Meaning of Research Methodology

Research Methodology is the systematic, theoretical analysis of the methods applied to a field of study.

The process used to collect information and data for the purpose of making decisions.

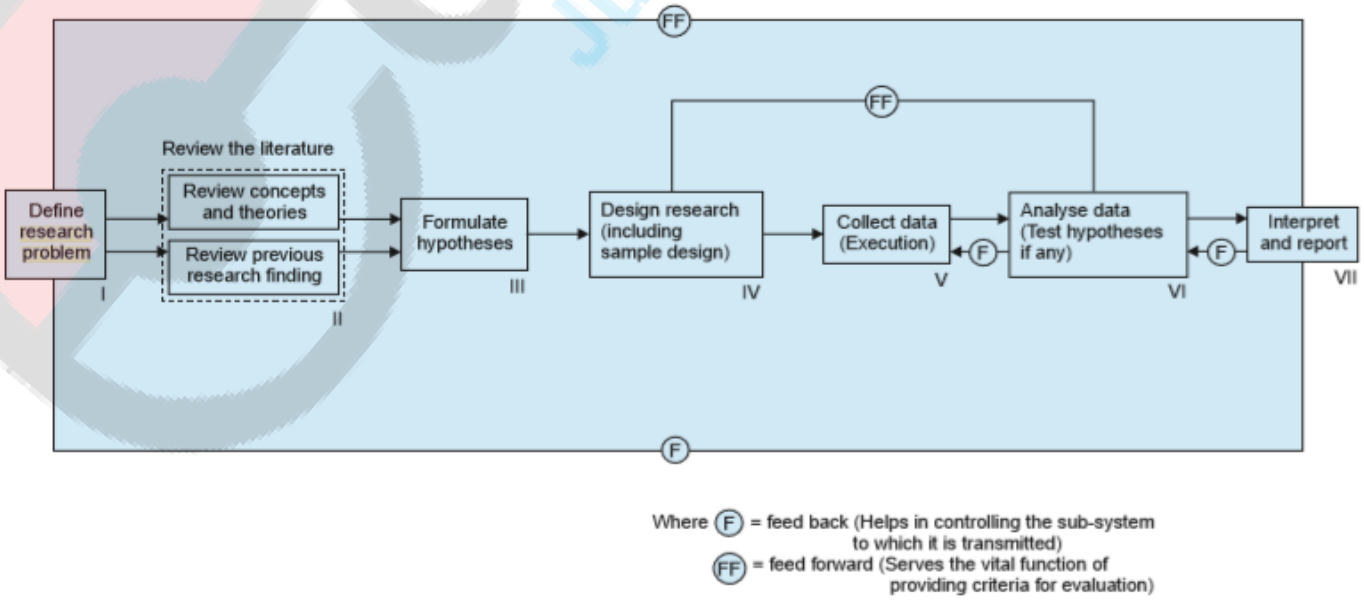
The methodology may include

1. Surveys and other research techniques like Interviews, questionnaires
2. Publication research and could include both present and historical information.

Stages in Scientific Research Process:

1. Identification and Selection of Research Problem
2. Formulation of Research Problem
3. Review of Literature
4. Formulation of Hypothesis
5. Formulation of research Design
6. Sample Design
7. Data Collection
8. Data Analysis
9. Hypothesis testing and Interpretation of Data
10. Preparation of Research Report

RESEARCH PROCESS IN FLOW CHART



Research process consists of series of actions or steps necessary to effectively carry out research.

The first step determines the nature of the last step to be undertaken. If subsequent procedures have not been taken into account in the early stages, serious difficulties may arise which may even prevent the completion of the study.

The various steps involved in a research process are not mutually exclusive; nor they are separate and distinct. They do not necessarily follow each other in any specific order and the researcher has to be constantly anticipating at each step in the research process the requirements of the subsequent steps.

Identification and Selection of Research Problem

A research problem is an issue or some difficulty which a researcher experiences in theory or practical Situation and wants to obtain solution for the same.

A problem is clearly stated is problem half solved.

