Research Methodology – Unit 2

Course Code: M23DE0205 – Academic year 2024-2025, II Semester MCA (Even Semester)

School of Computer Science and Applications

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LECTURE -1, UNIT – 2 DEFINING & FORMULATING THE RESEARCH PROBLEM

Agenda

➢ Unit 2 - Content

➢ Introduction

➢ Defining Research Problem

➢ Formulating the Research Problem

➢ Examples of Research Problems

UNIT 2 – SYLLABUS CONTENT

UNIT 1: Research and Types of research: Meaning of Research- Objectives of Research- Motivation in Research. Research methods vs Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical. Research Process. Criteria of good Research.

UNIT 2: Research Formulation : Defining and formulating the research problem. Selecting the problem - Necessity of defining the problem – Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs- patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.

DEFINING THE RESEARCH PROBLEM

Definition:
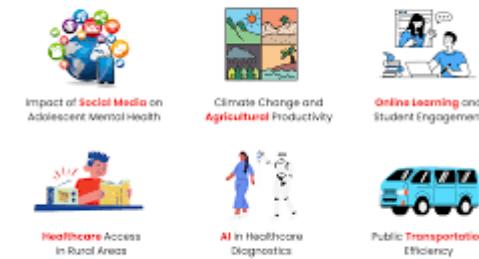
A Research problem is a specific issue, difficulty, or gap in knowledge that a researcher aims to address through a systematic study.

Importance of a Well-Defined Problem:

1. **Guides the Research:** A clear problem statement directs the focus and scope of the study.

2. **Sets the Research Agenda:** Defines what will be investigated, preventing unnecessary diversion.

3. **Facilitates Resource Allocation:** Helps in planning the resources required for the study.

DEFINING THE RESEARCH PROBLEM CONTD.

Identifying (Sources) of Research Problems:
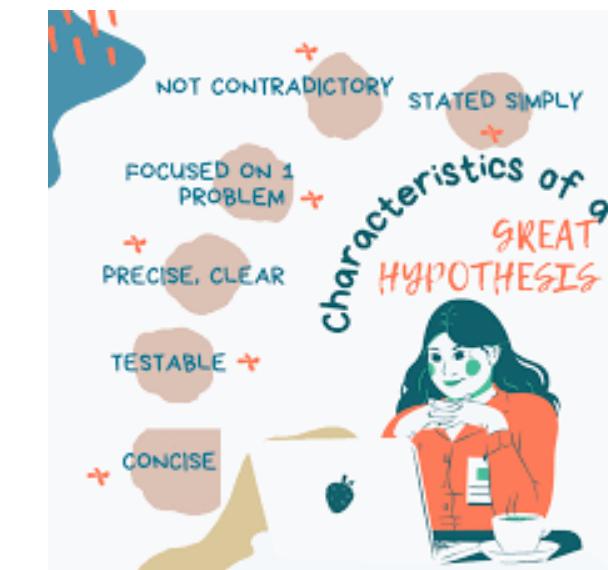
1. Personal Experience: Real-world issues that spark interest or curiosity.

2. Literature Review: Gaps or inconsistencies in existing research.

3. Societal Needs: Social, economic, or environmental issues requiring solutions.

4. Expert Consultation: Insights from field experts or practitioners.

DEFINING THE RESEARCH PROBLEM CONTD.

Characteristics of a Good Research Problem
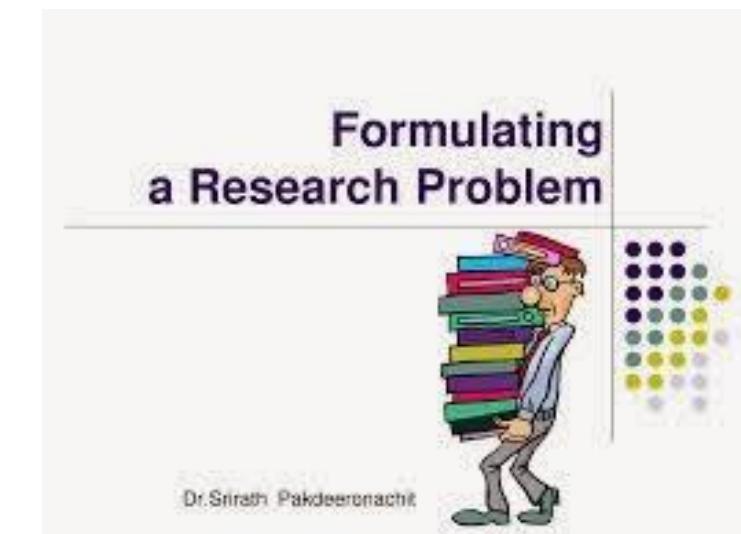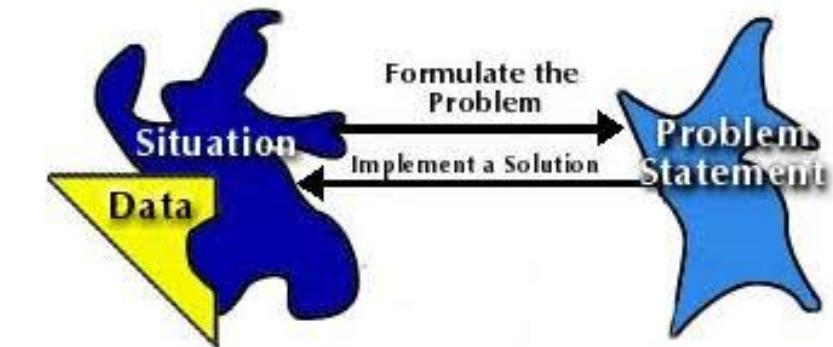
1. Clear and Concise: The problem should be articulated in straightforward language.
2. Researchable: It should be feasible to study within the given constraints (time, resources, access).
3. Significant: The problem should contribute to knowledge, theory, or practice.
4. Ethical: Addressing the problem should not pose ethical concerns.

FORMULATING THE RESEARCH PROBLEM

Steps to Formulate a Research Problem:

1. **Understand the Context:** Gather background information to grasp the scope and relevance.

2. **Narrow Down the Topic:** Focus on a specific aspect of the broader subject area.

3. **Identify Key Variables:** Determine the main factors or variables involved.

4. **State the Problem Clearly:** Use precise language to articulate the problem statement.

5. **Ensure Feasibility:** Consider practical aspects such as data availability and methodological constraints.

Formulating a Research Problem

Dr.Srirath Pakdeeronachit

EXAMPLES OF RESEARCH PROBLEMS

Example 1: Field: Environmental Science

Problem: How does urbanization affect local biodiversity in coastal areas?

Example 2: Field: Education

Problem: What are the impacts of remote learning on student engagement in high school science classes?

Example 3: Field: Healthcare

Problem: What are the barriers to accessing mental health services for adolescents in rural areas?

Writing Amazing Research Articles On Environmental science

100+ INTERESTING ENVIRONMENTAL SCIENCE RESEARCH TOPICS

SUMMARY

➢ Unit 2 - Content

➢ Introduction

➢ Defining Research Problem

➢ Formulating the Research Problem

➢ Examples of Research Problems

QUIZ

UNIT 2: Research Formulation : Defining and formulating the research problem. Selecting the problem - Necessity of defining the problem – Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs- patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.

LECTURE -2, SELECTING THE PROBLEM, NECESSITY OF DEFINING THE PROBLEM

RECAP

➢ Unit 2 - Content

➢ Introduction

➢ Defining Research Problem

➢ Formulating the Research Problem

➢ Examples of Research Problems

OBJECTIVE

➢ Selecting the Problem

➢ Necessity of Defining the Problem

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SELECTING THE PROBLEM

The process of selecting a research problem involves identifying a topic that is both significant and feasible to study within the given constraints.

Importance of Selection:

1. Influences the Study's Outcome: The problem defines the scope and direction of your research, affecting all subsequent stages.

2. Ensures Relevance: A well-chosen problem addresses real-world needs or theoretical gaps.

3. Maximizes Impact: Focuses efforts on issues that contribute valuable insights to the field.

What should you consider when selecting a Research Problem??

SELECTING THE PROBLEM CONTD.

