Chapter 1

Overview of Research Process

"All progress is born of inquiry. Doubt is often better than overconfidence, for it leads to inquiry, and inquiry leads to invention" - Hudson Maxim.

From this quote, any one can understand the significance of research. Humanity has benefited a lot due to research. Without research, many of the comforts we have today would not have been realized.

Research is an essential and powerful tool in leading man towards progress. Through research, new products, new facts, new concepts and new ways of doing things are continuously being found in all fields.

1.1 What is Research?

The word 'Research comprises of two words, Re+Search. It means to search again. So research means a systematic investigation or activity to gain new knowledge of the already existing facts.

There are many definitions of research. However in simple terms, research can be defined as a structured approach to discover, develop or verify knowledge.

The following are possible motivations for doing research:

(a) Aspire to get a research degree along with career benefits;

(b) Aspire to take up the challenge in solving the unsolved problems;

(c) Desire to get intellectual joy of doing a creative work;

(d) Aspire to do research to serve the society;

(e) Seek to get recognition and respect;

(f) Directives of government or employment conditions;

(g) Curiosity about new things.

1.2 Purpose of Research

The main aim of research is to bring to light new knowledge, correct the present mistakes, remove existing misconceptions and add new learning to the existing knowledge.

Though each research study has its own specific purpose, some general objectives of research are:

(a) To gain familiarity with a phenomenon or to achieve new insights into it.

(b) To determine the frequency with which something occurs or with which it is associated with something else.

(c) To test a hypothesis of a causal relationship between variables.

(d) To portray accurately the characteristics of something.

1.3 General Characteristics of Research

The following are the characteristics of research;

(a) Research is directed towards the solution of a problem.

(b) Research requires expertise.

(c) Research emphasizes the development of generalizations, principles, or theories that will be helpful in predicting future occurrences.

(d) Research is based upon observable experience or empirical evidences.

(e) Research demands accurate observation and description.

(f) Research involves gathering new data from primary or first-hand sources or using existing data for a new purpose.

(g) Research is characterized by carefully designed procedures that apply rigorous analysis.

(h) Research involves the quest for answers to un-solved problems.

(i) Research should not contain personal feelings and preferences.

(j) Research strives to be objective and logical, applying every possible test to validate the procedures employed in the data collected and the conclusions reached.

(k) Research is characterized by patience and unhurried activity.

(l) Research sometimes requires courage.

(m) Research is carefully recorded and reported

1.4 Types of Research

1.4.1 Descriptive vs Analytical Research

Descriptive research includes surveys and fact-finding enquiries of different kinds. The major purpose of descriptive research is description of the state of affairs as it exists at present.

This research is suitable for social sciences, business and management fields.

The main characteristic of this method is that the researcher has no control over the variables; s/he can only report what has happened or what is happening.

Most research projects of this nature are used for descriptive studies in which the researcher seeks to measure factors like frequency of shopping, brand preference of people, most popular media programme etc.

In analytical research, the researcher makes a critical evaluation of the material by analyzing facts and information already available.

The researcher has to use facts or information already available, and analyze these to make a critical evaluation of the material.

1.4.2 Applied Research vs. Fundamental Research

Applied Research aims at finding a solution for an immediate problem facing a society or an industrial / business organization, whereas Fundamental or Pure Research is mainly concerned with generalizations and concentrates on the formulation of a theory. "Gathering knowledge for the sake of knowledge is termed 'Pure' or 'Basic' or Fundamental research.

Thus, the central aim of applied research is to discover a solution for some pressing practical problem, whereas basic research is directed towards finding information that has a broad base of applications and thus, adds to the already existing organized body of scientific knowledge.

1.4.3 Quantitative vs. Qualitative Research

Quantitative research is based on the measurement of quantity or amount. It is applicable to phenomena that can be expressed in terms of quantity.

Qualitative research, on the other hand, is concerned with qualitative phenomenon, i.e., phenomena relating to or involving quality or kind. For instance, investigating the reasons for human behavior (i.e., why people think or do certain things) is a form of qualitative research.

1.4.4 Conceptual vs. Empirical Research

Conceptual research is that related to some abstract idea(s) or theory. It is generally used by philosophers and thinkers to develop new concepts or to reinterpret existing ones.

On the other hand, empirical (experimental) research relies on experience or observation alone, often without due regard for system and theory. It is data-based research, coming up with conclusions which are capable of being verified by observation or experiment.

1.5 Research Methodology versus Research Methods

Research methods are all those methods/techniques that are used for conducting research. Research methods or techniques, refer to the methods the researchers adopt to carry out their research.

Research methods can be put into the following three groups:

(a) Methods which are concerned with the collection/ acquisition of data; these methods will be used where the data already available are not sufficient to arrive at the required solution.

(b) The mathematical/statistical techniques which are used for establishing relationships between the data and the unknowns.

(c) Methods which are used to evaluate the accuracy of the results obtained.

Research methodology is a way to systematically solve the research problem. It is the science of studying how research is done scientifically. In it we formulate the various steps that are to be adopted by a researcher in studying his research problem along with the logic behind them. It is necessary for the researcher to know not only the research methods/techniques but also the methodology.

It is clear that research methodology has many dimensions and research methods do constitute a part of the research methodology.

Why a research study has been undertaken, how-the research problem has been defined, in what way and why the hypothesis has been formulated, what data have been collected and what particular method has been adopted, why particular technique of analyzing data has been used and a host of similar other questions are usually answered when we talk of research methodology concerning a research problem or study.

1.6 What Does not Constitute Research

Based on the above definition of research, there are at least three things which do not constitute scientific research but they are commonly misconceived as constituting research. These are:

1) **A literature review alone is not research**: Although reviewing and synthesizing literature is an important part of the research process, it is not itself a research. The process of reviewing literature does not add to our knowledge base.

2) **Theory construction or forging links between theories or perspectives in the absence of empirical data is not research**: Although the process of modifying and perhaps linking theories is an important part of research, it is not research by itself. For example, forging links between Newtonian physics and Einsteinian physics is not research. Any physicist should be able to derive such links analytically or at least conceptually.

3) **Collection and analysis of data without theoretical grounding (i.e., having no research question) and offering no explanation of the data is not research**: Data collection is an incredibly importantcentralpart of research; without data, no research could be done. However, data collection alone is not research, because there is no theory-driven question being asked nor answered. For example Census in a country where the data on the country's population is collected is not itself research.

1.7 Research Process

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

1) Formulating the research problem

2) Extensive literature survey

3) Developing the research hypothesis

4) Preparing the research design

5) Determining the sample design

6) Collecting the research data

7) Execution of the project

8) Analysis of data

9) Hypothesis testing

10) Generalizations and interpretation

11) Preparing of the report

These steps can be represented in a flow-chart as shown in Figure 1.1

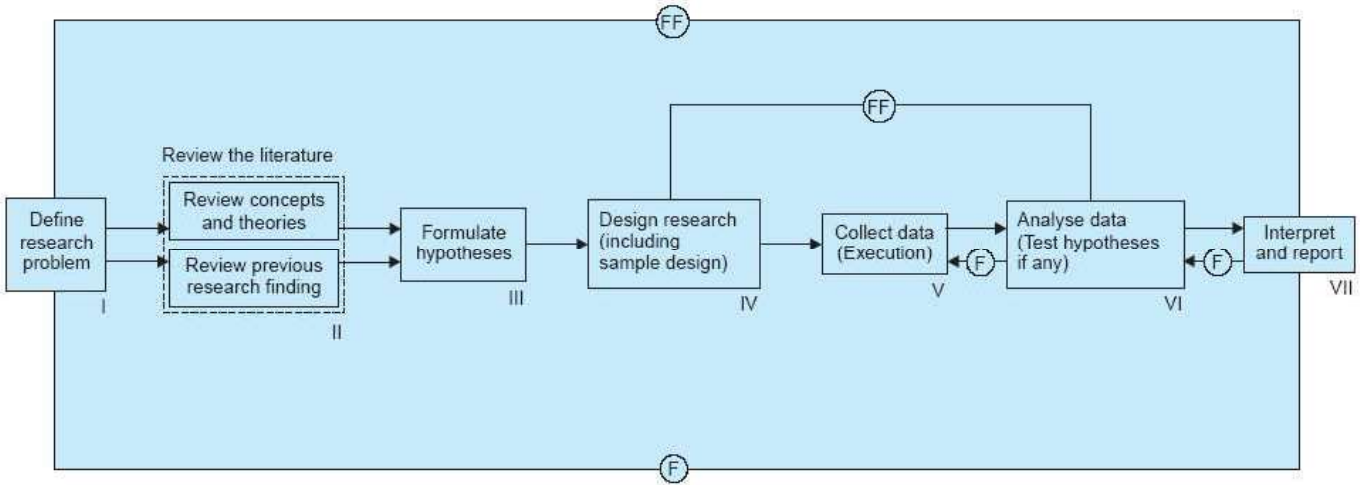

Figure 1.1: Research process in flow chart

A brief description of the above stated steps follow.

1.7.1 Formulating the Research Problem

At the very start, the researcher must single out the problem he wants to study, i.e., he must decide the general area of interest or aspect of a subject-matter that he would like to inquire into.

The formulation of a general topic into a specific research problem, therefore, constitutes the first step in a scientific research.

Essentially two steps are involved in formulating the research problem, that is, understanding the problem thoroughly, and rephrasing the same into meaningful terms from an analytical point of view.

Once the problem is formulated, a brief summary of it should be written down.

1.7.2 Extensive Literature Survey

Once the problem is formulated the researcher should undertake extensive literature survey connected with the problem.

Two types of literature are reviewed, that is

- The conceptual literature concerning the concepts and theories

- The empirical literature consisting of studies made earlier which are similar to the one proposed

Sources for the literature include but not limited to:

- Scientific journals
- Conference proceedings
- Books
- Government reports
- Patents

1.7.3 Development of Working Hypothesis

After extensive literature survey, a researcher should state in clear terms the working hypothesis or hypotheses. Working hypothesis or research question is a tentative guess of what will happen based on one's readings, observations and other experiences for further testing.

