SYLLABUS

B.Com. Hons III Year

Subject – Research Methodology

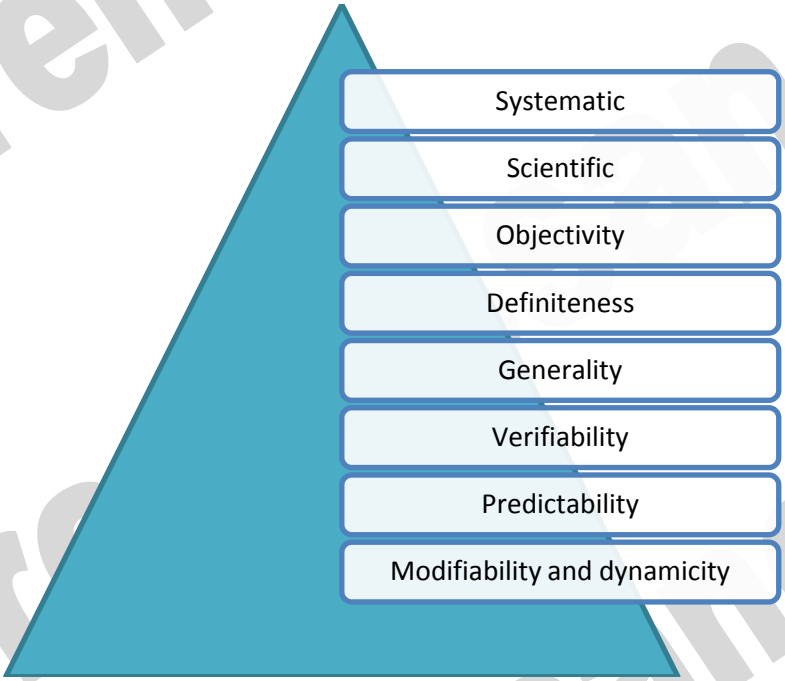
UNIT – I	Definition, Nature, Scope and Significance. Types of Research. Characteristics of a goods research.
UNIT – II	Research Process – Defining Research Problem, Title Formulation; Setting of Hypothesis, Research Design – Exploratory, Descriptive and Experimental Research Designs.
UNIT – III	Sampling Design, Criteria of Selecting a Sampling Procedure, Characteristics of Good Sample Design.
UNIT – IV	Measurement and Scaling, Methods of Collection of Primary and Secondary Data. Process of Questionnaire Design; Processing of Data – Editing, Coding, Classification and Tabulation.
UNIT – V	Analysis and Report Writing - Selection of Appropriate Statistical Techniques - Confidence Intervals and Hypothesis Tests Based on Two Samples; One way and Two way ANOVA; Chi Square Test. Introduction to Non Parametric Tests. Presentation of Result: Report Writing.

UNIT – 1
MEANING & TYPES OF RESEARCH

Meaning:

1) It is a scientific and systematic search for pertinent information on specific topic.
2) It is an art and as well as science of investigationυ Research may be defined as a 'careful critical enquiry or examination in seeking facts or principles; diligent investigation in order to ascertain something'.
3) Research common sense of the term refers to a search for knowledge. Research is a part and parcel of human knowledge.
4) Gathering and analyzing a body of information or data and **extracting new meaning** from it or **developing unique solutions** to problems or cases.
5) A **report** or **review**, not designed to create new information or insight but to collate and synthesize existing information.
6) A search for **individual facts or data**. May be part of the search for a solution to a larger problem

Nature of research



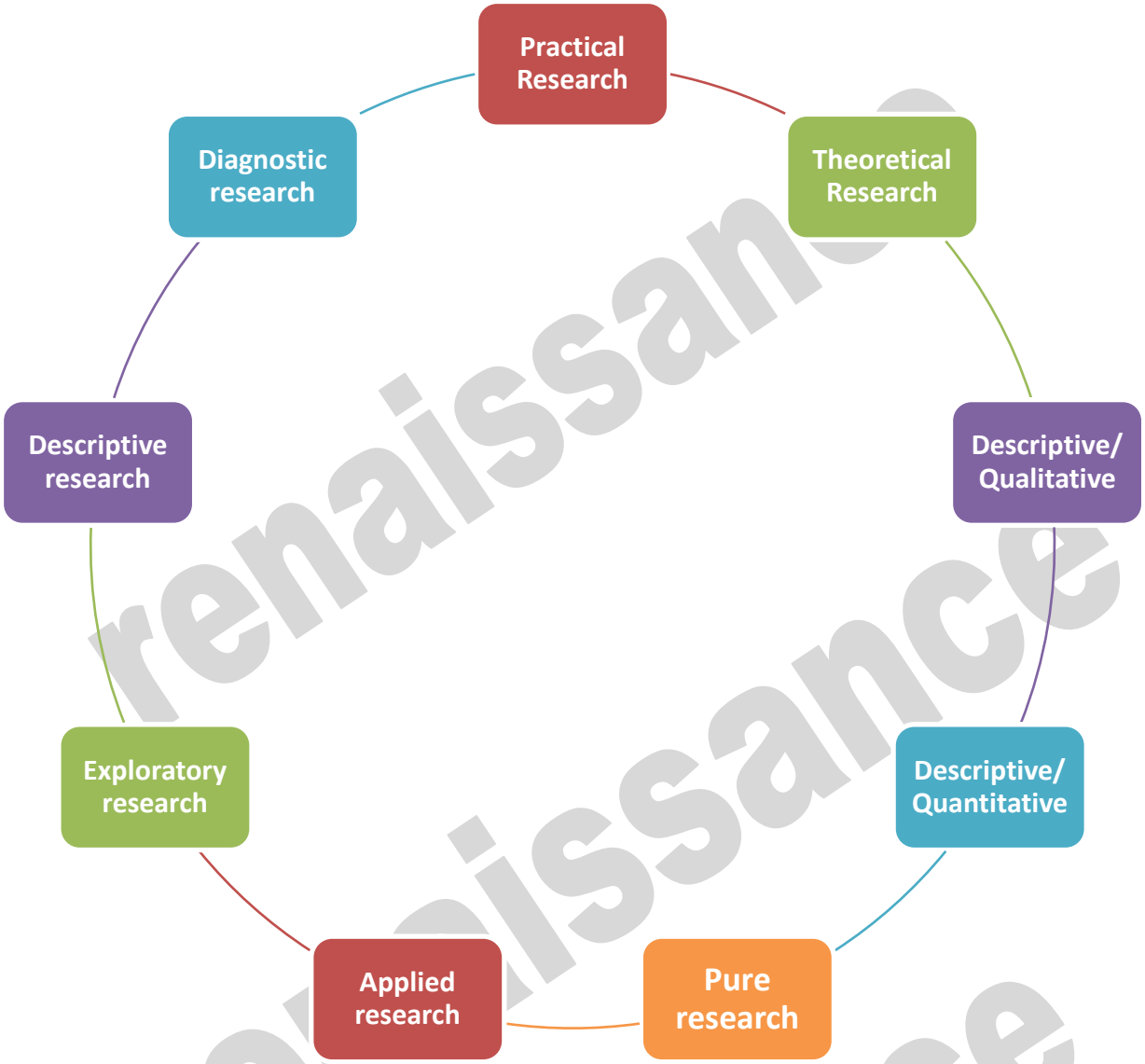
1. **Research is systematic and Scientific**- Research is a scientific and systematic search for pertinent information on a specific topic. • Generally, research has to follow a certain structural process.
2. **Research has objectivity** – Research is quite objective in its approach and is almost free from biases, prejudices and subjectivity.
3. **Research has definiteness** - Research is characterized by definiteness in its process as well as product. Here the modes and measures for (i) collection and organizing information or data and (ii) testing and verifying the collected information for arriving at the conclusion are all well planned and definite.

4. **Research has Verifiability**– Research lays emphasis on the proper verification of the collected information , data or facts. Here, nothing is accepted and derived unless verified through adequate observation, tests and experimentation.
5. **Research has Generality**– The conclusions or results derived from the scientific method show a marked characteristic of generality. First, it means that inductive reasoning and process is sued in making generalization and of the particular happenings or evens and secondly, the principles, laws and theories established through scientific method are quite universal having generalized application in similar situations.
6. **Research has Predictability**– The results obtained through scientific method are characterized with the ability of predicting the future outcomes of the things or events. In a given situation, under the known circumstances, what would happen to a person, object or phenomenon can be reasonably predicted through the properly derived conclusions or results of a scientific procedure.
7. **Research has modifiability and dynamicity**– The conclusion reached or results obtain through research are never final, absolute and static. They are always open to verification, observation and experimentation.
8. **Research has modifiability and dynamicity** – Consequently, what is true today in terms of the derived fact or reached generalization may be proved wrong tomorrow based on new findings. Therefore, research neither advocates rigidity in the process adopted for discovering the facts nor stands in the way of bringing desired modification and changes in the pre-established principles, laws or theories.

Significance of Research

- Research provides the basic for nearly all government policies in our economic system.
- The role of research in several fields of applied economics, whether related to business or to the economy as a whole, has greatly increased in modern times.
- Research inculcates scientific and inductive thinking and it promotes the development of logical habits of thinking and organization.
- According to Hudson Maxim Significance as, “All progress is born of inquiry. Doubt is often better than overconfidence, for it leads to inquiry and inquiry leads to investigation”
- Research is equally important for social scientists in studying social relationships and in seeking answers to various social problems. It gives intellectual satisfaction of knowing things for the sake of knowledge. It also possesses the practical utility for the social scientist to gain knowledge so as to be able to do something better or In a more efficient manner.
- Research has its special significance in solving various operational and planning problems of business and industry. In several ways, operations research, market research and motivational research are vital and their results assist in taking business decisions.
- Research provides the basis for nearly all government policies in our economic system.

Types of RESEARCH:



1) **Practical Research:** The practical approach consists of the empirical study of the topic under research and chiefly consists of hands on approach. This involves first hand research in the form of questionnaires, surveys, interviews, observations and discussion groups.
2) **Theoretical Research:** A non empirical approach to research, this usually involves perusal of mostly published works like researching through archives of public libraries, court rooms and published academic journals.
3) **Descriptive/Qualitative**: This type of research methods involve describing in details specific situation using research tools like interviews, surveys, and Observations. It focuses on gathering of mainly verbal data rather than measurements.
4) **Descriptive/Quantitative**: This type of research methods requires quantifiable data involving numerical and statistical explanations. Quantitative analysis hinges on researchers understanding the assumptions inherent within different statistical models. It generates numerical data or information that can be converted into numbers. The presentation of data is through tables containing data in the form of numbers and statistics.

5) Pure research

a. Also called as the fundamental or the theoretical research.
b. Is basic and original.
c. Can lead to the discovery of a new theory.
d. Can result in the development or refinement of a theory that already exists.
e. Helps in getting knowledge without thinking formally of implementing it in practice based on the honesty, love and integrity of the researcher for discovering the truth.

6) Applied research

a. Based on the concept of the pure research.
b. Is problem oriented.
c. Helps in finding results or solutions for real life problems.
d. Provides evidence of usefulness to society.
e. Helps in testing empirical content of a theory.
f. Utilizes and helps in developing the techniques that can be used for basic research.
g. Helps in testing the validity of a theory but under some conditions.
h. Provides data that can lead to the acceleration of the process of generalization.

7) Exploratory research

a. Involves exploring a general aspect.
b. Includes studying of a problem, about which nothing or a very little is known.
c. Follows a very formal approach of research.
d. Helps in exploring new ideas.
e. Helps in gathering information to study a specific problem very minutely.
f. Helps in knowing the feasibility in attempting a study.

8) Descriptive research

a. Simplest form of research.
b. More specific in nature and working than exploratory research.
c. It involves a mutual effort.
d. Helps in identifying various features of a problem.
e. Restricted to the problems that are describable and not arguable and the problems in which valid standards can be developed for standards.
f. Existing theories can be easily put under test by empirical observations.
g. Underlines factors that may lead to experimental research.
h. It consumes a lot of time.
i. It is not directed by hypothesis.