Steps to Select a Research Problem

4. Conduct Preliminary Research:
Gather background information to understand the context.

5. Evaluate Potential Problems:
Assess based on significance, feasibility, and interest.

6. Narrow Down Your Focus:
Use brainstorming and concept mapping.

6. Define the Problem Statement:
Ensure it is clear and concise with specific objectives.

How to formulate the Problem ?

SELECTING THE PROBLEM CONTD.

Criteria for Selecting a Research Problem

1. Significance: Contribution to knowledge and practical implications.

2. Feasibility: Availability of resources and data access.

3. Interest and Passion: Aligns with personal motivation and career goals.

4. Originality: Offers a unique perspective or novel approach.

NECESSITY OF DEFINING THE PROBLEM
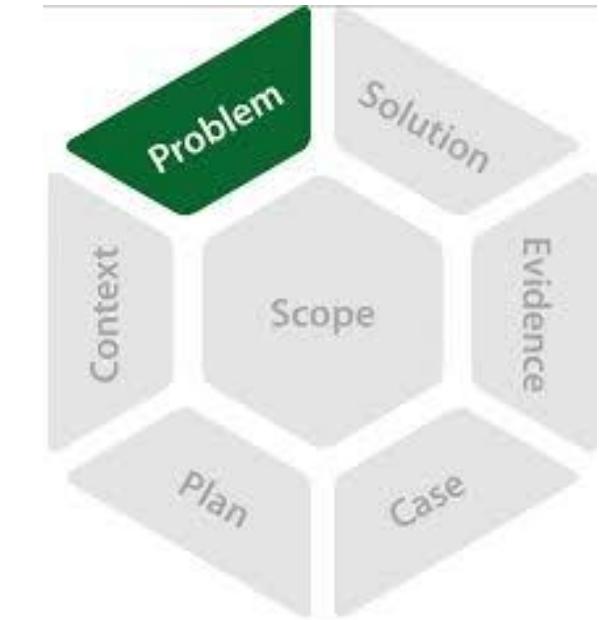
One must always define a problem correctly. In fact, research problem formulation is much more important than its prospective solution.

1. Provides Clarity and Focus:

   i. Guides the Research: Helps direct the study towards specific objectives and outcomes.

   ii. Prevents Ambiguity: Avoids confusion and misdirection by establishing clear parameters.

2. Enhances Research Efficiency:

   i. Saves Time and Resources: Reduces unnecessary exploration and helps streamline efforts.

   ii. Improves Planning: Facilitates the development of a clear research strategy.

SUMMARY

➢ Selecting the Problem

➢ Necessity of Defining the Problem

QUIZ

UNIT 2: Research Formulation : Defining and formulating the research problem. Selecting the problem - Necessity of defining the problem – Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs- patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.

LECTURE -3, IMPORTANCE OF LITERATURE REVIEW IN DEFINING A PROBLEM , LITERATURE REVIEW

RECAP

➤ Selecting the Problem

➤ Necessity of Defining the Problem

OBJECTIVE

➤ Literature Review

➤ Importance of Literature Review in Defining a Problem

LITERATURE REVIEW

It gives us knowledge about what others have found out in the related field of study and how they have done so.
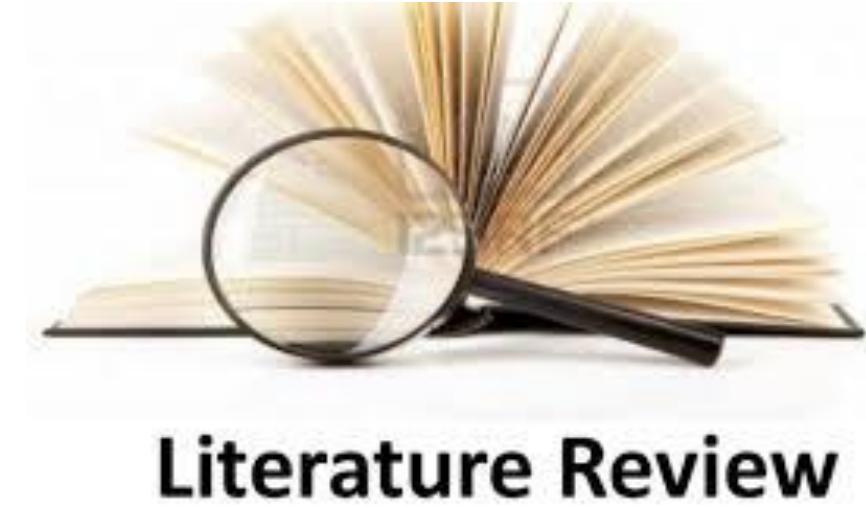
It is an extensive survey of all available past studies relevant to the field of investigation.

LITERATURE REVIEW

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Technologies

REVIEW PAPER

LITERATURE REVIEW CONTD.

Literature Review is the documentation of a comprehensive review of the published and unpublished work from secondary sources of data in the areas of specific interest to the researcher.

The main aim is to find out problems that are already investigated and those that need further investigation.

Literature Review

9 OPEN SCIENCE TOOLS TO HELP YOUR LITERATURE SEARCH
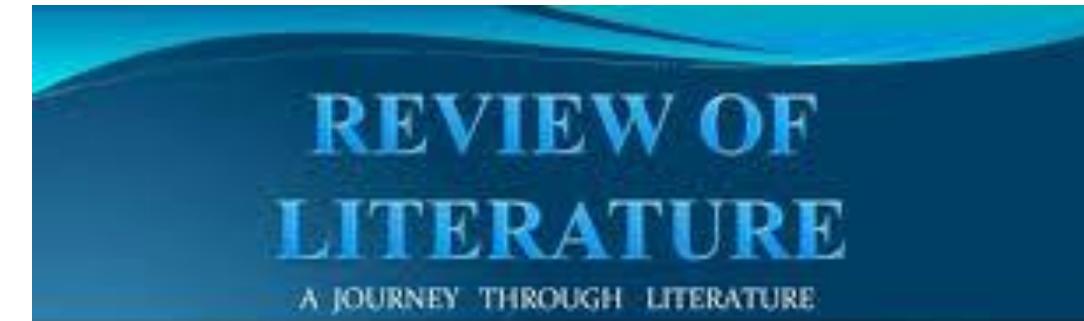
LITERATURE REVIEW CONTD.

1. **Definition:** A comprehensive summary and critical analysis of existing research

2. **Purpose:** To synthesize current knowledge on a topic

3. **Scope:** Includes academic articles, books, and other sources

4. **Importance:** Foundational step in research process

IMPORTANCE OF LITERATURE REVIEW IN DEFINING A PROBLEM

It serves several important purposes in research:

1.Contextualizing the Research Problem:
   - Literature reviews provide background information and context for the research problem. They help researchers understand the current state of knowledge in a particular field, allowing them to identify gaps, controversies, or areas that need further exploration.

2.Identifying Knowledge Gaps:
   - By reviewing existing literature, researchers can identify gaps in knowledge and areas where further research is needed. This helps in formulating research questions and objectives that contribute to the existing body of knowledge.

IMPORTANCE OF LITERATURE REVIEW IN DEFINING A PROBLEM CD.

3. Building a Theoretical Framework:
- Literature reviews help in establishing a theoretical framework for a study. They provide a foundation for understanding the concepts, theories, and models relevant to the research topic. This theoretical framework guides the formulation of hypotheses and the overall design of the study.

4. Avoiding Duplication of Effort:
- Researchers can avoid duplicating efforts by reviewing existing literature. This ensures that they do not repeat studies that have already been conducted, saving time and resources. Instead, researchers can focus on extending or building upon existing knowledge.

5. Evaluating Methodologies and Approaches:
- Literature reviews allow researchers to assess various methodologies and approaches used in previous studies. This helps in choosing appropriate methods for their own research and understanding the strengths and limitations of different research study designs.

IMPORTANCE OF LITERATURE REVIEW IN DEFINING A PROBLEM CD.

6. Providing a Rationale for Research Design:
  - A literature review justifies the choice of research design, methods, and instruments. It helps researchers explain why certain approaches were selected over others and how their study contributes to filling gaps or addressing limitations in the existing literature.

7. Criticizing and Synthesizing Findings:
  - Literature reviews involve critical analysis and synthesis of research findings. Researchers evaluate the quality of previous studies, identify inconsistencies or contradictions in the literature, and synthesize information to develop a comprehensive understanding of the topic.

