Journal of Information Systems Engineering and Management
2025, 10(63s)
e-ISSN: 2468-4376
https://jisem-journal.com/

Research Article

The Literature Review in the Study Design in the Quantitative Research Methodology

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ARTICLE INFO

Received: 15 Oct 2025

Revised: 25 Nov 2025

Accepted: 02 Dec 2025

ABSTRACT

The modality of science in the research study both designs and process contextual to the implementation on research methodologies. This study aims to highlight the points of value study type a d their sustainability of quantitatively research in study exploratory essays and research designer in quantitatively study. The study conducting of many similarity articles on investigation paper using Google Scholars pean and American and Bristh Europeans Journal online. PubMed, Ajmccr, Sc vision Medicare Nursing, midline and SPSS as baseline and medicine subject titles mix (Research Models in Quantitatively Research Study and non-observational analytical methodologies) study designs. The observation Approach (i.e., clinical observations and diagnostic study. In case control and cross-sectional studies, that the key point of study. The conclusion, of the research methodology is broadly classified as into observational and to observe role plays a significant part the role in decision – making of the data collection process verification of the credibility of quantitative research methodological.

Keywords: Research, Study Models, Quantitative Research Methodology.

Introduction

The **literature review** in a quantitative study is an essential step to support and direct the research. It serves to identify gaps in existing knowledge, relevant theories and hypotheses, as well as previous studies that can support the development of the research problem. Below, I detail how the literature review is integrated into the study design within the quantitative research methodology:

1. Identification of the research problem

The literature review helps to **delimit the research problem**, allowing the researcher to understand the current state of knowledge on the chosen topic. From this understanding, he can identify where the gaps are that the study will seek to fill. This process also makes it possible to avoid repeating studies that have already been carried out.

2. Theoretical foundation

When reviewing the literature, the researcher seeks **theories and models** that support and explain the phenomenon studied. From these theoretical bases, it is possible to formulate testable hypotheses and measurable variables for quantitative study.

3. Development of hypotheses

One of the most important results of the literature review in quantitative studies is the formulation of **hypotheses**. The review allows the researcher to create clear and specific hypotheses, based on previous evidence and theories. These hypotheses will then be tested by collecting numerical data.

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4. Definition of variables
The literature review also provides guidance in the **identification and definition of variables**. Based on previous studies, the researcher can define which dependent and independent variables will be investigated and how they have been measured in another research.
5. Choice of data collection method. In addition to helping to choose the variables and hypotheses, the literature review provides insights into **the best practices of data collection**. It can reveal which instruments or data collection methods (such as questionnaires, rating scales, etc.) have been validated and widely used in similar studies, helping to choose the best methodological approach.
6. Rationale for the study. When conducting the literature review, the researcher creates a clear justification for his research. He shows how the study aligns or differs from previous investigations, highlighting the **relevance and originality** of his work.
7. Comparative analysis of the results. At the end of the study, the literature review allows the researcher to compare their **results with the findings of previous studies**, allowing them to verify whether the results corroborate or contradict established theories and evidence.

Final Thoughts

Literature review in a quantitative study is critical to ensure that the investigation is rigorous, well-founded, and relevant. It not only theoretically underpins the research, but also offers directions for the development of the methodological design and the interpretation of the results.

Classification in Drawing Research

Classification in research design refers to the way studies are categorized based on specific characteristics, such as objectives, methodological approach, procedures, and period of implementation. Understanding these classifications is crucial to selecting the type of research best suited to the study objectives. Below, I detail the main classification criteria in the research design:
1. Objectives
Studies can be classified into three main types, depending on the purpose of the research:

- **Exploratory**: Seeks to understand a problem that is still little known or investigated. The focus is on exploring new insights, identifying variables, and generating hypotheses. Generally, this type of research does not have previously defined hypotheses and can use quantitative or qualitative methods.
- **Descriptive**: Aims to describe characteristics of a population, phenomenon or situation. This type of research quantifies variables or describes the occurrence of phenomena, but does not attempt to determine causal relationships between variables. An example would be the description of demographic profiles or behaviors.
- **Explanatory**: Focuses on identifying the causes of phenomena or relationships between variables. The objective is to explain the "why" and "how" of the interactions between the variables, often through experimental or quasi-experimental studies. Hypotheses are tested to validate or disprove causal relationships.

