The Art and Science of Transportation Research in the AI Era

Research Design and Methodology

M.Sc. Hiba Karam

Learning Goals

#1   Understand what is research

#2   Understand why we conduct research

#3   Understand research process

#4   Understand how to find a research topic

Lecture Structure

#1 Research Definition

#2 Research Purpose and Why We Conduct Research

#3 Research Process

#4 Finding a Topic

#5 Recap

#1 Research Definition

- Commonly used definition of research are:

"Research is a systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions." Oxford English Dictionary

"Research is a process of steps used to collect and analyze information to increase our understanding of a topic or issue". (Creswell, 2014)

- Research consists of three steps: **pose a question, collect data to answer the question, and present an answer to the question.**

- Therefore, research is everything, not just limited to writing a thesis; it is a fundamental process that applies to all aspects of learning, problem-solving, and decision-making in both **academic and real-world contexts.**

- Scientific Research: because it is more focused on generating new empirical knowledge and explaining natural or social phenomena through structured methodology.

#1 Research Definition

- Therefore, while we'll occasionally focus on the specifics of writing your thesis, keep in mind that the impact of research can **extend well beyond academia.**

- The process of research we discuss here can be used to conduct research shaping **policy decisions, influence urban transportation development, improving infrastructure, optimizing traffic management, and advance sustainable mobility systems, among other vital areas.**

#2 Research Purpose I Why We Conduct Research

Research is typically conducted for one of three main purposes: exploratory, descriptive, or explanatory, depending on the research objective (Creswell, 2014).

1. **Exploratory:** As the name suggests, researchers conduct exploratory studies **to explore and investigate an issue or phenomenon where little is known**. The answers and analytics may not offer a conclusion to the perceived problem.

2. Descriptive: It focuses on expanding knowledge on current issues through a process of data collection. Descriptive research aims to **describe the characteristics of a population, event, or phenomenon.**

This type of research provides detailed and factual information. The three primary purposes of descriptive studies are **describing, explaining**, and **validating the findings**.

3. **Explanatory:** focuses on understanding the causes and effects of a

phenomenon, usually by identifying relationships and drawing

connections between variables.

#2 Research Purpose I Why We Conduct Research

Exploratory Research:

Investigating the potential impacts of autonomous vehicles on urban traffic flow.
This research explores new trends and technologies to formulate hypotheses or identify variables of interest.

Descriptive Research:

A study measuring current traffic patterns in a metropolitan area by using traffic counts and surveys
to describe the characteristics of peak traffic times and road usage.

Explanatory Research:

Research examining the relationship between road congestion and the introduction of congestion pricing.
This would aim to explain how congestion pricing affects traffic flow and driver behavior.