Hypothesis is very important since it provides the focus of the research. The role of the hypothesis is to guide the researcher by delimiting the area of research and to keep him on the right track.

1.7.4 Preparing the Research Design

The research problem having been formulated in clear cut terms, the researcher will be required to state the conceptual structure within which research would be conducted.

The function of research design (methodology) is to provide for the collection of relevant evidence with minimal expenditure of effort, time and money.

Research design is a master plan specifying the methods and procedures for collection and analyzing the needed information.

Research design depends mainly on the research purpose. Research purposes may be grouped into the following four categories,

(i) Exploration

(ii) Description

(iii) Diagnosis

(iv) Experimentation

The following should be considered when preparing the research design:

(i) the means of obtaining the data

(ii) the availability and skills of the researcher

(iii) the time available for research

(iv) the finance available for the research.

1.7.5 Determining Sample Design

A sample design is a definite plan determined before any data are actually collected for obtaining a sample from a given population.

Sample designs can be either probability or non-probability. With probability samples each element has a known probability of being included in the sample but the non-probability samples do not allow the researchers 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.

The sample design to be used must be decided by the researcher taking into consideration the nature of the inquiry and other related factors.

1.7.6 Collecting the Data

There are several ways of collecting the appropriate data which differ considerably in context of money costs, time and other resources at the disposal of the researcher.

Primary data can be collected either through experiment or through survey. If the researcher conducts an experiment, he observes some quantitative measurements.

1.7.7 Execution of the Project

If the execution of the project proceeds on correct lines, the data to be collected would be adequate and dependable.

1.7.8 Analysis of Data

In this stage of research, the collected data should be processed and analyzed.

The processing stage includes the classification and tabulation/graphing of collected data ready to be analyzed.

The analyzing stage includes the interpretation of findings to determine the validity in which the conclusions would be based.

1.7.9 Hypothesis Testing

After analyzing the data, the researcher is in a position to test the hypothesis, if any, he had formulated earlier. Do the facts support the hypothesis or they happen to be contrary?

Hypothesis testing will result in either accepting the hypothesis or in rejecting it. If the researcher had no hypothesis to start with, generalizations established on the basis of data may be stated.

1.7.10 Generalizations and Interpretation

If a hypothesis is tested and upheld several times, it may be possible for the researcher to arrive at generalization i.e. to build a theory. As a matter of fact, the real value of research lies in its ability to arrive at certain generalizations.

If the researcher had no hypothesis to start with, he might seek to explain his findings on the basis of some theory. It is known as interpretation. The process of interpretation may quite often trigger off new questions which in turn may lead to further researches.

1.7.11 Preparation of the Report

Finally, the researcher has to prepare the report of what has been done. The layout of the report should be as follows; the preliminary pages, the main text and end matter.

1.8 Science and Scientific Research

The purpose of science is to create scientific knowledge. Scientific knowledge refers to a generalized body of laws and theories to explain a phenomenon or behavior of interest that are acquired using a scientific method.

Laws are observed patterns of phenomena or behaviors, while theories are systematic explanations of the underlying phenomenon or behavior.

The goal of scientific research is to discover laws and postulate theories that can explain natural or social phenomena, or in other words, build scientific knowledge.

Scientific method refers to a standardized set of techniques for building scientific knowledge, such as how to make valid observations, how to interpret results, and how to generalize those results. The scientific method allows researchers to independently and impartially test pre-existing theories and prior findings, and subject them to open debate, modifications, or enhancements. The scientific method must satisfy four characteristics:

(a) *Replicability*: Others should be able to independently replicate or repeat a scientific study and obtain similar, if not identical results.

(b) *Precision*: Theoretical concepts, which are often hard to measure, must be defined with such precision that others can use those definitions to measure those concepts and test that theory.

(c) *Falsifiability*: A theory must be stated in a way that it can be disproved. Theories that cannot be tested or falsified are not scientific theories and any such knowledge is not scientific knowledge. A theory that is specified in imprecise terms or whose concepts are not accurately measurable cannot be tested, and is therefore not scientific.

(d) *Parsimony:* When there are multiple explanations of a phenomenon, scientists must always accept the simplest or logically most economical explanation. Parsimony prevents scientists from pursuing overly complex or outlandish theories with endless number of concepts.

Chapter 2

Formulating a Research Problem

2.1 Introduction

In research process, the first and foremost step happens to be that of identifying a research problem.

A researcher must find the problem and formulate it so that it becomes susceptible to research.

The components of a research problem are:

(a) There must be difficulty or the problem being experienced

(b) There must be some objective(s) to be attained. If one wants nothing, one cannot have a problem.

(c) There must be alternative means (or the courses of action) for obtaining the objective(s) one wishes to attain. This means that there must be at least two means available to a researcher since if he has no choice of means, he cannot have a problem.

(d) There must remain some doubt in the mind of a researcher with regard to the selection of alternatives. This means that research must answer the question concerning the relative efficiency of the possible alternatives.

(e) There must be some environment(s) to which the difficulty pertains.

Thus, a research problem is one which requires a researcher to find out the best solution for the given problem, i.e., to find out by which course of action the objective can be attained optimally in the context of a given environment.

Generally speaking a research problem is a situation that needs a solution and for which there are possible solutions. If a situation has no possible solutions then it makes little or no sense expending resources researching it. Take this statement, everybody wants to go to heaven but

nobody wants to die. Dying looks like a problem that needs a solution yet there is no possible solution to it. People must die. A research on how people can live forever makes little or no sense at all.

A research problem may be described as an incongruence; a discrepancy between what is and what ought to be. It may be also described as the gap in knowledge that needs to be filled.

2.2 Selecting a Research Problem

The research problem undertaken for study must be carefully selected, and help is usually necessary from a research guide/supervisor.

The following points may be observed by a researcher in selecting a research problem or a subject for research:

(a) Subject which is overdone should not be chosen, for it will be very difficult to bring any new light in such a case.

(b) Controversial subject should not become the choice of an average researcher.

(c) Too narrow or too vague problems should be avoided.

(d) Choose a problem which is within your area of specialization and which you are keen to research on (Expertise and interest).

(e) Review first the earlier researches conducted in that area to know the recent trend and studies in the area (Preliminary literature review). Therefore, review data on the problem you choose should be available.

(f) The importance of the subject, the qualifications of a researcher, the costs involved and time factor must also be considered when selecting a problem. Therefore you should ask yourself the following questions:

   (a) Whether you are well equipped in terms of your background to carry out the research.

   (b) Whether the study falls within the budget you can afford.

   (c) Whether the study can be carried out within the given time frame

   (d) Whether you have access to the equipment/facilities needed to carry out the study.

   If the answers to all these questions are in the sincere affirmative, one may become sure so far as the practicability of the study is concerned

(g) Choose a problem which is relevant. Ensure that your study adds to the existing body of knowledge. Of course, this will help you to sustain interest throughout the research period.

(h) Research ethics should also be considered when choosing a research area. It is always good for you to identify ethics related issues during the research problem formulation itself.

2.3 Characteristics of Research Problems

A good research problem should have the following characteristics:

(a) A research problem must be researchable. For a problem to be researchable it musy it be:

- stated clearly and concisely
- significant i.e. not trivial or a repeat of previous work;
- possible to obtain the information required to explore the problem;
- possible to draw conclusions related to the problem, as the point of research is to find some answers.

(b) A research problem must have a goal

(c) A research problem should be free from ethical constraints

(d) A research problem should be limited in scope and should be specific

A research problem can be based on a question, an unresolved controversy, a gap in knowledge or an unrequited need within the chosen subject. An awareness of current issues in the subject and an inquisitive and questioning mind and an ability to express yourself clearly is required in order to find and formulate a problem that is suitable for a research project.

2.4 Sources of Research Problems

You can get a research problem from the following sources:

(a) Funding agencies.

(b) Past researches and literature review

(c) Social developments and technological changes are constantly bringing forth new problems and opportunities for research.

(d) Questioning attitude: A questioning attitude towards prevailing practices and research oriented academic experience will effectively promote problem awareness.

(e) Personal interest and experience

(f) Consulting supervisor, experts of the field and most experienced persons of the field. They may suggest most significant problems of the area.

(g) Discussions: Classroom discussions, seminars and exchange of ideas with faculty members and fellow scholars and students can suggest many stimulating problems to be solved

2.5 Problem Statement

A problem statement is a brief overview of the issues or problems existing in the concerned area selected for the research.

It is an explanation of the issues prevalent in a particular topic which drives the researcher to take interest in that topic for in-depth study and analysis, so as to understand and solve them.

It is the description of an issue currently existing which needs to be addressed. It provides the context for the research study and generates the questions which the research aims to answer. The statement of the problem is the focal point of any research.

Purpose of a problem statement:

(a) It represents the reasons/motivation behind your research

(b) It specifies the conditions you want to change or the gaps in existing knowledge you intend to fill

(c) It shows your familiarity with prior research on the topic and why it needs to be extended.

(d) It specifies your hypothesis that suggests a solution to the problem.

The key components of a problem statement are:

1) **Status quo**: Refers in general to things as they are regarding the problem. To persuade people to change their minds or their actions, you must first convince them to reexamine the status quo. This gives the background of the problem and reflects on facts related to the problem to make the reader understand about the gravity of the problem.

2) **Consequences of the status quo**: For you to sway the audeince from the status quo, you need to state clearly its negative impacts. This will;

   - motivate a change in thought or action,
   - reveal inadequacies and difficulties,
   - demonstrate a need for change,

3) **Ideal situation**: You need to state clearly how things should be as far as the problem is concerned and what will be improved if the status quo is changed. (Vision - what does the world look like if we solve the problem?). This will project benefits.