8. Supporting the Significance of the Study:
  - Literature reviews contribute to the significance of a research study by demonstrating its relevance in the context of existing knowledge. They help researchers articulate the importance of their work and how it advances understanding or addresses practical problems.

SUMMARY

➢ Literature Review

➢ Importance of Literature Review
in defining a Problem

PROBLEMS FOR PRACTICE

UNIT 2: Research Formulation : Defining and formulating the research problem. Selecting the problem - Necessity of defining the problem – Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs- patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.

LECTURE -4, PRIMARY AND SECONDARY SOURCES , REVIEWS, TREATISE, MONOGRAPHS, PATENTS

RECAP

- Literature Review

- Importance of Literature Review in defining a Problem

OBJECTIVE

- Primary and Secondary Sources

- Reviews and Treatise

- Monographs and Patents
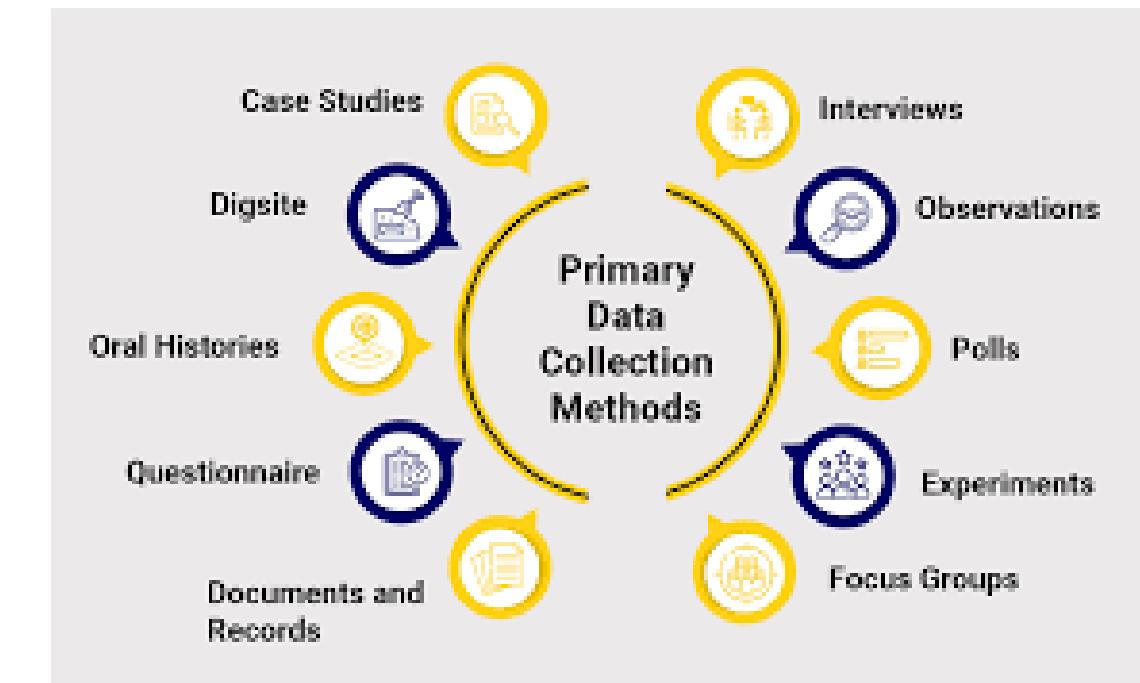
PRIMARY AND SECONDARY SOURCES

Primary Sources

Definition: Original materials or first-hand accounts

Examples:

✓ Original research articles

✓ Patents

✓ Interviews

✓ Diaries or personal accounts

✓ Raw data or statistics

Importance: Provide direct evidence and new insights

PRIMARY AND SECONDARY SOURCES CONTD.

Secondary Sources
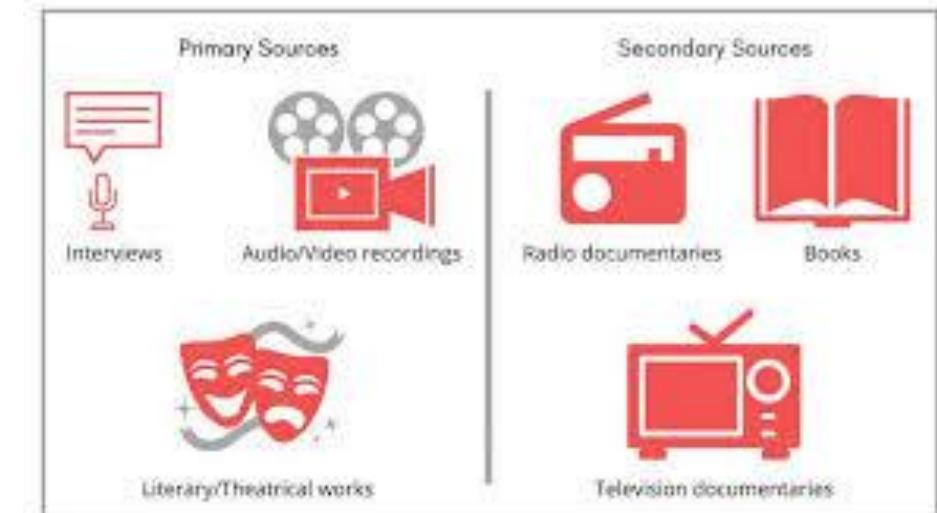
Definition: Subset of primary sources, it works that analyze, interpret, or discuss.
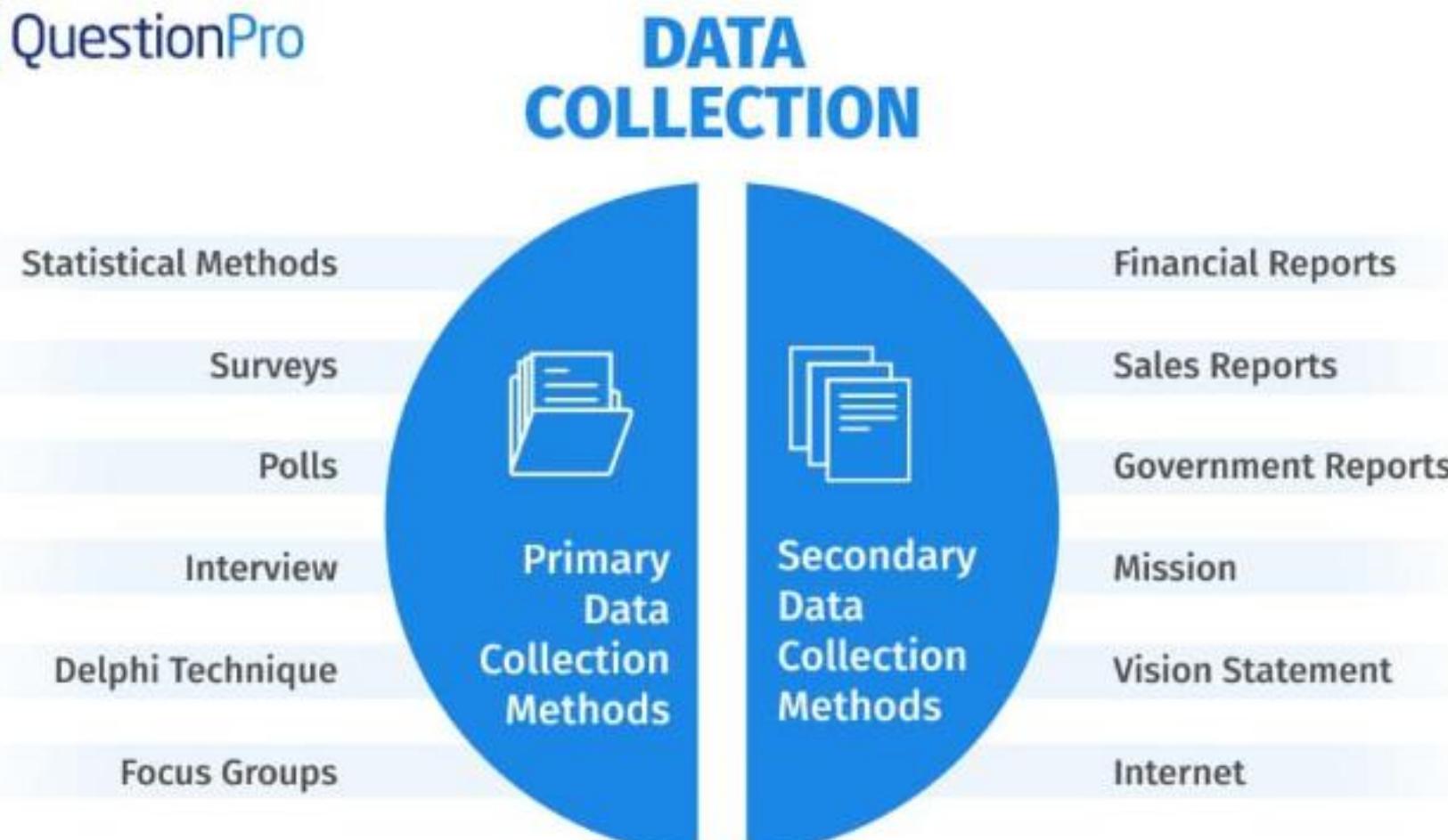
Examples: • Review articles

➢ Meta-analyses

➢ Textbooks

➢ Biographies

➢ Commentaries on original research

Importance: Offer context and synthesis of multiple primary sources

PRIMARY AND SECONDARY SOURCES CONTD.

