
Unit -2

Research design, design and data collection of sample surveys, interpretation and report writing.

Introduction to research design

- A conceptual structure within which research is conducted; it constitutes blueprint (technical drawing or design plan) for collection, measurement and analysis of data.
 - For ex: If we need to purchase of a car then we require the number of cars sold by a particular brand in past 2-3 years etc.
- The decisions are with respect to:
 - (i) What is the study about?
 - (ii) Why is the study being made?
 - (iii) Where will the study be carried out?
 - (iv) What type of data is required?
 - (v) Where can the required data be found?
 - (vi) What periods of time will the study include?
 - (vii) What will be the sample design?
 - (viii) What techniques of data collection will be used?
 - (ix) How will the data be analysed?
 - (x) In what style will the report be prepared?

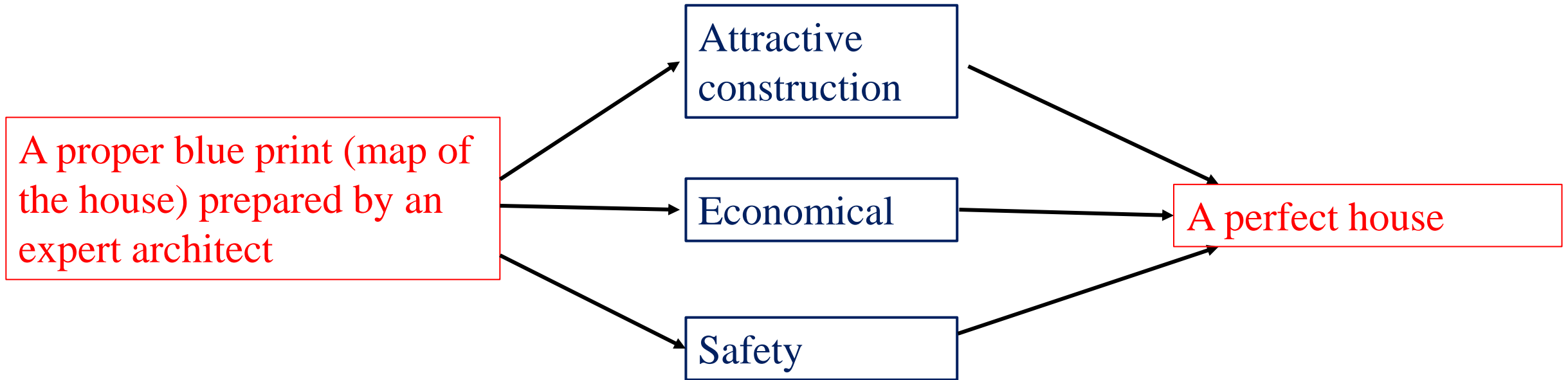
Features of research design

It is plan that specifies the sources and types of information relevant to research problem.

It is a strategy specifying which approach will be used for gathering and analyzing the data.

It also includes the time and cost budgets since most studies are done under these two constraints.

Need for research design



- Research design stands for advance planning of the methods to be adopted for collecting the relevant data and the techniques to be used in their analysis, keeping in view the objective of the research and the availability of staff, time and money.
- The design helps the researcher to organize his ideas in a form whereby it will be possible for him to look for flaws and inadequacies.

Research Design Process

- Selection of research topic/problem,
- Framing research design,
- Framing sampling design,
- Collection of data,
- Data analysis/editing, coding, processing and preservation
- Writing research reports

Types of research design: Exploratory research

1. Research design in case of exploratory research studies(Exploratory research)

- **Exploratory research** is usually conducted at the outset of research projects.
- It is usually conducted when the researcher does not know much about the problems.
 - **Uses of Exploratory Research are:**
 - Gain background information
 - Define terms
 - Clarify problems and hypothesis(A simple hypothesis is a statement made to reflect the relation between exactly two variables. One independent and one dependent. Consider the example, “Smoking is a prominent cause of lung cancer.” The dependent variable, lung cancer, is dependent on the independent variable, smoking.)
 - Establish research priorities

Types of research design: Exploratory research methods

Secondary data analysis: the process of searching for interpreting existing information relevant to the research topic

Experience surveys: refer to gathering information from those to be knowledgeable on the issues relevant to the research problem

- **Key-informant technique:** gathering information from those thought to be knowledgeable on the issues relevant to the problem
- **Lead-user survey:** used to acquire information from lead users of a new technology

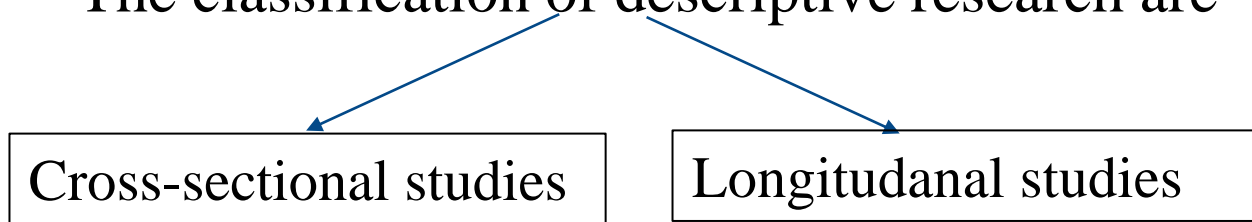
Types of research design: Exploratory research methods

- **Case analysis:** a review of available information about a former situation(s) that has some similarities to the current research problem.
- **Focus groups:** small groups brought together and guided by a moderator through an unstructured, spontaneous discussion for the purpose of gaining information relevant to the research problem.