4) **Solution:** This is your response on how you intent to change the status quo. State clearly the solution you need to introduce and its benefits of your solution over other ones. You need to answer the question, "How does this solution eliminate the perceived problem?

These elements should be brief so that the reader does not get lost. One page (or 150-300 words) is enough for a statement problem.

When writting a problem statement, ensure it answers the 5W's questions, that is:

- **Who** - Who does the problem affect? Specific groups, organizations, customers, etc.
- **What** - What is the problem?, What is the impact of the problem?, What will happen when the problem is fixed? What would happen if we don't solve the problem?
- **When** - When does the problem occur? When does it need to be fixed?
- **Where** - Where is the problem occurring?
- **Why** - Why is it important that we fix the problem?

Generally, a persuasive statement of problem is usually written in three parts:

1. **Part A (The ideal)**: This first part describes a desired goal or ideal situation, and explains how things should be.
2. **Part B (The reality)**: The next part describes the reality on the ground and the condition(s) that prevents the ideal situation being achieved at the moment. It should explain how the current situation falls short of the goal or ideal
3. **Part C (The consequences, need and intervention):** This last part should show how the situation on the ground contains little promise of improvement unless something is done. It should also emphasize the benefits of research by projecting the consequences of possible solutions and identifies the way you propose to improve the current situation and move it closer to the goal or ideal situation.

Example:

PART A (THE IDEAL)

The government of Kenya has a goal to industrialize the nation by the year 2030 (quote). In this regard it has encouraged growth-oriented micro and small enterprises (MSEs) that should graduate into medium and large enterprises capable of contributing to the industrialization goal.

There are several sessional papers (quote/cite) that contain specific measures to encourage and support MSEs.

PART B (THE REALITY)
Despite the said government efforts, there is slow growth of micro into small enterprises and even slower growth of small into medium scale enterprises (quote, show statistics). The government has officially acknowledged that there exists a missing middle in Kenya meaning that there is a gap between small and large enterprises in the country (cite, quote).

PART C (CONSEQUENCES, THE NEED AND INTERVENTION)
Should the missing middle gap persist, the industrialization goal may be difficult to achieve. A need therefore arises to investigate why there is a persistent missing middle despite government efforts.

2.6 Formulating Research Objectives

As earlier stated, a research problem must have some objective(s)/goals to be achieved.

After formulating a problem statement, the next step is to write or develop the objectives of the research. The research objectives of summarize what is to be achieved by the study and they should be closely related to the statement of the problem.

Research objectives are the goals that you set in your study, that you want to achieve through your study.

Research objectives inform the readers of what you want to research and how far you want to go. They also inform the readers about the scope and extent of your study.

The formulation of objectives will help you to:

- Focus the study (narrowing it down to essentials);
- Avoid the collection of data which are not strictly necessary for understanding and solving the problem you have identified;
- Organise the study in clearly defined parts or phases.

Properly formulated,objectives will facilitate the development of your research methodology and will help to orient the collection, analysis, interpretation and utilisation of data.

Characteristics of research objectives are:

1) Clarity: The wording of research objectives should have to be very clear and very well defined. Use simple sentences and avoid complexities in wording.

2) Completeness: Each phrase in the research objectives should have a sense of completeness because they tell the extent of your research.

3) SMART (Specific, Measurable, Achievable, Relevant and Time-bound

- Specific; The research objectives should specifically focus on the what, how, when and where questions, and avoid general statements. Use action verbs to describe what has to be done. Action verbs include; to determine, to develop, to compare, to verify, to calculate, to describe, to establish, to access, to evaluate, etc. Avoid the use of vague non-action verbs such as: to appreciate, to understand, to show, to indicate, etc.
- Measurable; Research objectives should be quantifiable. The objectives should be such that, its very easy to monitor the progress of the project and assess the final results. When the project is completed, the results will be compared to the objectives. If the objectives have not been spelled out clearly, the project cannot be evaluated.
- Achievable; Reseach objectives should attainable. You should know the resources and your capabilities.
- Relevant; Means result oriented. Your research objectives should be able to answer the questions like why should this project be done? what impact will this project have?
- Time-bound; Research objectives should be achievable within a reasonable particular time frame.

When formulating research objectives: care must be taken specifically to:

(a) State the objectives that are clear, well written and precise

(b) Make objectives specific, significant, realistic, and achievable

(c) Ensure that objectives flow logically from the statement of need and address the problem.

(d) Make objectives fall within the range of results, which are expected to be achieved within the limit of time, money and human resources available

(e) State the objectives as far as possible in terms, which allow measurements or at least observation of their achievement

(f) Objectives should be hierarchical and/or chronological

Research objectives are categorized into two: Main objectives and sub-objectives (specific objectives).

2.6.1 Main/General Objective(s)

The main objective is the purpose of the study and is an overall statement of the goal of your study.

This a broad statement of what the study seeks to achieve. It is derived from the statement of the problem. The researcher states succinctly what the study proposes to investigate.

2.6.2 Subobjectives or Specific Objectives

These are derived from the purpose and they set out what is to be achieved in a research study in specific terms.

They are crucial in any research since they determine the kind of questions and procedures to be used in data collection, and analysis.

The specific objectives set the goals that you want to achieve along with the main objectives. They are also relevant and specific to the research problem but they will only help in acieving the main objectives. They are thus not the main goal or aim of the research but they provide support in attaining the main goals.

Subobjectives should be numerically listed. They should be worded clearly and unambiguously. Make sure that each subobjective contains only one aspect of the study.

Example:

Main Objective
To find out the effects of alcoholism on the family.

Specific Objectives

1) To ascertain the impact of alcoholism on marital relations.

2) To determine the ways in which alcoholism affects the different aspects of childrens lives.

3) To find out the effects of alcoholism on the financial situation of the family.

Chapter 3

Literature Search and Review

3.1 Introduction

One of the essential preliminary tasks when you undertake a research study is to go through the existing literature in order to acquaint yourself with the available body of knowledge in your area of interest. Reviewing the literature can be time consuming, daunting and frustrating, but it is also rewarding.

Preliminary literature review can assist you in formulating your research problem, establishing the theoretical roots of your study, clarifying your ideas and developing your research methodology.

During research, the literature review serves to enhance and consolidate your own knowledge base and helps you to integrate your findings with the existing body of knowledge.

In summary, a literature review has the following functions:

- It provides a theoretical background to your study
- It brings clarity and focus to your research problem
- It helps you develop and improve a your methodology
- It helps you establish the links between what you are proposing to examine and what has already been studied. To understand where you are going, it is important to understand what came before you.
- It enables you to show how your findings have contributed to the existing body of knowledge in your profession. It helps you to integrate your research findings into the existing body of knowledge.
- It helps you broaden your knowledge base in your research area.
- It demonstrates to the reader that you are aware of up-to-date and important knowledge on your topic

In a literature review, you demonstrate that you have read and understood previous and current research in the your area of study.

Literature search is a systematic and thorough search of all types of published literature in order to identify a breadth of good quality references relevant to a specific topic for review.

The success of a research project is dependent on a thorough review of the academic literature.

Note that, literaure review is not an annotated bibliography, that is a list of resources followed by a brief description. However, a literature review synthesizes the key theories and results in a particular field of study. It describes, evaluates and critiques a large number of resources, then demonstrates how work in that area evolved and discusses the influences that made a difference.

Writting a literature review involves the following three steps:

1) Defin your research topic: you must define your topic and components of your topic
2) Search the relevant literature on your topic: use search tools (such as the library catalogue, databases, bibliographies) to find materials about your topic
3) Evaluate what you have found: read and evaluate what you have found in order to determine which material makes a significant contribution to the understanding of the topic.
4) Write a report of your review: Present the analysis, discussion, interpretation and conclusion of the findings of theliterature.

Therefore, preparing a literature review thus involves:

- Searching for reliable, accurate and up-to-date material on your selected topic or subject
- Reading and summarising the key points from this literature
- Synthesising these key ideas, theories and concepts into a summary of what is known
- Discussing and evaluating these ideas, theories and concepts
- Identifying particular areas of debate or controversy
- Preparing the ground for the application of these ideas to new research

Benefits of a good literature search are:

- This will prevent you from duplicating work which has already been done.
- By synthesizing information from previous studies, you will be able to provide a stronger background, justification and discussion of your own study

- Relevant studies can provide valuable insights and tips to make your own study better, such as the best methodology or data analysis methods to use.
- You will be able to find gaps and weaknesses in the existing research and thereby come up with useful and meaningful research questions

3.2 Literature Search

Ensure you review reliable, accurate and up-to-date literature material. Knowing where and how to get such material is very crucial.

There are three broad resources for literature: Books, journals/conference proceedings and theses/dissertations. With the help of internet, all these can be accessed electronically.

3.2.1 Books

Books can assist you get the theoretical background of your research.

The main advantage is that the material published in books is usually important and of good quality, and the findings are 'integrated with other research to form a coherent body of knowledge.

The main disadvantage is that the material in books is not completely up to date, as it can take a few years between the completion of a work and its publication in the form of a book.

The best way to search for a book is to look at your library catalogues or from the internet.

Searching appropriate books for your topic to review is very crucial. A guide is as follows:

- Use the subject catalogues or keywords option to search for books in your area of interest. Narrow the subject area searched by selecting the appropriate keywords. Look through these titles carefully and identify the books you think are likely to be of interest to you.
- When you have selected 10-15 books that you think are appropriate for your topic, examine the bibliography of each one.
- Go through these bibliographies carefully to identify the books common to several of them. If a book has been referenced by a number of authors, you should include it in your reading list.
- Prepare a final list of books that you consider essential reading.
- Examine their contents to double-check that they really are relevant to your topic. If you find that a book is not relevant to your research, delete it from your reading list

- If you find that something in a book's contents is relevant to your topic, make an annotated bibliography. An annotated bibliography contains a brief abstract of the aspects covered in a book and your own notes of its relevance.

3.2.2 Journals and Conference Proceedings

Journal articles and conference proceedings provide you with the most up-to-date information. You should get as many of them as possible so that you can read the emerging issues and researches on your research area.

