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RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS

MODULE-3

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Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs case of Exploratory research studies, case of descriptive and diagnostic research, case of hypothesis -testing , Basic Principles of Experimental Designs, Important Experimental Designs.

Results and Analysis: Importance and scientific methodology in recording results, importance of negative results, different ways of recording, industrial requirement, artifacts versus true results, types of analysis (analytical, objective, subjective), outcome as new idea, hypothesis, concept, theory, model etc.

Introduction:

Research Design:

Meaning of Research Design: The most important step after defining the research problem is preparing the design of the research project, which is popularly known as the research design. A research design helps to decide upon issues like what, when, where, how much, by what means etc.

Thus, research design provides an outline of what the researcher is going to do in terms of framing the hypothesis, its operational implications and the final data analysis.

Specifically, the research design highlights decisions which include:

1. The nature of the study
2. The purpose of the study
3. The location where the study would be conducted
4. The nature of data required
5. From where the required data can be collected
6. What time period the study would cover
7. The type of sample design that would be used
8. The techniques of data collection that would be used
9. The methods of data analysis that would be adopted and
10. The manner in which the report would be prepared

Features of a Good Design:

The important features of Research Design may be outlined as follows:

i. It constitutes a plan that identifies the types and sources of information required for the Research problem
ii. It constitutes a strategy that specifies the methods of data collection and analysis which would be adopted and
iii. It also specifies the time period of research and monetary budget involved in conducting the study, which comprise the two major constraints of undertaking any research

Important Concepts Relating to Research Design:

Dependent and independent variables

For example, if demand depends upon price, then demand is a dependent variable, while price is the independent variable.

Extraneous variables:

The independent variables which are not directly related to the purpose of the study but affect the dependent variables, are known as extraneous variables.

> For instance, assume that a researcher wants to test the hypothesis that there is a relationship between children's school performance and their self-confidence, in which case the latter is an independent variable and the former, a dependent variable.

Confounded relationship: The relationship between the dependent and independent variables is said to be confounded by an extraneous variable, when the dependent variable is not free from its effects.

Research hypothesis:

When a prediction or a hypothesized relationship is tested by adopting scientific methods, it is known as research hypothesis.

Experimental and non-experimental hypothesis testing research

When the objective of a research is to test a research hypothesis, it is known as hypothesis testing research. Such research may be experimental design or nonexperimental design. The research in which the independent variable is manipulated is known as experimental hypothesis-testing research‘, whereas the research in which the independent Variable is not manipulated is termed as ‘non- experimental hypothesis- testing research‘.

Experimental and control groups

When a group is exposed to usual conditions in an experimental hypothesis-testing research, it is known as ‘control group‘. On the other hand, when the group is exposed to certain new or special condition, it is known as an ‘experimental group‘.

Treatments

Treatments refer to the different conditions to which the experimental and control groups are subject to.

Experiment:

Experiment refers to the process of verifying the truth of a statistical hypothesis relating to a given research problem.

Experimental unit(s)

Experimental units refer to the pre-determined plots, characteristics or the blocks, to which different treatments are applied.

Different Research Designs:

Types of research design: There are different types of research designs.

(1) Exploratory research design
(2) Descriptive and diagnostic research design
(3) Hypothesis-testing research design.

The Exploratory Research Design is known as formulative research design. The main objective of using such a research design is to formulate a research problem for an in-depth or more precise investigation, or for developing a working hypothesis from an operational aspect. The major purpose of such studies is the discovery of ideas and insights.

Descriptive and diagnostic research design: A Descriptive Research Design is concerned with describing the characteristics of a particular individual or a group. Meanwhile, a diagnostic research design determines the frequency with which a variable occurs or its relationship with another variable.

Hypothesis-Testing research design: Hypothesis-Testing Research Designs are those in which the researcher tests the hypothesis of causal relationship between two or more variables. These studies require procedures that would not only decrease bias and enhance reliability, but also facilitate deriving inferences about the causality

Basic Principles of Experimental Designs : Professor Fisher has enumerated three principles of experimental designs:

(1) **the Principle of Replication**-the experiment should be repeated more than once. Thus, each treatment is applied in many experimental units instead of one. By doing so the statistical accuracy of the experiments is increased.

(1) **the Principle of Randomization**- The Principle of Randomization provides protection, when we conduct an experiment, against the effect of extraneous factors by randomization. In other words, this principle indicates that we should design or plan the experiment in such a way that the variations caused by extraneous factors can all be combined under the general heading of "chance."

Principle of Local Control- the extraneous factor, the known source of variability, is made to vary deliberately over as wide a range as necessary and this needs to be done in such a way that the variability it causes can be measured and hence eliminated from the experimental error.

Results and Analysis: **Importance and scientific methodology in recording results, importance of negative results, different ways of recording, industrial requirement, artifacts versus true results, types of analysis (analytical, objective, subjective), outcome as new idea, hypothesis, concept, theory, model etc.**

Importance of Recording Results in Scientific Research

Imagine you're baking a cake, and you want to get the recipe. You carefully measure each ingredient, write down the baking time, and note the temperature of the oven. If you don’t write it down, you might forget what worked well and what didn’t the next time you try.

In science, it's similar: recording results means keeping a detailed log of what you did and what happened so that you can replicate the experiment or share it with others.

Biology: A scientist is studying the effect of light on plant growth. They records the plant height every 3 days for two weeks. This data will help them analyze if light exposure influences the plant's growth rate.

Scientific Methodology in Recording Results

we are studying the effect of different types of fertilizer on the growth rate of tomato plants.

Step 1: Observation and Question

You observe that plants in your garden grow faster when fertilized, but you're unsure whether the type of fertilizer really makes a difference.