2. The methodological approach
Depending on how the data is collected and analyzed, the survey can be classified as:

- **Quantitative**: Focuses on the collection of numerical data and the use of statistical techniques for analysis. This type of research looks for measurable patterns and is ideal for testing hypotheses and determining relationships between variables. Quantitative studies often use questionnaires, experiments, and rating scales.
- **Qualitative**: Focused on a deep understanding of social, behavioral, or cultural phenomena. The data are usually descriptive and can be collected through interviews, observations, or document analysis. Qualitative research seeks detailed interpretations rather than numerical generalizations.
- **Mixed (or multimode):** Combines quantitative and qualitative approaches to obtain a more comprehensive understanding of the phenomenon studied. It can use different data collection methods to answer different survey questions, combining the advantages of both types of approach.

3. Procedures
This classification refers to the techniques and procedures used in the study. Some examples include:

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- **Experimental Research**: The researcher deliberately manipulates one or more independent variables to observe the effects on the dependent variable while maintaining tight control over other variables. This type of research is common in the natural and social sciences to test causal hypotheses.
- **Research. Quasi-experimental**: Similar to experimental research, but without the same strict control over all variables. There is no complete randomization of the experimental groups, which may limit the strength of the conclusions.
- **Survey**: Collects data from a representative sample of the population through standardized questionnaires or interviews, often used in descriptive and correlational studies.
- **Case Study**: Focuses on the detailed analysis of one or a few specific cases (people, organizations, events) to explore phenomena in depth. This type of study is widely used in qualitative research, but it can also integrate quantitative elements.
- **Bibliographic Research**: Based on already published materials, such as books, articles, theses and documents, with the objective of reviewing and synthesizing existing knowledge on a given topic.
- **Documentary Research**: Similar to bibliographic research, but using primary documents, such as reports, laws, and institutional archives, to investigate historical or social phenomena.

4. Regarding the time of completion

The survey can be sorted based on the time period it covers:

- **Cross-sectional research**: Collects data at a single point in time to describe or explore phenomena. Common in survey or descriptive studies.
- **Longitudinal Research**: Collects data over time to analyze changes and evolution of phenomena. It allows you to monitor the effects of variables on a given group or population over prolonged periods.

5. The nature of the data

The classification can also be made based on the type of data that will be analyzed:

- **Field Research**: Data is collected directly in the environment where the phenomenon occurs, in real situations, without strict control of variables.
- **Laboratory Research**: Conducted in a controlled environment, which allows greater control over the variables involved, but with less applicability to real-world situations.

Observational Versus Experimental

The distinction between **observational research** and **experimental research** is fundamental in scientific methodology, as it involves different approaches to data collection and analysis. Below, I explain each of these approaches and the main differences between them:

1. Observational Research

In **observational research**, the researcher collects data without interfering with or manipulating the environment or the variables studied. It simply observes and records the phenomena or behaviors as they occur naturally, without controlling or altering the conditions of the study. This type of research is widely used in contexts where it is not ethical, practical, or possible to manipulate variables.

Key features:

- **No manipulation of variables**: The researcher does not change or control the variables of interest; he only observes them.
- **Natural environment**: Data is collected in the environment where the phenomena occur naturally, without external intervention.
- **Correlation relationships**: Observational studies can detect **correlations** between variables (i.e., when one variable is associated with another), but they cannot establish causality with certainty, since there is no strict control over variables.
- **Examples**: Cohort studies, case-control studies, cross-sectional surveys, ethnographic observations.
- Types of observational studies:
- **Cohort study**: Follows a group of people over time to assess the association between exposures and outcomes.
- **Case-control study**: Compares people with a particular condition (cases) with people without the condition (controls) to identify factors that may be associated with the onset of the condition.

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- **Cross-sectional study**: Collects data from a group of people at a single point in time to identify patterns or correlations.
  Advantages:
- It allows you to study phenomena in natural environments, without the need for manipulation.
- Useful in situations where experimental intervention would be ethically impractical or impossible.
- It can cover large populations and extended periods.
  Limitations:
- **Inability to establish causality**: Observational research may show associations but not prove that one variable causes the other, due to a lack of control over external factors.
- **Potential for bias**: The researcher does not control for confounding variables, which can lead to misinterpretations of the data.