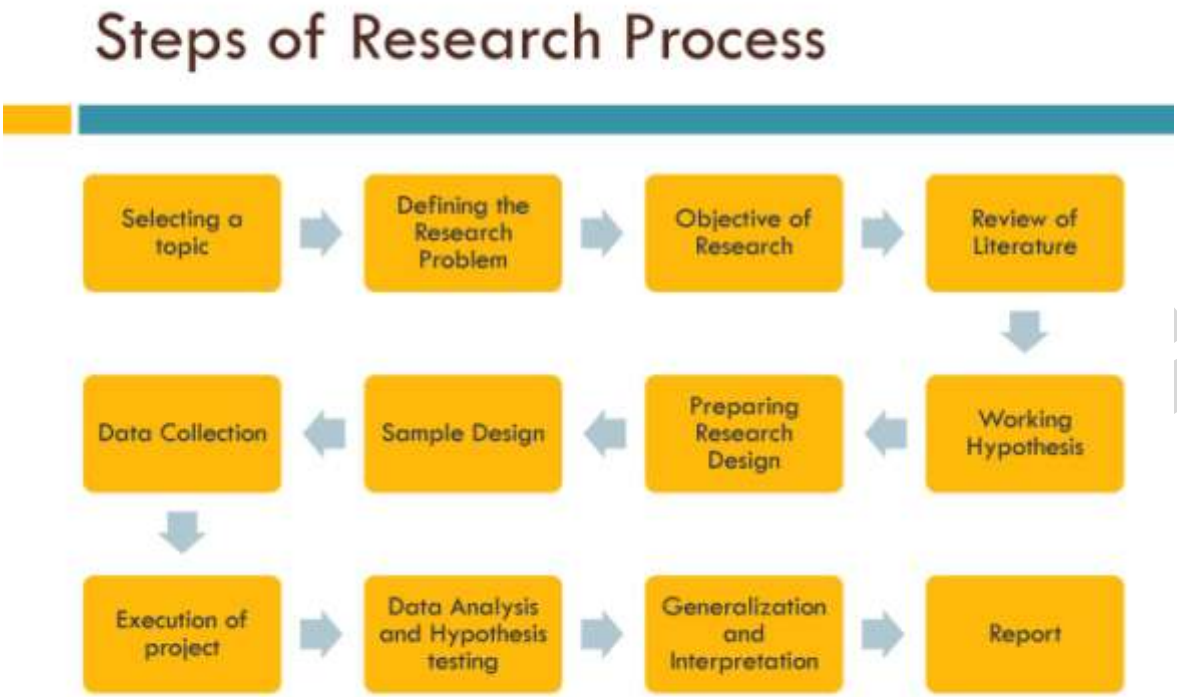
9) Diagnostic research

a. Quite similar to the descriptive research.
b. Identifies the causes of the problems and then solutions for these problems.
c. Related to causal relations.
d. It is directed by hypothesis.
e. Can be done only where knowledge is advanced.

Scope of Research

UNIT – 2
RESEARCH PROCESS

Research Process



1. Problem identification: The first step in a research process is to identify the problem or opportunity. The problem may be about decrease in sales, increase in competition, expansion of market, etc.

2. Problem definition: The second step in a research process is to define the problem. In this stage, the researcher must understand the problem correctly. He must find out the scope of the problem, the type of information needed, etc. If the problem is not defined properly, then it will result in waste of time, money and resources.

3. Research design: The third step in a research process is to prepare research design.
Research design is a plan for conducting a research. It guides the researcher in data collection. It gives proper direction to the research.
There are three types of research designs:

1. Exploratory research,
2. Descriptive Research and
3. Experimental Research.

All three types are used for marketing research.

4. Determining data needs: The fourth step in a research process is to determine the data needs. The researcher must consider the following issues:

1. Whether to use primary data or secondary data or both.
2. The accuracy and reliability of the data.
3. The availability of accurate and reliable data.
4. The cost and time required to collect the data.

5. Determining data sources: The fifth step in a research process is to determine the data sources. The researcher decides the sources of collecting data. The two main sources are secondary data and primary data. The researcher first collects secondary data. This is because it is easily available and less costly. It is collected by Desk Research. Desk Research can be internal for e.g. collected from company's records or external i.e. acquired from libraries, trade journals, government sources, etc. If the secondary data is not sufficient to solve the marketing problem, then primary data is wheeled.

Collecting primary data is very costly and time consuming. It can be collected by using survey methods, i.e. by doing personal interviews, telephone interviews and mail surveys. It can also be collected by using observational method and experimentation method.

So in this step the researcher decides what source and what method to use for collecting data.

6. Sampling design: The sixth step in a research process is of sampling design. The Researchers has limited time and other resources. So he cannot contact the total population. That is, he cannot collect information from all the people in the market. Therefore, he selects few persons from the population. These handful persons are called sample respondent. They are considered to represent the total population. The researcher collects data from the sample respondents. Sampling helps to save time, efforts and cost. It is used to collect primary data. The researcher has to decide about method of sampling, the size-of-sample, etc.

7. Designing questionnaire: The seventh step in a research process is of designing a questionnaire. In this stage, primary data is collected with the help of a questionnaire. So the researcher has to prepare a questionnaire. A questionnaire is a list of questions. These questions are asked to the respondents for collecting data. The questionnaire must be suitable so that the require data is collected easily, quickly and correctly. It is used for conducting person interview, telephone interviews and mail survey. The researcher must decide about the type of the information required, the type of questioned to be asked, the wordings of the questionnaire, its order, etc.

8. Field staff selection: The eighth step in a research process is of selecting field staff. After preparing the questionnaire, the researcher selects field interviewers. The field interviewers collect information from the respondents. They must be property trained. Students of psychology and statistics are good for this job.

9. Collection and processing of data: The ninth step in a research process is of collection and processing of data. In this stage, the data is collected from the respondents. The questionnaire is used for collecting data. In case of mail surveys, the questionnaire is sent to the respondents by post. In case of telephone interviews, the data is collected through telephone. In case of personal interviews, the data is collected by the field interviewers. The researcher can also use observation

method and experimentation method for collecting data. The data collected must be reliable and complete. It must also be collected quickly. Secondary data is also collected. The data collected is raw. It cannot be used directly. It has to be processed and organized neatly. That is, the data must be edited, coded, classified and tabulated. Editing helps to remove the unwanted data. Coding, classification and tabulation make the data ready for analysis and interpretation.

10. Analysis and interpretation of data: The tenth step in a research process is of analysis and interpretation of data. In this stage, the researcher analyzes and interprets the data. That is, he studies the data very careful and draws conclusions from it. These conclusions are then used to solve the marketing problem.

11. Project reporting: The eleventh step in a research process is to prepare a project report.
In this stage, the researcher prepares the final research report. This report contains a title of the report, method used, findings, conclusions and suggestions about how to solve the marketing problem. The language of the report must not be very difficult. The report must be submitted to the marketing executives for recommendations and implementation.

12. Follow up: Finally, the last step in a research process is to do a follow up.
In this stage, the marketing executive makes changes in the product, price, marketing policies, etc. as per the recommendations of the report. Here, the researcher should find out, whether his recommendations are implemented properly or not. He should also figure-out, whether the marketing problem is solved or not.

RESEARCH PROBLEM

Identification & formulation of Research Problem

The main steps in identification & formulation of research problem are:

1. Specify the Research Objectives

A clear statement of objectives will help you develop **effective research.**
It will help the decision makers evaluate your project. **It's critical** that you have manageable objectives. (Two or three clear goals will help to keep your research project focused and relevant.)

2. Review the Environment or Context of the Research Problem

As a marketing researcher, you must work closely with your team. This will help you determine whether the findings of your project will produce enough information to be worth the cost.
In order to do this, you have to identify the environmental variables that will affect the research project.

3. Explore the Nature of the Problem

Research problems range from simple to complex, depending on the number of variables and the nature of their relationship.
If you understand the nature of the **problem as a researcher**, you will be able to better develop a solution for the problem.
To help you understand all dimensions, you might want to consider focus groups of consumers, sales people, managers, or professionals to provide what is sometimes much needed insight.

4. Define the Variable Relationships

Marketing plans often focus on creating a sequence of behaviors that occur over time, as in the adoption of a new package design, or the introduction of a new product.

Such programs create a commitment to follow some behavioral pattern in the future.
Studying such a process involves:

- Determining which variables affect the solution to the problem.
- Determining the degree to which each variable can be controlled.
- Determining the functional relationships between the variables and which variables are critical to the solution of the problem.

During the **problem formulation** stage, you will want to generate and consider as many courses of action and variable relationships as possible.

5. The Consequences of Alternative Courses of Action

There are always consequences to any course of action. Anticipating and communicating the possible outcomes of various courses of action is a primary responsibility in the research process.

RESEARCH DESIGN

A **research design** is a systematic plan to study a scientific problem. The design of a study defines the study type (descriptive, correlational, semi-experimental, experimental, review, meta-analytic) and sub-type (e.g., descriptive-longitudinal case study), research question, hypotheses, independent and dependent variables, experimental design, and, if applicable, data collection methods and a statistical analysis plan. Research design is the framework that has been created to seek answers to research questions.

Confirmatory versus exploratory research

Confirmatory research tests *a priori* hypotheses—outcome predictions that are made before the measurement phase begins. Such *a priori* hypotheses are usually derived from a theory or the results of previous studies. The advantage of confirmatory research is that the result is more meaningful, in the sense that it is much harder to claim that a certain result is statistically significant. The reason for this is that in confirmatory research, one ideally strives to reduce the probability of falsely reporting a non-significant result as significant. This probability is known as α-level or a type I error. Loosely speaking, if you know what you are looking for, you should be very confident when and where you will find it; accordingly, you only accept a result as significant if it is highly unlikely to have been observed by chance.

Exploratory research on the other hand seeks to generate *a posteriori* hypotheses by examining a data-set and looking for potential relations between variables. It is also possible to have an idea about a relation between variables but to lack knowledge of the direction and strength of the relation. If the researcher does not have any specific hypotheses beforehand, the study is exploratory with respect to the variables in question (although it might be confirmatory for others). The advantage of exploratory research is that it is easier to make new discoveries due to the less stringent methodological restrictions. Here, the researcher does not want to miss a potentially interesting relation and therefore aims to minimize the probability of rejecting a *real* effect or relation, this probability is sometimes referred to as β and the associated error is of type II. In other words, if you want to see whether some of your measured variables could be related, you would want to increase your chances of finding a significant result by lowering the threshold of what you deem to be *significant*.

Sometimes, a researcher may conduct exploratory research but report it as if it had been confirmatory this is a questionable research practice bordering fraud.

Need and Importance of Research Design

Research design carries an important influence on the reliability of the results attained. It therefore provides a solid base for the whole research. It is needed due to the fact that it allows for the smooth working of the many research operations. This makes the research as effective as possible by providing maximum information with minimum spending of effort, money and time. For building of a car, we must have a suitable blueprint made by an expert designer. In a similar fashion, we require a suitable design or plan just before data collection and analysis of the research project. Planning of design must be carried out cautiously as even a small mistake might mess up the purpose of the entire project. The design helps the investigator to organize his ideas, which helps to recognize and fix his faults, if any. In a **good research design**, all the components go together with each other in a coherent way. The theoretical and conceptual framework must with the research goals and purposes. In the same way, the data gathering method must fit with the research purposes, conceptual and theoretical framework and method of data analysis.

A research design is like a successful journey:

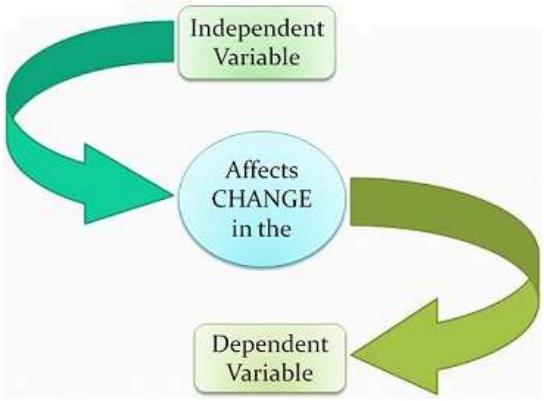
- Broadens your mind
- Provides fascinating & exciting experience
- Gives understanding of world around you
- Provides chance to meet people
- Gives fun and reward, but sometimes, very tedious & monotonous too.

The **importance of research design in research methodology** is due to the following:

- It may result in the preferred kind of study with helpful conclusion.
- It cuts down on inaccuracy.
- Allows you get optimum efficiency and reliability.
- Reduce wastage of time.
- Reduce uncertainty, confusion and practical haphazard related to any research problem.
- Of great help for collection of research material and testing of hypothesis.
- It is a guide for giving research the right path.
- Gets rid of bias and marginal errors.
- Provides an idea concerning the type of resources needed in terms of money, effort, time, and manpower.
- Smooth & efficient sailing (sets boundaries & helps prevent blind search)
- Maximizes reliability of results.
- Provides firm foundation to the endeavor.
- Averts misleading conclusions & thoughtless useless exercise.
- Provides opportunity to anticipate flaws & inadequacies (anticipates problems).
- Incorporates by learning from other people's critical comments & evaluations.

