Research Methodology and IPR

Module 1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.
Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration.

1.1 What is Research ?

D. Shlesinger and M. Stephenson in the Encyclopedia of Social Sciences define research as "the manipulation of things, concepts or symbols for the purpose of generalizing to extend, correct or verify knowledge, whether that knowledge aids in construction of theory or in the practice of an art. Research is, thus, an original contribution to the existing stock of knowledge making for its advancement. It is the pursuit of truth with the help of study, observation, comparison and experiment. In short, the search for knowledge through objective and systematic method of finding solution to a problem is research.

1.2 Objective of Research

1. To gain familiarity with a phenomenon or to achieve new insights into it (studies with this object in view are termed as exploratory or formulative research studies);

2. To portray accurately the characteristics of a particular individual, situation or a group (studies with this object in view are known as descriptive research studies);

3. To determine the frequency with which something occurs or with which it is associated with something else (studies with this object in view are known as diagnostic research studies);

4. To test a hypothesis of a causal relationship between variables (such studies are known as hypothesis-testing research studies)

1.3 Motivation for research

What is motivation ?

There are two major approaches to motivation:

- Extrinsic views (behaviorist approach)—people are motivated by external rewards and punishments; this is also called the carrot and stick approach.
- Intrinsic views (cognitive or humanist approach)—people are motivated by internal capacities, such as aspirations, perceptions, attitudes, or thoughts that can be motivating or demotivating.

Following are some of the motivations for research

- Desire to get a research degree
- Desire to face the challenge in solving the unsolved problems

- Desire to get intellectual joy of doing some creative work
- Desire to be of service to society;
- Desire to get respectability.

1.4 Types of research

1.4.1 Descriptive research

A descriptive approach to research is called as a foundation for research. Its logic is based on the statistics of the research analysis. So, the descriptive research can't take into account the validity of the research results. Descriptive research refers to research that provides an accurate portrayal of characteristics of a particular individual, situation, or group. Descriptive research, also known as statistical research. In short descriptive research deals with everything that can be counted and studied, which has an impact of the lives of the people it deals with.

- How Many children are affected by polio?
- How fast will covid spread?

Only report what has happened.

- **Observation Method**
- **Case Study Method**
- **Survey Method**

Advantages:

- The people or individual studied are unaware so they act naturally or as they usually do in everyday situation;
- It is less expensive and time consuming than quantitative experiments;
- Collects a large amount of notes for detailed studying;
- As it is used to describe and not make any conclusions , it is used to start the research with it;

Disadvantages:

- Descriptive research requires more skills.
- Does not identify cause behind a phenomenon
- Response rate is low in this research.
- Results of this research can change over the period of time.

1.4.2 Analytical Research

In analytical research the researcher has to analyze and give reasons to available facts and make a critical evaluation.

- Answers – Why it is? Cause – Effect

✓ Regression Analysis approach

✓ Grouping Analysis approach

✓ Multiple Equation Methods

1.4.3 3. Fundamental or Basic-Pure Research

Knowledge for knowledge sake. No particular application in mind. It is driven by a scientist's curiosity or interest in a scientific question. The main motivation is to expand man's knowledge, not to create or invent something. There is no obvious commercial value to the discoveries that result from basic research. Perceived as waste by some. But Foundation for all applied research

- ✓ How did the universe begin?
- ✓ What are protons, neutrons, and electrons composed of?

1.4.4 . Applied research

Also original research but directed towards a practical objective. It refers to scientific study and research that seeks to solve practical problems. Applied research is used to find solutions to everyday problems, cure illness, and develop innovative technologies, rather than to acquire knowledge for knowledge's sake .

- ❖ Fertilizer to Improve agricultural crop production
- ❖ Vaccine for covid
- ❖ Material to improve efficiency of solar panels

1.4.5 Qualitative Research

It is used to gain an understanding of underlying reasons, opinions, and motivations. It provides insights into the problem or helps to develop ideas or hypotheses for potential quantitative research. Qualitative Research is also used to uncover trends in thought and opinions, and dive deeper into the problem. This type of research aims at discovering the underlying motives and desires, using in depth interviews for the purpose. Other techniques of such research are word association tests, sentence completion tests, story completion tests and similar other projective techniques. Qualitative research is especially important in the behavioral sciences where the aim is to discover the underlying motives of human behavior. It is difficult.

Advantages

- ➢ It enables more complex aspects of a persons experience to be studied
- ➢ Fewer restriction or assumptions are placed on the data to be collected.
- ➢ Not everything can be quantified, or quantified easily, Individuals can be studied in more depth
- ➢ Good for exploratory research and hypothesis generation
- ➢ The participants are able to provide data in their own words and in their own way

Disadvantages

- It is more difficult to determine the validity and reliability of linguistic data there is more subjectivity involved in analyzing the data.
- "Data overload" – open-ended questions can sometimes create lots of data, which can take along time to analyse!