Conference proceedings can provide the latest findings and discussions on the topic youre studying and give you clues on forthcoming papers that may be published.

If you feel that a particular article is of interest to you, read its abstract. If you think you are likely to use it, depending upon your financial resources, either photocopy or print it, or prepare a summary and record its reference for later use.

Tips for effective search of journal articles are:

1. **Define your keywords**: Break up the topic you are researching into its main concepts, then define keywords for each concept.
2. **Start your search**: There are several sources designed to make your search for journals easier and these can save you enormous time. These include search engines and publication/indexing databases. They are useful in an academic setting for finding and accessing articles in academic journals, repositories, archives, or other collections of scientific and other articles. Examples of search engines are:
    - Google - Most common
    - Bing - Bing is Microsofts attempt to challenge Google in the area of search, but despite their efforts they still did not manage to convince users that their search engine can produce better results than Google.
    - Yahoo - Powered by Bing
    - Ask.com - Formerly known as Ask Jeeves, and is based on a question/answer format where most questions are answered by other users or are in the form of polls.
    - AOL.com
    - Baidu - was founded in 2000 and it is the most popular search engine in China
    - Wolframalpha - it is a Computational Knowledge Engine which can give you facts and data for a number of topics.
    - DuckDuckGo - It has a clean interface, it does not track users and it is not fully loaded with ads

- Internet Archive (eg. archive.org) - You can use it to find out how a web site looked since 1996. It is very useful tool if you want to trace the history of a domain and examine how it has changed over the years.

Examples of publication/indexing databases for engineering include:

- African Journals OnLine (AJOL)
- CiteSeerX
- IEEE Xplore
- IngentaConnect
- Science Citation Index
- Science Direct
- Scopus
- SearchTeam
- SpringerLink

Some of these databases are free while others require subscription for you to access the materials.

3. **Follow the citations**: Once you have identified some relevant journal articles, an easy way to find more studies is by looking through the reference lists of these articles (backward searching). In addition, look at the papers that have cited the articles since they were published (forward searching). This will help you find the newer studies that have built upon the work.

4. **Keep a written record of your searches**: Note down the names of journals that you come across often during your searches. Over time, you will get a good idea of which journals are most prominent in your field and which journals you should consider publishing in. In addition, keep a list of the keywords and keyword combinations that return the best results. This will not only reduce the time taken for future searches but also yield a list of terminologies that are common in your field.

5. **Keeping up with literature:** A large number of databases and publishers provide one or more of the following alerts features: Table-of-Contents (TOC) alerts, citation alerts, and keyword alerts. These alerts are very useful for keeping up with newly published papers and research topics. With many alert services, you receive alerts in the form of emails listing the title and authors of newly published papers, and sometimes even abstracts.

3.3 Literature Review

In research, literature is defined as scholarly publications which have been written on a particular topic, such as journal articles, research reports, government reports, text books, conference proceedings, among others. Review implies the careful selection of literature relevant to your topic and the presentation, interpretation, classification and evaluation of this literature.

When you have identified your credible, up-to-date, accurate information sources, you need to start building up a picture of your subject area and the research that has been done on it.

Literature review is NOT:

1. A summary of previous works - It is not a case of accepting blindly what experts have said and simply summarising it. It is a case of using the information you find to inform and develop your work while applying a critical assessment to the work that other people have done. Literature review is a critical, analytical account of the literature pertaining a research topic. Organised around ideas or arguments
2. An annotated bibliography - In an annotated bibliography the writer presents a summary and critical evaluation of each article or scholarly resource, one by one. There is little or no connection made between the various articles or resources. A literature review is organised around ideas or arguments.
3. An essay -In an essay a student is given a topic to discuss or a question to answer and the writing is organised around responding to that topic or question. The essay progresses in a linear way, where the student presents his/her first point, followed by an explanation which is supported by the literature. The student then moves on to the second point and so on.
4. A presentation of your own argument, but its a synthesis of the arguments of others

In the literature review, you WILL:

- Not answer a question
- Identify a gap in existing knowledge, that is, you will identify what we still need to know about this topic or issue.
- Compare and contrast different authors' views on an issue
- Note areas in which authors are in disagreement
- Highlight gaps
- Identify any particular shortcomings of past research

In this way your literature review becomes a critical discussion of the knowledge or ideas related to your research topic

When reviewing a literture, look specifically for:

a) The key point(s) discussed by the author:

b) What evidence has the author produced to support this central idea?

c) How convincing are the reasons given for the authors point of view?

d) Could the evidence be interpreted in other ways?

e) What is the author's research method (e.g. qualitative, quantitative, experimental, etc.)?

f) What assumptions are made by the author? Are they valid or they can be criticized?

g) Has the author critically evaluated the other literature in the field?

h) Is the research data valid i.e. based on a reliable method and accurate information?

i) What are the strengths and limitations of this study?

j) What does this literature contribute to my own topic or thesis?

The literature review itself, however, does not present new primary scholarly findings.

A literature rview might be:

1. A stand alone review article: Review articles provide an overview of recent research focused on an issue or problem. Review articles are often published in academic journals or as conference proceedings. This:
    - Evaluates and synthesises existing literature related to a specific issue (i.e. shows overlaps and gaps, implications, limitations). In other words, creates a picture about what is known and unknown in the research area.
    - Makes recommendations for further research to address gaps
2. A section or chapter of a research proposal or research report. This:
    - Provides a theoretical context or framework for the research being undertaken.
    - Evaluates and synthesises existing literature related to a research question or objective (i.e. shows key themes, overlaps, gaps, implications, significance, limitations). In other words, creates a picture about what is known and unknown in the research area.
    - Clearly identifies the gap in the body of knowledge that the proposed research will attempt to fill.
    - Provides a rationale or justification for the research being proposed (in a proposal) or reported on (in a research report).

3.3.1 Common Mistakes in Writting Literature Reviews

1. Inadequate introduction: Be sure to incorporate the key theoretical points or integrative theoretical framework early in the literature review by presenting the overall theoretical framework up front and using the remainder of the literature review to flesh it out.

2. Inadequate coverage of evidence: Be sure to describe studies methods and specific results, not just their conclusions.

3. Lack of integration: Be sure to explicitly explain how the procedures and observations of the various studies fit together and relate to your research topic

4. Lack of critical appraisal: Be sure to indicate how strong or how weak the overall evidence is for each main point of your literature review this can be done by providing critiques of groups of studies rather than commenting on each study individually as many studies on the same topic may be subject to similar flaws and criticisms and finally provide a summary as to how strong the evidence is.

5. Blurring assertion and proof: Be sure to distinguish between assertion and evidence, or what you or others argue versus what you or others find.

6. Selective review of rvidence: Be sure to include counterexamples or domains of evidence that may contradict the main conclusions and patterns in the literature to provide a balanced and unbiased review of the relevant literature.

7. Stopping at the present: Be sure to point out unresolved issues and questions, and what needs to be done in future research, perhaps identifying issues that your study will address

3.3.2 Sections of a Literature Review

A literature review should consists of 3 sections:

1. The Introduction - Briefly you tell the reader what topic you are covering and why. Also inform the reader of how you went about the process of conducting the literature review so that the reader can be assured of the rigor of your process.

2. The body - This contains your discussion of sources (what your literature review found). The body of your literature review can be organised in headings and subheadings informed by your readings in a way that best suits your topic:

   (a) Historically/chronologically - if you are looking at the evolution of a concept or practice overtime or evaluating whether a concept from 20 years ago holds up today, then a historical or chronological organization might be appropriate.

(b) Topic or issue (Thematic) - a very common way to organise the literature is according to key topics relating to your topic.

(c) Research questions - some writers organise their literature review around the research questions.

(d) Methodologically - organized as per the methods which can be used.

The body of the literature review is normally presented in paragraphs which are arranged each to cover one idea. Each paragraph should have an opening topic sentence, supporting sentences, concluding sentence.

3. The summary - At the end, you should summarise the main findings of the literature review, highlight the gap in the literature and make a connection between your literature review and your research questions. Avoid direct reference to authors. here

3.3.3 Research Gap

The main purpose of doing a literature review is to identify a gap or gaps in the literature pertaining the topic.

When doing the literature review, be original and you should strive to show clearly how the previous research is conflicting or lacking in some way. This lack is called a "gap, and your research should strive to "fill the gap.

Research gaps are classified into the following:

1. Theory-based gaps: Occurs when a theory or an aspect of a theory has not been investigated thoroughly, or not been tested in a particular way
2. Methodological gap: Occurs when a research design or methodology has not been applied to a particular phenomenon
3. Analytical gap: Occurs when a phenomenon has not been investigated using a particular analytical approach i.e., qualitative vs. quantitative
4. Knowledge-based gap: Most common, occurs when we dont know (enough) about a phenomenon.
5. Relationship-based: Occurs when we know about certain issues or variables well, but are unsure about their relationship

Always ask yourself the following:

- Why is the gap youve identified important?

- How important is the gap youve identified?
- What is the benefit of investigating this particular gap?

Chapter 4

Referencing and Reference Styles

4.1 Why Should you Reference

All academic writing draws on the ideas and findings of other researchers and writers. In your research, you will frequently refer to the opinions and findings of others in order to support the points you make. Whenever you do so, it is essential to include information about the original source in order to:

a) Acknowledge that you have used the words or ideas of another writer. If you do not acknowledge the source of your information, you are plagiarising, i.e. claiming credit for someone elses words or ideas.

b) Show that a statement or argument you have made is supported by evidence and allow readers to assess the validity of that evidence. In other words, you are showing the readers that you have read widely to develop your argument or ideas, and that you have strong evidence to support those ideas.

c) Allow readers to locate/trace the source if they want more information. It is important, therefore, that full and accurate details of each source are given.

d) To enable the reader distinguish your ideas from someone else's.

Providing this information about the source is called referencing or citing.