2. Experimental Research

In **experimental research**, the researcher **actively manipulates one or more independent variables** and observes the effects of that manipulation on one or more dependent variables, usually in a controlled environment. This type of research is ideal for **testing causal relationships** between variables, as tight control over the environment allows isolating the effect of the manipulated variable.
Key features:

- **Variable manipulation**: The researcher changes the independent variable to observe how it affects the dependent variable.
- **Strict control**: The researcher controls for other variables that could influence the results, ensuring that the only change is the manipulated variable.
- **Establishment of causality**: Experimental research allows the identification of **causal relationships**, that is, it can prove that one variable causes an effect on another, due to the strict control of experimental conditions.
- **Examples**: Laboratory experiments, field experiments, randomized controlled trials.
  Types of experimental studies:
- **Randomized controlled trials (RCTs):** Considered the gold standard of experimental research, where participants are randomly allocated into experimental and control groups.
- **Field experiments**: Carried out outside the laboratory, but with manipulation of the variables in the natural environment of the participants.
- **Quasi-experiments**: Similar to the experiments, but without complete randomization of the participants, which may limit the robustness of the conclusions.
  Advantages:
- **Ability to establish causality**: The greatest advantage of experimental research is that, with proper control, one can confidently determine cause-and-effect relationships.
- **Control over variables**: The researcher has control over the experimental conditions, which reduces the influence of external variables or confounding
- **Reproducibility**: Well-designed experiments can be replicated to confirm the results.
  Limitations:
- **Artificiality of the environment**: The controlled experimental environment may not faithfully represent reality, limiting the generalization of results to the "real world".
- **Ethical issues**: Some experimental manipulations may be ethically questionable or impractical in certain contexts (e.g., testing the harmful effects of a substance on humans).
- **Cost and complexity**: Designing and conducting rigorous experiments can be expensive and complicated, especially in studies involving humans.

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Main Differences Between Observational and Experimental

Characteristic	Observational Research	Experimental Research
Variable manipulation	No (observation only)	Yes (independent variable handled)
Variable control	Limited, without strict control	Strict control of variables
Causality	Doesn't establish causality with certainty	Can establish causality
Environment	Natural (actual situation)	Controlled (artificial or semi-controlled environment)
Risk of bias	More subject to biases and confounding variables	Less prone to bias due to experimental control
Examples	Cohort, cross-sectional, case-control studies	Laboratory experiments, clinical trials

Descriptive versus inferential analytical study

Descriptive **and** inferential (analytical) **analyses** are two distinct approaches to data analysis in quantitative studies. They differ in the way data is handled and the type of conclusions that can be drawn. Here are the main features and differences between them:

1. Descriptive Study

The **descriptive study** aims **to summarize and describe** the characteristics of a data set or a population. It focuses on **reporting** information about what's going on without making assumptions beyond what the data presents. Descriptive analysis does not seek to test hypotheses or make predictions, but rather to offer a clear view of the observed data.

Key features:

- **Focus on describing what the data shows**.
- It reports **frequencies, percentages, means, medians, standard deviation**, among others.
- It does not make inferences or generalizations beyond the sample studied.
- **It represents the data in a simple** and objective way.
- Ideal for the **first step** in any data analysis, helping to understand patterns and trends.

Examples of descriptive analytics:

- **Frequency distribution**: How many times a given response or event occurs in a dataset.
- **Core Trend Measures**: Mean, Median, and Mode.
- **Dispersion measures**: Variance, standard deviation, interquartile range.
- **Graphs and charts**: Histograms, bar graphs, pie charts, etc.

When to use:

- To **describe** the characteristics of a sample or population.
- When the goal is **to summarize** the data without making predictions or statistical tests.
- Useful in studies that seek to **identify general patterns** or characteristics of a sample.

2. Inferential (or analytical) study

Inferential study goes beyond the description of data and attempts **to make predictions or inferences about a population** based on a sample. It focuses on **testing hypotheses** and **evaluating relationships between variables**, allowing the sample results to be **generalized** to a larger population. To do this, it uses statistical methods that quantify the **probability** that the observed results will be representative of the population.