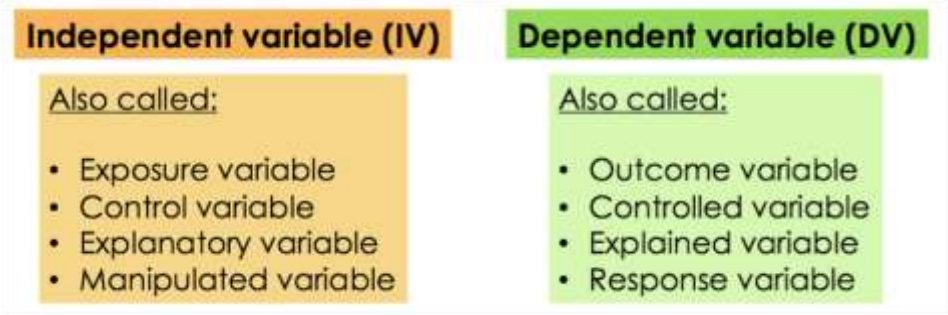
Variables & Types of Variables

When it comes to experiments and data analysis, there are two main types of variables: **dependent variables** and **independent variables**. It's easy to get these mixed up, but the difference between dependent and independent variables is simple. Here is a quick and easy definition of each one, along with some examples.



1) Dependent Variable: This is the output variable you are really interested in monitoring to see if it was affected or not. It can also be called the "measured variable," the "responding variable," the "explained variable," etc. I think it is easy to remember this one because it is *dependent* on the other variables.

2) Independent Variables: These are the individual variables that you believe may have an effect on the dependent variable. They are sometimes called "explanatory variables," "manipulated variables," or "controlled variables."



Example #1: Golf Balls

Here's a simple situation: Suppose you want to test golf ball flight distances, so you set up a simple experiment in which various golf balls are placed into a mechanical chute and fired into the air. The variable you really care about, the "output" or ***dependent variable*** is golf ball distance. ***Independent variables*** are the variables you are going to test to see how they affect distance. In this case, they are going to be things like air temperature, golf ball brand, and color of the golf ball. In the end, if you do a fancy regression analysis on all your data, you are going to end up with a formula that looks something like this: golf ball distance = 50 feet + air temperature factor + golf ball brand factor + golf ball color factor. See how all the independent variables (air temp, brand, color) have an effect on the dependent variable (distance)?

Example #2: Ice Cubes

Here's another simple example: Imagine that you have a bunch of ice cubes and you want to test how long it takes them to melt in various situations. You have an experiment with 1,000 equally shaped ice cubes. Some of them are made of frozen cranberry juice and some of them are frozen lemonade. You are going to set some of them on a metal sheet and others are going to be placed on a wooden plank. Air temperature, wind, and every other condition you can think of will remain constant. So, in this case, your ***dependent variable*** is ice cube melting time. Your two ***independent***

variables are: juice type (cranberry or lemonade) and melting surface (metal or wood). I'm not sure why anyone would care to do such an experiment, but hopefully the difference between the dependent and independent variables are clear now.

Hypothesis, Types & Formulation of Hypothesis

Introduction and Definition

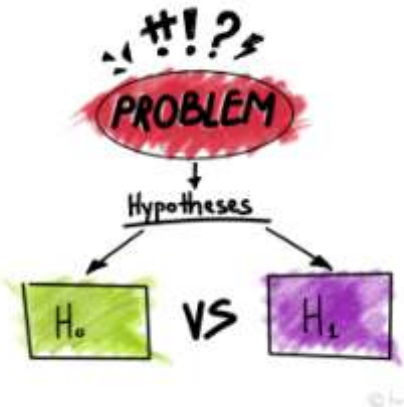
Hypothesis and the theories are generally responsible for the movement of knowledge from the unknown to the known. Hypotheses play a very important and a critical role in the assertion of a particular thing, as they are able to describe certain facts and are also able to explain the various relationships between these facts. As a result of this, hypotheses help a great deal in the investigation operations or activities.

On the institution of the problem to be answered in the process of the research, the researcher forms various tentative or possible solutions to these problems these proposed answers or the solutions are referred to as the hypothesis. But a very critical and essential point to be kept in mind here is that these propositions are not at all verified in nature.

So Hypothesis can be referred to as the interpretation of certain facts which is just a possible solution or a tentative answer to a problem and is completely or partly unverified in nature. Then afterwards on its establishment, it ceases to be a hypothesis and then finally becomes a theory or a principle. The word 'Hypothesis' has come from the Greek word hypo (means under)and tithenas (means to place) together these words indicate towards the support they provide to each other on the placement of the hypothesis under the evidence, which acts as a foundation.

According to George A Luniberg, hypothesis can be defined as a 'tentative generalization, the validity of which remains to be tested. In this elementary stage, the hypothesis may be very hunch, guess, imaginative data, which becomes the basis for an action or an investigation.'

A very vital point that should be kept in mind about the hypotheses is that these are not theories these only have some linkage to the theory but hypothesis is not that much elaborated as the theory is. But it can be said that the hypothesis is derived from the theory.



Role and Functions of the hypothesis

1. Helps in the testing of the theories.
2. Serves as a great platform in the investigation activities.
3. Provides guidance to the research work or study.

4. Hypothesis sometimes suggests theories.
5. Helps in knowing the needs of the data.
6. Explains social phenomena.
7. Develops the theory.
8. Also acts as a bridge between the theory and the investigation.
9. Provides a relationship between phenomena in such a way that it leads to the empirical testing of the relationship.
10. Helps in knowing the most suitable technique of analysis.
11. Helps in the determination of the most suitable type of research.
12. Provides knowledge about the required sources of data.
13. Research becomes focused under the direction of the hypothesis.
14. Is very helpful in carrying out an enquiry of a certain activity.
15. Helps in reaching conclusions, if it is correctly drawn.

Sources of hypothesis

1. Observations made in routine activities.
2. Theories based on the scientific approach.
3. Analogies.
4. Knowledge obtained from the functional executives.
5. Results of the research and development department.
6. Experience of the investigator.

Characteristics of hypothesis

1. Should be very specific in nature.
2. Concept of the hypothesis should be clear.
3. Should be empirically testable.
4. Should be related to the devices and the techniques that are available.
5. Should relate to the body of the theory.
6. Should recognize the specific variables and their relation

Problems faced during hypothesis formulation

Formulating a hypothesis is not at all an easy process and is faced with a large number of difficulties. According to Goode and Hatt, the various difficulties faced during the formulation of the hypothesis generally include the lack of the knowledge about the scientific approach of the method involved, as sometimes it becomes impossible to gather the complete information about a particular scientific method. One other major difficulty in the formulation of the hypothesis is the lack of clear theoretical background. Because of this problem of unclear and indefinite background of theory one is not able to arrive to a conclusion easily.

But with time answers to all such problems are available and these difficulties that arise during the hypothesis formulation can be easily removed by having complete and accurate information about the concepts of the subjects involved. Also the hypothesis should not be very long and should be timely in nature.

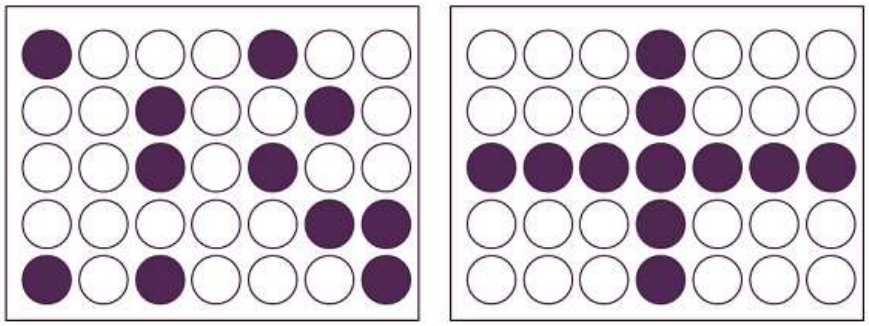
UNIT 3
SAMPLING DESIGN

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

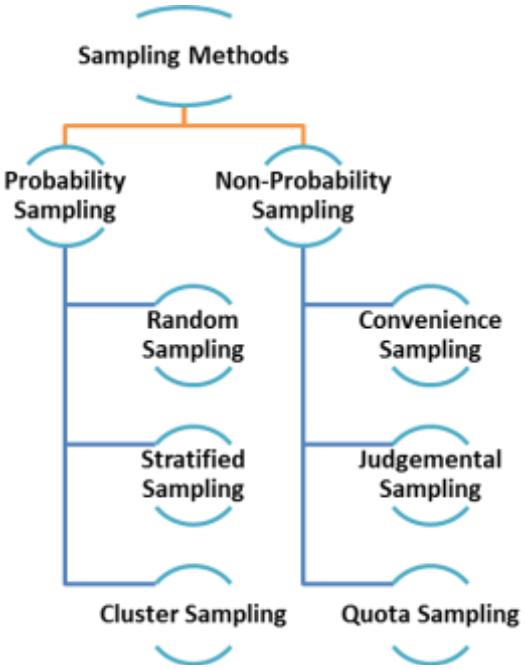
The researcher must decide the way of selecting a sample or what is popularly known as the sample design. In other words, a sample design is a definite plan determined before any data are actually collected for obtaining a sample from a given population. Thus, the plan to select 12 of a city's 200 drugstores in a certain way constitutes a sample design.

METHODS OF SAMPLING

Samples can be either probability or non-probability samples. With probability samples each element has a known probability of being included in the sample but the non-probability samples do not allow the researcher to determine this probability. Probability samples are those based on simple random sampling, systematic sampling, stratified sampling, cluster/area sampling whereas non-probability samples are those based on convenience sampling, judgement sampling and quota sampling techniques.



Probability Sampling Vs Non-Probability Sampling



Deliberate sampling:

Deliberate sampling is also known as purposive or non-probability sampling. This sampling method involves purposive or deliberate selection of particular units of the universe for constituting a sample which represents the universe. When population elements are selected for inclusion in the sample based on the ease of access, it can be called convenience sampling. If a researcher wishes to secure data from, say, gasoline buyers, he may select a fixed number of petrol stations and may conduct interviews at these stations. This would be an example of convenience sample of gasoline buyers. At times such a procedure may give very biased results particularly when the population is not homogeneous. On the other hand, in judgement sampling, the researcher's judgement is used for selecting items which he considers as representative of the population. For example, a judgement sample of college students might be taken to secure reactions to a new method of teaching. Judgement sampling is used quite frequently in qualitative research where the desire happens to be to develop hypotheses rather than to generalise to larger populations.

Simple random sampling:

This type of sampling is also known as chance sampling or probability sampling where each and every item in the population has an equal chance of inclusion in the sample and each one of the possible samples, in case of finite universe, has the same probability of being selected. For example, if we have to select a sample of 300items from a universe of 15,000 items, then we can put the names or numbers of all the15,000 items on slips of paper and conduct a lottery. Using the random number tables is another method of random sampling. To select the sample, each item is assigned a number from 1 to 15,000. Then, 300 five digits random numbers are selected from the table. To do this we select some random starting point and then a systematic pattern is used in proceeding through the table. We might start in the 4th row, second column and proceed down the column to the bottom of the table and then move to the top of the next column to the right. When a number exceeds the limit of the numbers in the frame, in our case over 15,000, it is simply passed over and the next number selected that does fall within the relevant range. Since the numbers were placed in the table in a completely random fashion, the resulting sample is random. This procedure gives each item an equal probability of being selected. Incase of infinite population,

the selection of each item in a random sample is controlled by the same probability and that successive selections are independent of one another.

Systematic sampling:

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

Stratified sampling:

If the population from which a sample is to be drawn does not constitute a homogeneous group, then stratified sampling technique is applied so as to obtain a representative sample. In this technique, the population is stratified into a number of non-overlapping subpopulations or strata and sample items are selected from each stratum. If the items selected from each stratum is based on simple random sampling the entire procedure, first stratification and then simple random sampling, is known as stratified random sampling.