4.2 Plagiarism

Plagiarism is using someone elses words or ideas as your own. You are plagiarising if, for instance, you quote someones exact words without using quotation marks and including the source of the

quote, or if you re-write another writers ideas in your own words without acknowledging the source of those ideas.

It is important to remember that plagiarism is not simply using another writers words; it is using another writers words or ideas without acknowledging the source.

Plagiarism is a very serious offence in academics since it is considered a form of theft.

Often, students plagiarise accidentally rather than intentionally. You can reduce the risk of unintentionally plagiarising by following a few key steps:

a) Keep full records of the bibliographic details of the sources you consult. If you forget to write down those details while you are taking notes, you might have difficulty finding the source again when it comes time to write your assignment.

b) In your notes, clearly identify information you have quoted and information you have paraphrased. A quote is a passage you have copied exactly from the original source; a paraphrase is a passage that includes ideas from the source that you have written in your own words, sentence structure and style. When you copy the exact words from someone elses writing, always put quotation marks (“) around the words in your notes. Later, when you are writing your assignment, the quotation marks will remind you that those words are not yours.

c) Understand the mechanics of referencing, and always reference whenever you quote or paraphrase

4.3 When to Reference

You should provide the source (ie. provide a reference, or citation) when you:

a) Quote someone elses words (written or spoken), ie. copy the words exactly.

b) Re-word (paraphrase) or refer to someone elses ideas or findings (written or spoken).

c) Use factual data (eg. facts, statistics, information from graphs) or equation from other sources.

d) Reprint a diagram, chart or other illustration.

e) Use someone elses way of organising or presenting information (e.g. a design format, a model).

f) Need to show the reader that you have evidence for a statement or argument you have made.

It is not necessary to provide a reference when:

a) Use general knowledge in the subject area in your own words. At first, it may be difficult for you to judge what is and is not general knowledge in the subject. If in doubt, you are better to play safe and provide a reference.

b) Use general common knowledge in your own words.

c) Use your own knowledge such as your own research findings.

4.4 Referencing Styles/Systems

There are several referencing systems used in academic writing. The way you are required to reference sources in an engineering assignment, for instance, is likely to be different from that required in a history assignment.

However, all systems:

a) show the readers which sources have contributed to, or support, a specific idea or point in your assignment,

b) provide the readers with information about the source you have referred to, so that they can find the source themselves.

All systems provide this information through two basic components:

(1) **An in-text citation**: In the body of the assignment, close to where the source is referred to, there is some information about the source used (or a reference number that directs the reader to a place in the text where that information can be found).

(2) **List of References**: At the end of the assignment, there is a complete list of the sources used, with all the details that will allow the reader to locate each source (i.e. the author, the title, and details about when, where and how the source was published). This is called the References list if it includes only the sources you have cited in the assignment, or the Bibliography if it also includes sources which you consulted but did not directly cite.

The way in which the basic information (i.e. the author, the title, and the publication details) is presented in the body of the text and at the end of the text differs from one referencing system to another.

The following are two broad types of referencing systems:

(1) Parenthetical systems: In this system of referencing, the source information is presented in the text in brackets (parentheses) in form of:

(a) Author-date: The source information usually includes the author and the date of publication in brackets (parentheses). Example; APA (American Psychological Association) style.

(b) Author-page: The source information usually includes the author and the page number(s) in brackets (parentheses). Example; MLA (Modern Language Association) style.

The reference list is presented at the end of the text alphabetically according to the author's name. Example of APA style:

Alcohol abuse is linked to genetic factors (Smith, 1991) as well as to environmental factors (Dwyer, 1992).

(2) Notation systems: In this system of referencing, the source information is presented in the text as a number:

(a) Footnote: A source is referred to, a superscript number (e.g.[1]) is placed in the text. This number refers the reader to a footnote or reference list that provides further information about the source. Example; Chicago style.

(b) Series of numbered references: A source is assigned a number in square brackets [1] in the text. This number refers the reader to a reference list that provides further information about the source. Example; IEEE (Institute for Electrical and Electronics Engineers) style.

The reference list is presented at the end of the text numerically according to the numbers assigned for each source in the text.

Within each system there are a number of variations. These variations are called styles, and the differences between them are usually minor. (Often styles vary only in punctuation.)

No-one expects you to learn all the referencing styles. Even the most experienced academic writers will have a Style Guide on their bookshelves to which they refer frequently.

As a student, you are expected:

(a) to understand the basic principles of referencing

(b) to know which system and style your institution prefers and to follow exactly the guidelines for that style. **IEEE referencing style is recommended for you.**

4.4.1 Guidelines for IEEE Referencing Style

Citing Referencs in the Text

Where a source is referred to within the text of a work it is only necessary to identify the source by a number in square brackets. Once you have numbered the reference use the same number if

it is cited again.

Place bracketed citations within the line of text, before any punctuation, with a space before the first bracket.

a) For a single citation:

This theory was first put forward in 1987 [1].

Scholtz [2] has argued that...

If the authors are more than two, cite the surname of the first author followed by et al. (and others)

Example:

Scholtz et al. [2] has argued that...

b) For multiple citations: When citing more than one source, list each reference number separately with a comma or dash between each reference: E.g. [1], [6], [10] or [1] - [4].

Reference List

The reference list consists of full references to the sources you have used to produce your work. General notes about references include:

(a) References for the sources should be listed in corresponding numerical order at the end of the text. The order of the list should be the same order as references appear in the text.

(b) Your number should appear on the left in square brackets as a hanging indent. The reference itself should be indented.

(c) List of references is not a chapter or section of your work, and is not included in your word count.

(d) Use p. for a single page or pp. for more than one page e.g. p. 5 or pp. 2-6.

(e) If a book/article is written by multiple authors, the first six authors have to be written in the reference lists. After that you put et al. (and others)

(f) Unlike other referencing systems, author initials are quoted before the surname and publication date is listed at the end.

(g) Nothing should appear in your reference list unless it has been cited specifically in the body of your work.

(h) Abbreviate the word edition to ed.

(i) Only put in an edition if there is more than one e.g. 2nd ed. or 3rd ed.

(j) If there is no edition after the title add a full stop, a comma if there is.

(k) Editor(s) are distinguished from authors by adding Ed. as an abbreviation for a single editor and Eds. for multiple editors.

(l) A book reference is cited as follows:

[Ref. No.] Author(s) initials. Family name. Title (in italics), Edition. Place of publication, Publisher, Year of publication, Page numbers.

Example:

[1] R. Pears and G. Shields Eds. *Cite Them Right*, 2nd ed. Hampshire: Palgrave Macmillan, 2013. (for editors with an edition and no page numbers). or

[2] R. Pears and G. Shields, *Cite Them Right*. Hampshire: Palgrave Macmillan, 2013, pp.100-120. (for auhtors, no edition and with page numbers).

(m) A journal article is cited as follows:

[Ref. No.] Author(s) initials. Family name. Title of article (In quotation marks), Title of Journal (In italics - Either spell out the entire name of a journal you reference or use the standard abbreviations.), Volume, Issue number, Page numbers, Month and Year of publication.

Example:

[3] C. Lee, M. Eden and M. Unser, "High-quality image resizing using oblique projection operators", *IEEE Trans. Image Processing*, vol.7, no.5, pp. 679- 692, May 1998.

(n) A conference paper is cited as follows:

[Ref. No.] Author(s) initials. Family name. Title of paper (In quotation marks), Title of Conference (In italics), Date, Page numbers.

Example:

[4] P. A. Reid, "Europpean standardization", *Presented at International Broadcasting Conference*, 1997, pp. 180-187.

(o) A thesis or dissertation is cited as follows:

[Ref. No.] Author(s) initials. Family name. Title of thesis (In quotation marks), Type of qualification, Department, University, Place, Year of Publication.

Example:

[5] A. J. Kennerly, "Miniature microwave filters for cellular telephone handsets", PhD thesis, Department of Electronic and Electrical Engineering, University of Bradford, Bradford, 2002.

(p) An ebook is cited as:

[Ref. No.] Author(s) initials. Family name. Title (in italics). Edition (in brackets), Year Type of medium (in square brackets). DOI or Internet address Date accessed (in square brackets)

Example:

[6] M. E. El-Hawary, *Electric Power Applications of Fuzzy Systems*, 1998 [eBook]. Available: http://www.knovel.com [Accessed: 4 Jun. 2010].

(q) A webpage is cited as follows:

[Ref. No.] Author(s) initials. Family name. (if no author organisation/corporate author instead) Year and month in brackets. Title (in italics). Available: Internet address. Date accessed (in square brackets).

[7] University of Bradford, (2010, April). *School of Engineering, Design and Technology.* Available: http://www.eng.brad.ac.uk [Accessed: 25 May 2010.]

Chapter 5

Writting a Research Proposal

5.1 Introduction

Any research must begin with a clearly focused research proposal.

A good research proposal has become a necessity not only for ensuring a high quality of research but also for the practical reason of landing a research grant.

In order to attract a research grant, a research proposal must be precise and convincing. The readers have to be convinced that you have something there, and that you can do it.

A research proposal is plan that details reasoned, rigorous and systematic inquiry into a topic to justify the need for study.

The proposal gives an indication of your intention for the research, justifying why you are proposing the research, and aims to persuade the reader of the value, feasibility and validity of your research.

A research proposal must demonstrate that:

a) you are engaging in genuine and worthwhile research and that there is a need for the research

b) the research is significant and important, and that it will contribute something original to the field you are working in.

c) the research has been informed by previous research

d) the research has clear aims and objectives

e) you can complete the research in the expected time period

f) the topic aligns with your interests and capabilities, and there are supervisors available who are open to working with you

g) there is enough funding or available equipment to be able to collect the data

h) you have developed suitable and feasible methodological approach to achieve your objectives

Therefore, the three essential ingredients of a research proposal are as shown in Figure 5.1.