Key features:

- **It makes inferences about a larger population** based on sample data.
- It uses statistical techniques to **test hypotheses** and evaluate relationships between variables.

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- It allows **generalizations** and predictions about populations.
- It involves estimating **population parameters** (such as means or proportions) and assessing statistical significance.
- It requires the use of **inferential statistics**, such as significance tests (t-tests, ANOVA, chi-square tests) and confidence intervals.

Examples of inferential analyses:

- **Hypothesis tests**: Student's t-test, ANOVA (Analysis of Variance), chi-square test, correlation and regression tests.
- **Confidence intervals**: Estimates of intervals within which the true population mean is likely to lie.
- **Regression**: Models that predict the value of a dependent variable based on one or more independent variables.
- **Correlation**: Evaluation of the strength and direction of the relationship between two variables.

When to use:

- When the goal is to **generalize** the results of a sample to a population.
- To **test hypotheses** and determine if the relationships or differences observed in the data are **statistically significant**.
- Ideal in studies that seek **to explore causal relationships or associations** between variables.

3. Differences between Descriptive and Inferential Studies

Characteristic	Descriptive Study	Inferential (Analytical) Study
Goal	Describe characteristics of the data or samples	Make inferences about a population based on a sample
Nature of the analysis	Summarizing data without hypothesis testing	Test hypotheses and evaluate relationships between variables
Common tools	Frequencies, Means, Medians, Graphs, Tables	Hypothesis testing, confidence intervals, regression
Generalization to the population	There is no generalization beyond the observed data	Generalizes sample results to the population
Level of complexity	Relatively simple	Requires more advanced statistical knowledge
Examples	Analysis of age, income, sex distribution	t-test, ANOVA, linear regression, correlation

4. Practical Examples

Descriptive Study:

A survey that collects data on the **age and gender** of students at a university can use descriptive analysis to calculate the **average age**, **age distribution,** and ratio **of male to female students**. Here, the objective is only to describe the characteristics of the students observed.

Inferential Study:

Now, if the same research wants to determine whether there is a **significant difference in average grades** between students of **different genders** or between students of **different courses**, it would need to use inferential analysis. This would involve, for example, applying a t-test to see if the difference in grades is statistically significant and can be generalized to the student population.

Control case versus cohort study

Case-control studies and **cohort studies** are two main types of **observational studies** used in epidemiology and the social sciences to investigate associations between exposures and outcomes. While

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e-ISSN: 2468-4376
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both are observational, they differ significantly in their design, execution, and the types of inferences they can make. Let's explore the key characteristics and differences between these two types of study:

1. Case-Control Study

The **case-control** study is retrospective, i.e., it starts from an outcome (disease or condition) and looks back, investigating previous exposures that may have caused the outcome. It is ideal for investigating rare diseases or conditions that take a long time to manifest.

Key features:

- **Retrospective**: Starts from an already known outcome (e.g., disease or condition) and seeks to investigate participants' prior exposure.
- **Two groups**: Participants are divided into two groups:
  - **Cases**: Individuals who have the condition or disease of interest.
  - **Controls**: Individuals who do not have the condition or disease.
- The aim is to compare **previous exposures** between the two groups to identify whether there is an association between exposure and outcome.

Advantages:

- **Ideal for rare diseases**: Because cases are already known, it is easier to identify individuals with the rare condition and compare with controls.
- **Less time and cost**: As it is retrospective, the study can be carried out in less time and with fewer resources, since there is no need to follow the participants over time.
- **Efficient for conditions with long latency** periods: Diseases that take years to develop can be studied effectively as the study looks backwards.

Limitations:

- **Risk of recall bias**: Because exposure data is collected retrospectively, participants may not accurately remember their previous exposures, which can lead to errors.
- **Not establishing causality directly**: The case-control study can identify associations, but it cannot prove that exposure causes the disease.
- **Selection of controls**: The choice of controls should be made carefully to ensure that they are representative of the population without the condition but with similar characteristics to the cases.

Example:

A study investigating the association between smoking and lung cancer. A group of individuals with lung cancer (cases) is compared with a group without the disease (controls), and both are asked about their previous smoking habits.