Quota sampling:

In stratified sampling the cost of taking random samples from individual strata is often so expensive that interviewers are simply given quota to be filled from different strata, the actual selection of items for sample being left to interviewer's judgement.

This is called quota sampling. The size of the quota for each stratum is generallyproportionate to the size of that stratum in the population. Quota sampling is thus an important form of non-probability sampling. Quota samples generally happen to be judgement samples rather than random samples.

Cluster sampling and area sampling:

Cluster sampling involves grouping the population and then selecting the groups or the clusters rather than individual elements for inclusion in the sample. Suppose some departmental store wishes to sample its credit card holders. It has issued its cards to 15,000 customers. The sample size is to be kept say 450. For cluster sampling this list of 15,000 card holders could be formed into 100 clusters of 150 cardholders each. Three clusters might then be selected for the sample randomly. The sample size must often be larger than the simple random sample to ensure the same level of accuracy because is cluster sampling procedural potential for order bias and other sources of error are usually accentuated. The clustering approach can, however, make the sampling procedure relatively easier and increase the efficiency of field work, specially in the case of personal interviews.

Area sampling

It is quite close to cluster sampling and is often talked about when the total geographical area of interest happens to be big one. Under area sampling we first divide the total area into a number of smaller non-overlapping areas, generally called geographical clusters, then a number of these smaller areas are randomly selected, and all units in these small areas are included in the sample. Area sampling

is specially helpful where we do not have the list of the population concerned. It also makes the field interviewing more efficient since interviewer can do many interviews at each location.

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

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

STEPS IN SAMPLE DESIGN

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

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

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

Source list:
It is also known as 'sampling frame' from which sample is to be drawn. It contains the names of all items of a universe (in case of finite universe only). If source list is not available, researcher has to prepare it. Such a list should be comprehensive, correct, reliable and appropriate. It is extremely important for the source list to be as representative of the population as possible.

Size of sample:

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

Parameters of interest:

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

Budgetary constraint:

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

Sampling procedure:

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

CRITERIA OF SELECTING A SAMPLING PROCEDURE

In this context one must remember that two costs are involved in a sampling analysis viz., the cost of collecting the data and the cost of an incorrect inference resulting from the data. Researcher must keep in view the two causes of incorrect inferences viz., systematic bias and sampling error. A *systematic bias* results from errors in the sampling procedures, and it cannot be reduced or eliminated by increasing the sample size. At best the causes responsible for these errors can be detected and corrected. Usually a systematic bias is the result of one or more of the following factors:

1. Inappropriate sampling frame:

If the sampling frame is inappropriate i.e., a biased representation of the universe, it will result in a systematic bias.

2.Defective measuring device:

If the measuring device is constantly in error, it will result in systematic bias. In survey work, systematic bias can result if the questionnaire or the interviewer is biased. Similarly, if the physical measuring device is defective there will be systematic bias in the data collected through such a measuring device.

3. Non-respondents:

If we are unable to sample all the individuals initially included in the sample, there may arise a systematic bias. The reason is that in such a situation the likelihood of establishing contact or receiving a response from an individual is often correlated with the measure of what is estimated.

4.Indeterminancy principle:

Sometimes we find that individuals act differently when kept under observation than what they do when kept in non-observed situations. For instance, if workers are aware that somebody is observing them in course of a work study on the basis of which the average length of time to complete a task will be determined and accordingly the quota will be set for piecework, they generally tend to work slowly in comparison to the speed with which they work if kept unobserved. Thus, the indeterminacy principle may also be a cause of a systematic bias.

5.Natural bias in the reporting of data:

Natural bias of respondents in the reporting of data is often the cause of a systematic bias in many inquiries. There is usually a downward bias in the income data collected by government taxation department, whereas we find an upward bias in the income data collected by some social organisation. People in general understate their incomes if asked about it for tax purposes, but they overstate the same if asked for social status or their affluence. Generally in psychological surveys, people tend to give what they think is the 'correct' answer rather than revealing their true feelings.

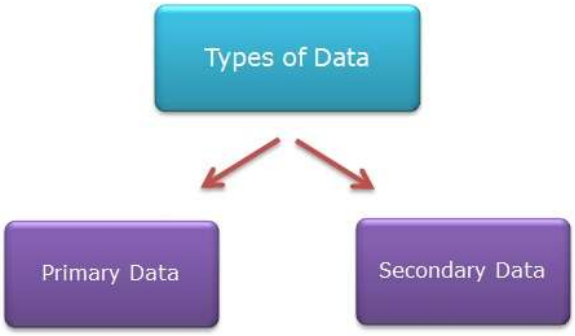
CHARACTERISTICS OF A GOOD SAMPLE DESIGN

From what has been stated above, we can list down the characteristics of a good sample design asunder:

(a)Sample design must result in a truly representative sample.
(b)Sample design must be such which results in a small sampling error.
(c)Sample design must be viable in the context of funds available for the research study.
(d)Sample design must be such so that systematic bias can be controlled in a better way.
(e)Sample should be such that the results of the sample study can be applied, in general, for the universe with a reasonable level of confidence

UNIT 4
MEASUREMENT AND SCALING

Sources of data: primary & secondary data



Primary Data:
Raw data (also known as primary data) is a term for data collected from a *source*. Raw data has not been subjected to processing or any other manipulation, and are also referred to as *primary* data.

Sources of primary data:
Primary data is the data collected by the researcher themselves, i.e.

1. interview
2. observation
3. action research
4. case studies
5. life histories
6. questionnaires
7. ethnographic research
8. longitudinal studies

Advantages of Primary data:

1) **Targeted Issues are addressed.** The organization asking for the research has the complete control on the process and the research is streamlines as far as its objectives and scope is concerned. Researching company can be asked to concentrate their efforts to find data regarding specific market rather than concentration on mass market.
2) **Data interpretation is better.** The collected data can be examined and interpreted by the marketers depending on their needs rather than relying on the interpretation made by collectors of secondary data.
3) **Fresh/Recent Data.** Usually secondary data is not so recent and it may not be specific to the place or situation marketer is targeting. The researcher can use the irrelevant seeming information for knowing trends or may be able to find some relation with the current scenario. Thus primary data becomes a more accurate tool since we can use data which is useful for us.
4) **Proprietary Issues**. Collector of primary data is the owner of that information and he need not share it with other companies and competitors. This gives an edge over competitors replying on secondary data.

Disadvantages of Primary data:

1) **High Cost.** Collecting data using primary research is a costly proposition as marketer has to be involved throughout and has to design everything.
2) **Time Consuming.** Because of exhaustive nature of the exercise, the time required to do research accurately is very long as compared to secondary data, which can be collected in much lesser time duration.
3) **Inaccurate Feed-backs.** In case the research involves taking feedbacks from the targeted audience, there are high chances that feedback given is not correct. Feedbacks by their basic nature are usually biased or given just for the sake of it.
4) **More number of resources are required**. Leaving aside cost and time, other resources like human resources and materials too are needed in larger quantity to do surveys and data collection.

Secondary Data:
Secondary data, is data collected by someone other than the user. Common sources of secondary data for social science include censuses, organisational records and data collected through qualitative methodologies or qualitative research. Primary data, by contrast, are collected by the investigator conducting the research.

Sources of secondary data:
Secondary sources are data that already exists

1. Previous research
2. Official statistics
3. Mass media products
4. Diaries
5. Letters
6. Government reports
7. Web information
8. Historical data and information

Advantages of secondary data :

1) **Ease of Access:** There are many advantages to using secondary research. This includes the relative ease of access to many sources of secondary data. In the past secondary data accumulation required marketers to visit libraries, or wait for reports to be shipped by mail. Now with the availability of online access, secondary research is more openly accessed. This offers convenience and generally standardized usage methods for all sources of secondary research.
2) **Low Cost to Acquire**
The use of secondary data has allowed researchers access to valuable information for little or no cost to acquire. Therefore, this information is much less expensive then if the researchers had to carry out the research themselves.
3) **Clarification of Research Question**
The use of secondary research may help the researcher to clarify the research question. Secondary research is often used prior to primary research to help clarify the research focus.
4) **May Answer Research Question**

The use of secondary data collection is often used to help align the focus of large scale primary research. When focusing on secondary research, the researcher may realize that the exact information they were looking to uncover is already available through secondary sources. This would effectively eliminate the need and expense to carry out there own primary research.

5) **May Show Difficulties in Conducting Primary Research**

In many cases, the originators of secondary research include details of how the information was collected. This may include information detailing the procedures used in data collection and difficulties encountered in conducting the primary research. Therefore, the detailed difficulties may persuade the researcher to decide that the potential information obtained is not worth the potential difficulties in conducting the research.

Disadvantages of secondary data :

1) **Quality of Research**

There are some disadvantages to using secondary research. The originators of the primary research are largely self-governed and controlled by the marketer. Therefore, the secondary research used must be scrutinized closely since the origins of the information may be questionable. Moreover, the researcher needs to take sufficient steps to critically evaluate the validity and reliability of the information provided.

2) **Not Specific to Researcher's Needs**

In many cases, secondary data is not presented in a form that exactly meets the researcher's needs. Therefore, the researcher needs to rely on secondary data that is presented and classified in a way that is similar to their needs.

3) **Incomplete Information**

In many cases, researchers find information that appears valuable and promising. The researcher may not get the full version of the research to gain the full value of the study. This is because many research suppliers offer free portions of their research and then charge expensive fees for their full reports.

4) **Not Timely**

When using secondary research, one must exercise caution when using dated information from the past. With companies competing in fast changing industries, an out-of-date research reports many have little or no relevance to the current market situation.

Interview Research

1) The qualitative research interview seeks to describe and the meanings of central themes in the life world of the subjects. The main task in interviewing is to understand the meaning of what the interviewees say.
2) A qualitative research interview seeks to cover both a factual and a meaning level, though it is usually more difficult to interview on a meaning level.
3) Interviews are particularly useful for getting the story behind a participant's experiences. The interviewer can pursue in-depth information around the topic. Interviews may be useful as follow-up to certain respondents to questionnaires, e.g., to further investigate their responses.

Characteristics of Interview

1) Interviews are completed by the interviewer based on what the respondent says.
2) Interviews are a far more personal form of research than questionnaires.
3) In the personal interview, the interviewer works directly with the respondent

4) Unlike with mail surveys, the interviewer has the opportunity toprobe or ask follow up questions.
5) Interviews are generally easier for respondent, especially if what is sought is opinions or impressions.
6) Interviews are time consuming and they are resource intensive.
7) The interviewer is considered a part of the measurement instrument and interviewer has to well trained in how to respond to any contingency

Types of Interviews

1) **Informal, conversational interview** -no predetermined questions are asked, in order to remain as open and adaptable as possible to the interviewee's nature and priorities; during the interview the interviewer "goes with the flow".
2) **General interview guide approach** -the guide approach is intended to ensure that the same general areas of information are collected from each interviewee; this provides more focus than the conversational approach, but still allows a degree of freedom and adaptability in getting the information from the interviewee.
3) **Standardized, open-ended interview** -the same open-ended questions are asked to all interviewees; this approach facilitates faster interviews that can be more easily analyzed and compared.
4) **Closed, fixed-response interview** -where all interviewees are asked the same questions and asked to choose answers from among the same set of alternatives. This format is useful for those not practiced in interviewing

Survey Research & its Types

A survey is defined as a brief interview or discussion with individuals about a specific topic. The term survey is unfortunately a little vague, so we need to define it better. The term survey is often used to mean 'collect information.

Classification of Survey Design According to Instrumentation

In survey research, the instruments that are utilized can be either a questionnaire or an interview (either structured or unstructured).

1. Questionnaires

Typically, a questionnaire is a paper-and-pencil instrument that is administered to the respondents. The usual questions found in questionnaires are closed-ended questions, which are followed by response options. However, there are questionnaires that ask open-ended questions to explore the answers of the respondents.

Questionnaires have been developed over the years. Today, questionnaires are utilized in various survey methods, according to how they are given. These methods include the self-administered, the group-administered, and the household drop-off. Among the three, the self-administered survey method is often used by researchers nowadays. The self-administered questionnaires are widely known as the mail survey method. However, since the response rates related to mail surveys had gone low, questionnaires are now commonly administered online, as in the form of web surveys.

- **Advantages:** Ideal for asking closed-ended questions; effective for market or consumer research

- **Disadvantages:** Limit the researcher's understanding of the respondent's answers; requires budget for reproduction of survey questionnaires

2. Interviews

Between the two broad types of surveys, interviews are more personal and probing. Questionnaires do not provide the freedom to ask follow-up questions to explore the answers of the respondents, but interviews do.