- Time consuming

1.4.6 Quantitative Research

Quantitative research is the process of collecting and analyzing numerical data to describe, predict, or control variables of interest. This type of research helps in testing the causal relationships between variables, making predictions, and generalizing results to wider populations. The objective of quantitative research is to develop and employ mathematical models, theories, and hypotheses pertaining to phenomena. The process of measurement is central to quantitative research because it provides the fundamental connection between empirical observation and mathematical expression of quantitative relationships. Qualitative research produces information only on the particular cases studied, and any more general conclusions are only hypotheses.

Advantages

- ❖ Quantitative research allows the researcher to measure and analyse data.
- ❖ The researcher is more objective about the findings of the research.
- ❖ Quantitative research can be used to test hypotheses in experiments because of its ability to measure data using statistics.

Disadvantages

- ➢ The main disadvantage of quantitative research is the context of the study or experiment is ignored.
- ➢ Quantitative research does not study things in a natural setting or discuss the meaning things have for different people.
- ➢ A large sample of the population must be studied for more accurate results

1.4.7 Correlational research

It refers to the systematic investigation or statistical study of relationships among two or more variables, without necessarily determining cause and effect. It Seeks to establish a relation / association / correlation between two or more variables that do not readily lend themselves to experimental manipulation

For example, to test the hypothesis " Listening to music lowers blood pressure levels" there are two ways of conducting research

- **Experimental –** group samples and make one group listen to music and then compare the BP levels
- **Survey** – ask people how they feel ? How often they listen? And then compare
- ***Advantages:***
- 1) Can collect much information from many subjects at one time.
- 2) Can study a wide range of variables and their interrelations.
- 3) Study variables that are not easily produced in the laboratory.

- ***Disadvantages:***
- 1) Correlation does not indicate causation(cause and effect).
- 2) Problems with self-report method

1.4.8 Ethnographic research

It refers to the investigation of a culture through an in-depth study of the members of the culture; it involves the systematic collection, description, and analysis of data for development of theories of cultural behaviour.

- It studies people, ethnic groups and other ethnic formations, their ethno genesis, composition, resettlement, social welfare characteristics, as well as their material and spiritual culture.
- Data collection is often done through participant observation, interviews, questionnaires, etc.
- The purpose of ethnographic research is to attempt to understand what is happening naturally in the setting and to interpret the data gathered to see what implications could be formed from the data.

1.4.9 Experimental research

It is an objective, systematic, controlled investigation for the purpose of predicting and controlling phenomena and examining probability and causality among selected variables.

Advantages

- Best establishes cause-and-effect relationships

Disadvantages

- Artificiality
- Feasibility
- Unethical

Most engineering research is experimental.

Here there are normally two variables(Independent versus Dependent variables).

The IV is the predictor variable whereas the DV is the outcome variable.

Researchers manipulate and control the IV to study it's effect on the DV.

The two groups of participants (Control versus Experimental group).

Before beginning the experiment, the researcher (randomly) assigns his/her sample to two different groups: the control group and the experimental (treatment group or clinical group).

The control group receives no manipulation of the IV (no treatment), whereas the experimental group receives the manipulation of the IV.

1.4.10 Exploratory Research

Exploratory research is a methodology approach that investigates research questions that have not previously been studied in depth. Exploratory research is often qualitative and primary in nature. However, a study with a large sample conducted in an exploratory manner can be quantitative as well. It is also often referred to as interpretive research or a grounded theory approach due to its flexible and open-ended nature. You can use this type of research if you have a general idea or a specific question that you want to study but there is no preexisting knowledge or paradigm with which to study it.

Eg : A company wants to understand why people abandon their online shopping carts. They might conduct in-depth interviews with shoppers to explore various reasons and motivations.

1.5 Research Approaches

Two approaches

- Quantitative Approach
- Qualitative Approach

1.5.1 Quantitative Approach involves the generation of data in quantitative form which can be subjected to rigorous quantitative analysis in a formal and rigid fashion. This approach can be further sub-classified into inferential, experimental and simulation approaches to research.

Inferential Approach : Form a data base from which to infer characteristics or relationships of population. This usually means survey research where a sample of population is studied (questioned or observed) to determine its characteristics, and it is then inferred that the population has the same characteristics.

Experimental approach is characterized by much greater control over the research environment and in this case some variables are manipulated to observe their effect on other variables.

Simulation approach involves the construction of an artificial environment within which relevant information and data can be generated. This permits an observation of the dynamic behavior of a system (or its sub-system) under controlled conditions.

