

Chapater 1

Introduction

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Research Fundamental

1. Research

- Research Aim and Objectives
- Features

2. Types of Research

- Descriptive vs. Analytical Research
- Applied vs. Fundamental Research
- Quantitative vs. Qualitative Research
- Conceptual vs. Empirical

3. 6Ps of Research

- Purpose of Research
- Product of Research

4. Research versus Project

- A search for knowledge
- A scientific and systematic search for significant information on a specific topic
- The purpose of research is to answer questions and acquire new knowledge
 - seeks the answer of certain questions which have not been answered so far and the answers depend upon human efforts
- For example: few years ago: did not know exactly the moon's south side?
 - make some assumptions about it
 - by efforts, now able to give concrete answer of the problem

- Research answers only those questions of which the answers are not available in literature i.e., in human knowledge
 - an original contribution to the existing stock of knowledge
- most important process for advancing knowledge to promote progress

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 - ② Desire to get intellectual joy of doing some creative work
 - ③ Desire to be of service to society

- to improve research procedures through the refinement and extension of knowledge
- each research study has its own specific purpose

Example:

"To investigate the effectiveness of machine learning algorithms in detecting cybersecurity threats in network traffic."

- to improve research procedures through the refinement and extension of knowledge
 - to discover answers to questions through the application of scientific procedures
- each research study has its own specific purpose

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"To investigate the effectiveness of machine learning algorithms in detecting cybersecurity threats in network traffic."

Research Objectives

- ① To gain familiarity with a phenomenon or to achieve new insights into it
 - exploratory or formulative studies
- ② To portray accurately the characteristics of a particular individual, situation or a group
 - descriptive studies
- ③ To determine the frequency with which something occurs or with which it is associated with something else
 - diagnostic studies
- ④ To test a hypothesis of a causal relationship between variables
 - hypothesis-testing studies

Exploratory or Formulative Study

- to gain familiarity with a phenomenon or to achieve new insights into it
- typically conducted when there is limited existing knowledge or understanding of the topic
- lay the groundwork for further research and may help in the formulation of hypotheses or the development of theoretical frameworks

Example

- To review existing literature on machine learning techniques applied to cybersecurity and network traffic analysis

Descriptive Study

- to portray accurately the characteristics of a particular individual, situation, or group
- focus on describing what currently exists or what has occurred, without attempting to determine causality or establish relationships between variables
- to provide a snapshot of a given phenomenon, helping researchers to understand its features, patterns

Example

- To identify common types of cybersecurity threats encountered in network traffic, such as malware, intrusion attempts, and data breaches
- To preprocess the dataset by extracting relevant features and preparing it for training and testing the machine learning models

Diagnostic Study

- To determine the frequency with which something occurs or with which it is associated with something else
- To identify and analyze relationships between variables, uncover patterns, and diagnose problems or conditions

Example

- Conducting statistical analyses to determine the correlation between the performance of machine learning algorithms in detecting cybersecurity threats and characteristics of the network traffic data, such as traffic volume, data distribution, and network topology
- Identifying and defining key performance indicators (KPIs) for evaluating the effectiveness of machine learning algorithms in detecting cybersecurity threats, such as detection rate, false positive rate, and response time

Hypothesis testing Study

- To test a hypothesis of a causal relationship between variables
- To determine whether there is a statistically significant relationship between variables
 - ANOVA test
 - t-test

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 - Research the technologies and platforms commonly used for developing e-commerce websites

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- **Descriptive:** Define the target audience for the e-commerce website, including demographics, preferences, and buying behavior
 - Conduct market research to identify competitors, their products, pricing strategies, and unique selling propositions
 - Document the key features and functionalities required for the e-commerce website based on user needs and market analysis

- **Diagnostic:** Analyze existing e-commerce platforms or websites to identify common issues, challenges, and pain points faced by users
- **Hypothesis-Testing :**Formulate hypotheses about the potential impact of specific variables (e.g., website design, product pricing, marketing strategies) on user engagement and conversion rates
 - Design experiments or A/B tests to systematically test the hypotheses by manipulating variables and measuring outcomes
 - Refine and optimize the e-commerce website based on the findings from hypothesis-testing research to improve its effectiveness in achieving business objectives

Features of Research

- ① **Systematic Process**
- ② **Objective Orientation**
- ③ **Empirical Basis**
- ④ **Logical Reasoning**
- ⑤ **Cumulative Nature**
- ⑥ **Generalizability**
- ⑦ **Ethical Considerations**
- ⑧ **Communication and Dissemination**
- ⑨ **Continuous Improvement**

