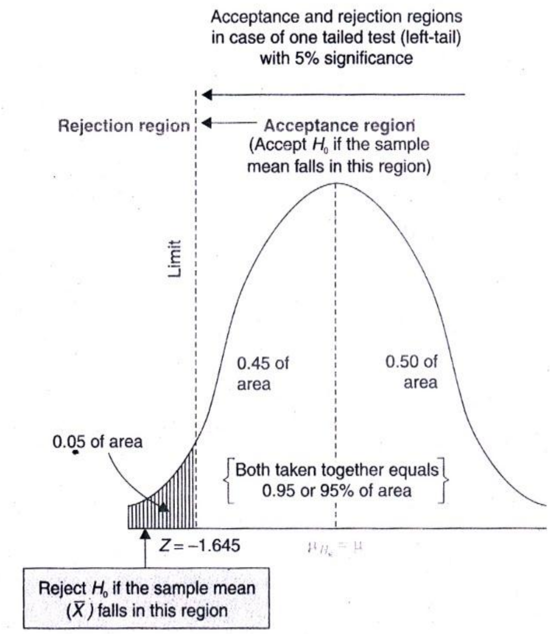



Mathematically we can state:

Acceptance Region A : $|Z| \leq 1.96$

Rejection Region R : $|Z| \geq 1.96$

If the significance level is 5 per cent and the two-tailed test is to be applied, the probability of the rejection area will be 0.05 (equally splitted on both tails of the curve as 0.025) and that of the acceptance region will be 0.95 as shown in the above curve. If we take $\mu$ = 100 and if our sample mean deviates significantly from 100 in either direction, then we shall reject the null hypothesis; but if the sample mean does not deviate significantly from μ, in that case we shall accept the null hypothesis. But there are situations when only one-tailed test is considered appropriate. A one-tailed test would be used when we are to test, say, whether the population mean is either lower than or higher than some hypothesized value. For instance, if our $H_0 : \mu = \mu H_0$ and $H_a : \mu \neq \mu H_0$, then we are interested in what is known as left tailed test (wherein there is one rejection region only on the left tail) which can be illustrated as below:



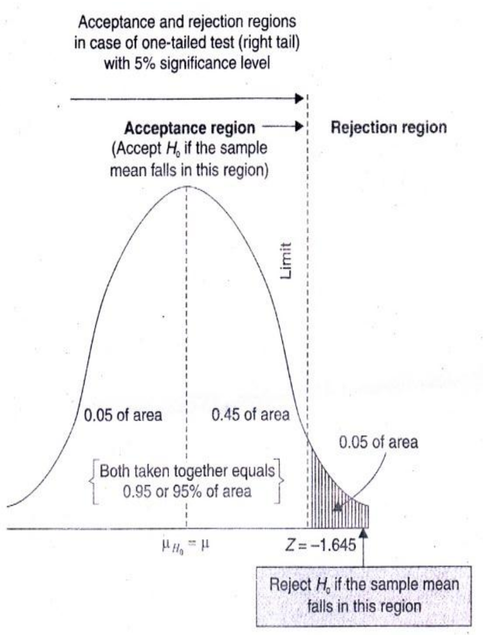

Mathematically we can state:

Acceptance Region A : Z > - 1.645

Rejection Region R : Z ≤ - 1.645

If our μ = 100 and if our sample mean deviates significantly from 100 in the lower direction, we shall reject $H_0$ , otherwise we shall accept $H_0$ at a certain level of significance. If the significance level in the given case is kept at 5%, then the rejection region will be equal to 0.05 of area in the left tail as has been shown in the above curve.