Types of research design: Descriptive research

2. Research design in case of descriptive and diagnostic research studies:

- **Descriptive research** is undertaken to describe answers to questions of who, what, where, when, and how.
- It is desirable when we wish to project a study's findings to a larger population, if the study's sample is representative.
 - The classification of descriptive research are



Descriptive research : Longitudinal and Cross sectional studies

- **Cross-sectional studies** measure units from a sample of the population at only one point in time (or “snapshot”).
 - Sample surveys are cross-sectional studies whose samples are drawn in such a way as to be representative of a specific population.
 - These studies are usually presented with a margin of error.
- **Longitudinal studies** repeatedly measure the same sample units of a population over time.
 - Since they involve multiple measurements over time, they are often described as “movies” of the population.

Examples for Longitudinal and Cross sectional studies

TABLE 4.1 Results of Two Cross-Sectional Studies “Which Brand of Chocolate Chip Cookie Did You Most Recently Purchase?”

| Brand | Cross-Sectional Survey 1 | Cross-Sectional Survey 2 |
|-----------------|--------------------------|--------------------------|
| Famous Amos | 100 | 75 |
| Pepperidge Farm | 200 | 200 |
| Nabisco | 200 | 225 |
| Total Families | 500 | 500 |

TABLE 4.2 Results of Two Waves of a Longitudinal Study “Which Brand of Chocolate Chip Cookie Did You Most Recently Purchase?”

| Wave 1 Brand | Wave 2 Brand | | | Totals, Wave 1 |
|-----------------|--------------|-----------------|---------|----------------|
| | Famous Amos | Pepperidge Farm | Nabisco | |
| Famous Amos | 50 | 50 | 0 | 100 |
| Pepperidge Farm | 25 | 150 | 25 | 200 |
| Nabisco | 0 | 0 | 200 | 200 |
| Totals, Wave 2 | 75 | 200 | 225 | |

Types of research design: Experimental research design

3. **Research design in case of hypothesis-testing research studies:** Hypothesis-testing research studies (generally known as experimental 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.

Usually experiments meet this requirement. Hence, when we talk of research design in such studies, we often mean the design of experiments.

Types of research design: Experimental research design

- An Experiment is a test or a series of tests.
- Experiments are used widely in the engineering world
 - **Process characterization & optimization**(Identify process parameters that impact on product quality and yield, Identify interactions between process parameters and critical quality attributes)
 - **Evaluation of material properties**
 - **Product design & development**
 - **Component & system tolerance determination**
- “All experiments are designed experiments, some are poorly designed, some are well-designed”

Need for Experimental research design

- **Reduce Time to design/develop new products & processes**
- **Improve performance of existing processes**
- **Improve reliability and performance of products**
- **Achieve product & process robustness**
- **Evaluation of materials, design alternatives, setting component & system tolerances, etc.**

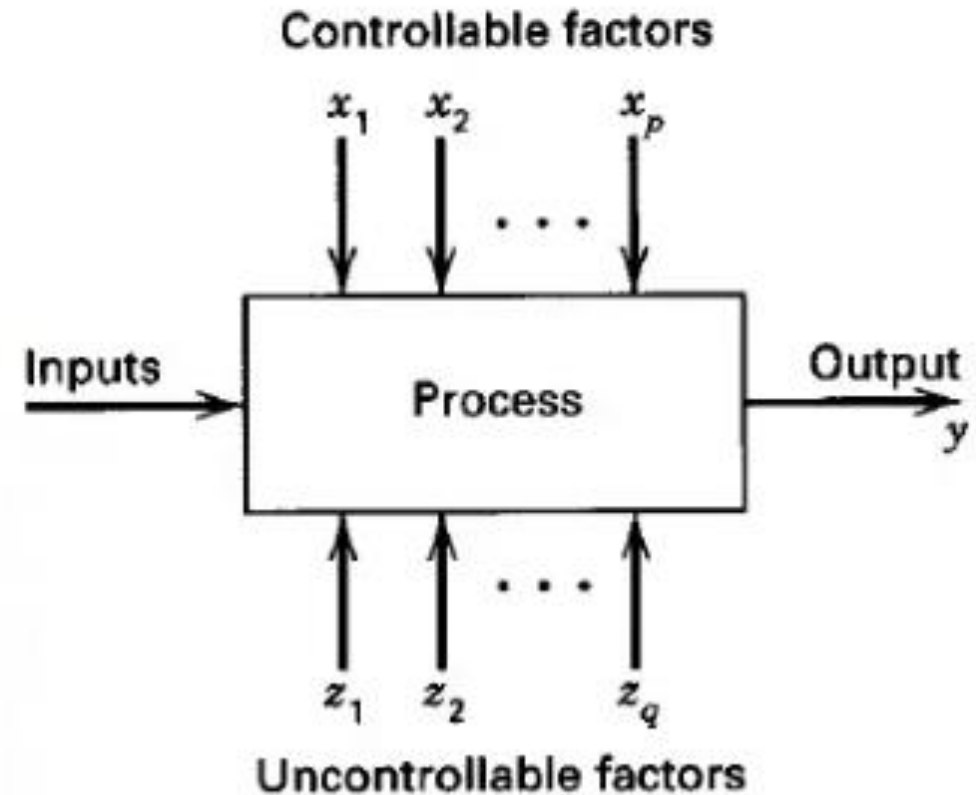


Figure 1-1 General model of a process or system.