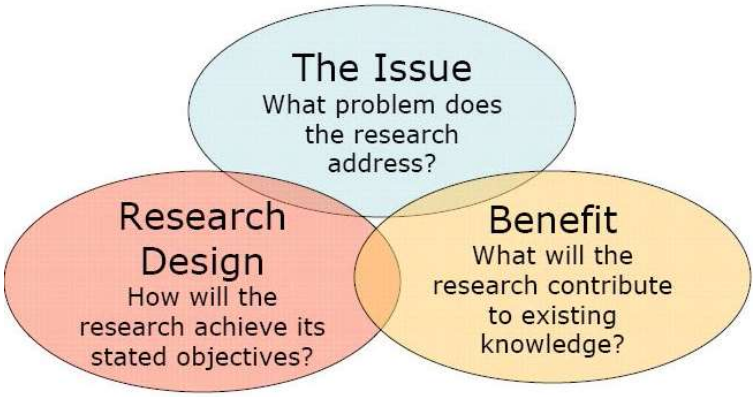

Figure 5.1: Essential ingredients of a research proposal

A research prposal will make you:

a) think through your data collection methods

b) outline the steps in your proposed research

c) justify your research

d) anticipate a realistic timetable

e) anticipate Potential problems

Note that the research proposal you are submitting is not inflexible, and that it will probably change in focus and perhaps substance as you develop your ideas and progress in through the necessary stages of conducting the research.

5.2 Structure of a Research Proposal

A typical research proposal should contain the following:

5.2.1 Title Page

It should contain:

a) your research area through a tentative or proposed title: The title should be clear and unambiguous, its usually refined at the end of writting the proposal

b) your name and supervisors names

c) the institutional or university name, as well as the specific department

d) the degree level being attempted

5.2.2 Table of Contents

A table of contents should:

a) list the research proposal sections and subsections in a hierarchical way, using titles and subtitles

b) give accurate page references for each section

5.2.3 Abstract

The abstract is a brief summary of the entire proposal. A good abstract accurately reflects the content of the proposal, while at the same time being coherent, readable, and concise.

Do not add any information in the abstract that is not previously discussed throughout the proposal.

Because it highlights the entire proposal, it would be wise to wait and write the abstract last. This way, one merely has to reword information that was previously written.

Therefore, the abstract should capture in brief the following:

a) The background of the problem

b) The statement of the problem and the research gaps the research intents to fill

c) The main aim of the proposed research

d) Data acquisition (proposed methodology)

e) What is expected to be achieved at the end of the research

5.2.4 Introduction

This section is usually divided into the following subsections:

(1) Background: This should provide background information that orientates the reader to the researchs general context of the problem. Introduce the topic at hand, and provide a brief definition of the theory from which the study is based.

(2) Problem Statement: In this subsection, inform the reader of the research need and motivation. This is an attempt to convince the reader that the research will be useful, interesting, or significant for the academic community, and may be suggestive of the research 'gap which arises from the literature review. The following questions should be answered: Why does this research study need to be conducted? What specific issues does this study raise that have not been observed in other literature pertaining to the topic? Answering these questions will allow readers to understand why this particular study is important and how the study will attempt to answer new, never-before asked questions.

(3) Objectives: Here, the the purpose of the research is unambiguously and concisely stated. Also the specific aims of the proposed research are outlines. These aims should eb related the main purpose. Each specific aim will require one or more methodologies, and it is always advisable to have these methodologies in mind when you write your specific aims.

5.2.5 Literature Review

The purpose of this section is to:

a) demonstrate to your readers that you have read enough and you have acquired theoretical background to your study and you are aware of up-to-date and important knowledge on your topic.

b) demonstrate to your readers that you have critically reviewed the literature and you have identified the gaps existing and methodologies which can be used to fill these gaps.

At the end of this section, always provide a summary of the identified gaps.

5.2.6 Methodology

This section details the approaches you will use to achieve your specific objectives. As stated earlier, each specific objective should have a methodological approach to achieve it.

It should capture how data will be acquired whether it is a survey, experiment, modeling, observation, secondary data of analysis, etc.

If data will be acquired through experiments, then design and present the experimental set ups for data acquisition.

If data will be acquired through modeling and simulation, then present the governing modeling equations and design simulation flow charts.

Describe also the strategy you intend to use for data analysis. Specify whether the data will be analysed manually or by computer. For computer analysis, identify the program and where appropriate the statistical procedures you plan to perform on the data.

5.2.7 Expected Outcomes

A research proposal does not have a conclusion section, instead present what you anticipate to achieve at the end of the study. The outcomes should be consistent with the outlined spepcific objectives, that is, each specific objective should have corresponding outcome(s).

Also include some paragraphs discussing the significance of the proposed study, such as how the results will affect future research, policy, etc., that is, how the knowledge or results generated by your study will be beneficial to the society. These may be technological, economic or academic benefits.

5.2.8 References

This section should provide a list of the sources or academic works that have been consulted when developing the proposal

It is recommended you use the IEEE refernce style as discussed earlier.

Use Endnote or Jabref softwares for referencing and generation of your references list.

5.2.9 Appendices

This section should provide relevant documents which are best not seen in the main proposal text (because they affect readability).

These may include:

a) Theoretical information and equations which did not appear on the text, but you feel they are important to the reader.

b) Pilot study data.

c) Interview questions and surveys questionnaires.

d) List of equipment required for the research: Indicate those available. In case of an unavailable equipment, indicate how and where you will access it.

e) Budget: Indicate in tabular form the cost implication of your research. Include the estimated costs of what you need to procure and other associated research costs such as; publication costs, acquisition of literature for review, conference costs among others. Clearly indicate if funds will be provided by the school or other source(s) such as project grant funding.

f) Work Schedule: List the various operational steps you need to undertake in your research and indicate against each the date by which you aim to complete that task. Its recommended to use a Gantt chart

5.3 General Guidelines for Writing a Research Proposal

a) Since a research proposal is a short report, use sections instead of chapters

b) Title page should not be page numbered

c) Use Roman page numbers from the Table of Contents to the Abstact

d) Use Arabic page numbers from the Introduction section onwords.

e) Each section should begin on a new page.

f) Text should be justified

g) Text font should be Times New Roman with font size of 12 pts and line spacing of 1.5 through out.

h) Using the text font indicated above, it is recommended that the total page numbers of the body of the proposal (From Introduction to Expected Outcomes) should be between 15-25 pages.

i) Avoid use of too long sentences which affect clarity and makes it hard for the reader to comprehend.

j) Avoid use of too long paragraphs. This is a common problem that makes it harder to read a paper.

k) Avoid a paragraph of one sentense. A paragraph should be a collection of sentenses.

l) Dont use awkward, vague, long-winded, or too informal language. The best writing is concise and to the point.

m) Always ensure you cited your sources each time you express an idea that is not you own.

n) Ensure you utilized the correct style for citing articles or books. I recommend IEEE referencing style.

o) Avoid writing in first person, such as I, We, Our..etc. Always writing using the third person.

p) Too much detail on minor issues, but not enough detail on major issues.

q) Avoid too much rambling – going "all over the map" without a clear sense of direction. (The best proposals move forward with ease and grace like a seamless river.)

r) Use active verbs throughout.

s) Make sure your proposal does not contain any grammatical/spelling mistakes or typos; engage a proofreader.

Chapter 6

Data Collection, Analysis and Presentation

6.1 Introduction

The word data is the plural form of datum and refers to the facts, such as values or measurements, observations or even just descriptions of things which are collected during research.

Data collection is very important in any type of research. Data collection impacts greatly on the research results, and innacurate data collection ultimately leads to invalid results.

Data can be classified into Primary or Secondary Data

(a) **Primary data**: Refers to the data collected by yourself or by your representatives at the source. Are collected afresh and for the first time, and thus happen to be original in character. Primary data is usually current and may be more accurate. However, its more difficult and time/energy consuming to collect.

(b) **Secondary data**: Refers to the existing data which was originally collected. For example, computerized database, company records or archives, publications, etc. Secondary data is less expensive and more easier to collect than primary data. However, it is not current and may be not accurate.

Data can also be either quantitative or qualitative.

Quantitative data is data that is mainly numbers. It refers to the information that is collected as, or can be translated into, numbers, which can then be displayed and analyzed mathematically. On the other hand, qualitative data is data that is mainly words, sounds or images, and it can't always be reduced to something definite. A number may tell you how well a student did on a test; the look on her face after seeing her grade, however, may tell you even more about the effect of that result on her. That look can.t be translated to a number.

6.2 Data Collection in Engineering Research

The methods of collecting primary and secondary data differ since primary data are to be originally collected, while in case of secondary data the nature of data collection work is merely that of compilation.

Primary data can be collected through the following methods:

(a) Questionnaires

(b) Interviews

(c) Experiments

(d) Observations

(e) Simulation

The choice of which method to use depends on the following factors:

(i) Nature, scope and object of research: This constitutes the most important factor affecting the choice of a particular method to use in data collection. The method selected should be such that it suits the type of enquiry that is to be conducted by the researcher.

(ii) Availability of funds: Availability of funds for the research project determines to a large extent the method to be used for the collection of data. When funds at the disposal of the researcher are very limited, he will have to select a comparatively cheaper method which may not be as efficient and effective as some other costly method.

(iii) Availability of facilities and equipment: Experiments involves instrumentation which requires facilities and equipment. If you do not have access to them, the you may settle on other method especially simulation.

(iv) Time factor: Availability of time has also to be taken into account in deciding a particular method of data collection. Some methods take relatively more time, whereas with others the data can be collected in a comparatively shorter duration. The time at the disposal of the researcher, thus, affects the selection of the method by which the data are to be collected.

(v) Precision required: Precision required is yet another important factor to be considered at the time of selecting the method of collection of data.

6.2.1 Questionnaires

A questionnaire is a systematic compilation of questions that are submitted to a sampling of population from which information is desired. It is a device for securing answers to questions by using a form which the respondent will fill by himself.