An interview includes two persons - the researcher as the interviewer, and the respondent as the interviewee. There are several survey methods that utilize interviews. These are the personal or face-to-face interview, the phone interview, and more recently, the online interview.

- **Advantages:** Follow-up questions can be asked; provide better understanding of the answers of the respondents
- **Disadvantages:** Time-consuming; many target respondents have no public-listed phone numbers or no telephones at all

Classification of Survey Design According to the Span of Time Involved

The span of time needed to complete the survey brings us to the two different types of surveys: cross-sectional and longitudinal.

1. Cross-Sectional Surveys

Collecting information from the respondents at a single period in time uses the cross-sectional type of survey. Cross-sectional surveys usually utilize questionnaires to ask about a particular topic at one point in time. For instance, a researcher conducted a cross-sectional survey asking teenagers' views on cigarette smoking as of May 2010. Sometimes, cross-sectional surveys are used to identify the relationship between two variables, as in a comparative study. An example of this is administering a cross-sectional survey about the relationship of peer pressure and cigarette smoking among teenagers as of May 2010.

2. Longitudinal Surveys

When the researcher attempts to gather information over a period of time or from one point in time up to another, he is doing a longitudinal survey. The aim of longitudinal surveys is to collect data and examine the changes in the data gathered. Longitudinal surveys are used in cohort studies, panel studies and trend studies.

PROCESS OF QUESTIONNAIRE DESIGN

There are nine steps involved in the development of a questionnaire:

1. Decide the information required.
2. Define the target respondents.
3. Choose the method(s) of reaching your target respondents.
4. Decide on question content.
5. Develop the question wording.
6. Put questions into a meaningful order and format.
7. Check the length of the questionnaire.
8. Pre-test the questionnaire.
9. Develop the final survey form.

1. **Deciding on the information required**

It should be noted that one does not start by writing questions. The first step is to decide 'what are the things one needs to know from the respondent in order to meet the survey's objectives?' These, as has been indicated in the opening chapter of this textbook, should appear in the research brief and the research proposal.

One may already have an idea about the kind of information to be collected, but additional help can be obtained from secondary data, previous rapid rural appraisals and exploratory research. In respect of secondary data, the researcher should be aware of what work has been done on the same or similar problems in the past, what factors have not yet been examined, and how the present survey questionnaire can build on what has already been discovered. Further, a small number of preliminary informal interviews with target respondents will give a glimpse of reality that may help clarify ideas about what information is required.

2. **Define the target respondents**

At the outset, the researcher must define the population about which he/she wishes to generalise from the sample data to be collected. For example, in marketing research, researchers often have to decide whether they should cover only existing users of the generic product type or whether to also include non-users. Secondly, researchers have to draw up a sampling frame. Thirdly, in designing the questionnaire we must take into account factors such as the age, education, etc. of the target respondents.

3. **Choose the method(s) of reaching target respondents**

It may seem strange to be suggesting that the method of reaching the intended respondents should constitute part of the questionnaire design process. However, a moment's reflection is sufficient to conclude that the method of contact will influence not only the questions the researcher is able to ask but the phrasing of those questions. The main methods available in survey research are:

· personal interviews
· group or focus interviews

· mailed questionnaires
· telephone interviews.

Within this region the first two mentioned are used much more extensively than the second pair. However, each has its advantages and disadvantages. A general rule is that the more sensitive or personal the information, the more personal the form of data collection should be.

4. Decide on question content

Researchers must always be prepared to ask, "Is this question really needed?" The temptation to include questions without critically evaluating their contribution towards the achievement of the research objectives, as they are specified in the research proposal, is surprisingly strong. No question should be included unless the data it gives rise to is directly of use in testing one or more of the hypotheses established during the research design.

There are only two occasions when seemingly "redundant" questions might be included:

· Opening questions that are easy to answer and which are not perceived as being "threatening", and/or are perceived as being interesting, can greatly assist in gaining the respondent's involvement in the survey and help to establish a rapport.

This, however, should not be an approach that should be overly used. It is almost always the case that questions which are of use in testing hypotheses can also serve the same functions.

· "Dummy" questions can disguise the purpose of the survey and/or the sponsorship of a study. For example, if a manufacturer wanted to find out whether its distributors were giving the consumers or end-users of its products a reasonable level of service, the researcher would want to disguise the fact that the distributors' service level was being investigated. If he/she did not, then rumours would abound that there was something wrong with the distributor.

5. Develop the question wording

Survey questions can be classified into three forms, i.e. closed, open-ended and open response-option questions. So far only the first of these, i.e. closed questions has been discussed. This type of questioning has a number of important advantages;

· It provides the respondent with an easy method of indicating his answer - he does not have to think about how to articulate his answer.

· It 'prompts' the respondent so that the respondent has to rely less on memory in answering a question.

· Responses can be easily classified, making analysis very straightforward.

· It permits the respondent to specify the answer categories most suitable for their purposes.

Disadvantages are also present when using such questions

· They do not allow the respondent the opportunity to give a different response to those suggested.

· They 'suggest' answers that respondents may not have considered before.

With open-ended questions the respondent is asked to give a reply to a question in his/her own words. No answers are suggested.

Example: "What do you like most about this implement?"

Open-ended questions have a number of advantages when utilised in a questionnaire:

· They allow the respondent to answer in his own words, with no influence by any specific alternatives suggested by the interviewer.

· They often reveal the issues which are most important to the respondent, and this may reveal findings which were not originally anticipated when the survey was initiated.

· Respondents can 'qualify' their answers or emphasise the strength of their opinions.

However, open-ended questions also have inherent problems which means they must be treated with considerable caution. For example:

· Respondents may find it difficult to 'articulate' their responses i.e. to properly and fully explain their attitudes or motivations.

· Respondents may not give a full answer simply because they may forget to mention important points. Some respondents need prompting or reminding of the types of answer they could give.

· Data collected is in the form of verbatim comments - it has to be coded and reduced to manageable categories. This can be time consuming for analysis and there are numerous opportunities for error in recording and interpreting the answers given on the part of interviewers.

· Respondents will tend to answer open questions in different 'dimensions'. For example, the question: "When did you purchase your tractor?", could elicit one of several responses, viz:

"A short while ago".
"Last year".
"When I sold my last tractor".
"When I bought the farm".

Such responses need to be probed further unless the researcher is to be confronted with responses that cannot be aggregated or compared.

It has been suggested that the open response-option questions largely eliminate the disadvantages of both the afore-mentioned types of question. An open response-option is a form of question which is both open-ended and includes specific response-options as well. For example,

What features of this implement do you like?

· Performance
· Quality
· Price
· Weight
· Others mentioned:

The advantages of this type of question are twofold:

· The researcher can avoid the potential problems of poor memory or poor articulation by then subsequently being able to prompt the respondent into considering particular response options.

· Recording during interview is relatively straightforward.

The one disadvantage of this form of question is that it requires the researcher to have a good prior knowledge of the subject in order to generate realistic/likely response options before printing the questionnaire. However, if this understanding is achieved the data collection and analysis process can be significantly eased.

Clearly there are going to be situations in which a questionnaire will need to incorporate all three forms of question, because some forms are more appropriate for seeking particular forms of response. In instances where it is felt the respondent needs assistance to articulate answers or provide answers on a preferred dimension determined by the researcher, then closed questions should be used. Open-ended questions should be used where there are likely to be a very large number of possible different responses (e.g. farm size), where one is seeking a response described in the respondent's own words, and when one is unsure about the possible answer options. The mixed type of question would be advantageous in most instances where most potential response-options are known; where unprompted and prompted responses are valuable, and where the survey needs to allow for unanticipated responses.

There are a series of questions that should be posed as the researchers develop the survey questions themselves:

"Is this question sufficient to generate the required information?"

For example, asking the question "Which product do you prefer?" in a taste panel exercise will reveal nothing about the attribute(s) the product was judged upon. Nor will this question reveal the degree of preference. In such cases a series of questions would be more appropriate.

"Can the respondent answer the question correctly?"

· An inability to answer a question arises from three sources:

· Having never been exposed to the answer, e.g. "How much does your husband earn?"

· Forgetting, e.g. What price did you pay when you last bought maize meal?"

· An inability to articulate the answer: e.g. "What improvements would you want to see in food preparation equipment?"

"Are there any external events that might bias response to the question?"

For example, judging the popularity of beef products shortly after a foot and mouth epidemic is likely to have an effect on the responses.

"Do the words have the same meaning to all respondents?"

For example, "How many members are there in your family?"

There is room for ambiguity in such a question since it is open to interpretation as to whether one is speaking of the immediate or extended family.

"Are any of the words or phrases loaded or leading in any way?"

For example," What did you dislike about the product you have just tried?"

The respondent is not given the opportunity to indicate that there was nothing he/she disliked about the product. A less biased approach would have been to ask a preliminary question along the lines of, "Did you dislike any aspect of the product you have just tried?", and allow him/her to answer yes or no.

"Are there any implied alternatives within the question?"

The presence or absence of an explicitly stated alternative can have dramatic effects on responses. For example, consider the following two forms of a question asked of a 'Pasta-in-a-Jar' concept test:

1. " Would you buy pasta-in-a-jar if it were locally available?"
2. "If pasta-in-a-jar and the cellophane pack you currently use were both available locally, would you:
· Buy only the cellophane packed pasta?
· Buy only the pasta-in-a-jar product?
· Buy both products?"

The explicit alternatives provide a context for interpreting the true reactions to the new product idea. If the first version of the question is used, the researcher is almost certain to obtain a larger number of positive responses than if the second form is applied.

"Will the question be understood by the type of individual to be interviewed?"

It is good practice to keep questions as simple as possible. Researchers must be sensitive to the fact that some of the people he/she will be interviewing do not have a high level of education. Sometimes he/she will have no idea how well or badly educated the respondents are until he/she gets into the field. In the same way, researchers should strive to avoid long questions. The fewer

words in a question the better. Respondents' memories are limited and absorbing the meaning of long sentences can be difficult: in listening to something they may not have much interest in, the respondents' minds are likely to wander, they may hear certain words but not others, or they may remember some parts of what is said but not all.

"Is there any ambiguity in my questions?"

The careless design of questions can result in the inclusion of two items in one question. For example: "Do you like the speed and reliability of your tractor?"

The respondent is given the opportunity to answer only 'yes' or 'no', whereas he might like the speed, but not the reliability, or vice versa. Thus it is difficult for the respondent to answer and equally difficult for the researcher to interpret the response.

The use of ambiguous words should also be avoided. For example: "Do you regularly service your tractor?"

The respondents' understanding and interpretation of the term 'regularly' will differ. Some may consider that regularly means once a week, others may think once a year is regular. The inclusion of such words again present interpretation difficulties for the researcher.

"Are any words or phrases vague?"

Questions such as 'What is your income?' are vague and one is likely to get many different responses with different dimensions. Respondents may interpret the question in different terms, for example:

· hourly pay?
· weekly pay?
· yearly pay?
· income before tax?
· income after tax?
· income in kind as well as cash?
· income for self or family?
· all income or just farm income?

The researcher needs to specify the 'term' within which the respondent is to answer.

"Are any questions too personal or of a potentially embarrassing nature?"

The researcher must be clearly aware of the various customs, morals and traditions in the community being studied. In many communities there can be a great reluctance to discuss certain questions with interviewers/strangers. Although the degree to which certain topics are taboo varies from area to area, such subjects as level of education, income and religious issues may be embarrassing and respondents may refuse to answer.

"Do questions rely on feats of memory?"

The respondent should be asked only for such data as he is likely to be able to clearly remember. One has to bear in mind that not everyone has a good memory, so questions such as 'Four years ago was there a shortage of labour?' should be avoided.

6. **Putting questions into a meaningful order and format**

Opening questions: Opening questions should be easy to answer and not in any way threatening to THE respondents. The first question is crucial because it is the respondent's first exposure to the interview and sets the tone for the nature of the task to be performed. If they find the first question difficult to understand, or beyond their knowledge and experience, or embarrassing in some way, they are likely to break off immediately. If, on the other hand, they find the opening question easy and pleasant to answer, they are encouraged to continue.

Question flow: Questions should flow in some kind of psychological order, so that one leads easily and naturally to the next. Questions on one subject, or one particular aspect of a subject, should be grouped together. Respondents may feel it disconcerting to keep shifting from one topic to another, or to be asked to return to some subject they thought they gave their opinions about earlier.