Basic principles of Experimental research design

Basic Principles of Experimental Designs.

- The Principle of Replication: **the experiment should be repeated more than once. By doing so the statistical accuracy of the experiment is increased.**
- **The Principle of Randomization(Randomization is the process of assigning participants to treatment and control groups, assuming that each participant has an equal chance of being assigned to any group. Randomization has evolved into a fundamental aspect of scientific research methodology):**
- **The Principle of Randomization provides protection, when we conduct an experiment, against the effects of extraneous factors by randomization.**
- **We should design or plan the experimentation such a way that the variations caused by extraneous factors can all be combined under the general heading of "chance".**
- **Through the application of the Principle of randomization, we can have a better estimate of the experimental error.**

Basic principles of Experimental research design

The principle of local control:

- The extraneous factor, the known source of variability is made to vary deliberately and this needs to be done in such a way that the variability it causes can be measured and hence eliminated from the experimental error.
- We divide the field into several homogeneous parts, known as blocks, and then each such block is divided into parts equal to the number of treatments. Then the treatments are randomly assigned to these parts of a block.
- Through the principle of local control we can eliminate the variability due to extraneous factor(s) from the experimental error.

The principle of local control is a principle of experimental design that involves controlling all factors except the ones being investigated. Local control consists of two techniques:

- Balancing: Assigning treatments to experimental groups in a balanced manner
- Blocking: Grouping similar experimental units together to create homogenous groups for treatment purposes

An example of local control is **dividing a field into several homogeneous parts, known as blocks. Each block is then divided into parts equal to the number of treatments. The treatments are then randomly assigned to these parts of a block.**

Important Experimental research design

- **Two group simple randomized design**(An example of two-group design would be to evaluate the effectiveness of caffeine on improving alertness amongst two groups. One group, the experimental group, would receive the treatment, the caffeine. While the other group, the control group, would not receive the treatment, the caffeine)
- **Randomized Block design**(If a farm has a field of corn affected by a plant disease and wants to test the efficacy of different fungicides in controlling it, they may split the field into blocks and randomly treat sections of each block with the various fungicides to be tested)
- **Factorial design**(can include any number of independent variables with any number of levels. For example, an experiment could include the type of psychotherapy (cognitive vs. behavioral), the length of the psychotherapy (2 weeks vs. 2 months), and the sex of the psychotherapist (female vs male). This would be a $2 \times 2 \times 2$ factorial design and would have eight conditions. Adding a fourth independent variable with three levels (e.g., therapist experience: low vs. medium vs. high) to the current example would make it a $2 \times 2 \times 2 \times 3$ factorial design with 24 distinct conditions.)

Cognitive and behavioral are two branches of psychology. Cognitive psychology focuses on internal mental processes, such as: Memory, Perception, Problem-solving, Decision making.

Behavioral psychology focuses on observable behaviors and the impact of environmental stimuli.

Cognitive psychology investigates how internal mental processes affect how someone feels and behaves. Behavioral psychology concentrates on determining contingencies of external environmental phenomena.

Cognitive psychology explains learning as the acquisition of knowledge and the processing of information. Behavioral approaches view learning as a behavior that can be observed and measured.

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- **Hybrid Design**(many types of randomized and non-randomized trial designs can be used in the context of a hybrid depending on the specific aims)
 - **Covariance**(Covariance evaluates how the mean values of two random variables move together. For example, if stock A's return moves higher whenever stock B's return moves higher, and the same relationship is found when each stock's return decreases, these stocks are said to have positive covariance. In one study, a scientist looks at the covariance between two variables: outdoor temperature and ice cream consumption. The covariance for this data set is calculated as 35.89. This value means that the two variables move in the same direction as each other, so that as one rises so does the other.)

Research design: Two group simple randomized design

(1) Two group simple randomized design

- **The population is defined and then from the population a sample is selected randomly.**
- **After being selected randomly from the population, be randomly assigned to the experimental and control groups.**
- **Thus, this design yields two groups as representatives of the population.**
- **The two groups (experimental and control groups) of such a design are given different treatments of the independent variable.**
- **Advantage:-It is simple and randomizes the differences among the sample items.**
- **Disadvantage: -The individual differences among those conducting the treatments are not eliminated. It doesn't control the extraneous variable and as such the result of the experiment may not depict the correct picture.**

Types of research design : Randomized block design

- **(2) Randomized Block design**
- **In the RB. design, subjects are first divided into groups, known as blocks, such that within each group the subjects are relatively homogeneous in respect to some selected variable .**
- **The variable selected for grouping the subjects is one that is believed to be related to the measures to be obtained in respect of the dependent variable.**
- **The variable selected for grouping the subjects is one that is believed to be related to the measures to be obtained in respect of the dependent variable.**
- **The number of subjects in a given block would be equal to the number of treatments and one subject in each block would be randomly assigned to each treatment.**