PRIMARY AND SECONDARY SOURCES CONTD.

Feature	Primary Research	Secondary Research
Data Collection	• Original data	• Existing data
Time	• Often time-consuming	• Can be quicker
Cost	• Can be expensive	• Generally less expensive
Control	• Researcher has high control	• Researcher has limited control
Relevance	• Highly relevant to specific research question	• May need to be adapted to fit research question

Key Differences between Primary and Secondary Research

REVIEWS

Role in Literature Review:
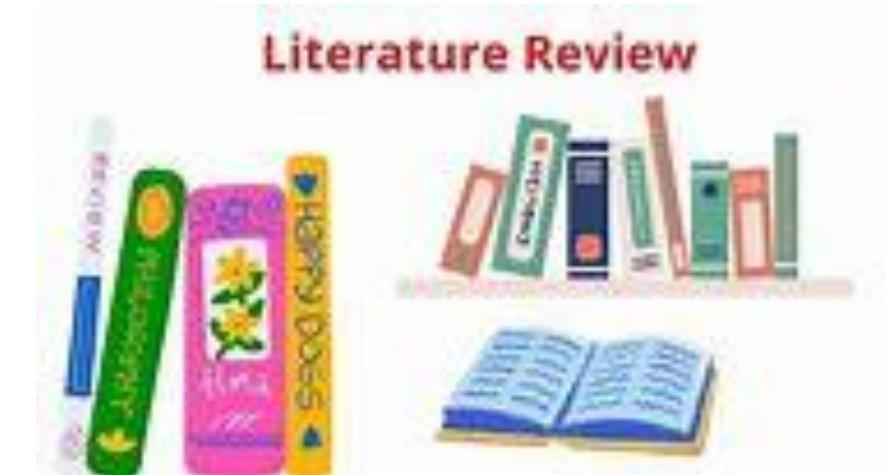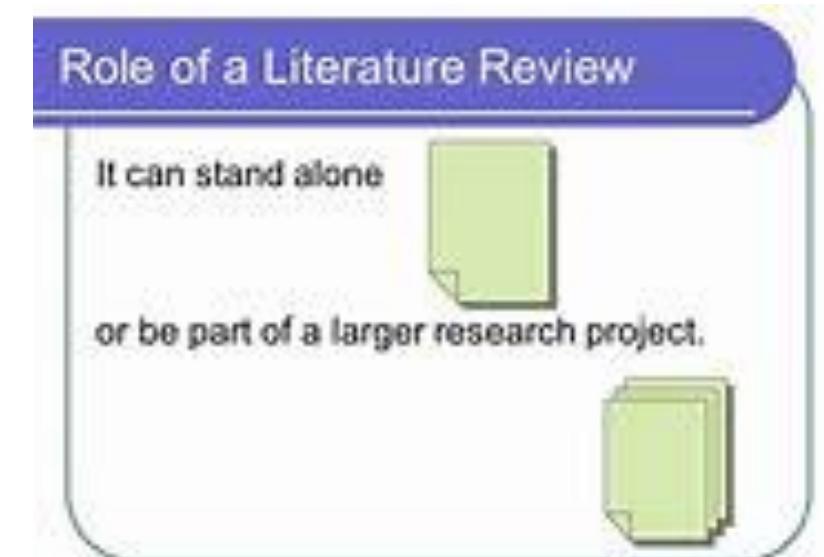
1. Primary sources: Form the core of your review, providing direct evidence

2. Secondary sources: Help interpret primary sources and identify trends

Balancing Sources:

Aim for a mix of both types

Use secondary sources to guide you to relevant primary sources

Critically evaluate both types for reliability and relevance

Role of a Literature Review

It can stand alone

or be part of a larger research project.

Literature Review
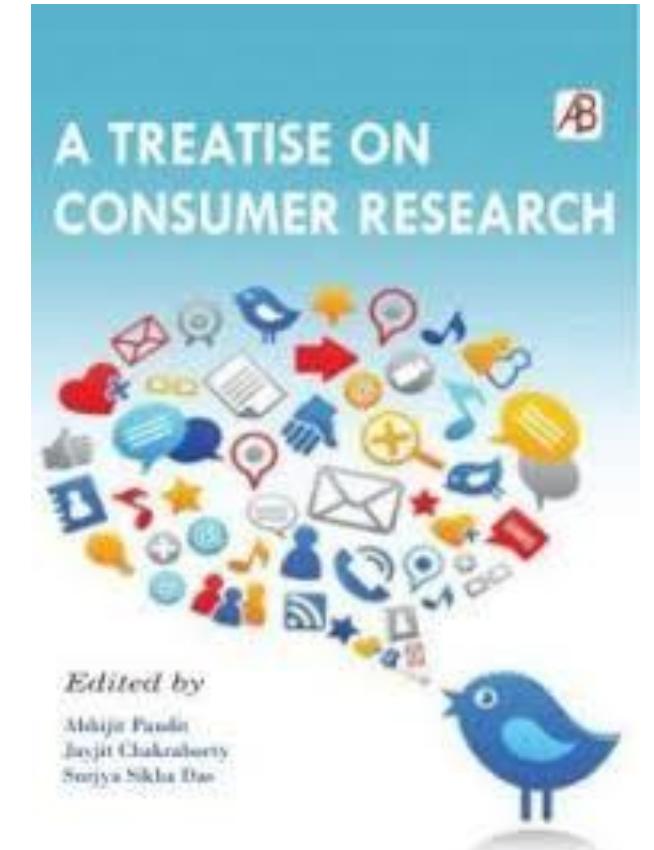
TREATISE

Treatise:

A type of secondary authority that extensively covers one topic.

Treatises are available in print and electronic formats.

The size of a treatise may vary from one single volume set to a large multi-volume set.

MONOGRAPHS AND PATENTS

Monographs

Its primary data type

They are single-volume, in-depth scholarly works focused on a specific subject or aspect of a subject.
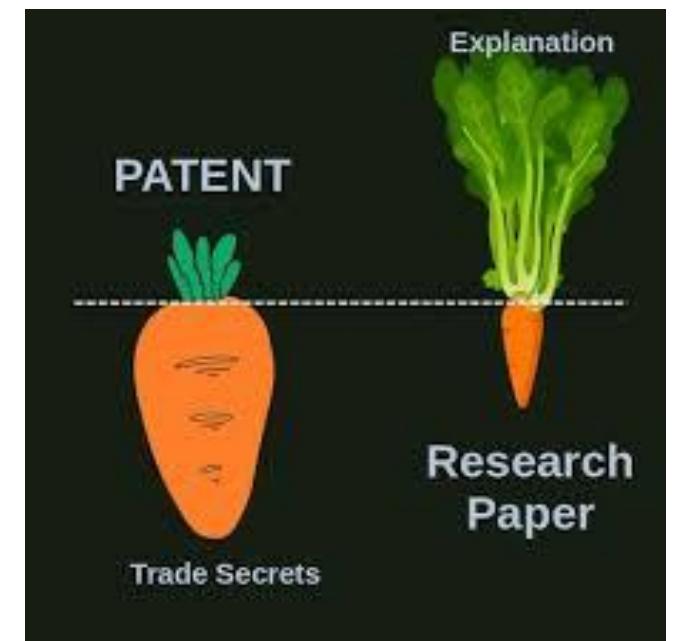
They often represent original research and contribute new insights to academic fields, distinguishing them from textbooks which offer broader surveys.