2. Cohort Study

The **cohort** study is prospective (or retrospective, in some cases) and follows a group of people exposed to a risk factor (or a particular characteristic) and another group that is not exposed, following them over time to observe the emergence of the outcome (e.g., a disease or condition).

Key features:

- **Prospective**: It starts with individuals who do not have the outcome of interest and follows them over time to see who develops the outcome based on their exposures. In some cases, the study may be retrospective, looking at past records from an established cohort.
- **Two groups**:
  - **Exposed**: Individuals who have been exposed to a specific risk factor.
  - **Not exposed**: Subjects who have not been exposed to the risk factor.
- The aim is to compare the **rates of outcome development** between the two groups.

Advantages:

- **Determines temporality**: As participants are followed over time, it is possible to establish the temporal sequence between exposure and outcome, which helps to infer causality.
- **Lower recall bias**: Data collection is done prospectively, which reduces the risk of recall bias.
- **Allows multiple outcomes to be studied**: A cohort study can investigate multiple outcomes from the same exposure.

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Limitations:

- **Cost and time**: Cohort studies can be lengthy and expensive, as they require following up with large groups of people over time.
- **Not ideal for rare diseases**: For rare conditions, the cohort study may not be efficient, as it would be necessary to follow a large number of people for the outcome to occur in a significant number of participants.
- **Loss to follow-up**: Over time, some participants may drop out of the study or be lost to follow-up, which can introduce bias.

Example:

A study that followed a group of smokers and another group of nonsmokers over 20 years to look at the incidence of lung cancer in both groups.

3. Main Differences Between Case-Control Study and Cohort Study

Characteristic	Case-Control Study	Cohort Study
Temporal approach	Retrospective (from the outcome to the exhibition)	Prospective (from exposure to outcome)
Comparison groups	Cases (with outcome) and controls (without outcome)	Exposed (to a risk factor) and not exposed
Outcome known at the beginning	Yes (starts with cases that have already developed the outcome)	No (follows individuals without the outcome over time)
Suitable for arras diseases	Yes, efficient for studying rare diseases	No, inefficient for rare diseases
Establishing causality	Not directly, but it suggests association	Yes, better to infer causality
Recall bias	High (retrospective)	Low (prospective)
Time and cost	Lower time and cost	Increased time and cost
Usage Example	Rare Cancer Study Investigating Past Exposures	Cohort Study on Smoking and Cancer Over Time

4. When to Use Each Type of Study

- **Case-Control Study**:
  - Useful when the outcome is **rare** or has a long latency period.
  - Ideal when it is necessary to investigate past exposures, especially when the outcome has already occurred.
  - Faster and less expensive to accomplish.
- **Cohort Study**:
  - Preferred when the goal is to **determine the temporal relationship** between exposure and outcome.
  - Best for studying **multiple outcomes** associated with the same exposure.
  - Suitable for more common conditions or with well-defined risk factors.

Perspective versus retrospective study in smoking. Example Research Drawing in structured figure study

Prospective **and** retrospective **studies** are used to investigate the relationship between risk factors, such as smoking, and health outcomes, such as lung cancer. The choice between a prospective or retrospective approach depends on the objectives of the research, the time available and the nature of the condition studied.

1. Prospective Study

In the **prospective** study, researchers follow a group of individuals over time, observing whether or not they develop the outcome of interest (such as lung cancer), from an initial point where the outcome has not

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2025, 10(63s)
e-ISSN: 2468-4376
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yet occurred. This type of study is ideal for establishing a clear temporal relationship between exposure and outcome.
Key features:

- **Initiation with healthy subjects**: None of the participants have the outcome of interest at baseline.
- **Time follow-up**: The study group (smokers and nonsmokers) is followed over a period of time to see who develops the outcome.
- **Temporal determination**: As follow-up is done prospectively, it is possible to establish the temporal sequence between exposure and outcome.
- **Example**: A group of people is recruited and classified into smokers and nonsmokers. They are followed for 10 years to see who develops lung cancer.