Types of research design : Randomized block design

- **In general, blocks are the levels at which we hold the extraneous factor fixed, so that its contribution to the total variability of data can be measured .**
- **The main feature of the RB design is that in this each treatment appears the same number of times in each block.**
- **The R.B. design is analyzed by the two-way analysis of variance (two-way' ANOVA)" technique.**
- **Example ; Suppose four different forms of a standardized test in statistics were given to each of five students (selected one from each of the five I.Q. blocks) and following are the scores which they obtained**

Types of research design : Randomized block design

| | Very low I.Q. | Low I.Q. | Average I.Q. | High I.Q. | Very high I.Q. |
|--------|---------------|-----------|--------------|-----------|----------------|
| | Student A | Student B | Student C | Student D | Student E |
| Form 1 | 82 | 67 | 57 | 71 | 73 |
| Form 2 | 90 | 68 | 54 | 70 | 81 |
| Form 3 | 86 | 73 | 51 | 69 | 84 |
| Form 4 | 93 | 77 | 60 | 65 | 71 |

Types of research design : Randomized block design

- **If each student separately randomized the order in which he or she took the four tests (by using-random numbers or some similar device), we refer to the design of this experiment as a R.B. design .**
- **The purpose of this randomization is to take care of such possible extraneous factors (say as fatigue) or perhaps the experience gained from repeatedly taking the test.**

Types of research design : Factorial design

Factorial designs are used in experiments where the effects of varying more than one factor are to be determined.

- **They are specially important in several economic and social phenomena where usually a large number of factors affect a particular problem.**
- **Factorial designs can be of two types; (I) simple factorial designs and (2) complex factorial designs.**

Design of sample surveys: Examine a part of the whole

The first idea is to draw a sample:

- **We would like to know about an entire population of individuals but examining all of them is usually impractical, if not possible.**
- **We settle for examining for a smaller group of individuals – a sample- selected from the population.**
- **Sampling is natural thing to do – You taste a small part of what you are cooking to get an idea about the dish.**

Design of sample surveys: Examine a part of the whole

- **Opinion polls are example of sample surveys, designed to ask questions of a small group of population in the hope of learning something about the entire population.**
 - **Professional pollsters work quite hard to ensure that the sample they take is representative of the population.**
 - **If not, the sample can give misleading information.**
 - **The best way to avoid bias is to select individuals for the sample at the random.**
 - **The value of deliberately introducing randomness is one of the great insight of statistics.**

Design of sample surveys: Sampling methods

- The methods used commonly for sampling are

(1) Random sampling: It is similar to drawing numbers from a box.

- It protects from the influence of all features of our population even ones that we may not have thought about.
 - Randomizing makes sure that on the average the sample looks like the rest of the population.

(2) Systematic sampling: Ex – A group can choose to interview every 4th person leaving the theatre after watching a movie.

(3) Stratified sampling: Ex- A group may choose to interview only people of age, gender, etc.

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Benefits of Each Method

- **Random Sampling**

- - simple to use
- - equal opportunity of being chosen, no bias

- **Systematic Sampling**

- - more uniform coverage of population compared to random
- - simpler to use (just interview every 4th person, do not need to constantly check the random numbers)

- **Stratified Sampling**

- - more precise data when sampling a specific subset/group e.g. focus only on a specific age group or gender

Sampling and non-sampling errors

- **The errors involved in collection, processing and analysis of data in a survey may be classified as:**
 - **Sampling errors**
 - **Non-sampling errors**

Types of error

- Non-sampling error – Error associated with collecting and analyzing the data
- Sampling error – Error associated with failing to interview the entire population

Non-Sampling Error

- Coverage error
 - Wrong population definition
 - Flawed sampling frame
 - Interviewer or management error in following sampling frame
- Response error
 - Badly worded question results in invalid or incorrect response
 - Interviewer bias changes response
- Non-response error
 - Respondent refuses to take survey or is away
 - Respondent refuses to answer certain questions

Non-Sampling Error

- Processing errors
 - Error in data entry or recording of responses
- Analysis errors
 - Inappropriate analytical techniques, weighting or imputation are applied

Sampling Error

- Sampling error is known after the data are collected by calculating the Margin of Error and confidence intervals
- **Surveys don't have a Margin of Error, questions do**
- It is common to see sample sizes of 400 and 1000 for surveys (these are associated with 5% and 3% margins of error)
- In most cases the size of the population being sampled from is irrelevant
- The margin of error should be calculated using the size of the subgroups sampled