A research problem should be clearly stated and be specific in nature.

We can say research problem is the seed [centre of research]]of any research, so, first of all research problem must be identified and adequately defined then systematic and scientific process of making observations can be smoothly carried out. Because how u can solve the problem if u r not knowing exactly what is the problem is?

Selecting the problem:

1. Help from research guide
2. Brainstorming
    a. Fellow friends
    b. Subject Experts

Techniques to define problem

1. First of all the problem should be stated in a broad general way
- The researcher must immerse himself thoroughly in the subject matter. Must conduct a preliminary survey also called as “Pilot Survey”
- Can seek the guidance of research guide or subject expert.
- Often, the guide puts forth the problem in general terms, and it is then up to the researcher to narrow it down and phrase the problem in operational terms.

2. Understand its origin and nature clearly.
- Discuss with those who have raised it first.
- Discuss with subject experts

3. The researcher must be well-conversant with relevant theories in the field, reports and records as also all other relevant literature

- Researcher must devote sufficient time in reviewing of research already undertaken on related problems.

4. Discussion concerning a problem often produces useful information.

- Various new ideas can be developed through such an exercise.
- Hence, a researcher must discuss his problem with his colleagues and others who have enough experience in the same area or in working on similar problems. This is known as an experience survey.

5. Finally, the researcher must sit to rephrase the research problem into a working proposition.

- Once the nature of the problem has been clearly understood, discussions over the problem have taken place and the available literature has been surveyed and examined, rephrasing the problem into analytical or operational terms is not a difficult task.
- Further it will help researcher in formulation of working Hypothesis.

Formulation of Research Problem

Broad general way → in as specific terms as possible

1. Ambiguities, if any, relating to the problem be resolved
2. The feasibility of a particular solution has to be considered

Initially the problem may be stated in a broad general way and then the ambiguities, if any, relating to the problem be resolved. Then, the feasibility of a particular solution has to be considered before a working formulation of the problem can be set up.

Essentially two steps are involved in formulating the research problem,

1. Understanding the problem thoroughly

2. Rephrasing the same into meaningful terms from an analytical point of view

Often, the guide puts forth the problem in general terms, and it is then up to the researcher to narrow it down and phrase the problem in operational terms.

Review of Literature

Definition: "A literature review is an objective, critical summary of published research literature relevant to a topic under consideration for research. Its purpose is to create familiarity with current thinking and research on a particular topic, and may justify future research into a previously overlooked or understudied area. "

- Literature review is the huge part of our research.
- It is process of reviewing work of others within your field and relate it to your own research.
- It should be done not only at the beginning of the research but also throughout the research.
- It is helpful to gain knowledge of the background work.

Writing a Literature Review

Definition: "A literature review is an objective, critical summary of published research literature relevant to a topic under consideration for research. Its purpose is to create familiarity with current thinking and research on a particular topic, and may justify future research into a previously overlooked or understudied area. "

Purpose of the Literature Review

1. Readers get easy access to research on a particular topic
2. Provides a starting point for researchers in a new area by forcing them to summarize, evaluate, and
3. Compare original research in that specific area
4. Ensures no duplication is done
5. Provide clues as to direction of research or recommended focus areas
6. Highlights key findings
7. Identifies inconsistencies, gaps and contradictions in the literature

- We need to read some articles, academic journals, conference proceedings, government reports, books related to our topic. More we read papers we will be able to write Literature Review efficiently.
- While writing literature review we need to structure our literature review that is the most important and creative task.
- Research gate and academia.edu are some peer sharing sources, from where you can get literature for study.

Formulation of Hypothesis

Effects of a thermostat on room temperatures.

Three components

1. Research Problem: "How does changing the thermostat setting impact a room's temperature?"
2. Hypothesis: It is known as tentative solution to the problem. It is an Empirical Statement that could be verified based upon observations or experiences. It is Testable to be true or false through the research study findings.
3. Variables : There are two types of variable
    1. Dependent : - Relies upon IV to occur
    2. Independent: - Manipulated to influence DV

Hypothesis: Changing the temperature setting on a thermostat up or down will cause the room temperature change in the same way.