2. Retrospective Study
In the **retrospective** study, researchers start with the outcome that has already occurred (e.g., individuals who already have lung cancer) and investigate their previous exposures, such as smoking. This type of study is ideal for rare diseases or conditions that take a long time to develop.
Key features:

- **Initiation with outcome**: The study starts with individuals who have already developed the outcome of interest (cases) and compares with a control group (people without the outcome).
- **Retrospective data collection**: Data on exposure to smoking are collected by looking at the past, from medical records or interviews with participants.
- **Associations**: The aim is to identify associations between exposure (smoking) and outcome (cancer).
- **Example**: A group of lung cancer patients is compared with a group of people without cancer, investigating whether the patients were smokers or not in the past.

Structured Figure of Research Design: Prospective vs. Prospective Study Retrospective on Smoking.
Let's see how these two types of studies can be structured:
Structured Figure
moon
Copy code

Foresight Study	Retrospective Study
Home	Starts with individuals healthy, without the outcome	It starts with individuals who already have the outcome (Ex: cancer)
Groups	Smokers and Non-Smokers (defined in the home)	Cases (with cancer) and controls (Cancer Free)
Exhibition	Exhibition Monitoring smoking over the course weather	Investigates past exposure smoking (retrospective)
Outcome	Keeps up with development of the outcome (e.g., cancer) over time	Outcome occurred, investigate exposures that may have it caused
Weather	Longitudinal, years of Follow-up	The study looks to the past Based on old records
Causality	Best to Establish Causal Relationships	Does not establish causality Certainty, only association

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Research Design Example: Prospective Study in Smoking
Study Title: Longitudinal Follow-up of the Association Between Smoking and Lung Cancer in Healthy Adults

1. Goal

To investigate whether smoking is a significant risk factor for the development of lung cancer in healthy adults over 10 years.

2. Method

- **Study population**: 5,000 healthy adults, initially without a cancer diagnosis, will be recruited and divided into two groups:
  - **Smokers**: Individuals who smoke regularly.
  - **Non-smokers**: Subjects who have never smoked or have quit for more than 10 years.
- **Exposure**: Smoking status will be recorded at baseline and monitored over time.
- **Follow-up**: All participants will be followed for 10 years, with annual evaluations to check for the development of lung cancer.
- **Outcome**: The number of lung cancer cases will be recorded in both groups over the 10 years. The analysis will compare cancer incidence rates between smokers and non-smokers.

3. Expected outcomes

The smoking group is expected to have a **higher incidence** of lung cancer over the 10 years compared to the nonsmoking group, indicating a strong association between smoking and lung cancer.

Compared to observation and experimental study

When we compare an **observational study** with an **experimental study**, we find important differences regarding the control that the researcher has over the variables studied, the objective of the research, and the types of inferences that can be made from the results. Let's examine each type of study and its main characteristics:

1. Observational Study

In an **observational study**, the researcher **does not intervene directly** in the variables. It just observes and records what happens naturally, without manipulating or controlling the factors that may influence the results. This type of study is widely used in areas such as epidemiology, social sciences, and ecology, where it would not be ethical or feasible to carry out experimental interventions.

Key features:

- **No manipulation of variables**: The researcher only observes the behavior of the variables in their natural environment.
- **Divided into two main types**:
  - **Descriptive**: Focuses on describing phenomena without necessarily exploring cause-and-effect relationships.
  - **Analytical**: Explores possible associations between variables (such as smoking and lung cancer), but without intervention.
- **Used in situations where the intervention is not ethical or practical**: For example, it would not be ethical to deliberately expose individuals to risk factors such as smoking or drug use.

Examples:

- **Cohort and case-control studies**: Look at exposure to risk factors (such as smoking) and track outcome (such as lung cancer) over time.
- **Field study**: A researcher observes the behavior of animals in their natural habitat without intervening.

Advantages:

- **Applicable to real-world situations**: Observes phenomena in natural environments, providing insights into how variables interact without interference.
- **Ethical**: Especially useful in areas where direct intervention would not be ethical, such as in public health studies involving dangerous risk factors.

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Limitations:

- **Difficulty in establishing causality**: Although it may suggest associations, an observational study cannot prove that one variable cause another, as other uncontrolled variables may influence the outcome.
- **Increased risk of bias**: Uncontrolled factors can skew results, making accurate conclusions difficult.

2. Experimental Study

In **the experimental study**, the researcher **manipulates one or more independent variables** to observe the effect that this manipulation has on a dependent variable. This type of study is the **gold standard** for determining cause-and-effect relationships. Experimental studies are more common in fields such as psychology, biology, and natural sciences.