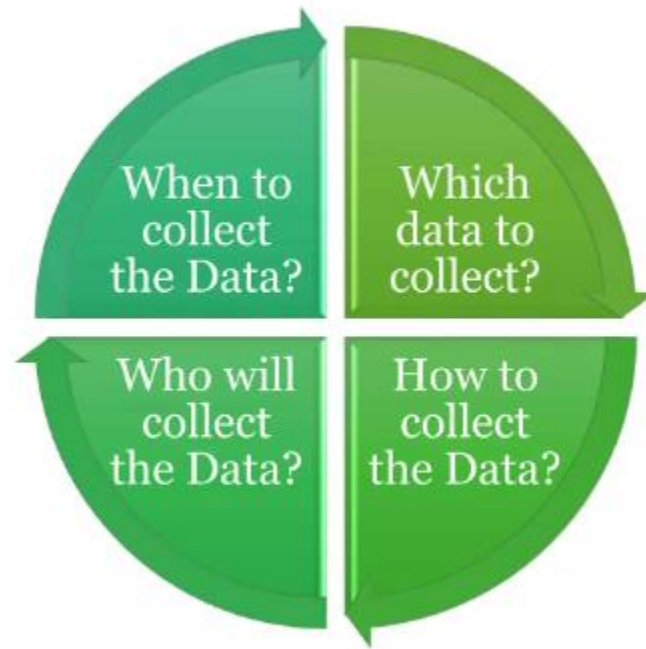
Census survey and sample survey

- Census survey is the type of survey involving the process of collecting information about each member of a given population.
- The use of census survey is usually employed for statistical research, population count or business marketing purposes.
- Advantages of census survey are:
 - Increase confidence interval
 - Everyone is invited
 - More accurate
 - Maximum chance of identifying negative feedback
- The process of collecting information by selecting some true representative to get information is known as sample survey

Data collection

- It is a process by which the researcher collects the information needed to answer the research problem.
- The task of data collection begins after a research problem has been defined and research design is chalked out.

In collecting the data, the researcher must decide



Criteria To Select Method



Resources available



Credibility



Analysis and reporting



And the skill of the evaluator

Data collection

Methods of Data collection



Primary



Secondary

Data collection: Primary data collection

Methods Of Primary Data Collection



1. Interviews



2. Surveys & Questionnaires



3. Observation



4. Focus Groups



5. Experiments

1. Interviews: Merits and demerits

ADVANTAGES

- More information at greater depth can be obtained
- Resistance may be overcome by a skilled interviewer
- Personal information can be obtained
- Better communication
- Samples can be collected effectively
- Questionnaire can be restructured based on the need

DISADVANTAGES

- It is an expensive Method
- Interviewer bias
- Respondent bias
- Time consuming

2. Questionnaire: Merits and demerits

ADVANTAGES

1. **Inexpensive**
2. **They are practical**
3. **Quick results**
4. **Scalability**
5. **Comparability**
6. **Easy analysis and visualization**
7. **They don't have time constraints**
8. **They can cover every aspect of the topic**

DISADVANTAGES

1. **Dishonest answers**
2. **Unanswered questions**
3. **Differences in understanding and interpretation**
4. **Hard to convey feelings and emotions**
5. **Accessibility issues**
6. **Survey fatigue**

3. Observations

- **Observation is watching behavior of persons who are under observations as it actually happens without controlling it.**
- **It includes recording information without asking any questions.**

ADVANTAGES

- 1. Directness**
- 2. Natural environment**
- 3. Non-verbal behavior**

DISADVANTAGES

- 1. Lack of control**
- 2. Difficulties in quantification**
- 3. Smallness in sample size**
- 4. No opportunity to learn past.**

4. Focus groups



A focus group is a group interview of approximately six to twelve people who share similar characteristics or common interests. Focus groups are useful for gathering in-depth information on perceptions,



insights, attitudes, experiences, or beliefs. Focus groups are a qualitative data collection method, meaning that the data is descriptive and cannot be measured numerically.



The main methods of data collection during a focus group discussion include audio and tape recording, note-taking and participant observation

ADVANTAGES

1. Quick and relatively easy to setup
2. The group dynamic can provide useful info. That individual data collection cannot provide.

DISADVANTAGES

1. Susceptible to facilitator bias
2. No valid info at individual level
3. The info is not a representative of other groups.

5. Experiments

- **An experiment is a data collection method where a researcher change some variables and observe their effect on other variables and observe their effect on other variables.**
- **The variables that manipulate are referred to as independent variable while the variables that change as a result of manipulation are dependent variables.**
- **Applied to different fields such as medical research, agriculture, sociology and psychology.**

ADVANTAGES

- 1. High level of control**
- 2. Excellent results**
- 3. Applied to different fields**
- 4. Allows researchers to utilize many variations.**

DISADVANTAGES

- 1. Leads to artificial situation**
- 2. Can take a lot of time and money**
- 3. Affected by errors**

Secondary data



Data gathered and recorded by someone else prior to and for a purpose other than the current project



Secondary data is data that has been collected for another purpose. It involves less cost, time and effort



Secondary data is data that is being reused. Usually in a different context.



For example: data from a book.

External sources (Financial applications): Journals, newspapers, magazines, internet sources etc.

Internal sources (Marketing applications) : Sales records, cost information, customer feedback.

Comparison of Primary and Secondary data

| Basis For Comparison | Primary Data | Secondary Data |
|--------------------------|---|---|
| Meaning | Primary Data Refers To The Firsthand Data Gathered By The Researcher Himself. | Secondary Data Means Data Collected By Someone Else Earlier. |
| Data | Real Time Data | Past Data |
| Process | Very Involved | Quick And Easy |
| Source | Survey, Observations, Expérimentes, Questionnaire, Personale Interview, Etc. | Government Publications, Websites, Books, Journal Articles, Internal Records Etc. |
| Cost Effectiveness | Expensive | Economical |
| Collection Time | Long | Short |
| Specific | Always Specific To The Researcher's Needs. | May Or May Not Be Specific To The Researcher's Need. |
| Available In | Crude Form | Refined Form |
| Accuracy And Reliability | More | Relatively Less |