Does the type of fertilizer affect the growth rate of tomato plants

Step 2: Hypothesis

You form a hypothesis based on prior knowledge or observations. A hypothesis is an educated guess that can be tested.

Hypothesis: Tomato plants will grow faster when fertilized with organic fertilizer compared to synthetic fertilizer.

Step 3: Experimentation

You design an experiment to test your hypothesis. In this case, you'll use different types of fertilizer on tomato plants and record the growth.

Variables:

Independent Variable: The type of fertilizer (organic, synthetic, no fertilizer as a control).

Dependent Variable: The growth of the tomato plants, measured by plant height and number of leaves.

Controlled Variables: The amount of water, amount of sunlight, and the type of tomato plant.

Importance of Negative Results

We are testing whether a plant grows better in water with a certain chemical added. After a few weeks, the plants with the chemical are stunted and unhealthy.

Negative results show what doesn't work, and that's just as valuable as what does. It saves time and resources by pointing out paths that don't lead to success.

Example:

Experiment: we test a new type of fertilizer on two groups of plants—one with the fertilizer and one without.

Negative Result: The plants with the fertilizer don't grow as well as the control group. Even though you didn't get the expected result, this negative outcome tells you that the fertilizer isn't effective, and you can try something else.

Different Ways of Recording Results

There are many ways to record data, depending on what you're studying. Some experiments need numbers, while others might require descriptions.

Examples:

Quantitative Data (Numbers): If you measure how much water a plant needs each day, you might record the amount of water in milliliters for each plant.

Example: "Plant A needed 150 mL of water on day 1, 160 mL on day 2..."

Qualitative Data (Descriptions): If you are studying the behavior of birds in a park, you might write detailed notes about what they're doing.

Example: "The birds are mostly pecking at the ground during the morning hours and flying in groups at midday."

1. Tables

* Organize data into rows and columns.
* Useful for comparing values.
* Tools: Hand-drawn, Excel, Google Sheets.

2. Charts and Graphs

* Visual display of data.
* Types: Bar chart, line graph, pie chart, histogram.
* Helps identify patterns and trends.

3. Written Descriptions

* Use words to describe observations or outcomes.
* Good for qualitative data.
* Example: “The water turned blue after mixing.”

4. Tally Charts

* Record counts using tally marks.
* Quick and easy for frequency data.
* Often used in surveys or simple data collection

5. Numbered Lists

* Step-by-step recording.
* Good for processes or sequential data.
* Example: Steps in an experiment.

6. Photographs or Diagrams

* Visual record of setups or results.
* Useful for showing changes or outcomes.
* Example: Growth of a plant over time.

7. Videos or Audio Recordings

- Capture real-time results or observations.
- Useful in behavioral studies or interviews.

8. Spreadsheets or Databases

* Store and analyze large amounts of data.

* Tools: Excel, Google Sheets, Microsoft Access.

9. Logbooks or Journals

* Daily or regular entries to track progress.

* Useful for long-term projects or experiments.

Industrial Requirements in Recording Results

Industries like pharmaceuticals or food production have strict rules about how data must be recorded because it impacts product safety, quality, and regulation.

Example:

Pharmaceutical Industry: When developing a new drug, the FDA (Food and Drug Administration) requires exact records on how the drug was tested, what doses were given, and what results were observed. If something goes wrong with the drug later, these records can help identify what happened.

Food Industry: A factory must record the temperature at which food is stored, so if a product spoils, they can trace the issue back to improper conditions.

Artifacts vs True Results

An artifact is an error or misrepresentation in data due to outside factors. A true result is an accurate representation of the experiment.

Example:

Artifact: You're testing the boiling point of water, but your thermometer is broken and gives incorrect readings. The result you get is an artifact because it doesn't reflect the true boiling point of water.

True Result: If the thermometer works correctly, the true result shows that water boils at 100°C at sea level. That's the real result.

Types of Analysis

Once we've recorded the data, we need to analyze it to make sense of it. There are three types of analysis:

Analytical Analysis:

Use numbers or statistics to analyze your data. This helps to find patterns, relationships, or trends.

Example: You count how many hours students spend studying and how it correlates with their test scores. After analyzing the data, you might find that more study hours lead to higher scores.

Objective Analysis:

This is when we focus strictly on facts and data without adding personal interpretation or bias.

Example: In a plant experiment, you objectively measure the height of plants at regular intervals. The fact that one plant is 10 cm taller than another is just data, not influenced by your opinion.

Subjective Analysis:

This type of analysis involves personal interpretation, usually based on qualitative data (like observations or opinions).

Example: After observing two groups of birds, we may write, "The birds in Group A seem more aggressive than those in Group B." This is subjective because it's based on your interpretation of the birds' behavior.

Outcome of Research: New Ideas, Hypotheses, Theories, and Models

When we record and analyze results, our research might lead to several possible outcomes. The different results contribute to scientific knowledge:

New Idea:

This could be a fresh concept or a novel approach to solving a problem.

Example: You have an idea to combine two existing technologies to create a more efficient solar panel.

New Hypothesis:

A hypothesis is an educated guess about how things might work, based on your observations.

Example: After observing that plants grow better in sunlight, you hypothesize that plants need light to perform photosynthesis, which helps them grow.

New Concept:

A concept is a broader understanding or theory that explains a pattern or phenomenon.

Example: The concept of evolution explains how species change over time through natural selection.

Theory:

A theory is an explanation of a phenomenon based on a large body of evidence.

Example: The Theory of Gravity explains how objects attract each other, and it is supported by centuries of evidence.

Model:

A model is a simplified representation that helps explain complex phenomena.

Example: Climate models predict how the Earth's climate will change in the future based on different variables like CO_2 levels.

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Thank You