Formulation of research Design

- A Research Design is a plan, structure and strategy of investigation so conceived as to obtain answers to research question or problems. The plan is the complete scheme or programme of the research. It includes an outline of what the investigator will do from writing the hypothesis to the final analysis of data. (Kerlinger 1986)
- A traditional research design is a blue print or detailed plan for how a research study is to be completed-operationalizing variables so they can be measured, selecting a sample of interest to study, collecting data to be used as a basis for testing hypotheses, and analysing the results. (Thyer 1993)
- A research design is an arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure. (Selltiz, Deutsch and Cook 1962)

- The Research Design includes an outline of what the researcher will do from writing the hypothesis → the final analysis of data.

Preparation of the research design should be done with great care as any error in it may upset the entire project.

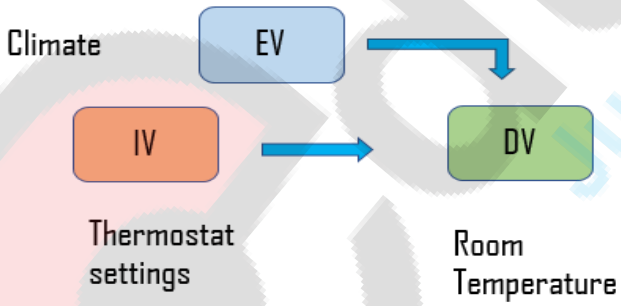
Need for Research Design:

- Just as for better, economical and attractive construction of a house, we need a blueprint (or what is commonly called the map of the house) well thought out and prepared by an expert architect, similarly we need a research design or a plan in advance of data collection and analysis for our research project.
- So, research design stands for the methods to be adopted for advance planning of collecting the relevant data and the techniques to be used in their analysis

Imp concepts relating to Research Design

1. Independent & Dependent Variables

2. Extraneous Variables: Independent variables that are not related to the purpose of the study, but may affect the dependent variable are termed as extraneous variables.



Ex: If I want to measure the relationship b/w student working hour and exam performances.

Student intelligence play as one of the extraneous variable in the study.

3. Control: The technical term 'control' is used when we design the study minimising the effects of extraneous independent variables. A scientific **control** is an **experiment** or **observation designed** to minimize the effects of variables

4. Confounded relationship: When the dependent variable is not free from the influence of extraneous variable(s), the relationship between the dependent and independent variables is said to be confounded by an extraneous variable(s).

5. Research Hypothesis: When a prediction or a hypothesised relationship is to be tested by scientific methods, it is termed as research hypothesis.

The research hypothesis is a predictive statement that relates an independent variable to a dependent variable.

Usually a research hypothesis must contain, at least, one independent and one dependent variable.

6. Experimental and non-experimental hypothesis-testing research

 Research in which the independent variable is manipulated 

'experimental hypothesis-testing research' 'non-experimental hypothesis-testing research'

7. Experimental and control groups: In an experimental hypothesis-testing research when a group is exposed to usual conditions, it is termed a 'control group', but when the group is exposed to some novel or special condition, it is termed an 'experimental group'.

8. Treatments: The different conditions under which experimental and control groups are put are usually referred to as 'treatments'.

9. Experiment: The process of examining the truth of a statistical hypothesis, relating to some research problem, is known as an experiment.

10. Experimental unit: The pre-determined plots or the blocks, where different treatments are used, are known as experimental units

Example:

1. A patient in a hospital
2. A class of students
3. A group of animals in a pen

Different Research Design

1. Exploratory research studies
2. Descriptive & Diagnostic research studies
3. Hypothesis-testing research studies

Exploratory research studies

The major emphasis is on the discovery of ideas and insights.

Three methods

1. The survey of concerning literature
2. Experience survey
3. Analysis of 'insight-stimulating' examples

Descriptive & Diagnostic research studies

Such studies focus attention on the following:

- Formulating the objective of the study (what the study is about and why is it being made?)
- Designing the methods of data collection (what techniques of gathering data will be adopted?)
- Selecting the sample (how much material will be needed?)
- Collecting the data (where can the required data be found and with what time period should the data be related?)
- Processing and analysing the data.
- Reporting the findings.