Interpretation and report writing

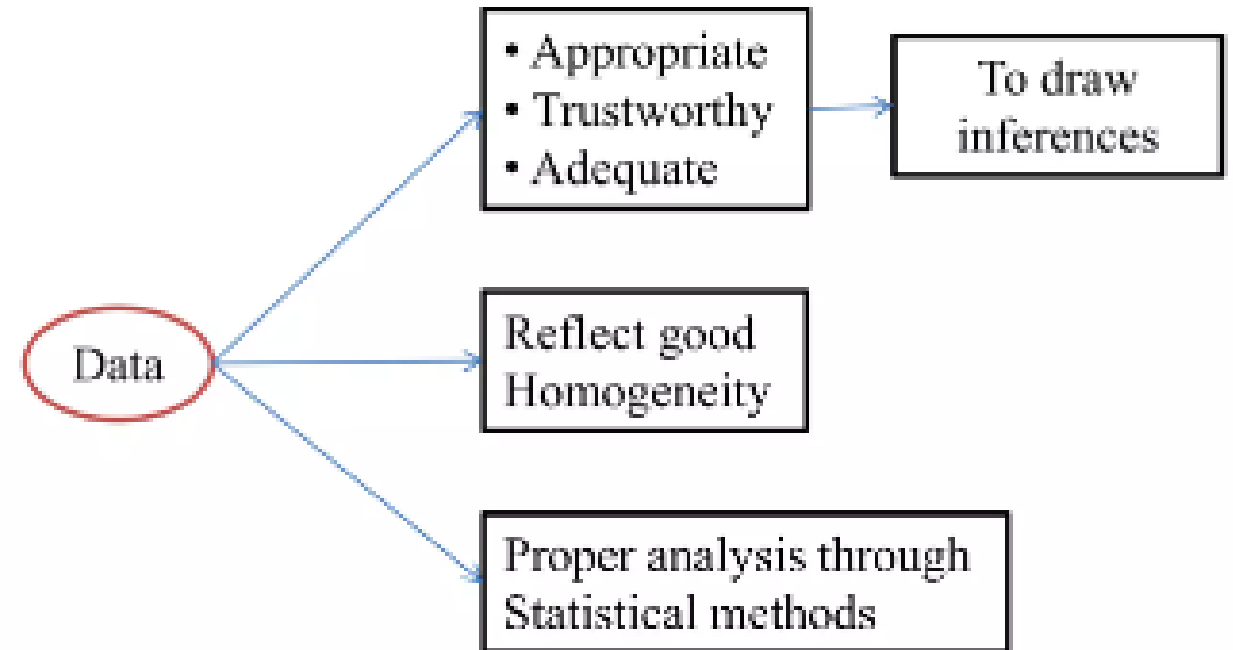
- Interpretation is the process of making in the sense of numerical data that has been collected, analyzed and presented.
- A common method of assessing numerical data is known as statistical data analysis and the activity of analyzing and interpreting data in order to make prediction is known as inferential statistics.
- Interpretation refers to the task of drawing inferences from the collected facts after an analytical and or experimental study.

Technique of Interpretation

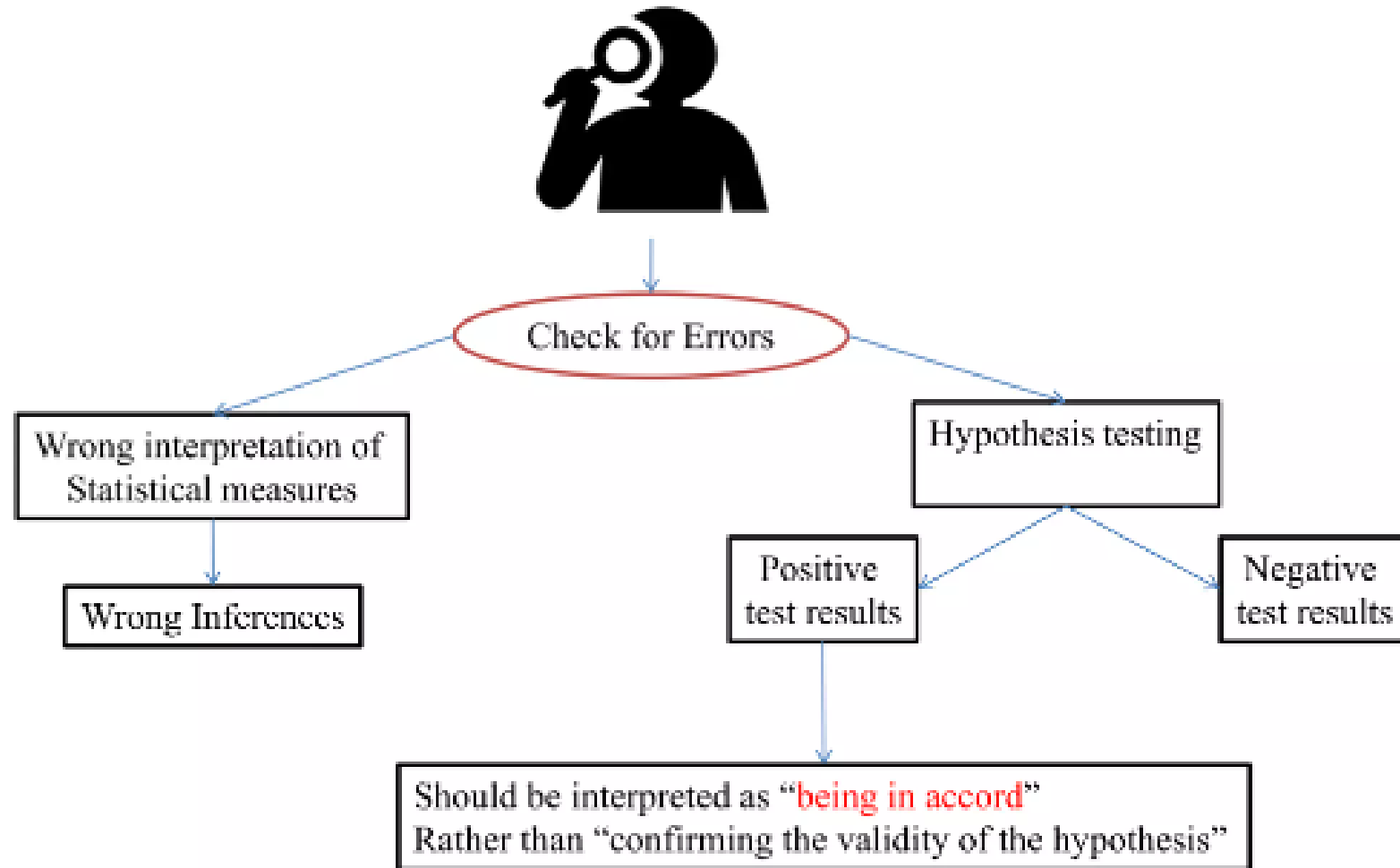
- Generalization and concept formulation
- Extraneous information (irrelevant /unrelated to the subject being studied) must be considered which prove to be a key factor in understanding the problem under consideration
- Before final interpretation consult a subject expert with that specialization to point out the omissions and errors in research work.
- Considering all relevant factors to avoid false generalizations.