Question variety:. Respondents become bored quickly and restless when asked similar questions for half an hour or so. It usually improves response, therefore, to vary the respondent's task from time to time. An open-ended question here and there (even if it is not analysed) may provide much-needed relief from a long series of questions in which respondents have been forced to limit their replies to pre-coded categories. Questions involving showing cards/pictures to respondents can help vary the pace and increase interest.

Closing questions

It is natural for a respondent to become increasingly indifferent to the questionnaire as it nears the end. Because of impatience or fatigue, he may give careless answers to the later questions. Those questions, therefore, that are of special importance should, if possible, be included in the earlier part of the questionnaire. Potentially sensitive questions should be left to the end, to avoid respondents cutting off the interview before important information is collected.

In developing the questionnaire the researcher should pay particular attention to the presentation and layout of the interview form itself. The interviewer's task needs to be made as straight-forward as possible.

· Questions should be clearly worded and response options clearly identified.

· Prescribed definitions and explanations should be provided. This ensures that the questions are handled consistently by all interviewers and that during the interview process the interviewer can answer/clarify respondents' queries.

Ample writing space should be allowed to record open-ended answers, and to cater for differences in handwriting between interviewers.

7. Physical appearance of the questionnaire

The physical appearance of a questionnaire can have a significant effect upon both the quantity and quality of marketing data obtained. The quantity of data is a function of the response rate. Ill-designed questionnaires can give an impression of complexity, medium and too big a time commitment. Data quality can also be affected by the physical appearance of the questionnaire with unnecessarily confusing layouts making it more difficult for interviewers, or respondents in the case of self-completion questionnaires, to complete this task accurately. Attention to just a few basic details can have a disproportionately advantageous impact on the data obtained through a questionnaire.

Use of booklets	The use of booklets, in the place of loose or stapled sheets of paper, make it easier for interviewer or respondent to progress through the document. Moreover, fewer pages tend to get lost.
Simple, clear formats	The clarity of questionnaire presentation can also help to improve the ease with which interviewers or respondents are able to complete a questionnaire.
Creative use of space and typeface	In their anxiety to reduce the number of pages of a questionnaire these is a tendency to put too much information on a page. This is counter-productive since it gives the questionnaire the appearance of being complicated. Questionnaires that make use of blank space appear easier to use, enjoy higher response rates and contain fewer errors when completed.
Use of colour coding	Colour coding can help in the administration of questionnaires. It is often the case that several types of respondents are included within a single survey (e.g. wholesalers and retailers). Printing the questionnaires on two different colours of paper can make the handling easier.
Interviewer instructions	Interviewer instructions should be placed alongside the questions to which they pertain. Instructions on where the interviewers should probe for more information or how replies should be recorded are placed after the question.

In general it is best for a questionnaire to be as short as possible. A long questionnaire leads to a long interview and this is open to the dangers of boredom on the part of the respondent (and poorly considered, hurried answers), interruptions by third parties and greater costs in terms of interviewing time and resources. In a rural situation an interview should not last longer then 30-45 minutes.

8. Piloting the questionnaires

Even after the researcher has proceeded along the lines suggested, the draft questionnaire is a product evolved by one or two minds only. Until it has actually been used in interviews and with respondents, it is impossible to say whether it is going to achieve the desired results. For this reason it is necessary to pre-test the questionnaire before it is used in a full-scale survey, to identify any mistakes that need correcting.

The purpose of pretesting the questionnaire is to determine:

· whether the questions as they are worded will achieve the desired results

· whether the questions have been placed in the best order

· whether the questions are understood by all classes of respondent

· whether additional or specifying questions are needed or whether some questions should be eliminated

· whether the instructions to interviewers are adequate.

Usually a small number of respondents are selected for the pre-test. The respondents selected for the pilot survey should be broadly representative of the type of respondent to be interviewed in the main survey.

If the questionnaire has been subjected to a thorough pilot test, the final form of the questions and questionnaire will have evolved into its final form. All that remains to be done is the mechanical process of laying out and setting up the questionnaire in its final form. This will involve grouping and sequencing questions into an appropriate order, numbering questions, and inserting interviewer instructions.

Measurement Scales

1) Dichotomous Scales

A dichotomous scale is a two-point scale which presents options that are absolutely opposite each other. This type of response scale does not give the respondent an opportunity to be neutral on his answer in a question.

Examples:

- Yes- No
- True - False
- Fair - Unfair
- Agree – Disagree

2) Rating Scales

Three-point, five-point, and seven-point scales are all included in the umbrella term “rating scale”. A rating scale provides more than two options, in which the respondent can answer in neutrality over a question being asked.

Examples:

1. Three-point Scales

- Good - Fair – Poor
- Agree – Undecided - Disagree
- Extremely- Moderately - Not at all
- Too much - About right - Too little

2. Five-point Scales (e.g. Likert Scale)

- Strongly Agree – Agree – Undecided / Neutral - Disagree - Strongly Disagree
- Always – Often – Sometimes – Seldom – Never
- Extremely – Very - Moderately – Slightly - Not at all
- Excellent - Above Average – Average - Below Average - Very Poor

3. Seven-point Scales

- Exceptional – Excellent – Very Good – Good – Fair – Poor – Very Poor
- Very satisfied - Moderately satisfied - Slightly satisfied – Neutral - Slightly dissatisfied - Moderately Dissatisfied- Very dissatisfied

3) Semantic Differential Scales

A semantic differential scale is only used in specialist surveys in order to gather data and interpret based on the connotative meaning of the respondent's answer. It uses a pair of clearly opposite words, and can either be marked or unmarked.

Examples:

1. Marked Semantic Differential Scale

Please answer based on your opinion regarding the product:

	very	slightly	neither	slightly	very	
Inexpensive	[ ]	[ ]	[ ]	[ ]	[ ]	Expensive
Effective	[ ]	[ ]	[ ]	[ ]	[ ]	Ineffective
Useful	[ ]	[ ]	[ ]	[ ]	[ ]	Useless
Reliable	[ ]	[ ]	[ ]	[ ]	[ ]	Unreliable

2. Unmarked Semantic Differential Scale

The central line serves as the neutral point:

Inexpensive _____|_____ Expensive
Effective _____|_____ Ineffective
Useful _____|_____ Useless
Reliable _____|_____ Unreliable

Techniques of Developing Scales

1) Define the attitude

The first step in designing an attitude scale is to define the attitude you want to measure. What does the attitude mean? What does "desire to learn" mean? If students do not have a desire to learn, what do they have? Perhaps, "desire to get a degree." With these two end points we can begin to build a scale to differentiate between those who desire to learn, and those who merely want a credential. In defining the attitude, we must choose which end of the scale will be positive, and which will be negative. The simplest way to do this is to assign the positive end of the scale to your attitude. For our example, we'll make "desire to learn" positive, and "desire to get a degree" negative.

2) **Determine related areas**

Having defined the end points of the scale, we next determine what attitudes, opinions, behaviors, or feelings might be related to each end of the scale. What kinds of things would reflect the positive side? The negative side? These related areas provide the raw material from which we'll develop attitudinal statements. In what areas would "learn" and "degree" students differ? Here's my suggested list: doing homework, using the library, extra reading, free time discussion, meetings with professors, opinions concerning the meaning of a degree, and views on grades.

3) Write statements

Next, we will write statements that reflect positive and negative aspects of these areas. We've defined "positive" to mean "that which agrees with my position," and "negative" means "that which disagrees with my position." The statements, even though reflecting subjective variables, should be objective. That is, statements must not be systematically biased toward one position or the other. Students who really want merely to get a degree should have no trouble scoring low on the scale. They should tend to agree with statements reflecting "degree" and tend to disagree with statements reflecting "learning." In the same way, students who really want to learn should tend to agree with "learning" statements, and tend to disagree with "degree" statements.

4) Create an item pool

Continue writing items, both positive and negative, until you have an item pool at least twice the size of your intended instrument. If you plan to have 20 statements in your final scale, then create an item pool of 40 items.

Validating the items

Enlist a validation panel of 6-8 persons to evaluate each item. It is suggested that you have persons on the panel who represent both extremes of the scale. Have the panel rate each item on its clarity and potency in defining the attitude in question.

Rank

Rankorder the evaluated items on clarity and potency. Choose an equal number of positive and negative items from the best statements.

Formatting the Scale

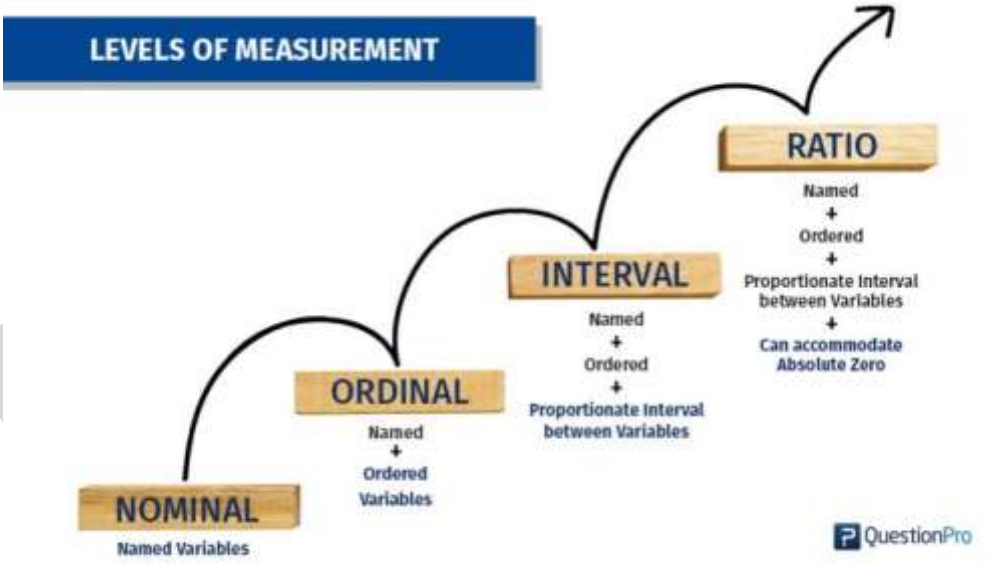
Randomly order the selected statements. Use letters to indicate choices, such as "SD", "D", "A", and "SA" rather than numbers. I recommend that you use four or six levels of response. Using an even number of responses forces respondents to mark the direction of their attitudinal tendencies — positive or negative. Mean scores for groups filling out the scale have more meaning in this less stable construction. Many Likert scales have 5 levels, with a "no opinion" center. This neutral middle option allows subjects an easy way to avoid considering the statement.

Scoring the scale

The points given for each response depend on whether the statement is positive or negative. The person who "strongly agrees" with a "positive statement" gets the maximum points. One who "strongly disagrees" with a "positive statement" gets the minimum points. For a four-point scale, the scoring would be as follows for *positive statements*: SD=1, D=2, A=3, SA=4.

The person who "strongly agrees" with a negative statement gets the minimum number of points (1), while the one who "strongly disagrees" with a negative statement gets the maximum points (4). In our four-point example, the scoring for *negative statements* would be as follows: SD=4, D=3, A=2, and SA=1.