Hypothesis-testing research studies

Hypothesis-testing research studies are those where the researcher tests the hypotheses of causal relationships between variables. Such studies require procedures that will not only reduce bias and increase reliability, but will permit drawing inferences about causality.

Data Collection

In research two types of data collection is done-

1. **Primary data collection** and
2. **Secondary data collection**

Primary data collection: The primary data are those which are collected afresh and for the first time, and thus happen to be original in character.

There are several methods to collect primary data, here we are going to learn 4 main data collection method:

1. Observation Method
2. Interview Method
3. Through Questionnaires
4. Through Schedules

Secondary data collection: The secondary data, on the other hand, are those which have already been collected by someone else and which have already been passed through the statistical process.

Under this secondary data collection we will learn Case Study method for collecting data.

1. **Observation Method**

- It is a scientific tool of data collection for research.
- Here the information is collected by observing the process at work without asking from the respondent.
- Observation is probably the most common and the **simplest method** of data collection.
- It does not require much technical knowledge
- It is very **expensive method**,
- Collected data is more **reliable and valid** since researcher he/she self-observed the real life situation.

- A key advantage of conducting observations is that you can observe what people actually do or say, rather than what they say they do.
- People are not always willing to write their true views on a questionnaire or tell a stranger what they really think at interview.

Structured Observation: If researcher decides well in advance about –

1. What should be observed?
2. How the observation should be recorded? So that accuracy of the observation can be ensured.
3. Style of the recording the observed information
4. Selection of relevant data of observation then it's known as structured observation.

Advantages	Disadvantage
1. Reliable and valid	1. Expensive
2. Simplest method	2. Time consuming
3. Independent of respondents' willingness to respond	3. Some people are rarely accessible to direct observation creates obstacle for this method

Participant Observation: When researcher making himself member of the group, so that he/she can experience what the member of the group experience. Also called as overt observation

Non-participant Observation: When the observer is observing in such a manner that his presence may be unknown to the people he is observing, Also called as covert observation.

If the observation takes place in the natural setting, it may be termed as **uncontrolled observation,** but when observation takes place according to definite pre-arranged plans is termed as **Controlled Observation**

2. Interview Method

- This method can be used through **personal interviews** and through **telephone interviews**.
- Personal interview method requires a person known as the interviewer asking questions generally in a face-to-face contact to the other person or persons.
- Sometimes the interviewee may also ask certain questions and the interviewer responds to these, but usually the interviewer initiates the interview and collects the information.