Precautions in Interpretation

If data are properly calculated and analyzed but wrong interpretation is done that leads to inaccurate conclusion.

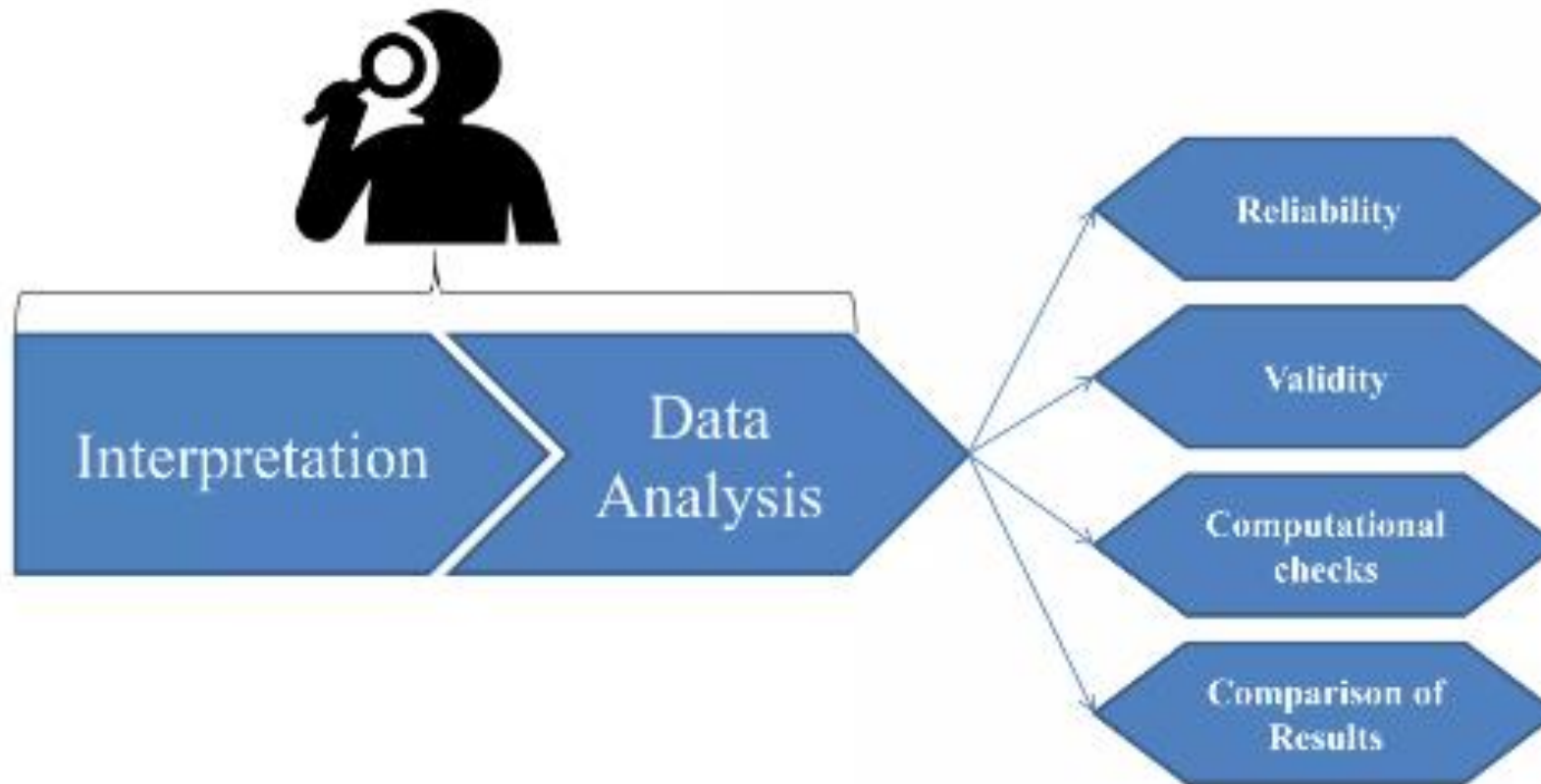


Precautions in Interpretation



Precautions in Interpretation

Researcher must consider interpretation with data analysis



Precautions in Interpretation

There should be constant **interaction** between **empirical observation** (data from experimentation) and **theoretical conception** (theoretical concepts of subject under study).