The questionnaire is mailed to respondents who are expected to read and understand the questions and write down the reply in the space meant for the purpose in the questionnaire itself

The questionnaire is probably most used and most abused of the data gathering devices. It is easy to prepare and to administer.

Normally used where one cannot see personally all of the people from whom he desires responses or where there is no particular reason to see them personally.

Characteristics of a good questionnaire are:

(a) Its significance is carefully stated on the questionnaire itself or on its covering letter.

(b) It seeks only that data which cannot be obtained from the resources like books, reports and records.

(c) It is as short as possible, only long enough to get the essential data.

(d) Directions are clear and complete, important terms are clarified.

(e) The questions are objective, with no clues, hints or suggestions.

(f) Questions are presented in a order from simple to complex.

(g) Double barreled questions or putting two questions in one question are also avoided.

(h) It is easy to tabulate, summarize and interpret.

(i) The questions carry adequate number of alternatives.

Advantages of questionnaire method for data collection are:

(a) Its very economical even when the universe is large and is widely spread geographically.

(b) It is free from the bias of the interviewer; answers are in respondents own words.

(c) Respondents have adequate time to give well thought out answers.

(d) Large samples can be used and thus the results can be made more dependable and reliable.

(e) Respondents, who are not easily approachable, can also be reached conveniently.

Disadvantages of questionnaire method for data collection are:

(a) It can be used only when respondents are educated and cooperating.

(b) The control over questionnaire may be lost once it is sent.

(c) There is also the possibility of ambiguous replies or omission of replies altogether to certain questions;

(d) It is difficult to know whether willing respondents are truly representative.

(e) The method may likely be very slow.

(f) Due to lack of contact with the respondents, chances of receiving incomplete response are more.

6.2.2 Interview Method

Interview is a two way method which permits an exchange of ideas and information orally.

Differences between use of questionnaire and interview methods are:

Questionnaire Method	**Interview Method**
Data is gathered indirectly.	Data is gathered directly.
No face to face contact between two.	There is face to face contact between interviewer and interviewee.
Interviewer should have the general knowledge of the topic.	Skillful interviewer is needed.
We get written information only.	We get written and oral both type of information.

Advantages of interview method for data collection are:

(a) More information and also in greater depth can be obtained.

(b) Non-response is usually low.

(c) The interviewer may catch the informant off-guard and thus may secure the most spontaneous reactions than would be the case if mailed questionnaire is used.

(d) The interviewer can usually control which person(s) will answer the questions. This is not possible in mailed questionnaire approach.

(e) There is greater flexibility under this method as the opportunity to restructure questions is always there.

(f) Interviewer by his own skill can overcome the resistance, if any, of the respondents;

(g) Sincerity, frankness, truthfulness and insight of the interviewee can be better judged through cross questioning.

(h) It can be used when dealing with young children and illiterate persons.

Disadvantages of interview method for data collection are:

(a) It is a very expensive and time consuming method, specially when large and widely spread geographical sample is taken.

(b) The presence of the interviewer on the spot may over-stimulate the respondent, sometimes even to the extent that he may give imaginary information just to make the interview interesting.

6.2.3 Simulation Method

Simulation can be defined as a method for using computer software to model the operation of "real-world processes, systems, or events.

The researcher develops a model of the phenomenon under investigation and then chooses an appropriate simulation method.

The model is run many times under various conditions to observe the outcomes. In a simulation the researcher is experimenting with the model rather than the actual phenomenon.

Simulation involves the following generic steps:

1) **Research problem**: Identify a research problem that is suitable for study by simulation.

2) **Model design**: Model design involves specification of the target to be modelled in the simulation and the selection of an appropriate simulation method. There are a number of different methods from which to choose depending on the problem being investigated. Model design will usually involve some data collection to inform the parameters for the model and the initial conditions for the simulation.

3) **Model building**: The next step is building the simulation model. A number of software programs are now available to support specific simulation methods but if no suitable software package is available you will have to write the program yourself.

4) **Model verification**: Verification involves running the simulation and testing whether or not the model is working as it should. If there any problems with the simulation these should be corrected.

5) **Run the simulation**: Simulations can be thought of as virtual experiments during which you run a series of experiments under different conditions that can be varied as required. Variation allows different assumptions to be tested in order to answer the research questions and also to test the sensitivity of the model to changes in parameters.

6) **Model validation**: Any model developed should be validated. Validation involves confirming that the model is a good representation of the physical phenomenon. Validation can be done by comparing results of the simulation with empirical or experimetal data. Validation can be a challenging process due to the nature of simulation and potential limitations on available empirical data.

7) **Findings and conclusions**: As with other research designs, your findings and conclusions should be formulated in response to the research problem

Model Verification and Validation

One of the most difficult problems facing the simulation analyst is determining whether a simulation model is an accurate representation of the actual system being studied (i.e., whether the model is valid).

If the simulation model is not valid, then any conclusions derived from it is of virtually no value.

Validation and verification are two of the most important steps in any simulation project.

Validation is the process of determining whether the conceptual model is an accurate representation of the actual system being analyzed. Validation deals with building the right model.

Verification is the process of determining whether a simulation computer program works as intended (i.e., debugging the computer program). Verification deals with building the model right.

Consider the simplified version of the model development process shown in Figure 6.1.

- The problem entity is the system (real or proposed), idea, situation, policy, or phenomena to be modeled.
- The conceptual model is the mathematical/logical/verbal representation (mimic) of the problem entity developed for a particular study. The conceptual model is developed through analysis and modeling phase.
- The computerized model is the conceptual model implemented on a computer. The computerized model is developed through a computer programming and implementation phase, and inferences about the problem entity are obtained by conducting computer experiments on the computerized model in the experimentation phase.
- Conceptual model validation is defined as determining that the theories and assumptions underlying the conceptual model are correct and that the model representation of the problem entity is reasonable for the intended purpose of the model.
- Computerized model verification is defined as assuring that the computer programming and implementation of the conceptual model is correct.

- Operational validation is defined as determining that the models output behavior has sufficient accuracy for the models intended purpose over the domain of the models intended applicability.
- Data validity is defined as ensuring that the data necessary for model building, model evaluation and testing, and conducting the model experiments to solve the problem are adequate and correct.

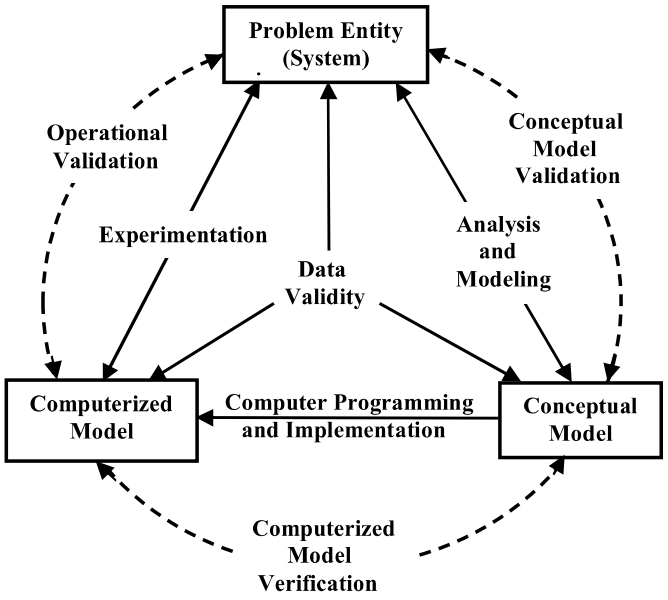

Figure 6.1: Simplified version of the modeling process

Some of the techniques used in verification of simulation models are:

1) Use good programming practice: Write and debug the computer program in modules or subprograms. In general, it is always better to start with a "moderately detailed model, and later detail it, if needed.

2) Use "structured walk-through: Have more than one person to read the computer program.

3) Check simulation output for reasonableness: Run the simulation model for a variety of input scenarios and check to see if the output is reasonable. In some instances, certain measures of performance can be computed exactly and used for comparison.

4) Animate: Using animation, the users see dynamic displays (moving pictures) of the simulated system. Since the users are familiar with the real system, they can detect programming and conceptual errors.

5) Compare final simulation output with analytical results: May verify the simulation response by running a simplified version of the simulation program with a known analytical result. If the results of the simulation do not deviate significantly from the known mean response, the true distributions can then be used.

Some techniques used in validation of simulation models:

1) Develop a model with high face validity: The objective of this step is to develop a model that, on the surface, seems reasonable to people who are familiar with the system under study. This step can be achieved through discussions with system experts, observing the system, or the use of intuition. It is important for the modeler to perform a structured walk-through of the conceptual model before key people to ensure the correctness of models assumptions .

2) Test the assumptions of the model empirically: In this step, the assumptions made in the initial stages of model development are tested quantitatively. For example, if a theoretical distribution has been fitted to some observed data, graphical methods and goodness of fit tests are used to test the adequacy of the fit. Sensitivity analysis can be used to determine if the output of the model significantly changes when an input distribution or when the value of an input variable is changed. If the output is sensitive to some aspect of the model, that aspect of the model must be modeled very carefully.

3) Determine how representative the simulation output data are: The most definitive test of a models validity is determining how closely the simulation output resembles the output from the real system. This can be done experimentally or statistically. Statistical methods are available for comparing the output from the simulation model with those from the real-world system.

4) Comparison to other models: Various results (e.g., outputs) of the simulation model being validated are compared to results of other (valid) models. For example; simple cases of a simulation model are compared to known results of analytical models, and the simulation model is compared to other simulation models that have been validated.

Some of the reasons due to which the models fail the validation tests are

(a) Model-structure - In both the conceptual model and the simulation model, mathematical simplifications might be inadequate for capturing complex dynamics

(b) Numerical solution - The solution of the simulation model might differ dramatically from the ideal solution.

(c) Inappropriate simulation software either too inflexible or too difficult to use

(d) System noise - Failure to recognize random changes which exist in the real system.