#3 Research Process
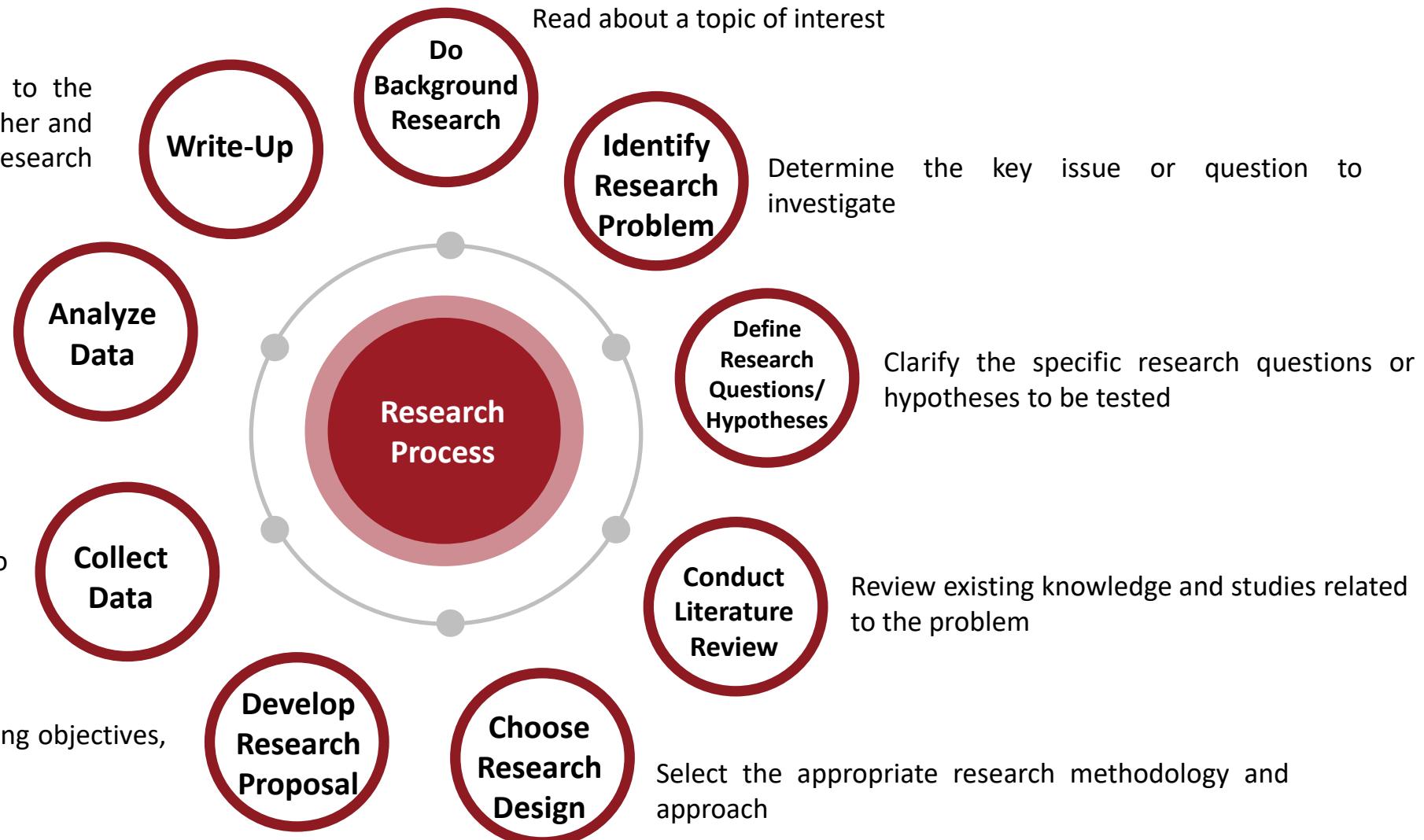
Make sense of the data and relate it to the research question or hypotheses and gather and reference sources and incorporate the research into your own writing