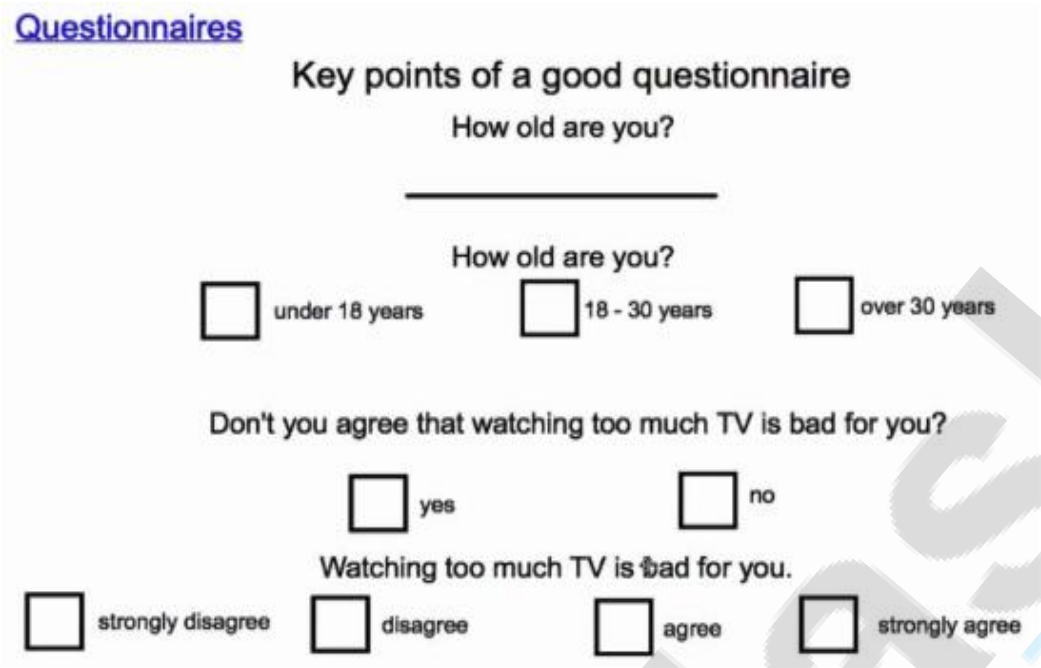
- **Structured interviews:** Such interviews involve the use of a set of predetermined questions and of highly standardized techniques of recording.
- **Focussed interview** is meant to focus attention on the given experience of the respondent and its effects. Under it the interviewer can decide the manner and sequence in which the questions would be asked.
- **Clinical interview** is concerned with broad underlying feelings or motivations or with the course of individual's life experience.
- **Non-directive interview:** the interviewer's function is simply to encourage the respondent to talk about the given topic with a bare minimum of direct questioning.
- This method of collecting information consists in contacting respondents on telephone itself. It is not a very widely used method, but plays important part in industrial surveys, particularly in developed regions.
- For Ex: When your car is serviced from service center, after 3-4 days you receive all from service for getting feedback of service done.

Advantages	Disadvantage
1. It is more flexible in comparison to mailing method	1. Little time is given to respondents for considered answers; interview period is not likely to exceed five minutes in most cases.
2. It is faster than other methods	2. Surveys are restricted to respondents who have telephone facilities.
3. It is cheaper than personal interviewing Method	3. Extensive geographical coverage may get restricted by cost considerations.
4. Recall is easy; call backs are simple and economical.	4. It is not suitable for intensive surveys where comprehensive answers are required to various questions.
5. There is a higher rate of response than what we have in mailing method.	5. Possibility of the bias of the interviewer is relatively more.
6. Replies can be recorded without causing embarrassment to respondents.	6. Questions have to be short and to the point; probes are difficult to handle.
7. No field staff is required.	

3. Through Questionnaires

- This method of data collection is quite popular, particularly in case of big enquiries.
- It is being adopted by private individuals, research workers, private and public organisations and even by governments. In this method a questionnaire is sent (usually by post) to the persons concerned with a request to answer the questions and return the questionnaire.
- A questionnaire consists of a number of questions printed or typed in a definite order on a form.

Advantages	Disadvantage
1. There is low cost even when the universe is large and is widely spread geographically.	1. Low rate of return of the duly filled in questionnaires
2. Answers are in respondents' own words.	2. It can be used only when respondents are educated and cooperating.
3. Respondents have adequate time to give well thought out answers.	3. The control over questionnaire may be lost once it is sent.
4. Respondents, who are not easily approachable, can also be reached conveniently.	4. There is also the possibility of ambiguous replies or omission of replies altogether to certain questions
5. The results can be made more dependable and reliable.	5. It is difficult to know whether willing respondents are truly representative.
	6. This method is likely to be the slowest of all.



4. **Through Schedules:**

- It is just like a questionnaire only the difference is to fill the schedules enumerators are appointed. Enumerators helps respondents to fill the schedule.
- If respondents feel difficulty to understand any term mentioned in schedule then enumerators explain them.
- Enumerator means a person employed in taking a census of the population.
- Enumerators explain the aims and objects of the investigation and also remove the difficulties which any respondent may feel in understanding the implications of a particular question or the definition or concept of difficult terms.
- The enumerators should be trained to perform their job well and the nature and scope of the investigation should be explained to them thoroughly so that they may well understand the implications of different questions put in the schedule.
- Enumerators should be intelligent and must possess the capacity of cross examination in order to find out the truth. Above all, they should be honest, sincere, and hardworking and should have patience and perseverance.