(e) Wrong input data used

Disadvandages of simulation include:

(i) Simulation provides only estimates of a solution

(ii) Simulation solves one parameter at a time

(iii) Simulation can take a large amount of development and/or computer time.

(iv) Its very hard to intepret simulation results

Dont use computer simulation if:

(i) An analytical solution is available

(ii) Simulation costs outweigh benefits

(iii) an experiments can easily be conducted

(iv) The real system is too complicated

Simulation method is usually used:

(i) To optimise an existing design

(ii) To verify analytical solutions (theories)

(iii) To test new designs and theories

(iv) When the real system is very complicated, small, big, dangerous or destructive

6.2.4 Experimental Methods

Experiments are performed in almost any field of enquiry and are used to study the performance of processes and systems.

The process is a combination of machines, methods, people and other resources that transforms some input into an output that has one or more observable responses.

Experiments carried out for the purpose of collecting data to be analysed and studied are carried out in the laboratory or in the field.

Laboratory experiments can be standard testing methods, independently developed procedures or laboratory scale model investigations.

- Standard testing methods are based on established standards and are commonly used to test materials and systems to be used in or related to the research. The standard tests are usually used to gather preliminary data on the material to be used in model testing or field experiments. In the case of numerical or computer modelling, data and results from standard laboratory tests can be used as the specific data input for the model. For example,

in a computer structural model, data on material properties such as strength, modulus and dimensions are required. These data has to be established or ready before computer numerical model investigation can proceed

- Scientific research is about discovery of new things, methods, systems or theories. It is almost inevitable that in the course of most experimental research, a researcher will have to come up with one or more independent procedures that can be calibrated and repeated.
- Laboratory scale model is a small scale, physical model of a larger actual or prototype structure or systems. It is constructed in a laboratory and tested under controlled and monitored conditions. The advantages of small scale models can be their benefits in terms of controllable varied loading conditions, observable effect of extreme/failure loading conditions, and the minimum cost of construction

Experiments carried out in the field require careful planning and coordination. In the field, it could be harder to control or to limit the various influences from natural conditions.

Thus, the following factors usually are considered when selecting an experimental method:

- experience in the use of instruments;
- knowledge of calibration methods and awareness of the different errors to which instruments are subject;
- understanding of the relative merits and limitations of alternate instrumentation and their applicability to different experimental situations.

Instrumentation

For you to record data from an experiment, you will need an experimental set up or instrumentation to control, measure and transmit information data during the experimentation.

Typical instrumentations include hardware for transducers and software for data processing and storage.

A transducer is a device that converts a physical parameter sensed by its sensor into an analogue electrical signal. Some common transducers and their applications are described in the following table below.

Transducers	**Description**
Strain gage	This is the most basic form of transducer. It operates on the principle of electrical resistance. It can detect positive or negative strain of the object the gage is bonded to. It can be bonded to metal, concrete, plastic etc. It can be used to construct other type of transducers such as load cell, pressure cell etc.
LDVT (Linear Displacement Variable Transducer)	LDVT can be used to measure displacement or movement of components in the research relative to its position. This is basically an electronic version of a dial gage but with more capabilities because the movement can be detected by computers in a very short time interval.
Load Cell	Load cell is used to measure force in tension or compression. Load cell with low and high range capacity are available for various types of loading.
Pressure cell	This transducer measures fluid pressure.
Temperature transducer/meter	This is usually a stand-alone transducer. But in specific research that requires measurement of temperature or heat continuously, it can be connected to a data logging system.
Accelerometer	Accelerometer measures acceleration with respect to gravity (g). This is commonly used in research related to vibration, earthquake, impact, blast and speed.
Piezometer	Piezometer is used to measure liquid or water pressure underground in the field. It utilizes pneumatic or strain gage systems. Vibrating wire (VW) piezometer is more popular now for pore water pressure.
Sound meter	Measures level of environmental noise
Light meter	Measures light intensity

Transducers described above produce analogue electrical signals that need to be converted to a digital signal for it to be able to be used in digital computer processing. This can be done through the use of specialized hardware and software called a data logger. In some situations, if the analogue signal is too small or too noisy, it has to go through another piece of hardware called an amplifier to be filtered and amplified first.

There are two general classes of data logger. One is the static data logger and the other one is the dynamic data logger. The choice of use depends on the type and quality of data required. If the required data is very sensitive to time such as impact, vibration and other high-speed phenomena, the dynamic data logger is required. The static data logger is sufficient for tests such as load, pressure and temperature tests. The data capture interval for a static data logger is usually only up to one second interval.

Characteristics of measurement systems:

1. Accuracy: It is the degree of closeness with which the reading approaches the true value of the quantity to be measured.

2. Sensitivity: The sensitivity denotes the smallest change in the measured variable to which the instrument responds. It is defined as the ratio of the changes in the output of an instrument to a change in the value of the quantity to be measured. Thus, if the calibration

curve is linear, the sensitivity of the instrument is the slope of the calibration curve. If the calibration curve is not linear as shown, then the sensitivity varies with the input.

3. Reproducibility: It is the degree of closeness with which a given value may be repeatedly measured. It is specified in terms of scale readings over a given period of time.

4. Repeatability: Repeatability is used for expressing the precision of an instrument and is defined the ability of a measuring instrument to give identical indications, or responses, for repeated applications of the same value of the measured quantity under the same conditions of use.

5. Resolution: If the input is slowly increased from some arbitrary value, it will again be found that output does not change at all until a certain increment is exceeded. This increment is called resolution.

6. Threshold: If the instrument input is increased very gradually from zero there will be some minimum value below which no output change can be detected. This minimum value defines the threshold of the instrument.

7. Stability: It is the ability of an instrument to retain its performance throughout its specified operating life.

8. Tolerance: The maximum allowable error in the measurement is specified in terms of some value which is called tolerance.

9. Range or span: The minimum & maximum values of a quantity for which an instrument is designed to measure is called its range or span.

10. Speed of response: It is defined as the rapidity with which a measurement system responds to changes in the measured quantity.

11. Measuring lag: It is the retardation or delay in the response of a measurement system to changes in the measured quantity.

12. Dynamic error: It is the difference between the true value of the quantity changing with time & the value indicated by the measurement system if no static error is assumed. It is also called measurement error.

Disadvantages of experimental methods include:

(a) Colleced dat highly subjective due to the possibility of human error

(b) It is a time-consuming process.

(c)

Research process: Hypothesis

Definition:

- a logically conjectured *relationship* between two or more *variables* expressed in the form of a testable statement.

- Relates an **independent** variable to a **dependent** variable.

- Hypothesis must contain *at least* one independent variable and one dependent variable.

- They are **tentative, intelligent guesses/assumptions** as to the solution of the problem

Research process: Hypothesis

Definition:

Examples	
Public enterprises are more suited for centralized planning".	
Families with higher incomes spend more on recreation	
H_0: There is no relationship between a family's income and expenditure on recreation	
H_A: There is a definite relationship between family's income and expenditure on recreation	

Research process: Hypothesis

Advantage of working with hypothesis:

They delimit the area of research and keep the researcher on the right track

Research process: Hypothesis

Variables:

- Anything that can take on differing or changing values

Examples:
Age, Production units, Absenteeism, Sex, Motivation, Income, Height, Weight etc.

Values can differ at various times for the same object or person (or) at the same time for different objects or persons.

Research process: Hypothesis

Attributes:

A specific value on a variable (qualitative).

For example:

- The variable SEX/GENDER has 2 attributes - Male and Female.

- The variable AGREEMENT has 5 attributes – Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree

Research process: Hypothesis

Types of variables:

Dependant vs Independent Variable

Independent: Variable whose change results in the change in another variable

Dependent: Variable that changes in relationship to changes in another variable(s)

Explanatory vs Extraneous Variable

Explanatory: Variables selected for analysis

Extraneous: All other variables that are not related to the purpose of the study but may affect the dependent variable.

Research process: Hypothesis

Characteristics of a hypothesis:

- *Conceptual Clarity* - It should be clear and precise.
- *Specificity* - It should be specific and limited in scope.
- *Consistency* - It should be consistent with the objectives of research.
- *Testability* - It should be capable of being tested.
- *Expectancy* - It should state the expected relationships between variables.

Research process: Hypothesis

Characteristics of a hypothesis:

- *Simplicity* - It should be stated as far as possible in simple terms.
- *Objectivity* - It should not include value judgments, relative terms or any *moral preaching*.
- *Theoretical Relevance* - It should be consistent with a substantial body of established or known facts or existing theory.
- *Availability of Techniques* – Statistical methods should be available for testing the proposed hypothesis

Research process: Hypothesis

Sources of hypothesis:

- Discussions with colleagues and experts about the problem, its origin and objectives in seeking a solution.
- Examination of data and records for possible trends, peculiarities.
- Review of similar studies.
- Exploratory personal investigation / Observation.
- Logical deduction from the existing theory.
- Continuity of research.
- Intuition and personal experience.

Research process: Hypothesis

Types of Hypothesis:

1. **Descriptive**
2. **Relational**
3. **Null (Ho or H_0)**
4. **Alternative (H_A or H1)**

Descriptive	Relational	Null	Alternative
Assumptions that describe the characteristics of a variable. The variable may be an object, person, organization, situation or event. (e.g. size, form or distribution)	Assumptions that describe the relationship between two variables. The relationship suggested may be positive, negative or causal relationship.	A Negatively stated hypothesis. It is a **'no difference', 'no relationship'** hypothesis. It states that no relationship exists between the Variables/parameter/statistic being compared. It is usually represented as H_O or H_0.	Describes the researcher's prediction that, there exist a relationship between two variables It is the opposite of null hypothesis. Directional vs. non-directional It is represented as H_A or H_1.
Public enterprises are more suited for centralized planning".	*Families with higher incomes spend more on recreation*	*H_0: There is no relationship between a family's income and expenditure on recreation*	*H_A: There is a definite relationship between family's income and expenditure on recreation.*