Read about a topic of interest

Determine the key issue or question to investigate
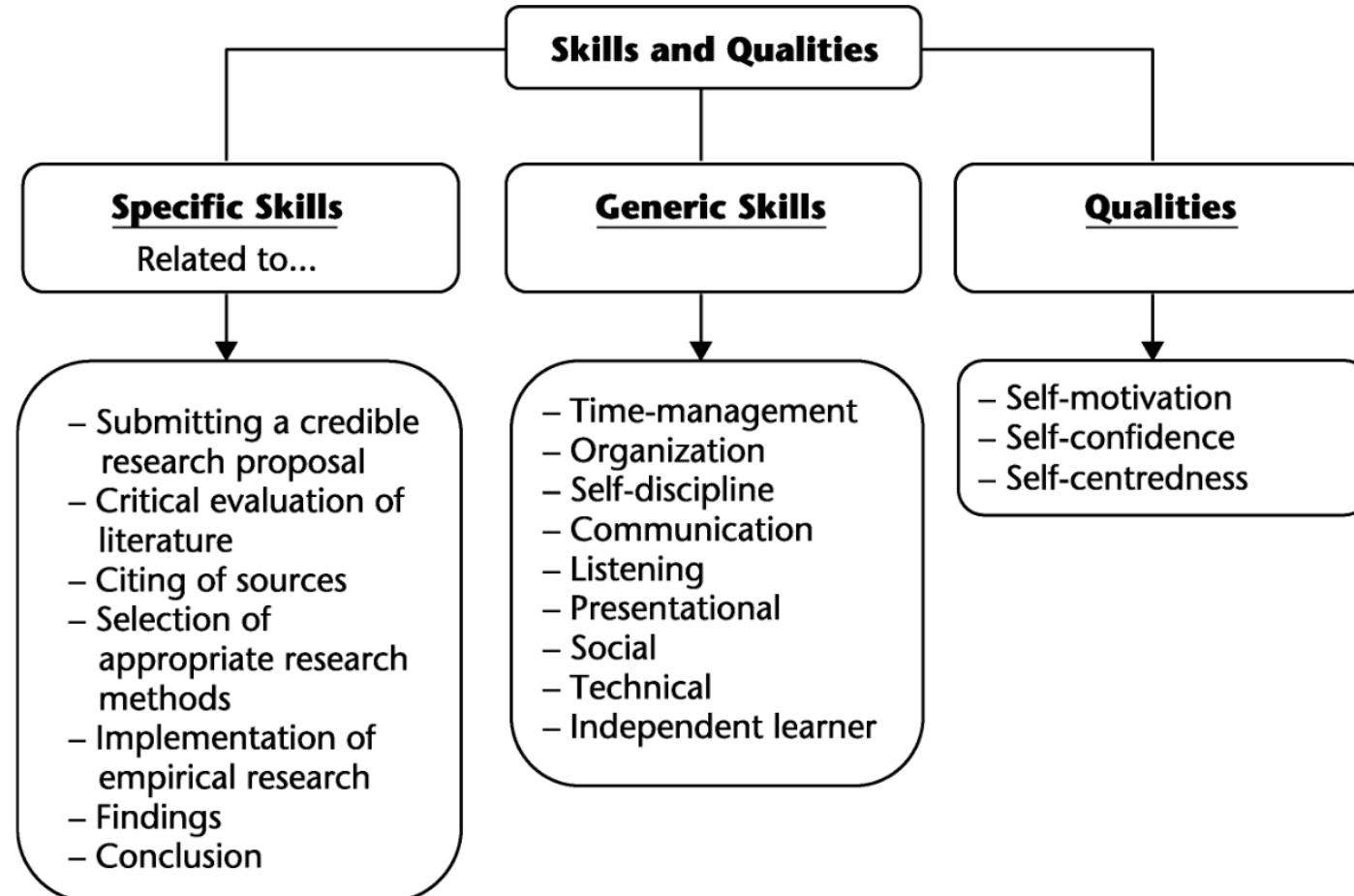
Process and analyze the collected data to draw meaningful conclusions

Clarify the specific research questions or hypotheses to be tested

Gather the necessary data according to the selected research design

Review existing knowledge and studies related to the problem

Outline the plan for the research, including objectives, methods, and expected outcomes