In case our $H_0 : \mu = \mu H_0$ and $H_a : \mu \neq \mu H_0$, we are then interested in what is known as one-tailed test (right tail) and the rejection region will be on the right tail of the curve as shown below :




Mathematically we can state:

Acceptance Region A : $|Z| \leq 1.645$

Rejection Region R : $|Z| > 1.645$

If our μ = 100 and if our sample mean deviates significantly from 100 in the upward direction, we shall reject $H_0$ , otherwise we shall accept the same. If in the given case the significance level is kept at 5%, then the rejection region will be equal to 0.05 of area in the right-tail as has been shown in the above curve.

It should always be remembered that accepting $H_0$ on the basis of sample information does not constitute the proof that $H_0$ is true. We only mean that there is no statistical evidence to reject it, but we are certainly not saying that $H_0$ is true (although we behave as if $H_0$ is true).

## 8.2 PROCEDURE FOR SIGNIFICANCE TESTING

Whenever we perform a significance test, it involves comparing a test value that we have calculated to some critical value for the statistic. It doesn't matter what type of statistic we are calculating (e.g., a t-statistic, a chi-square statistic, an F-statistic, etc.), the procedure to test for significance is the same.

1. Decide on the *critical alpha level* you will use (i.e., the error rate you are willing to accept).

2. Conduct the research.

3. Calculate the statistic.

4. Compare the statistic to a *critical value* obtained from a table or compare the probability of the statistic to the *critical alpha level*.

If your statistic is higher than the *critical value* from the table or the probability of the statistic is less than the critical alpha level:

Your finding is significant.

You reject the null hypothesis.

The probability is small that the difference or relationship happened

by chance, and p is less than the critical alpha level (p < ☼ ).

If your statistic is lower than the *critical value* from the table or the probability of the statistic is higher than the critical alpha level:

Your finding is not significant.

You fail to reject the null hypothesis.

The probability is high that the difference or relationship happened

by chance, and p is greater than the critical alpha level (p > ☼ ).

## 8.3 STATISTICAL HYPOTHESIS TESTING

**0. State your background assumptions, particularly population and sampling assumptions.**

Identify the population(s) and variable(s), and specify the notation and meaning (in words) of the parameters involved. For example, if you assume that the population variable is Normal, $N(\mu,\sigma)$, you should tell what $\mu$ and $\sigma$ represent in the given context. We often assume that the data can be treated as an SRS, or as two independent SRSs in two-sample problems. For decision problems, state in advance the value of $\alpha$, your level of significance.

**1. State the hypotheses to be tested.**

State the null hypotheses, $\mathbf{H_0}$, and the alternative hypothesis, $\mathbf{H_a}$ (or $\mathbf{H_1}$). These hypotheses state different claims about population parameter(s). The null hypothesis is usually the hypothesis of "no effect" or "no difference." The null hypothesis usually involves a claim of equality.

The alternative hypothesis usually states the effect we suspect or want to prove.

The alternative usually expresses an inequality: one-sided (<, >) or two-sided ($\neq$).

**2. Calculate your test statistic.**

Collect your data, and calculate the value of the test statistic based on these data. The test statistic may be an estimator of the parameter involved in the hypotheses, or it may be related to the estimator. Examples: the sample mean and its *z*-score. The statistician needs to know the distribution of the test statistic when the null hypothesis is true. (This is one reason why $\mathbf{H_0}$ should be a statement of equality.)

**3. Calculate the *P*-value.**

The *P*-value is the probability, computed assuming the null hypothesis, of getting a test statistic value as extreme or more extreme (in the direction favoring $\mathbf{H_a}$) than the value observed. Generally, a one-sided alternative has a one-tail *P*, and a two-sided alternative has a two-tail *P*.

**4. State your conclusion in context.**

A very small *P*-value provides strong evidence against the null hypothesis, because it tells us that the outcome actually observed would be very unlikely to occur if the null hypothesis were true. Describe in words and in context the strength of the evidence for or against the hypotheses. If a level of significance $\alpha$ has been set, and if $P \le \alpha$, we say that the data are **statistically significant at level $\alpha$**, and we reject the null hypothesis (but also state our conclusion in non-jargon terms).