PATENTS

Patents are primary sources and a legal mechanism for researchers and inventors to protect their intellectual property (IP), specifically new inventions, for a period of up to maximum 20 years.
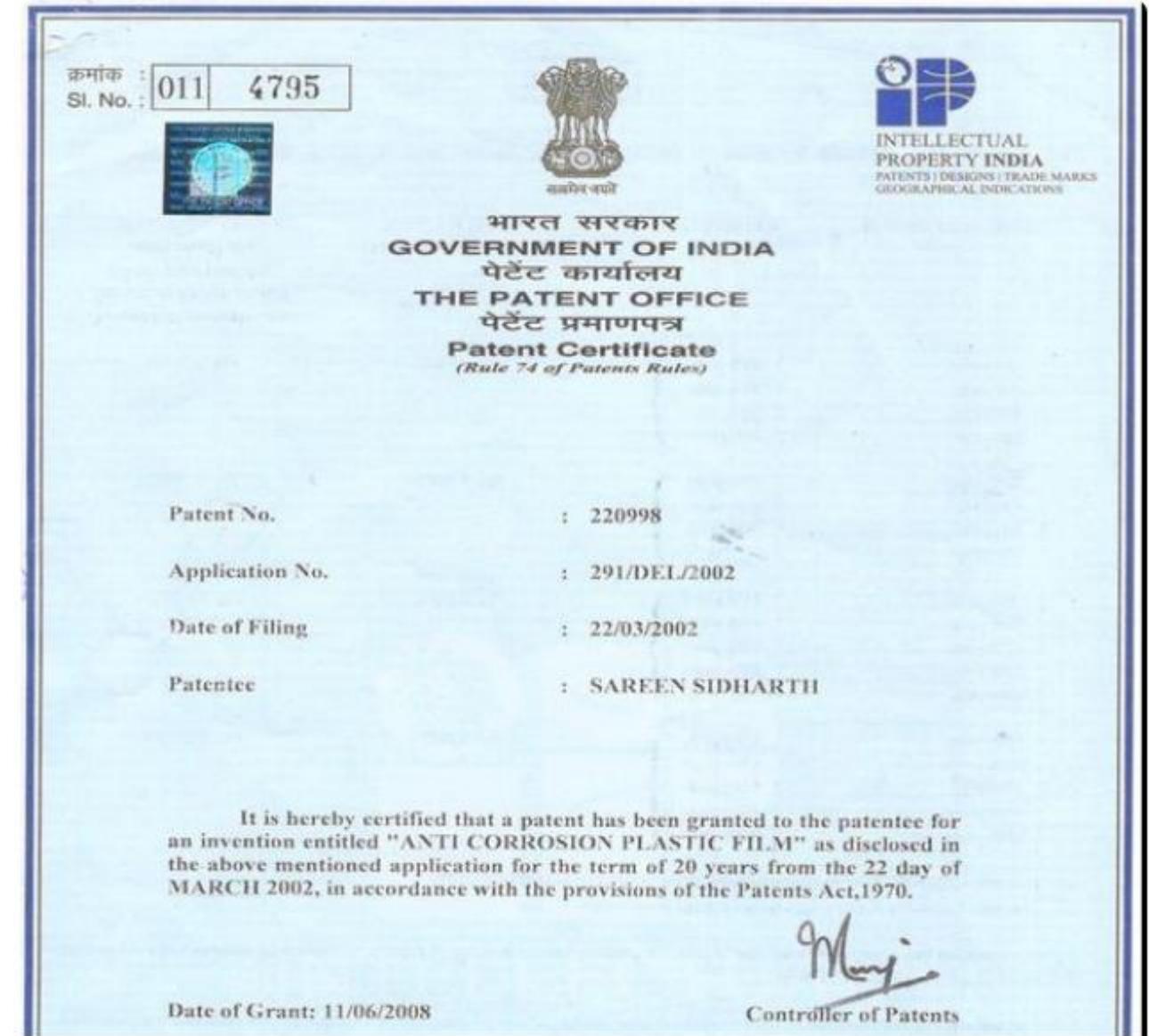
They provide exclusive rights to the patent holder, preventing others from making, using, or selling the patented invention without their consent.

PATENTS

Example:
Many drug companies and university researchers seek patent protection to recover research and development costs for patents related to specific genes and proteins, laboratory techniques and drugs.

SUMMARY

➢ Primary and Secondary Sources

➢ Reviews and Treatise

➢ Monographs and Patents

PROBLEMS FOR PRACTICE

UNIT 2: Research Formulation : Defining and formulating the research problem. Selecting the problem - Necessity of defining the problem – Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs- patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.

LECTURE -5, WEB AS A SOURCE , SEARCHING THE WEB

RECAP

➢ Primary and Secondary Sources

➢ Reviews and Treatise

➢ Monographs and Patents

OBJECTIVE

➢ Web as a Source

➢ Searching the Web
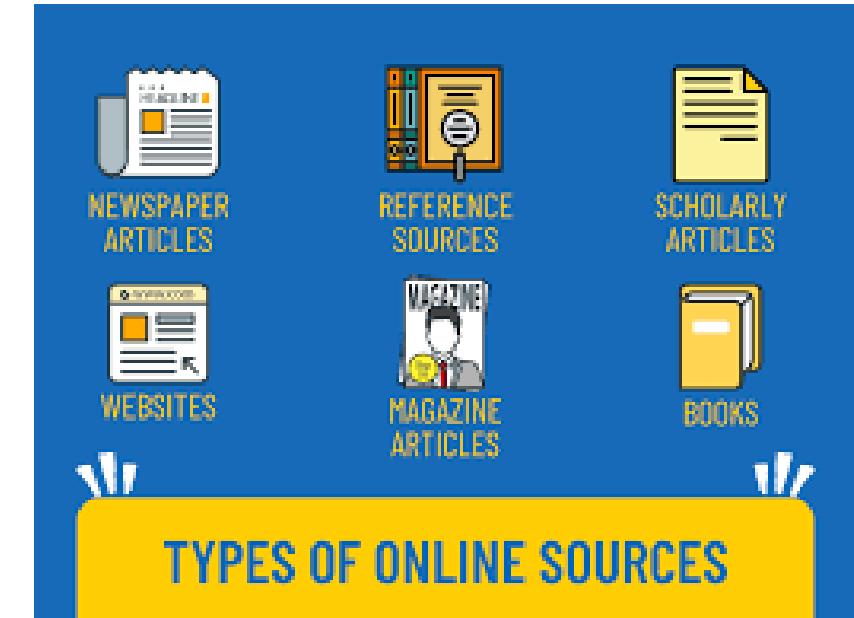
# WEB AS A SOURCE

Web as a sources can be broadly categorized into several types, including websites, web pages, blogs, online articles, social media, and more. These sources vary in their format, purpose, and reliability, offering diverse avenues for information access and consumption

Types of web sources:
- Academic databases (e.g., JSTOR, Science Direct)
- Open access journals
- Institutional repositories
- Preprint servers (e.g., arXiv)
- Government websites
- Professional organizations

SEARCHING THE WEB

➢ Use of Boolean operators (AND, OR, NOT)

➢ Phrase searching with quotation marks

➢ Wildcard and truncation symbols (* and ?)