Systematic Process

- follows a systematic and structured process that involves:
 - formulation of a problem
 - research questions or hypotheses or problem statement
 - data collection
 - analysis
 - interpretation of findings

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- Conducting a study to investigate the impact of mindfulness meditation on stress levels among college students
- The research follows a systematic process
 - defining research questions
 - designing a randomized controlled trial
 - collecting data through surveys and physiological measures
 - analyzing the data using statistical methods
 - interpreting the findings

Objective Orientation

- driven by specific objectives, aims, or questions that guide the inquiry and provide clarity about the desired outcomes

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Example

- Examining the relationship between sleep duration and academic performance among students
- Driven by specific objectives to determine if there is a correlation between the two variables (sleep duration and academic performance)

- empirical evidence obtained through observation, experimentation, or data collection from the real world
- emphasizes the use of verifiable and replicable methods to support conclusions and findings

Empirical Basis

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Example

- Studying the effectiveness of a new teaching method on student learning outcomes in mathematics
- The research collects quantitative data on student performance scores before and after implementing the teaching method, providing empirical evidence to support conclusions about its efficacy

- involves logical reasoning and critical thinking to analyze data, draw conclusions, and make inferences

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Example

- Investigating the impact of environmental factors on public health outcomes, such as air pollution levels on respiratory illnesses
- The research applies
 - logical reasoning to analyze data
 - consider alternative explanations
 - draw conclusions about the causal relationship between environmental exposures and health outcomes

- builds upon existing knowledge and contributes to the collective body of knowledge within a field or discipline

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Example

- Examines the effects of rising global temperatures on agricultural productivity across different regions
- Findings contribute to the cumulative body of knowledge on climate change impacts
 - inform strategies for mitigating its effects on food security

- aims to generate findings that are applicable beyond the specific context or sample studied
- establish generalizable principles, patterns, or trends that can be applied to broader populations or situations

Generalizability

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- establish generalizable principles, patterns, or trends that can be applied to broader populations or situations

Example

- Examining the relationship between sleep duration and academic performance among students
- Findings based on a diverse sample of participants
 - provides insights into generalizable principles to find the relationship between sleep duration and academic performance

- Research adheres to ethical principles and guidelines to ensure
 - the protection of human subjects
 - the responsible conduct of research
 - the integrity of the research process

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Example

- Conducting a study on sensitive topics such as mental health or substance abuse
- Researchers obtain informed consent from participants
 - ensures the confidentiality of data
 - provide appropriate support or referrals for individuals experiencing distress

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Example

- Publishing research findings on the efficacy of a new teaching method on student learning outcomes in mathematics
- findings reach relevant stakeholders
 - contribute to advancements in teaching area

Continuous Improvement:

- Research is an iterative process that involves ongoing reflection, refinement, and revision
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Example

- Revising research methods based on feedback from peer reviewers to enhance the validity and reliability of study findings
- Researchers may refine study designs, adjust data collection procedures, or incorporate additional analyses to address limitations and improve the quality of their research

Types of Research

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Descriptive Research

- To portray accurately the characteristics of a particular individual, situation, or group
- focuses on describing what currently exists or what has occurred, without attempting to determine causality or establish relationships between variables

Methodology

- observational methods, surveys, questionnaires, and other data collection techniques to gather information about the subject of study
- emphasizes the collection of quantitative data to describe and summarize the features, behaviours, or attributes of interest

Example

Conducting a study to investigate the impact of mindfulness meditation on stress levels among college students

Case study: Understanding Customer Satisfaction Trends in Online Retail

Background

An online retail company, XYZ E-Store, has been experiencing fluctuations in customer satisfaction ratings over the past year. Management is keen to understand the underlying factors contributing to these fluctuations and to identify areas for improvement in their services

Analytical Research

- researcher has to use facts or information already available, and analyze these to make a critical evaluation of the material
- interpret data to uncover patterns, relationships, or causal links between variables
- seeks to understand why certain phenomena occur, predict future outcomes, or test hypotheses about the relationships between variables

Methodology

- employs statistical analysis, experimentation, modeling, and other advanced techniques to examine the relationships between variables and draw conclusions based on empirical evidence
- involves comparing and contrasting data, identifying trends, and testing hypotheses to infer causal relationships

Example

Investigating the performance and energy efficiency of parallel computing

Case Study: Analyzing Performance Optimization Techniques in Database Management Systems

Example

A software development company, DataTech Solutions, is developing a new database management system (DBMS) to improve performance for large-scale data processing applications. The company wants to analyze various performance optimization techniques to identify the most effective strategies for enhancing DBMS performance.