*****

# Part IX

# VALIDITY & RELIABILITY

# Part IX

# VALIDITY & RELIABILITY

## 9.1 VALIDITY

Validity refers to the accuracy or truthfulness of a measurement. Are we measuring what we think we are? This is a simple concept, but in reality, it is extremely difficult to determine if a measure is valid.

- Face validity is based solely on the judgment of the researcher. Each question is scrutinized and modified until the researcher is satisfied that it is an accurate measure of the desired construct. The determination of face validity is based on the subjective opinion of the researcher.
- Content validity is similar to face validity in that it relies on the judgment of the researcher. However, where face validity only evaluates the individual items on an instrument, content validity goes further in that it attempts to determine if an instrument provides adequate coverage of a topic. Expert opinions, literature searches, and open-ended pretest questions help to establish content validity.
- Criterion-related validity can be either predictive or concurrent. When a dependent/independent relationship has been established between two or more variables, criterion-related validity can be assessed. A mathematical model is developed to be able to predict the dependent variable from the independent variable(s). Predictive validity refers to the ability of an independent variable (or group of variables) to predict a future value of the dependent variable. Concurrent validity is concerned with the relationship between two or more variables at the same point in time.
- Construct validity refers to the theoretical foundations underlying a particular scale or measurement. It looks at the underlying theories or constructs that explain a phenomena. This is also quite subjective and

depends heavily on the understanding, opinions, and biases of the researcher.

## 9.2 RELIABILITY

Reliability is synonymous with repeatability. A measurement that yields consistent results over time is said to be reliable. When a measurement is prone to random error, it lacks reliability. The reliability of an instrument places an upper limit on its validity. A measurement that lacks reliability will necessarily be invalid. There are three basic methods to test reliability: test-retest, equivalent form, and internal consistency.

A test-retest measure of reliability can be obtained by administering the same instrument to the same group of people at two different points in time. The degree to which both administrations are in agreement is a measure of the reliability of the instrument. This technique for assessing reliability suffers two possible drawbacks. First, a person may have changed between the first and second measurement. Second, the initial administration of an instrument might in itself induce a person to answer differently on the second administration.

The second method of determining reliability is called the equivalent-form technique. The researcher creates two different instruments designed to measure identical constructs. The degree of correlation between the instruments is a measure of equivalent-form reliability. The difficulty in using this method is that it may be very difficult (and/or prohibitively expensive) to create a totally equivalent instrument.

The most popular methods of estimating reliability use measures of internal consistency. When an instrument includes a series of questions designed to examine the same construct, the questions can be arbitrarily split into two groups. The correlation between the two subsets of questions is called the split-half reliability. The problem is that this measure of reliability changes depending on how the questions are split. A better statistic, known as Cronbach's alpha, is based on the mean (absolute value) interitem correlation for all possible variable pairs. It provides a conservative estimate of reliability, and generally represents the lower bound to the reliability of a scale of items. For dichotomous nominal data, the KR-20 (Kuder-Richardson) is used instead of Cronbach's alpha.

*****

# REFERENCES :


- Aggarwal L.N. and Diwan,Parag, Research Methodology and Management Decisions, Global Business Press, New Delhi, 1997.
- Chawla D and Sondhi , N. Research Methodology – Concepts and cases , 1st Edition, Vikas Publishing House Pvt. Ltd.,New Delhi, 2011.
- C.R.Kothari ,Research Methodology-Methods and Techniques, 2nd Revised Edition, New Age International Publishers, New Delhi, 2014.
- Cooper R., Donald, Business Research Methods, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2006.
- Majhi P.R., Khatua P.K., Research Methodology – Concepts, Methods, Techniques and SPSS) (Text and Cases), 2013, Himalaya Publishing House.
- Zikmund, William G.,Business Research Methods, 5th Edition, Dryden Press, Harcourt Brace college Publishers, 1997.