Select the appropriate research methodology and approach

Research Process

Do Background Research

Identify Research Problem

Define Research Questions/ Hypotheses

Conduct Literature Review

Choose Research Design

Develop Research Proposal

Collect Data

Analyze Data

Write-Up

#3 Research Process

Skills and qualities needed to succeed in writing your thesis

(Biggam, 2011)
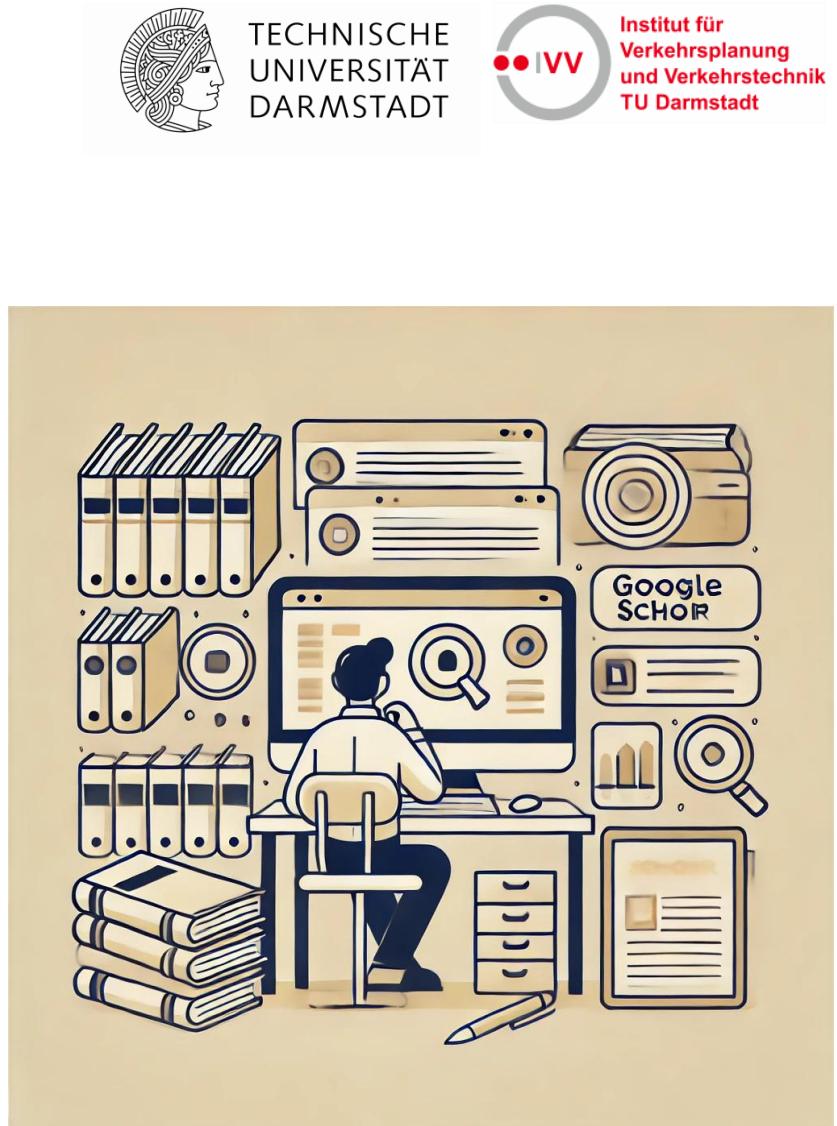
#4 Finding a Topic

- Sometimes, finding a topic for a research paper can be **the most challenging part of the process**.

- When you're looking out at a field brimming with possibilities, it's easy to get overwhelmed.

- Therefore, the next slides are designed to help you navigate and structure your thoughts throughout the process of finding a research topic.

#4.1 Finding a Topic | Background Research

- Start by doing **background research, or pre-research**, to figure out and grasp the foundational concepts, terminology, and context of the topic.

- Fill in any gaps by looking at **general sources** (Google, Wikipedia, etc.).

- Further explore conference proceedings, journal papers, and published reports through **publication platforms** (e.g., Web of Science, ScienceDirect, Google Scholar).

- You can utilize **university library databases** to gain subscription access.

#4.1 Finding a Topic l Background Research

Example: As cities grow and urbanization intensifies, **managing traffic congestion** has become a critical challenge for transportation planners. In response, **innovative smart mobility** solutions have emerged offering potential alternatives to traditional transportation.

#4.2 Finding a Topic l Research Gap

- Once you understand the basics of your topic, look for **disagreements** in the literature and investigate **conflicting** sources. By doing so, you can identify a research gap: **a missing or underexplored area in the field**.

- The research gap can help refine and narrow your research area.

- Avoid rushing to define your study's specifics. Readers need to understand **why** your research matters and **how** it meets a specific need.

- Identifying the research gap clarifies how your work will contribute to the existing body of knowledge or solve a problem.

#4.2 Finding a Topic l Research Gap

Example: With the rise of smart mobility solutions like ride-sharing and micro-mobility, cities are actively exploring innovative strategies to alleviate traffic congestion. However, despite the increasing adoption of these technologies, **current research on their actual impact on traffic flow and urban mobility is limited** (citation needed).

#4.3 Finding a Topic l Research Focus

- The research focus **narrows down** the broader topic to a specific aspect you want to investigate in depth. It **defines the boundaries of your research**.

- It is the specific element or issue within the research gap on which you will concentrate.