➢ Advanced search features:

- Site-specific searches (site: edu)

- File type specification (filetype :pdf)

➢ Utilizing search filters:

- Date range • Language • Geographic region

➢ Importance of keyword selection and variation

SEARCHING THE WEB

1. General academic search engines:

- Google Scholar
- Microsoft Academic
- Semantic Scholar

2. Subject-specific databases:

- PubMed (medicine) • IEEE Xplore (engineering) • ERIC (education)
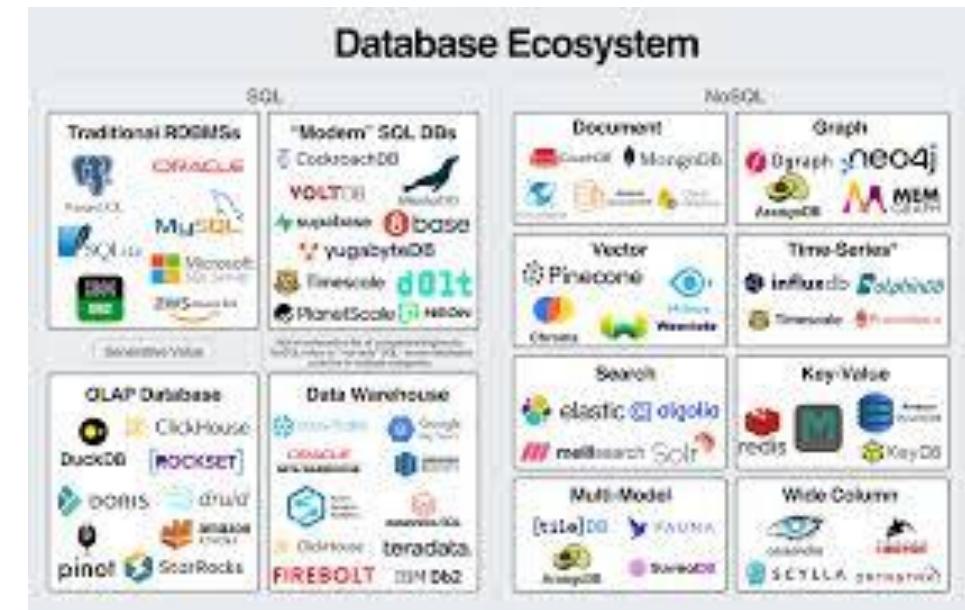
3. Features to leverage:

- Citation tracking • Author profiles • Related article suggestions

4. Access considerations:

- Institutional subscriptions • Open access options

Academic Search Engines (Free)

Santosh Kumar Kori
(Librarian)
Govt. College Makroniya, Sagar M.P.

Database Ecosystem

SEARCHING THE WEB CONTD.

5. Reference management tools:
   • Zotero • Mendeley • EndNote
6. Features:
   • Automatic citation capture • PDF annotation • Bibliography generation
7. Organizing strategies:
   • Tagging and categorizing sources • Creating thematic folders • Maintaining research notes
8. Best practices:
   • Regular backups • Consistent naming conventions • Proper attribution and citation
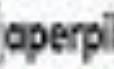
Best Reference Management Tools for Researchers

Zotero	**Zotero** offers automatic citation capture from web pages, PDFs, and other sources.
Mendeley	**Mendeley** integrates very easily with Microsoft Word for seamless citation and bibliography generation.
EndNote	**EndNote** is very user-friendly and is widely used in the scientific and academic community.
RefWorks	**RefWorks** supports direct export from many popular databases. Also, you can attack PDFs.
JabRef	**JabRef** offers options for over 15 reference formats. Also, fetches info based on ISB, DOI and arXiv-ID.
Paperpile	**PaperPile** allows you to add citations to Google docs. It has a very smart and intuitive interface.
Crossref	**CrossRef** is a not-for-profit organization that makes research objects easy to find, cite, link, assess, and reuse.

SEARCHING THE WEB CONTD.

Best Reference Management Tools for Researchers

zotero	**Zotero** offers automatic citation capture from web pages, PDFs, and other sources.
Mendeley	**Mendeley** integrates very easily with Microsoft Word for seamless citation and bibliography generation.
EN EndNote	**EndNote** is very user-friendly and is widely used in the scientific and academic community.
RefWorks	**RefWorks** supports direct export from many popular databases. Also, you can attack PDFs.
JabRef	**JobRef** offers options for over 15 reference formats. Also, fetches info based on ISB, DOI, and arXiv-ID.
Paperpile	**PaperPile** allows you to add citations to Google docs. It has a very smart and intuitive interface.
Crossref	**CrossRef** is a not-for-profit organization that makes research objects easy to find, cite, link, assess, and reuse.

SUMMARY

➢ Web as a Source

➢ Searching the Web

PROBLEM FOR PRACTICE

UNIT 2: Research Formulation : Defining and formulating the research problem. Selecting the problem - Necessity of defining the problem – Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs- patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.

LECTURE -6, CRITICAL LITERATURE REVIEW, IDENTIFYING GAP AREAS FROM LITERATURE REVIEW

RECAP

- ➢ Web as a Source

- ➢ Searching the Web

OBJECTIVE

- ➢ Critical Literature Review

- ➢ Identifying Gap Areas from Literature Review

CRITICAL LITERATURE REVIEW

A critical literature review analyzes and evaluates multiple sources on a specific topic, summarizing the current state of knowledge, highlighting strengths and weaknesses, and identifying gaps in research.

It goes beyond simple summarization to critically assess arguments, compare sources, and draw conclusions about the overall understanding of the topic.

IDENTIFYING GAP AREAS FROM LITERATURE REVIEW

"A Research Gap is an area or topic within a field that lacks sufficient or conclusive research and understanding."

Identifying Research gaps in the literature is a critical part of conducting a literature review, as it highlights areas that require further research and contributes to advancing the field.
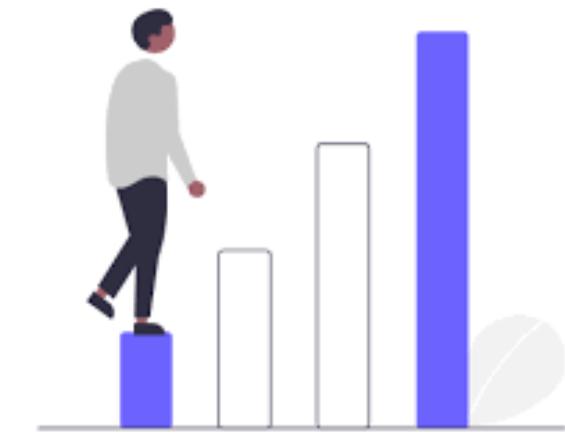
IDENTIFYING GAP AREAS FROM LITERATURE REVIEW CONTD.

Importance of Identifying Gaps:

➢ Discuss why identifying gaps is crucial for advancing knowledge. Consider points like:

➢ Guiding future research directions.

➢ Highlighting opportunities for innovation.

➢ Addressing overlooked or emerging issues.

GAP ANALYSIS
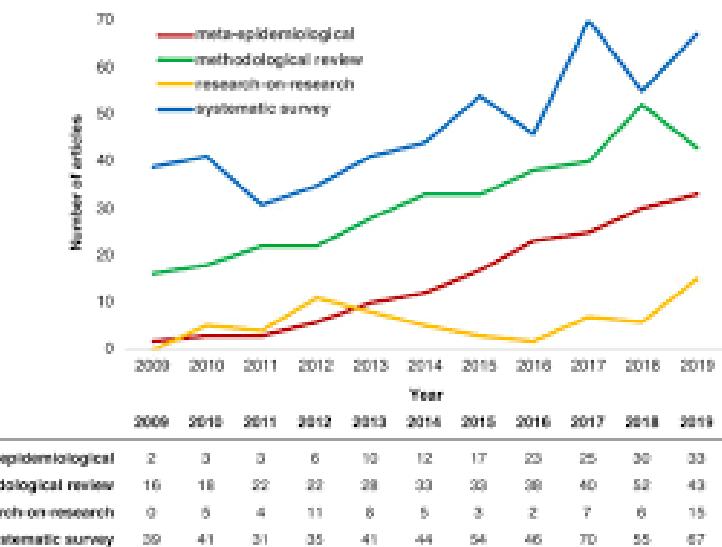
Gap Analysis

Objective of Gap Analysis:
"This analysis aims to identify unaddressed areas in the current literature on specific topic."
**Types of Gap Analysis:**
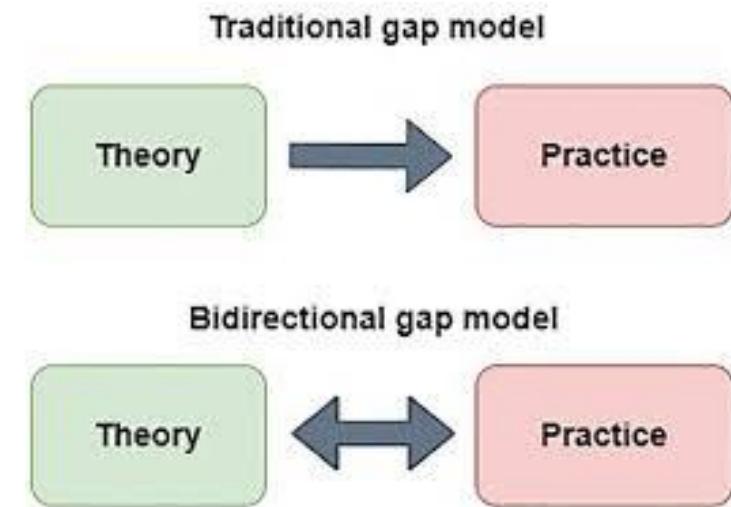
Knowledge Gaps: Areas where information is incomplete or lacking. For example: "Limited understanding of specific aspect."