Difference b/w Questionnaire & Schedule:-

- The questionnaire is generally sent through mail to informants to be answered as specified in a covering letter, but otherwise without further assistance from the sender. The schedule is generally filled out by the research worker or the enumerator, who can interpret questions when necessary.

- To collect data through questionnaire is relatively cheap and economical since we have to spend money only in preparing the questionnaire and in mailing the same

to respondents. Here no field staff required. To collect data through schedules is relatively more expensive since considerable amount of money has to be spent in appointing enumerators and in importing training to them. Money is also spent in preparing schedules.

- Non-response is usually high in case of questionnaire as many people do not respond and many return the questionnaire without answering all questions. Bias due to non-response often remains indeterminate. As against this, non-response is generally very low in case of schedules because these are filled by enumerators who are able to get answers to all questions. But there remains the danger of interviewer bias and cheating.

- In case of questionnaire, it is not always clear as to who replies, but in case of schedule the identity of respondent is known.

- The questionnaire method is likely to be very slow since many respondents do not return the questionnaire in time despite several reminders, but in case of schedules the information is collected well in time as they are filled in by enumerators.

- Personal contact is generally not possible in case of the questionnaire method as questionnaires are sent to respondents by post who also in turn return the same by post. But in case of schedules direct personal contact is established with respondents.

- Questionnaire method can be used only when respondents are literate and cooperative, but in case of schedules the information can be gathered even when the respondents happen to be illiterate.

- Wider and more representative distribution of sample is possible under the questionnaire method, but in respect of schedules there usually remains the difficulty in sending enumerators over a relatively wider area.

- Risk of collecting incomplete and wrong information is relatively more under the questionnaire method, particularly when people are unable to understand questions properly. But in case of schedules, the information collected is generally complete and accurate as enumerators can remove the difficulties, if any, faced by respondents in correctly understanding the questions. As a result, the information collected through schedules is relatively more accurate than that obtained through questionnaires.

- The success of questionnaire method lies more on the quality of the questionnaire itself, but in the case of schedules much depends upon the honesty and competence of enumerators.

- In order to attract the attention of respondents, the physical appearance of questionnaire must be quite attractive, but this may not be so in case of schedules as they are to be filled in by enumerators and not by respondents.

- Along with schedules, observation method can also be used but such a thing is not possible while collecting data through questionnaires.

Advantages	Disadvantage
1. It is generally sent through mail to informants to be answered.	1. It is generally filled out by the research worker or the enumerator.
2. It is relatively cheap and economical since we have to spend money only in preparing the questionnaire and in mailing the same to respondents. No field staff required.	2. It is relatively more expensive since considerable amount of money has to be spent in appointing enumerators and in giving training to them.
3. Many people do not respond, and many return the questionnaire without answering all questions.	3. Non-response is generally very low in case of schedules because these are filled by enumerators who are able to get answers to all questions.
4. It is not always clear as to who replies.	4. The identity of respondent is known.
5. It is likely to be very slow since many respondents do not return the questionnaire in time despite several reminders.	5. The information is collected well in time as they are filled in by enumerators.
6. Direct personal contact is not established with respondents.	6. Direct personal contact is established with respondents.
7. It can be used only when respondents are literate and cooperative.	7. The information can be gathered even when the respondents happen to be illiterate.

Secondary data may either be published data or unpublished data.