Key features:

- **Manipulation of variables**: The researcher actively controls the independent variable and observes the effects of this manipulation on the dependent variable.
- **Control and experimental groups**: Generally, participants are divided into two groups:
  - **Experimental group**: Receives the intervention or manipulation.
  - **Control group**: Does not receive the intervention, serving as a basis for comparison.
- **Electrification**: Participants are usually randomly distributed among groups to reduce bias.

Examples:

- **Randomized controlled trial (RCT):** A type of experimental study in which participants are randomly assigned to receive either a new treatment (experimental group) or a placebo (control group), allowing the effect of the treatment to be isolated and measured.
- **Laboratory experiments**: The researcher changes one variable (such as temperature) and observes its effect on another (such as the behavior of an organism).

Advantages:

- **Establishes causality**: Because the researcher controls for variables, he or she can determine whether changes in the independent variable cause changes in the dependent variable.
- **Variable control**: By directly manipulating conditions, the researcher minimizes the impact of external factors that could confound the results.

Limitations:

- **It can be artificial**: Because experiments are often conducted in controlled environments, the results may not reflect what would happen in the "real world."
- **Ethical and practical issues**: In many cases, it is not ethical or practical to conduct experiments on humans, especially when it involves a health risk (e.g., exposing people to smoking).

Comparison between Observational and Experimental Study

Characteristic	Observational Study	Experimental Study
Variable manipulation	There is no manipulation; the researcher just observes	The researcher manipulates the independent variable
Control of external variables	Little control; Other variables can interfere	High control over external variables
Groups	Groups are formed naturally	Groups are assigned and usually randomized
Establishing causality	Observed associations but not causal proof	Establishes cause and effect relationships
Applicability	Useful for natural phenomena or risk factors	Useful for testing interventions or treatments
Example	Cohort Study to Investigate Smoking	Clinical trial to test a new drug

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Characteristic	Observational Study	Experimental Study
Ethics	Used when intervention would be unethical	May face ethical constraints, depending on the intervention
Environment	Natural, without interference from the researcher	Often performed in controlled environments

Smoking Research Example: Observational Study vs. Experimental Study

1. Observational Study (Cohort)

Objective: To investigate the association between smoking and the development of lung diseases in an adult population.

Method: A group of smokers and another group of nonsmokers were observed over a period of 10 years. No intervention is made; The researchers only monitor the health of the participants, checking who develops lung diseases.

Conclusion: At the end of the study, the researchers were able to observe a higher incidence of lung diseases among smokers, suggesting an association but not directly proving that smoking causes the diseases.

2. Experimental Study (Clinical Trial)

Objective: To test the effectiveness of a new program to help smokers quit smoking and to see if smoking cessation reduces the risk of lung disease.

Method: Smoking participants are randomly divided into two groups:

- **Experimental group:** Participates in the smoking cessation program.
- **Control group:** Do not receive any intervention. The two groups are followed over 5 years, and the incidence of lung diseases is compared.

Conclusion: If the experimental group has a lower incidence of lung disease than the control group, the researchers can conclude that the program was effective in reducing the risk of disease.

Conclusion

- Observational **studies** are useful for identifying associations between variables in natural environments, but they cannot prove causality due to the lack of control over external variables.
- **Experimental studies** offer a high degree of control, allowing researchers to establish causal relationships, but they are often conducted in more artificial settings and may face ethical constraints.

The choice between an observational and experimental study depends on the **objectives of the research**, the **nature of the phenomenon** being investigated, and the **ethical issues** involved.

Main Differences Between Observational and Experimental

Characteristic	Observational Research	Experimental Research
Variable manipulation	No (observation only)	Yes (independent variable handled)
Variable control	Limited, without strict control	Strict control of variables
Causality	Doesn't establish causality with certainty	Can establish causality
Environment	Natural (actual situation)	Controlled (artificial or semi-controlled environment)
Risk of bias	More subject to biases and confounding variables	Less prone to bias due to experimental control
Examples	Cohort, cross-sectional, case-control studies	Laboratory experiments, clinical trials

Journal of Information Systems Engineering and Management
2025, 10(63s)
e-ISSN: 2468-4376
https://jisem-journal.com/

Research Article

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