In this short 8-item example attitude scale subject attitude scores will range from a low of "**8**" (8 x 1 = 8) to a high of "**32**" (8 x 4 = 32). For a twenty-five item scale, this procedure yields scores ranging from 25 to 100. These scores can then be used to compare groups on the defined attitude.



a) Nominal scale:

Nominal scale is simply a system of assigning number symbols to events in order to label them. The usual example of this is the assignment of numbers of basketball players in order to identify them. Such numbers cannot be considered to be associated with an ordered scale for their order is of no consequence; the numbers are just convenient labels for the particular class of events and as such have no quantitative value. Nominal scales provide convenient ways of keeping track of people, objects and events. One cannot do much with the numbers involved. For example, one cannot usefully average the numbers on the back of a group of football players and come up witha meaningful value. Neither can one usefully compare the numbers assigned to one group with the numbers assigned to another. The counting of members in each group is the only possible arithmetic operation when a nominal scale is employed. Accordingly, we are restricted to use mode as the measure of central tendency. There is no generally used measure of dispersion for nominal scales. Chi-square test is the most common test of statistical significance that can be utilized, and for the measures of correlation, the contingency coefficient can be worked out. Nominal scale is the least powerful level of measurement. It indicates no order or distance relationship and has no arithmetic origin. A nominal scale simply describes differences between things by assigning them to categories. Nominal data are, thus, counted data. The scale wastes any information that we may have about varying degrees of attitude, skills, understandings, etc. In spite of all this, nominal scales are still very useful and are widely used in surveys and other-*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 researchrelating to qualitative phenomena. A student's rank in his graduation class involves the use of an ordinal scale. One has to be very careful in making statement about scores based on ordinal scales. For instance, if Ram's position in his class is 10 and Mohan's position is 40, it cannot be said that Ram's position is four times as good as that of Mohan. The statement would make no sense at all. Ordinal scales only permit the ranking of items from highest to lowest. Ordinal measures have noabsolute 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 tendencies 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:

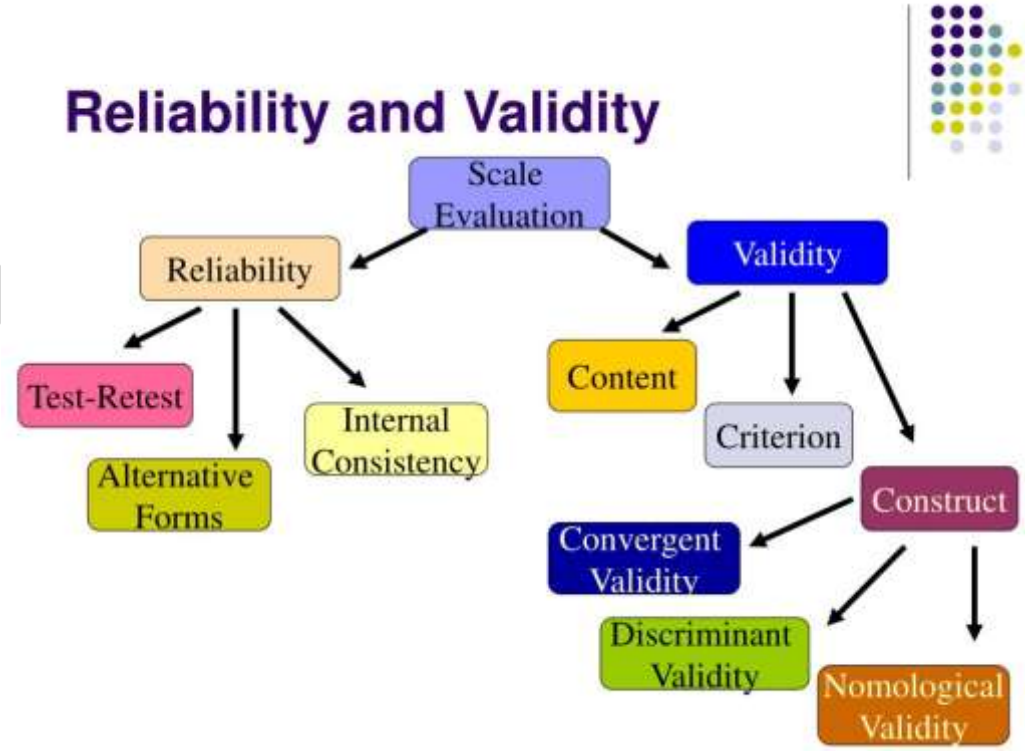
In the case of interval scale, the intervals are adjusted in terms of some rule thathas been established as a basis for making the units equal. The units are equal only in so far as one accepts the assumptions on which the rule is based. Interval scales can have an arbitrary zero, but it is not possible to determine for them what may be called an absolute zero or the unique origin. The primary limitation of the interval scale is the lack of a true zero; it does not have the capacity to measure the complete absence of a trait or characteristic. The Fahrenheit scale is an example of an interval scale and shows similarities in what one can and cannot do with it. One can say that an increase in temperature from 30° to 40° involves the same increase in temperature as an increase from 60° to 70°, but one cannot say that the temperature of 60° is twice as warm as the temperatureof 30° because both numbers are dependent on the fact that the zero on the scale is set arbitrarily at the temperature of the freezing point of water. The ratio of the two temperatures, 30° and 60°, means nothing because zero is an arbitrary point. Interval scales provide more powerful measurement than ordinal scales for interval scale also incorporates the concept of equality of interval. As such more powerful statistical measures can be used with interval scales. Mean is the appropriate measure of central tendency, while standard deviation is the most widely used measure of dispersion. Product moment correlation techniques are appropriate and the generally used tests for statistical significance are the 't' test and 'F' test.

(d) Ratio scale:

Ratio scales have an absolute or true zero of measurement. The term 'absolute zero' is not as precise as it was once believed to be. We can conceive of an absolute zero of length and similarly we can conceive of an absolute zero of time. For example, the zero point on a centimeter scale indicates the complete absence of length or height. But an absolute zero of temperature is theoretically unobtainable and it remains a concept existing only in the scientist's mind. The number of minor traffic-rule violations and the number of incorrect letters in a page of type script on ratio scales. Both these scales have absolute zeros and as such all minor traffic violations and all

typing errors can be assumed to be equal in significance. With ratio scales involved one can make statements like "Jyoti's" typing performance was twice as good as that of "Reetu." The ratio involved does have significance and facilitates a kind of comparison which is not possible in case of an interval scale. Ratio scale represents the actual amounts of variables. Measures of physical dimensions such as weight, height, distance, etc. are examples. Generally, all statistical techniques are usable with ratio scales and all manipulations that one can carry out with real numbers can also be carried out with ratio scale values. Multiplication and division can be used with this scale but not with other scales mentioned above. Geometric and harmonic means can be used as measures of central tendency and coefficients of variation may also be calculated.

Reliability & Validity of Scales



Validity:

Validity is the extent to which an instrument measures what it is supposed to measure and performs as it is designed to perform. Does the measure employed really measure the theoretical concept (variable)? It is rare, if nearly impossible, that an instrument be 100% valid, so validity is generally measured in degrees. As a process, validation involves collecting and analyzing data to assess the accuracy of an instrument. There are numerous statistical tests and measures to assess the validity of quantitative instruments, which generally involves pilot testing.

Three types of validity in this connection: (i) Content validity; (ii) Criterion-related validity and (iii) Construct validity.(i)

Content validity

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

Criterion-related validity

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

Relevance:

(A criterion is relevant if it is defined in terms we judge to be the proper measure.)

Freedom from bias:

(Freedom from bias is attained when the criterion gives each subject an equa lopportunity to score well.)

Reliability:

(A reliable criterion is stable or reproducible.)

Availability:

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

In fact, a Criterion-related validity is a broad term that actually refers to:

(i) *Predictive validity*

(ii) *Concurrent validity*

The former refers to the usefulness of a test in predicting some future performance whereas the latter refers to the usefulness of a test in closely relating to other measures of known validity. Criterion-related validity is expressed as the coefficient of correlation between test scores and some measure of future performance or between test scores and scores on another measure of known validity.

Construct validity

It is the most complex and abstract. A measure is said to possess construct validity to the degree that it confirms to predicted correlations with other theoretical propositions. Construct validity is the degree to which scores on a test can be accounted for by the explanatory constructs of a sound theory. For determining construct validity, we associate a set of other propositions with the results received from using our measurement instrument. If measurements on our devised scale correlate in a predicted way with these other propositions, we can conclude that there is some construct validity. If the above stated criteria and tests are met with, we may state that our measuring instrument is valid and will result in correct measurement; otherwise we shall have to look for more information and/or resort to exercise of judgement.

Reliability:

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

There are four general estimators that you may encounter in reading research:

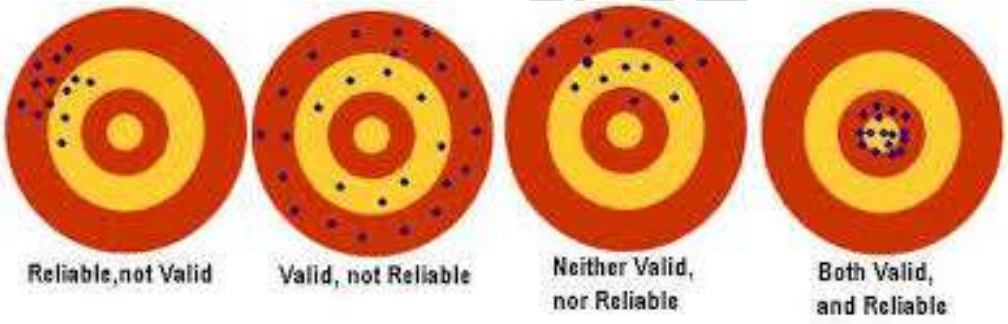
1. ***Inter-Rater/Observer Reliability***: The degree to which different raters/observers give consistent answers or estimates.
2. ***Test-Retest Reliability***: The consistency of a measure evaluated over time.
3. ***Parallel-Forms Reliability****:* The reliability of two tests constructed the same way, from the same content.
4. ***Internal Consistency Reliability****:* The consistency of results across items, often measured with Cronbach's Alpha.

Relating Reliability and Validity

Reliability is directly related to the validity of the measure. There are several important principles. First, a test can be considered reliable, but not valid. Consider the SAT, used as a predictor of success in college. It is a reliable test (high scores relate to high GPA), though only a moderately valid indicator of success (due to the lack of structured environment – class attendance, parent-regulated study, and sleeping habits – each holistically related to success).

Second, validity is more important than reliability. Using the above example, college admissions may consider the SAT a reliable test, but not necessarily a valid measure of other quantities colleges seek, such as leadership capability, altruism, and civic involvement. The combination of these aspects, alongside the SAT, is a more valid measure of the applicant's potential for graduation, later social involvement, and generosity (alumni giving) toward the alma mater.

Finally, the most useful instrument is both valid and reliable. Proponents of the SAT argue that it is both. It is a moderately reliable predictor of future success and a moderately valid measure of a student's knowledge in Mathematics, Critical Reading, and Writing.



UNIT 5

ANALYSIS AND REPORT WIRITNG

Hypothesis Testing

Hypothesis can be referred to as the interpretation of certain facts which is just a possible solution or a tentative answer to a problem and is completely or partly unverified in nature. Then afterwards on its establishment, it ceases to be a hypothesis and then finally becomes a theory or a principle. The word 'Hypothesis' has come from the Greek word hypo (means under)and tithenas (means to place) together these words indicate towards the support they provide to each other on the placement of the hypothesis under the evidence, which acts as a foundation.

Step 1: State the Null Hypothesis.

The null hypothesis can be thought of as the opposite of the "guess" the research made (in this example the biologist thinks the plant height will be different for the fertilizers). So the null would be that there will be no difference among the groups of plants. Specifically in more statistical language the null for an ANOVA is that the means are the same. We state the Null hypothesis as:

$H_0 : \mu_1 = \mu_2 = \cdots = \mu_k$

for *k* levels of an experimental treatment.

Step 2: State the Alternative Hypothesis.

H_1 : treatment level means not all equal

The reason we state the alternative hypothesis this way is that if the Null is rejected, there are many possibilities.For example, $\mu_1 \neq \mu_2 = \cdots = \mu_k$ is one possibility, as is $\mu 1 = \mu 2 \neq \mu 3 = \cdots = \mu k$. Many people make the mistake of stating the Alternative Hypothesis as: $\mu 1 \neq \mu 2 \neq \cdots \neq \mu k$ which says that every mean differs from every other mean. This is a possibility, but only one of many possibilities. To cover all alternative outcomes, we resort to a verbal statement of 'not all equal' and then follow up with mean comparisons to find out where differences among means exist. In our example, this means that fertilizer 1 may result in plants that are really tall, but fertilizers 2, 3 and the plants with no fertilizers don't differ from one another. A simpler way of thinking about this is that at least one mean is different from all others.

Step 3: Set α (Significance level)

If we look at what can happen in a hypothesis test, we can construct the following contingency table:

	In Reality	
Decision	H_0 is TRUE	H_0 is FALSE
Accept H_0	OK	Type II Error β = probability of Type II Error
Reject H_0	Type I Error α = probability of Type I Error	OK

You should be familiar with type I and type II errors from your introductory course. It is important to note that we want to set α before the experiment (*a-priori*) because the Type I error is the more 'grevious' error to make. The typical value of α is 0.05, establishing a 95% confidence level. **For this course we will assume α =0.05.**

Step 4: Collect Data
Remember the importance of recognizing whether data is collected through an experimental design or observational.