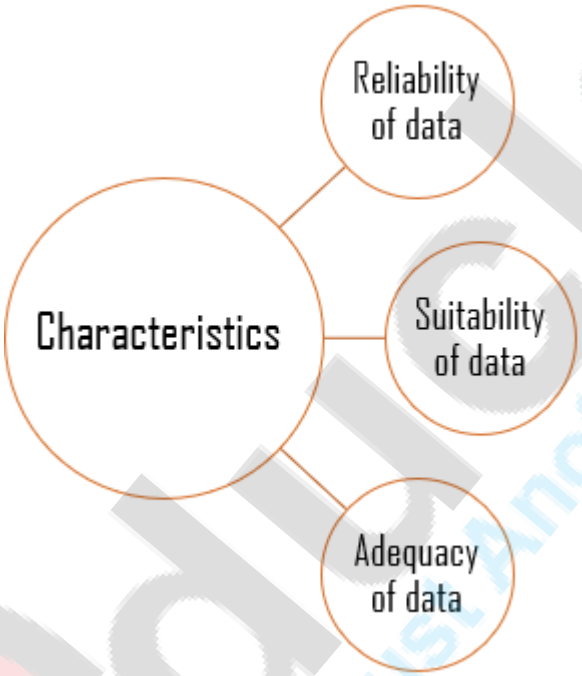
Published data are available in:

- various publications of the central, state are local governments;
- various publications of foreign governments or of international bodies and their subsidiary organizations;
- technical and trade journals;
- books, magazines and newspapers;

- reports and publications of various associations connected with business and industry, banks, stock exchanges, etc.;
- reports prepared by research scholars, universities, economists, etc. in different fields; and
- Public records and statistics, historical documents, and other sources of published information.

The sources of **unpublished data** are many; they may be found in diaries, letters, unpublished biographies and autobiographies and also may be available with scholars and research workers, trade associations, labor bureaus and other public/ private individuals and organizations.

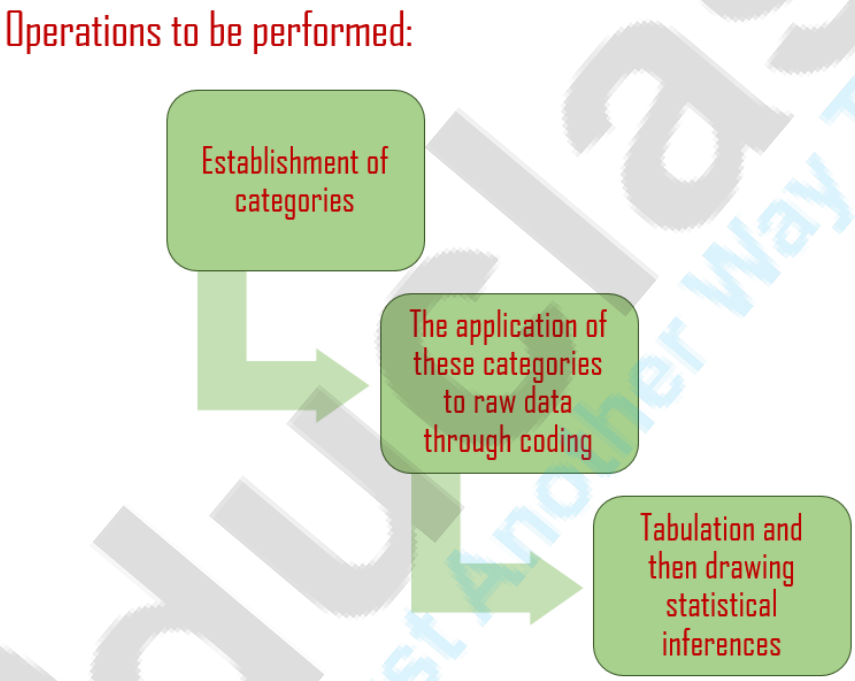
Characteristics:



Data Analysis:

- Analysis of data: After the data have been collected, the researcher turns to the task of analyzing them.
- The analysis of data requires a number of closely related operations such as establishment of categories, the application of these categories to raw data through coding, tabulation and then drawing statistical inferences.
- The unwieldy data should necessarily be condensed into a few manageable groups and tables for further analysis.
- Thus, researcher should classify the raw data into some purposeful and usable categories.

- Coding operation is usually done at this stage through which the categories of data are transformed into symbols that may be tabulated and counted.
- Editing is the procedure that improves the quality of the data for coding. With coding the stage is ready for tabulation.
- Tabulation is a part of the technical procedure wherein the classified data are put in the form of tables.
- The mechanical devices can be made use of at this juncture.
- A great deal of data, especially in large inquiries, is tabulated by computers.
- Computers not only save time but also make it possible to study large number of variables affecting a problem simultaneously.