Methodological Gaps: Flaws or limitations in existing research methods. For example: "Reliance on qualitative data without quantitative validation."

IDENTIFYING GAP AREAS FROM LITERATURE REVIEW CONTD.

Theoretical Gaps: Lack of comprehensive theories or models. For example: "Absence of a unified theory to explain specific phenomenon."
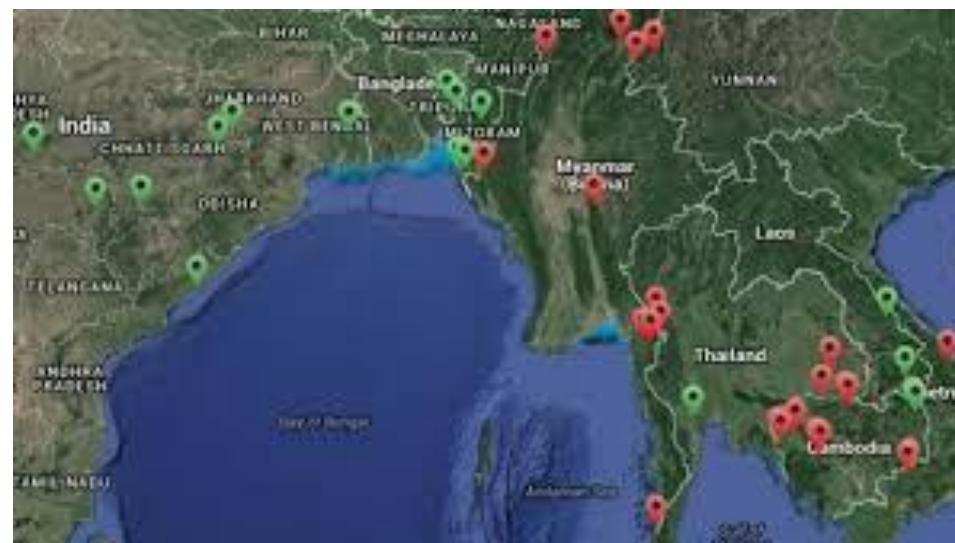
Population Gaps: Underrepresentation of certain groups or demographics. For example: "Limited research on specific group."

Geographical Gaps: Areas or regions that have been under-researched.
For example: "Most studies focus on Western countries, neglecting Asia and Africa."

SUMMARY

➢ Critical Literature Review

➢ Identifying Gap Areas from Literature Review

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PROBLEMS FOR PRACTICE

UNIT 2: Research Formulation : Defining and formulating the research problem. Selecting the problem - Necessity of defining the problem – Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs- patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.

LECTURE -7, DEVELOPMENT OF WORKING HYPOTHESIS
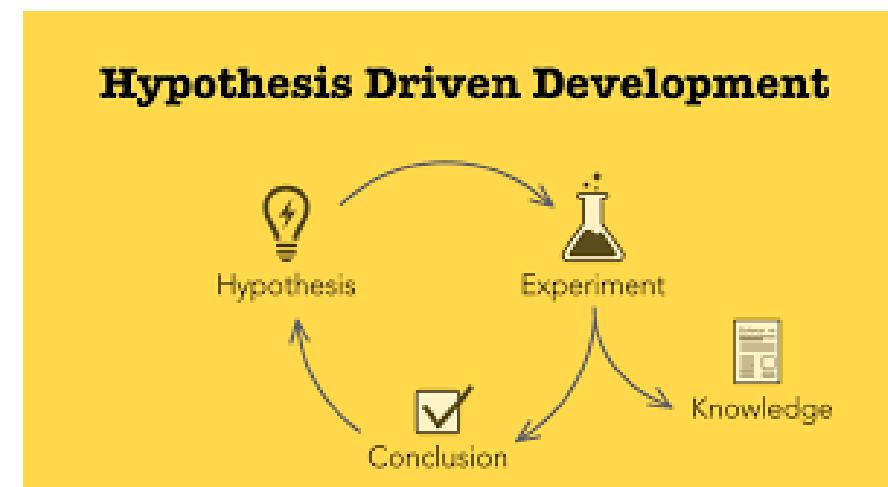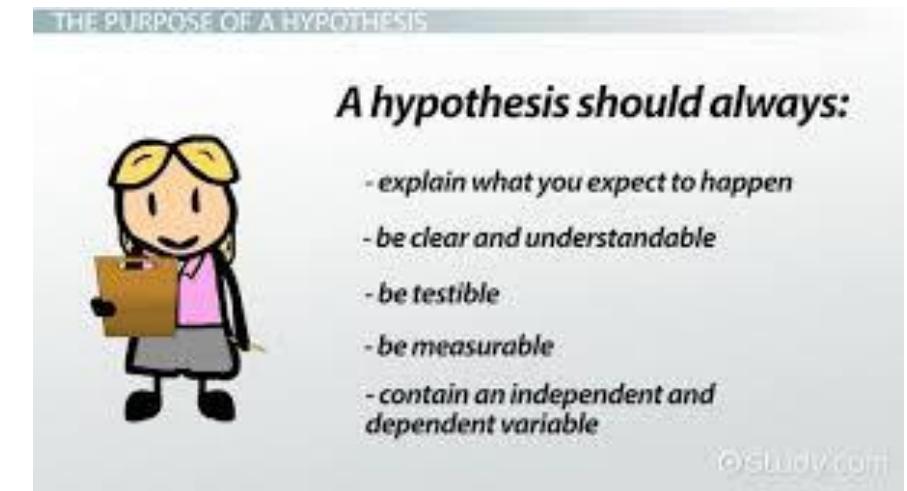
RECAP

➢ Critical Literature Review

➢ Identifying Gap Areas from Literature Review

OBJECTIVE

➢ Development of Working Hypothesis.

➢ Characteristics of a Good Hypothesis

➢ Directional vs. Non-directional Hypotheses

DEVELOPMENT OF WORKING HYPOTHESIS

Definition of a Working Hypothesis:
"A working hypothesis is a testable statement that predicts a possible outcome or explains a observed phenomenon based on existing knowledge."


THE PURPOSE OF A HYPOTHESIS

A hypothesis should always:
- explain what you expect to happen
- be clear and understandable
- be testible
- be measurable
- contain an independent and dependent variable

Hypothesis Driven Development

Hypothesis
Experiment
Knowledge
Conclusion
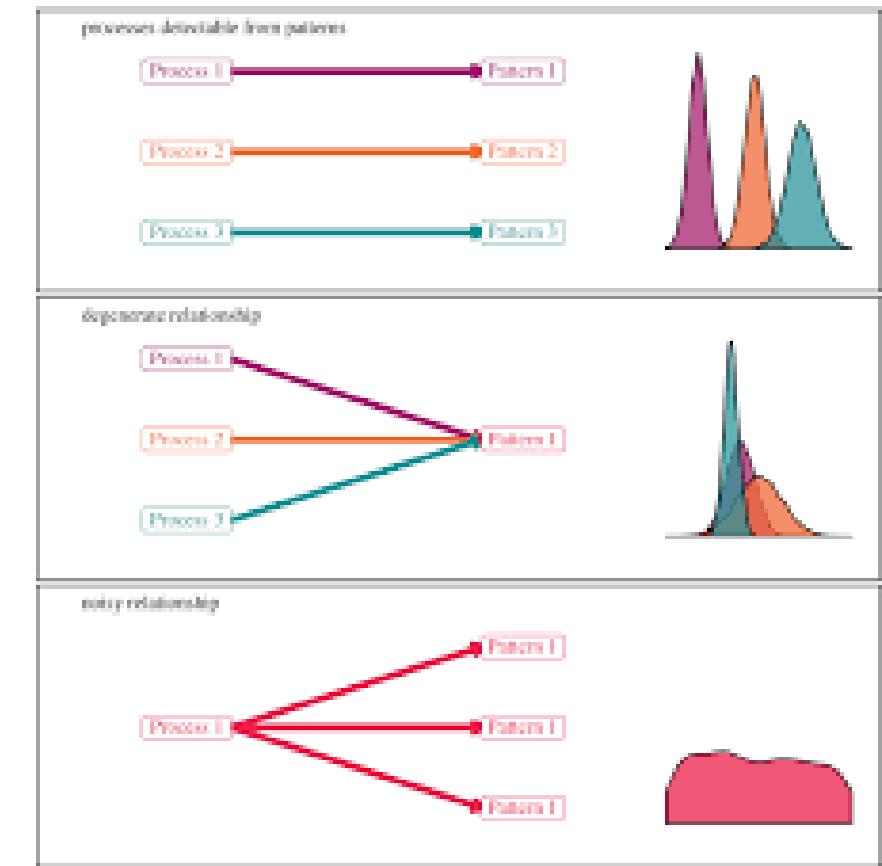
DEVELOPMENT OF WORKING HYPOTHESIS CONTD.