Numerical model, Software model say using MATLAB, etc. Helps also in predicting future behavior

1.5.2 Qualitative approach to research is concerned with subjective assessment of attitudes, opinions and behavior. Research in such a situation is a function of researcher's insights and impressions. Such an approach to research generates results either in non-quantitative form or in the form which are not subjected to rigorous quantitative analysis. Generally, the techniques of focus group interviews, projective techniques and depth interviews are used.

1.6 Significance of Research

- Make progress possible.
- Inculcates scientific and inductive thinking.
- Promotes the development of logical habits of thinking and organization.

- Solve operational problems.
- Aid to economic policy
- Necessary with regard to the allocation of nation's resources
- Market research - efficient policies for purchasing, production and sales.
- Operations research - application of mathematical, logical and analytical techniques to the solution of business problems of cost minimization or of profit maximization
- Social research - studying social relationships and in seeking answers to various social problems.
- Clinical and Medical research – Diagnosis, treatment, medicine, quality of life

1.7Significance of research for various stakeholders

* **Students** - career or a way to attain a high position in the social structure;

* Professionals in research methodology-a source of livelihood;

* **Philosophers and thinkers** - the outlet for new ideas and insights;

* **Literary men and women-** the development of new styles and creative work;

***Analysts and intellectuals** - generalizations of new theories.

Thus, research is the fountain of knowledge for the sake of knowledge and an important source of providing guidelines for solving different business, governmental and social problems.

1.8 Techniques , Methods and Methodology

Research method – What you want to do?

Research technique – how you want to do it?

Generally, the two are together called Research method. Three groups.

- Include those methods which are concerned with the collection of data. These methods will be used where the data already available are not sufficient to arrive at the required solution;
- The second group consists of those statistical techniques which are used for establishing relationships between the data and the unknowns
- The third group consists of those methods which are used to evaluate the accuracy of the results obtain (2&3 are analytical methods)

Research methodology is a systematic way of finding the solution to the problem being studied. We need to know when to use a particular model or technique, if it is relevant. It is a breakdown of the process of research into steps. In each step determine the model/technique you will use. So, the methodology has to be designed by the researcher and is unique to the problem on hand. It is a specific plan of action. Research method is a part of research methodology.

Scientific method – Pursuit of truth. Attempts to achieve "this ideal by experimentation, observation, logical arguments from accepted postulates and a combination of these three in varying proportions."

The scientific method is, thus, based on certain basic postulates which can be stated as under:

1. It relies on empirical evidence;

2. It utilizes relevant concepts;

3. It is committed to only objective considerations;

4. It presupposes ethical neutrality; it aims at nothing but making only adequate and correct statements about population objects;

5. It results into probabilistic predictions;

6. Its methodology is made known to all concerned for critical scrutiny are for use in testing the conclusions through replication;

7. It aims at formulating most general axioms or what can be termed as scientific theories.

Scientific method implies an objective, logical and systematic method; a method free from personal bias or prejudice, a method to ascertain demonstrable qualities of a phenomenon capable of being verified, a method wherein the researcher is guided by the rules of logical reasoning, a method wherein the investigation proceeds in an orderly manner and a method that implies internal consistency.

1.9 Importance of knowing research methodology

A sound methodology helps in

- Gathering material
- Data collection
- Field work and experimentation
- Statistics
- Data analysis
- Interpretation
- Documentation

1.10 Steps in Research

Step 1 – Identify the research problem

The first step involves identifying the issues or questions that need to be answered. Researchers spend a considerable amount of time defining problems clearly and precisely. This involves asking questions such as the following:

- ✓ What is the nature of the problem?

- ✓ What are the key variables involved?
- ✓ Who or what will be affected by this research?
- ✓ Is the problem relevant – Objectivity and validity ?
- ✓ What is currently unknown or not well understood in your field?
- ✓ What real-world challenges or inefficiencies could be addressed?

Step 2: Extensive literature review

A literature review involves examining previous research to understand the context and background of your topic. This step helps ensure that you are building on existing knowledge rather than duplicating past work.

- ❖ Identify key theories, concepts, and frameworks related to your research.
- ❖ Highlight gaps or inconsistencies in previous studies that your research could address.
- ❖ Evaluate the methods and findings of existing studies to inform your research design.

Step 3 : Develop a hypothesis

Formulating a hypothesis – a statement that predicts the research outcome. A hypothesis is an educated guess about the relationships between variables and guides the research design and analysis. It should be:

- ✓ Clear and concise.
- ✓ Testable with the data and methods chosen.
- ✓ Based on existing theory and research.

You can formulate it with help of peers, colleagues, past records, similar research, discussion with stakeholders.