Hypothesis testing and Interpretation of Data

- Hypothesis is known as tentative solution to the problem. Now before finding the results, not working on the problem, on the basis of my literature review or my knowledge I am trying to formulate a hypothesis.

Null Hypothesis:

- We know that **Null** means **zero** or **empty** but when we say NULL Hypothesis means **"Default Hypothesis"**.
- The thing that something we want to establish.
- It is denoted by H_0 .
- It is called **currently accepted value for a parameter**.
- We are trying to investigate something like mean of IQ for population.

- May be based on previous study that say birth rate of human is between so and so.
- That the currently accepted thing but someone come along and challenge this that is not correct, we call it that **Alternative Hypothesis**.
- We denote it with H_a.
- It is also called as **Research Hypothesis**. And it involves the claim to be tested.
- Newton came with simple hypothesis regarding Law of gravity, but 100 years later came Einstein, who gave alternative hypothesis that gravity is not only..gravity is really space time and so on.. And his alternative hypothesis was complex and it's much more accurate.

For Example:

It is believed that a candy machine makes chocolate bars that are on average 5g. A worker claims that the machine after maintenance no longer makes 5g bars. Write H_0 and H_a

H_0: $\mu = 5g$ Where μ is mean of population of chocolate bar is 5g.

H_a: $\mu \neq 5g$ [Machine is no longer makes 5g bars]

H_0 and H_a are **mathematical opposites**.

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

So, what is the possible out come of this test? [Is the investigation of alternative hypothesis?]

1. We can **Reject** the **NULL Hypothesis H_0 [**it means we are saying that H_0: $\mu = 5g$ is not true and the person who is saying H_a: $\mu \neq 5g$ is more true.**]**

2. Fail to Reject Null Hypothesis H_0[it means that H_0: $\mu = 5g$ is not true**]**

So, How we can do testing or how can we determine that H_0 is rejected or not?

For that we need to perform **Test Statistics** that means **Calculate from Sample Data.** Which is used to decide whether to reject the hypothesis or not to reject the hypothesis.

So, for Candy Bar factory:

Statistically significant: for a laymen it is – where do we draw the line to make decision?

- **Monday** found **AVG value is 5.12g**
- **Wednesday** found **AVG is 5.72g**
- **Friday** found **AVG is 7.23g**

Level of confidence [C]:- It must be above 95%==0.95 0r 99%=0.99,

[Basically it tells us how confident are we in our decision?]

Level of significance [α]:-

It is α =1-C

So if C=95% then

α=1-0. 95= 0.05

Preparation of Research Report

Preparation of the report or the thesis: Finally, the researcher has to prepare the report of what has been done by him. Writing of report must be done with great care keeping in view the following:

1. The layout of the report should be as follows:

- The preliminary pages;
- The main text, and
- The end matter.

In its **preliminary pages** the report should carry title and date followed by acknowledgements and foreword. Then there should be a table of contents followed by a list of tables and list of graphs and charts, if any, given in the report.

The **main text** of the report should have the following parts:

- **Introduction**: It should contain a clear statement of the objective of the research and an explanation of the methodology adopted in accomplishing the research. The scope of the study along with various limitations should as well be stated in this part.
- **Summary of findings**: After introduction there would appear a statement of findings and recommendations in non-technical language. If the findings are extensive, they should be summarised.

- **Main report**: The main body of the report should be presented in logical sequence and broken-down into readily identifiable sections.
- **Conclusion**: Towards the end of the main text, researcher should again put down the results of his research clearly and precisely. In fact, it is the final summing up.

At the **end** of the report, appendices should be enlisted in respect of all technical data. Bibliography, i.e., list of books, journals, reports, etc., consulted, should also be given in the end. Index should also be given specially in a published research report.

2. Report should be written in a concise and objective style in simple language avoiding vague expressions such as 'it seems,' 'there may be', and the like.

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

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