Step 5: Calculate a test statistic.
For categorical treatment level means, we use an *F* statistic, named after R.A. Fisher. We will explore the mechanics of computing the *F* statistic beginning in Lesson 2. The *F* value we get from the data is labeled $F_{calculated}$.

Step 6: Construct Acceptance / Rejection regions.
As with all other test statistics, a threshold (critical) value of *F* is established. This *F* value can be obtained from statistical tables, and is referred to as $F_{critical}$ or F α . As a reminder, this critical value is the minimum value for the test statistic (in this case the *F* test) for us to be able to reject the null.
The *F* distribution, F α , and the location of Acceptance / Rejection regions are shown in the graph below:

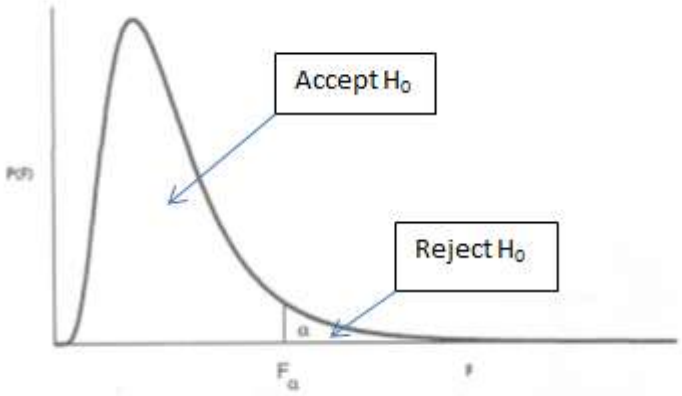


Figure K.1: The F distribution

Step 7: Based on steps 5 and 6, draw a conclusion about H_0.
If the $F_{calculated}$ from the data is larger than the Fα, then you are in the Rejection region and you can reject the Null Hypothesis with (1-α) level of confidence.
Note that modern statistical software condenses step 6 and 7 by providing a *p*-value. The *p*-value here is the probability of getting an $F_{calculated}$ even greater than what you observe. If by chance, the $F_{calculated}$ = F α , then the *p*-value would exactly equal to α. With larger $F_{calculated}$ values, we move further into the rejection region and the *p*-value becomes less than α. So the decision rule is as follows:
If the *p*-value obtained from the ANOVA is less than α, then Reject H_0 and Accept H_A.

Errors In Hypothesis Testing

Type I Error (False Positive Error)

1) A type I error occurs when the null hypothesis is true, but is rejected. Let me say this again, a *type I error occurs when the null hypothesis is actually **true**, but was rejected as **false** by the testing*.

2) A type I error, or false positive, is asserting something as true when it is actually false. This false positive error is basically a "false alarm" – a result that indicates a given condition has been fulfilled when it actually has not been fulfilled (i.e., erroneously a positive result has been assumed).

Type II Error (False Negative)

1) A type II error occurs when the null hypothesis is false, but erroneously fails to be rejected. Let me say this again, a *type II error occurs when the null hypothesis is actually **false**, but was accepted as **true** by the testing.*

2) A type II error, or false negative, is where a test result indicates that a condition failed, while it actually was successful. A Type II error is committed when we fail to believe a true condition.

A tabular relationship between truthfulness/falseness of the null hypothesis and outcomes of the test can be seen in the table below:

	Null Hypothesis is true	Null hypothesis is false
Reject null hypothesis	Type I Error**False Positive**	**Correct Outcome**True Positive
Fail to reject null hypothesis	**Correct outcome**True Negative	Type II Error**False Negative**

Let's look at some business related examples. In these examples I have reworded the null hypothesis, so be careful on the cost assessment.

Null Hypothesis	Type I Error / False Positive	Type II Error / False Negative
Medicine A cures Disease B	(H_0 **true**, but rejected as **false**)Medicine A **cures** Disease B, but is **rejected as false**	(H_0 **false**, but accepted as **true**)Medicine A **does not cure** Disease B, but is **accepted as true**
Cost Assessment	Lost opportunity cost for rejecting an effective drug that could cure Disease B	Unexpected side effects (maybe even death) for using a drug that is not effective

Let's try one more.

Null Hypothesis	Type I Error / False Positive	Type II Error / False Negative
Display Ad A is effective in driving c onversions	(H_0 **true**, but rejected as **false**)Display Ad A **is effective** in driving conversions, but is **rejected as false**	(H_0 **false**, but accepted as **true**)Display Ad A is **not effective** in driving conversions, but is **accepted as true**
Cost Assessment	Lost opportunity cost for rejecting an effective Display Ad A	Lost sales for promoting an ineffective Display Ad A to your target visitors

The cost ramifications in the medicine example are quite substantial, so additional testing would likely be justified in order to minimize the impact of the type II error (using an ineffective drug) in our example. However, the cost ramifications in the Display Ad example are quite small, for both the type I and type II errors, so additional investment in addressing the type I and type II errors is probably not worthwhile

Parametric & Non Parametric Tests

1) **Parametric Test:** If the information about the population is completely known by means of its parameters then statistical test is called parametric test∗ Eg: t- test, f-test, z-test, ANOVA are Parametric Tests.

2) **Non parametric test:** If there is no knowledge about the population or parameters, but still it is required to test the hypothesis of the population. Then it is called non-parametric test∗ E.g.: Mann-Whitney, rank sum test, Kruskal-Wallis test.

Parametric Tests	Nonparametric Tests
Independent-Samples T Test	Mann-Whitney Test
Paired-Samples T Test	Wilcoxon Signed-Rank Test
One-way ANOVA	Kruskal-Wallis Test
One-way Repeated Measures ANOVA	Friedman's ANOVA

t-TEST

- The t test tells you how significant the differences between groups are; In other words it lets you know if those differences (measured in means/averages) could have happened by chance.
- **A very simple example:** Let's say you have a cold and you try a naturopathic remedy. Your cold lasts a couple of days. The next time you have a cold, you buy an over-the-counter pharmaceutical and the cold lasts a week. You survey your friends and they all tell you that their colds were of a shorter duration (an average of 3 days) when they took the homeopathic remedy. What you *really* want to know is, are these results repeatable? A t test can tell you by comparing the means of the two groups and letting you know the probability of those results happening by chance.

There are **three main types of t-test:**

- An Independent Samples t-test compares the means for two groups.
- A Paired sample t-test compares means from the same group at different times (say, one year apart).
- A One sample t-test tests the mean of a single group against a known mean.

F-TEST

An "F Test" is a catch-all term for any test that uses the F-distribution. In most cases, when people talk about the F-Test, what they are actually talking about is The *F-Test to Compare Two Variances.*

Chi Square test

The **Chi Square** statistic is commonly used for testing relationships between categorical variables. The null hypothesis of the Chi-Square test is that no relationship exists on the categorical variables in the population; they are independent.

$$\chi^2 = \sum \frac{(\text{Observed Value} - \text{Expected Value})^2}{(\text{Expected Value})}$$

Degrees of freedom (df) =(n-1), where n is the number of classes

Analysis of Variance (ANOVA)

Purpose

1) The reason for doing an ANOVA is to see if there is any difference between groups on some variable.

2) For example, you might have data on student performance in non-assessed tutorial exercises as well as their final grading. You are interested in seeing if tutorial performance is related to final grade. ANOVA allows you to break up the group according to the grade and then see if performance is different across these grades.

ANOVA is available for both parametric (score data) and non-parametric (ranking/ordering) data.

Types of ANOVA

One-way between groups

The example given above is called a **one-way between groups model.**

You are looking at the differences between the groups.

There is only one grouping (final grade) which you are using to define the groups.

This is the simplest version of ANOVA.

This type of ANOVA can also be used to compare variables between different groups - tutorial performance from different intakes.

One-way repeated measures

A one way repeated measures ANOVA is used when you have a single group on which you have measured something a few times.

For example, you may have a test of understanding of Classes. You give this test at the beginning of the topic, at the end of the topic and then at the end of the subject.

You would use a one-way repeated measures ANOVA to see if student performance on the test changed over time.

Two-way between groups

A two-way between groups ANOVA is used to look at complex groupings.

For example, the grades by tutorial analysis could be extended to see if overseas students performed differently to local students. What you would have from this form of ANOVA is:

The effect of final grade

The effect of overseas versus local

The interaction between final grade and overseas/local

Each of the **main effects** are one-way tests. The **interaction effect** is simply asking "is there any significant difference in performance when you take final grade and overseas/local acting together".

RESEARCH REPORTING

Characteristics of a Research Report:

1. Information collected in the report must be **relevant and focused** to derive desired results. Pictorial and graphical presentation of data and related information help to understand the details easily. There is a possibility that the collected data in the report needs to be represented at many places in different formats to fulfill the report goals. The ultimate goal is to determine all the issue and make suitable strategies to cope up with these issue or problems.

2. Report should follow the exact predefined goals and objectives. If there is any sort of divergence of related information which does not match the goals then the results are of no use. In fact there is a probability of landing up in making negative or out of focus strategies, which will be very dangerous.

3. The report should always contain the executive summary of the work. This is generally kept before the actual report starts as it shows the summary of the desired business plan.

4. Apart from the actual analysis the report should also depict the reasons of making this report and what advantages and profit it can provide after successful implementation of business plans described inside the report.

5. It should also contain the methodology of the research which shows the overall process adopted to create the report.

6. It is important that the report contains the possibility of errors in any of the module or process so that immediate measures could be taken to cope up with these errors.

7. The report should contain the description of the questionnaires used in analysis and the way it has been prepared.

8. The methodology used in the interviews should also be elaborated and what was achieved in this should also be described.

9. If the information show that some aspects needs to predict the future trends then the reports should depict that prediction. This prediction should have scale of success so that the accuracy could be judged efficaciously. The report should also define each and every variable and element used in creating these predictive analyses.

10. The report should be flexible enough to be changed accordingly. The analytical information described inside the report should be maintained in such a way that there is no extra effort labored if any strategy or process it to be changed in future. It should necessarily mould the changes without changing the structure of the report.

Types of Research Reports

1) Journal Articles

2) Peer review

3) Blind review

4) Primary vs. secondary source

5) Presentations at conferences

6) Theses and Dissertations

7) Books

Content of Research Journal Article

1) Abstract – 100 to 200 words max

2) Introduction

3) Variables under study

4) Purpose

5) Research questions/ or hypotheses

6) Literature review

7) Theoretical framework

8) Significance

9) Methodology

- Sample
- Research design
- Measurement tools
- Data collection
- Procedures

10) Results-findings

- Statistical tests
- Value of calculated statistic
- Significance (statistical) .05 or .01 usually

Here is a table containing all parts of a research report and a brief description to each of them:

#	Research Report Sections/ Parts	What Is Written in Research Report Section
1	Title Page	It contains a title, the name of the author, submission date.
2	Contents	They contain a list of sections, subsections, etc.
3	Executive Summary or Abstract	It is an overview of the research. Usually, it consists of two to four paragraphs in length. An abstract is a kind of hook that aims to capture your reader's attention.
4	Introduction of Research Report	The Introduction contains the information on the key question of a research report and is divided into 4 components: Purpose, Background, Methods of Investigation, Scope. Usually, it is written in present or past tenses with format-numbered headings. Let's figure out what to write in each of these components of a research report.
4.1	Purpose	It specifies the objectives of a given report. This part includes also the information on what a research report recommends.
4.2	Background	It describes the situation or issue which caused the investigation. This part refers to secondary

		resources, for example, newspaper reports. In other words, it may refer to the findings obtained by other researchers.
4.3	The Method of Investigation or Methodology of Research Report	It tells about the ways the research was conducted and is usually called primary data as it is discovered by the author of the paper.
4.4	Scope	The Scope describes all the areas of research conducted. It may include reasons and consequences.
5	Findings and Results	They are aimed to summarize, analyze and comment the facts and information obtained during the research. You shouldn't include too much information not to bury the most important results. Don't try to interpret or evaluate the facts and better provide a link to the conclusion section to discuss your findings there.
6	Research Report Conclusion	The Conclusion contains deductions based on your findings, and logically leads to the last body section of the research report called Recommendations.
7	Recommendations	They are the assumptions and suggestions based on the research report conclusions. This part shows how the findings might be applied.
8	References and Bibliography	They provide a list of authors and papers cited in the report. Be sure to follow the format through the entire paper if you need MLA, Chicago, Harvard, or APA style research report. If you are writing a research report APA Style Free Referencing Tool will be of great use to you.