- To find a solution for an immediate or practical problem facing a society or an industrial/business organisation
- Researchers collaborate with industry or government partners to tackle specific problems
- The results of applied research often lead to the development of new products, technologies, or processes

Example

Develop chatbots that can handle customer inquiries, provide support, and assist with common tasks

Fundamental Research

- also known as basic research, aims to deepen our understanding of fundamental principles, theories, and concepts
- driven by curiosity and seeks to explore the underlying mechanisms without immediate practical applications
- Researchers explore mathematical models, proofs, and abstract concepts

Example

- Analyzing the time and space complexity of algorithms, i.e., Traveling Salesman Problem
- Fundamental research explores the limits of data compression, error correction, and communication

Quantitative Research

- involves collecting and analyzing numerical data to describe, predict, or control variables of interest
- aims to test causal relationships between variables, make predictions, and generalize results to wider populations

Example

- experiment comparing the performance of two different sorting algorithms on large datasets to see which one performs faster or more accurately
- assess user satisfaction with a particular product, asking them to rate their experience on a scale from 1 (poor) to 5 (excellent)

- understand the underlying meanings, experiences, and social contexts related to a phenomenon relating to or involving quality
- seeks to explore subjective experiences, beliefs, and behaviors

Example

Working with a software development team to improve their code review process

- also known as theoretical research, focuses on developing theories, models, or frameworks
- aims to deepen our understanding of fundamental principles and concepts
 - contributes to the theoretical foundation of a field

- involves collecting and analyzing data to answer specific research questions
 - data-based research
- come up with conclusions which are capable of being verified by observation or experiment

6Ps of Research

- ① **Purpose**
- ② **Product**
- ③ **Process**
- ④ **Participants**
- ⑤ **Paradigm**
- ⑥ **Presentation**

- ❶ **Purpose:** the reason for conducting research
 - It clarifies what you aim to achieve and guides your research questions
 - why it is important or useful to study this, the specific research question(s) asked and the objectives set
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 - Think about what you intend to produce as a result of your research effort

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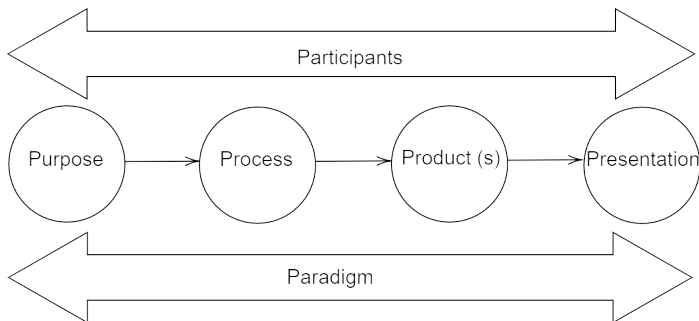
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- ❸ **Process:** the sequence of activities undertaken in any research
 - involves identifying research topics, establishing a conceptual framework (how you choose to think about your research topic)
 - selecting and using a research strategy and data generation methods, analyzing data
 - drawing conclusions, and recognizing any limitations in your research

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- 6 **Presentation:** means by which the research is disseminated and explained to others
 - written up in a paper or thesis, or a conference paper is presented to an audience of conference delegates
 - a computer-based product is demonstrated to clients, users or examiners
 - Important that the presentation is carried out professionally
 - otherwise your audience might assume your whole research project was not undertaken in a professional manner

6Ps of Research



Purpose of Research

- incorporates the reason for doing it, the topic of interest
- why it is important or useful to study this
- the specific problem statement or research question(s) asked and the objectives set
- Why do people do research?
 - To add to the body of knowledge
 - To solve a problem
 - To find out what happens
 - To find the evidence to inform practice
 - To develop a greater understanding of people and their world

Product of Research

- A new or improved product
- A new theory
- A re-interpretation of an existing theory

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- ➍ **Methodology:** employs systematic methods and methodologies to collect, analyze, and interpret data. It often involves empirical investigation, literature review, theoretical analysis, and hypothesis testing
- ➎ **Outcomes:** include new insights, discoveries, theories, or empirical evidence that contribute to the body of knowledge within the field. Research findings are often disseminated through publications, presentations, or academic conferences

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- ⑤ **Outcomes:** include deliverables or outputs that satisfy project requirements and stakeholder expectations. These may include tangible products, services, reports, prototypes, or completed activities

Key Differences

	Research	Project
Purpose	generate new knowledge	achieve specific goals or objectives
Approach	a systematic inquiry process	a structured project management approach
Scope	focus on theoretical exploration	specific objectives to accomplish
Outcomes	new insights, theories, or empirical evidence	tangible deliverables or outputs