Step 4 : Research Design

(i) Provides means of obtaining the information;

(ii) availability and skills of the researcher and team(if any);

(iii) explanation of the way in which selected means of obtaining information will be organized and the reasoning leading to the selection;

(iv) the time available for research; and

(v) the cost factor relating to research, i.e., the finance available for the purpose

It involves

- ➢ The research methodology (qualitative, quantitative, or mixed methods).
- ➢ The design of the study (experimental, correlational, survey, etc.).
- ➢ The sample size and sampling method.

- The tools and techniques for data collection (surveys, interviews, experiments, etc.).
- A robust research design is crucial for obtaining reliable and valid results.

Step 5 : Data Collection

Researchers collect the data to be used in the study. This step is critical and must be done carefully to avoid bias and errors. Data collection can involve:

- ✓ Conducting experiments.
- ✓ Administering surveys or questionnaires.
- ✓ Performing observations.
- ✓ Reviewing records or existing databases.
- ✓ The quality of the research findings heavily relies on the accuracy and integrity of the data collected.

Step 6 : Analysing data

Analyze it to see if it supports or contradicts their hypothesis. This step involves using statistical tools and techniques to make sense of the data. Researchers need to:

- Process and organize the data for analysis.
- Use statistical methods to test the hypothesis.
- Interpret the results in the context of the research questions and the existing literature.
- This analysis helps to draw meaningful conclusions about the research question.
- Raw Data must be must be classified into meaningful groups
- Coding – Transform into symbols
- Editing – data cleansing
- Tabulation
- Look for difference in results due to sampling Population
- Statistical measures

Step 7 : Conclusions

The final step in the research process is summarizing the findings and drawing conclusions. This involves:

- ✓ Discuss how the results relate to the hypothesis and research questions.
- ✓ Considering the implications of the findings for theory, practice, and future research.
- ✓ Identify any limitations of the study and suggest areas for further research.
- ✓ Report and documentation

1.11 Criterion of good research

- Clearly defined problem
- Research design should be objective
- Detailed design to be described for repeatability
- Validity and reliability of data
- Analysis should be adequate
- Conclusions should be in line with data
- Report any flaws or assumptions in procedure
- Researcher has confidence and integrity

Good research is

1. Systematic : Research process elaborated in steps, in proper sequence in accordance to rules. Gives room for creativity but not guessing and intuition
2. Logical : Governed by logical reasoning of induction/ deduction/ abduction
3. Empirical : related basically to one or more aspects of a real situation and deals with concrete data that provides a basis for external validity to research results.
4. Replicable: Verifiable, repeatable. Gives validity

1.12 Problems of researchers in India

1. Lack of training in research methodology
2. Insufficient interaction between academics, research institutions and government organizations. So lot of data is unavailable.
3. Industries do not trust researchers and so hesitate to provide data
4. Duplication of work due to lack of interaction
5. Lack of proper code of conduct
6. Lack of secretarial assistance
7. Libraries are not technology oriented
8. Timely availability of data
9. Problem of data collection

1.13 Defining a Research Problem

It's a problem – theoretical or practical a researcher has identified and wants to solve. It involves a group or organization, with a certain number of controlled variables, existing in an environment. Now if a number of actions are possible on the controlled variables, and each action produces a unique outcome, then the research problem involves in identifying the best outcome and the action that results in it.

So, the research problem has

- ✓ A group or organization with some problem
- ✓ There is an environment where the problem exists
- ✓ They have a specific objective
- ✓ There are atleast two courses of action
- ✓ The researcher finds out the outcomes of each course and chooses the best alternative

Selection of research problem

- ❖ Area which already has lot of research should be avoided
- ❖ Controversial subjects to be avoided
- ❖ Should not be too narrow or vague
- ❖ Researcher should be familiar with subject
- ❖ Possesses necessary skills to conduct research
- ❖ Is adequate budget, support available
- ❖ Proper pre study to be conducted

Necessity of defining a problem

- ❖ Problem must be clearly stated to identify relevant data .
- ❖ Will enable researcher to be on track
- ❖ Pre requisite for any research

1.14 Technique to define problem

1. Stating the problem in a broad way. Thorough understanding, pilot survey

- Monitoring of solar roof top panels

2. Understanding the nature of the problem

    - What are the different types of panels? What are parameters to be monitored? Why ? Environment where these are used?

3. Survey available literature

    - What techniques are available for monitoring? Their drawbacks.

4. Develop ideas through interactions and discussions

- Interact with manufacturers, users, technicians etc.

5. Rephrase problem

- Build a monitoring system using IoT to identify faults and pollution

In defining problem

- Should state assumptions
- Define glossary
- Define why problem is chosen . Its importance
- Time period of data validity
- Scop of the problem and its limitations

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