“A report is a statement of the result of an investigation or of any matter on which definite information is required”.

Different steps in writing report

1. Logical analysis of the subject matter:-

- Primarily concerned with the development of a subject.
- There are two ways in which to develop a subject:
 - (a) logically:
 - (b) chronologically:

2.Preparation of the final outline

- Outlines are the framework upon which long written works are constructed.
- They are an aid to the logical organization of the material and a reminder of the points to be stressed in the report.”

3. Preparation of the rough draft

- This follows the logical analysis of the subject and the preparation of the final outline.
- Such a step is of utmost importance for the researcher now sits to write down what he has done in the context of he is research study.

Report writing

- He will write down the procedure adopted by him in collecting the material for his study along with various limitation faced by him.
- The various suggestion he wants to offer regarding the problem concerned.

4. Rewriting and polishing of the rough draft.

- This step happens to be most difficult part of all formal writing.
- “In addition the researcher should give due attention to fact that in his rough draft he has been consistent or not. He should the mechanics of writing- grammar, spelling and usage.

5. Preparation of the final bibliography:-

- Next in order come the task of the preparation of the final bibliography. The bibliography ,which is generally appended to the research report.
- The bibliography should be arranged alphabetically.
- Generally this pattern of bibliography is considered convenient and satisfactory from the point of view of reader.

6. Writing the final draft:-

- The final draft should be written in a concise and objectives style and in simple language.
- Avoiding vague expression such as a “it seems”, “there may be “, and the like once.
- It must be remembered that every report should be an attempt to solve some intellectual problem and must contribute to the solution of a problem and must add to the knowledge of both the researcher and the reader.

Significance of Report writing

- It is considered a **major component of the research study** as the **research remains incomplete without report.**
- A report should **be properly dated & signed by the concerned authority or by the chairman of the committee or by all committee members.** This has a **legal significance** and needs special attention in report writing.
- **A lengthy report is not necessary.** Infact, report should **be brief and compact document**, it should give complete picture of problem under investigation.

Significance of Report writing

- **Writing reports needs skills** and this task should be accomplished by the researcher with the utmost care.
- Reports **communicate the planning, policies, and other matters regarding an organization.**
- Reports **discloses unknown information.**
- A good report is one which is **drafted in a simple and clear language.** Its should not be difficult and a reader should be able to understand the entire report easily, exactly & quickly.

Significance of Report writing

- All the **skills and the knowledge of the professionals are communicated through reports.**
- Reports **help the top line in decision making.**
- A true and balanced report also helps in problem solving.**
- A report should be in a proper format. The report should have all **the essentials components such as title, introduction, findings & recommendations.**

Significance of Report writing

- Reports **present adequate information on various aspects of the business.**
- In a report writing attention should be given to **certain essential technical details.** For eg: the **pages and paragraphs of the report should be numbered properly. Marginal heading and titles should be given. This gives convenience to the readers.**
- **The data collection, analysis and interpretation of the data conclusions** drawn and the recommendations made in report should be made **accurate so as to make the whole report reliable** and dependable for future reference and **also for policy decisions.**

Layout of report

| BROAD DIVISION | INDIVIDUAL SECTIONS |
|---------------------------|---------------------------|
| 1. Preliminary Material | Title of Report |
| | Table of Contents |
| | Abstract / Synopsis |
| 2. Body of Report | Introduction |
| | Literature Review |
| | Methodology |
| | Results |
| | Discussion |
| | Conclusion |
| | Recommendations |
| 3. Supplementary Material | References / Bibliography |
| | Appendices |

Types of report writing

- During your time at university you may be asked to write different types of report.
- Laboratory reports.
- Technical reports.
- Reports of a work placement or industrial visit.
- Reports of a field trip or field work.

Types of report writing

- Mainly two types of report :

(a) **Thesis:** A long essay or dissertation involving personal research , written as part of a university Doctorate degree.

(b) **Dissertation:** A long essay, especially one written for a university degree or diploma.

Difference

- A thesis is a presentation of learned and existing information, while the purpose of a dissertation is to develop a unique concept and defend it based on theoretical and practical results.
- Regardless of where and when you earn your master's or doctoral degree, you will likely have to complete a thesis or dissertation. The main difference between a thesis and dissertation is the level at which you complete them. A thesis is for a master's degree, and a dissertation is for a doctoral degree.
- Some students may find a dissertation harder than a thesis. A dissertation requires students to develop an original research idea, which can sometimes be harder than building upon existing ideas. Though, the difficulty of a thesis or dissertation depends on your personal skill set.