Purpose and Importance:

Describe why a working hypothesis is essential in research:
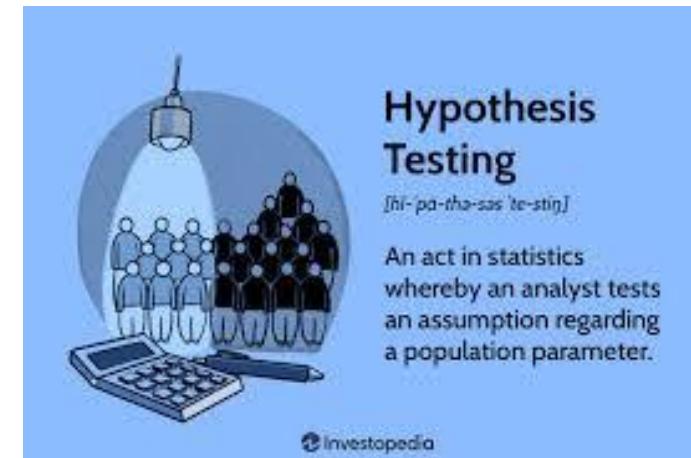
- ➤ Guides the research process by providing a clear focus.

- ➤ Helps in formulating research questions and designing experiments.

- ➤ Facilitates the interpretation of results

CHARACTERISTICS OF A GOOD HYPOTHESIS.

State the key characteristics:

➢ **Testable:** Can be empirically tested using experiments or observations.

➢ **Specific**: Clearly defined and focused.

➢ **Falsifiable**: Can be proven false through evidence.

DEVELOPMENT OF WORKING HYPOTHESIS CONTD.

Step 1: Conduct a Literature Review:
Briefly explain the importance of reviewing existing literature to identify gaps and gather background information.

Step 2: Identify Key Variables:
Define the variables involved in the research. For example: "In a study on the effects of sleep on cognitive performance, the key variables might be sleep duration (independent variable) and test scores (dependent variable)."

DEVELOPMENT OF WORKING HYPOTHESIS CONTD.

Step 3: Formulate the Hypothesis:
Discuss how to articulate the hypothesis based on the literature review and identified variables.
Example of Hypothesis Structure: "If [independent variable], then [dependent variable], because [rationale based on literature]."
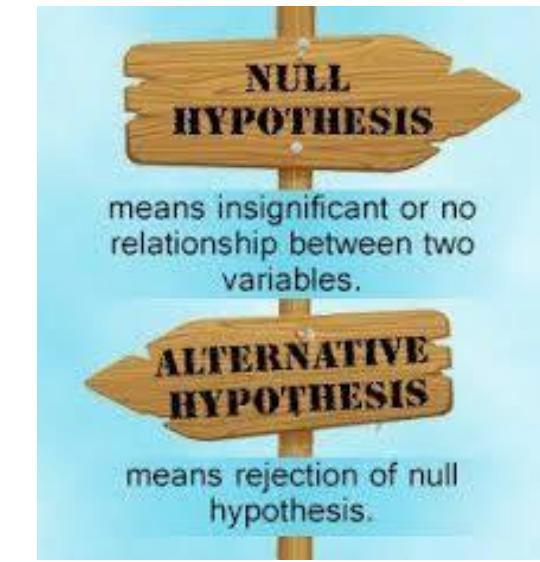
# DEVELOPMENT OF WORKING HYPOTHESIS CONTD.

Null Hypothesis (H$_0$):
Definition: A statement that there is no effect or no difference.
Example: "There is no significant difference in test scores between students who sleep 8 hours and those who sleep 6 hours."

Alternative Hypothesis (H$_1$):
Definition: A statement that indicates the presence of an effect or difference.
Example: "Students who sleep 8 hours score significantly higher on tests than those who sleep 6 hours."

NULL HYPOTHESIS
means insignificant or no relationship between two variables.

ALTERNATIVE HYPOTHESIS
means rejection of null hypothesis.

Null Hypothesis:

$H_0; \mu = 85\%$
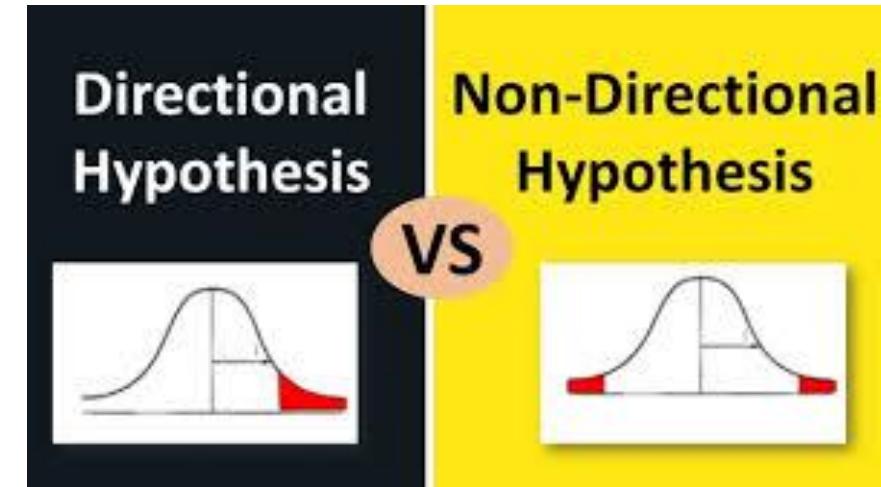
Alternative Hypothesis:

$H_1; \mu \neq 85\%$

DIRECTIONAL VS. NON-DIRECTIONAL HYPOTHESES.
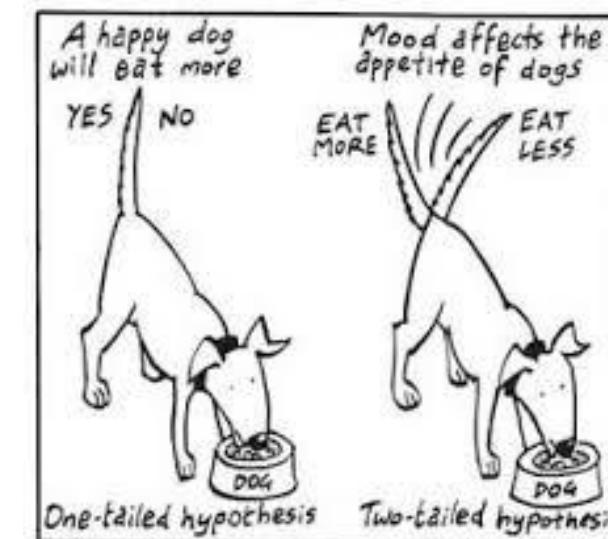
Directional Hypothesis: Predicts the direction of the effect.
Example: "Increased sleep leads to higher test scores."

Non-directional Hypothesis: Predicts an effect but not the direction.
Example: "There is a difference in test scores based on sleep duration."

SUMMARY

➢ Development of Working Hypothesis

➢ Characteristics of a Good Hypothesis

➢ Directional vs. Non-directional Hypotheses

PROBLEMS FOR PRACTICE

UNIT 2: Research Formulation : Defining and formulating the research problem. Selecting the problem - Necessity of defining the problem – Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs- patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.