- The research focus helps frame your study by zooming in on a **manageable part of the topic** that you can explore in depth.

- **Example:** Therefore, this research will focus on analyzing the effects of ride-sharing and micro-mobility solutions, specifically **e-scooters**, in reducing peak-hour traffic congestion in **Berlin**. (Further justify this)

#4.4 Finding a Topic l Research Aim

- The research aim is the **overall goal or purpose** of your research. **It describes what you hope to achieve or the main focus of your study.**

- Your aim should clearly state **what your research will address in response to the identified gap**. It is usually broad, but specific enough to guide the entire research process.
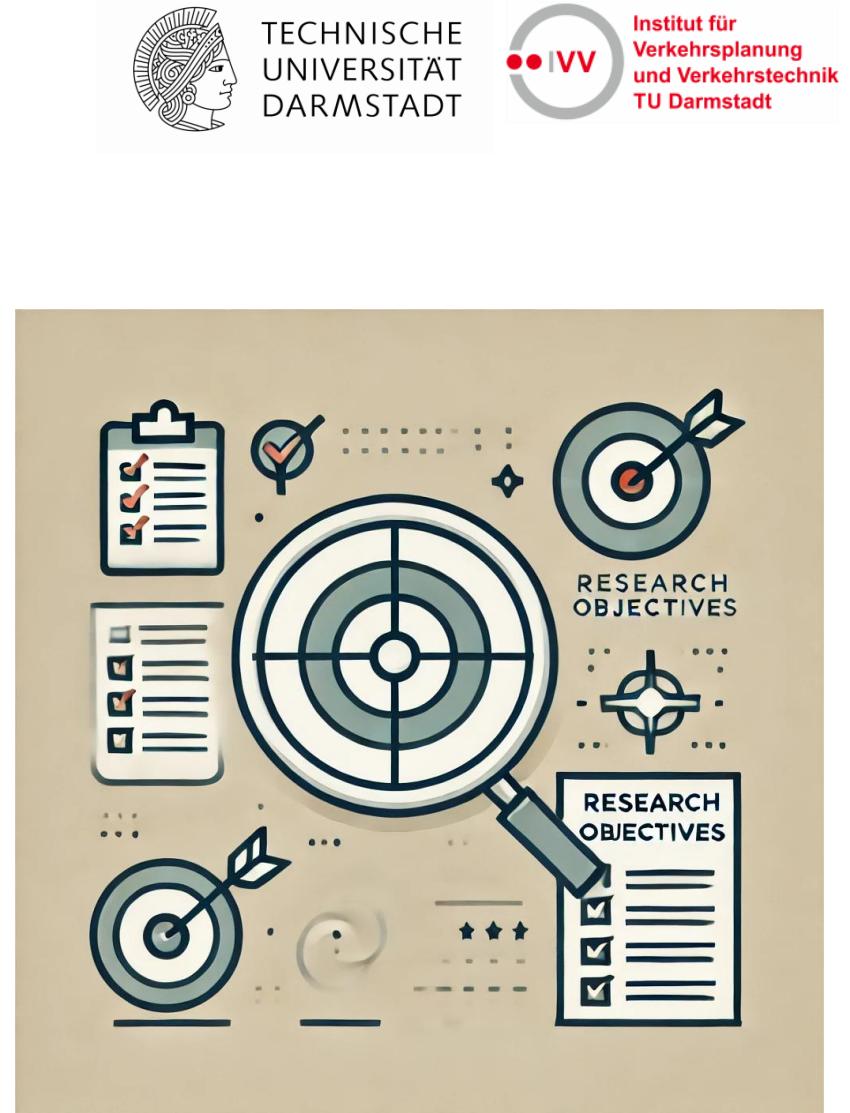
- **Example:** Therefore, the research aim is to thoroughly analyze the effectiveness of ride-sharing services and micro-mobility solutions, with a particular focus on **e-scooters**, in mitigating peak-hour traffic congestion in Berlin. By examining real-world data and usage patterns, this study seeks to **evaluate** how these alternative transportation modes **contribute to easing urban traffic pressure**, particularly during high-demand periods.

#4.5 Finding a Topic l Research Objectives
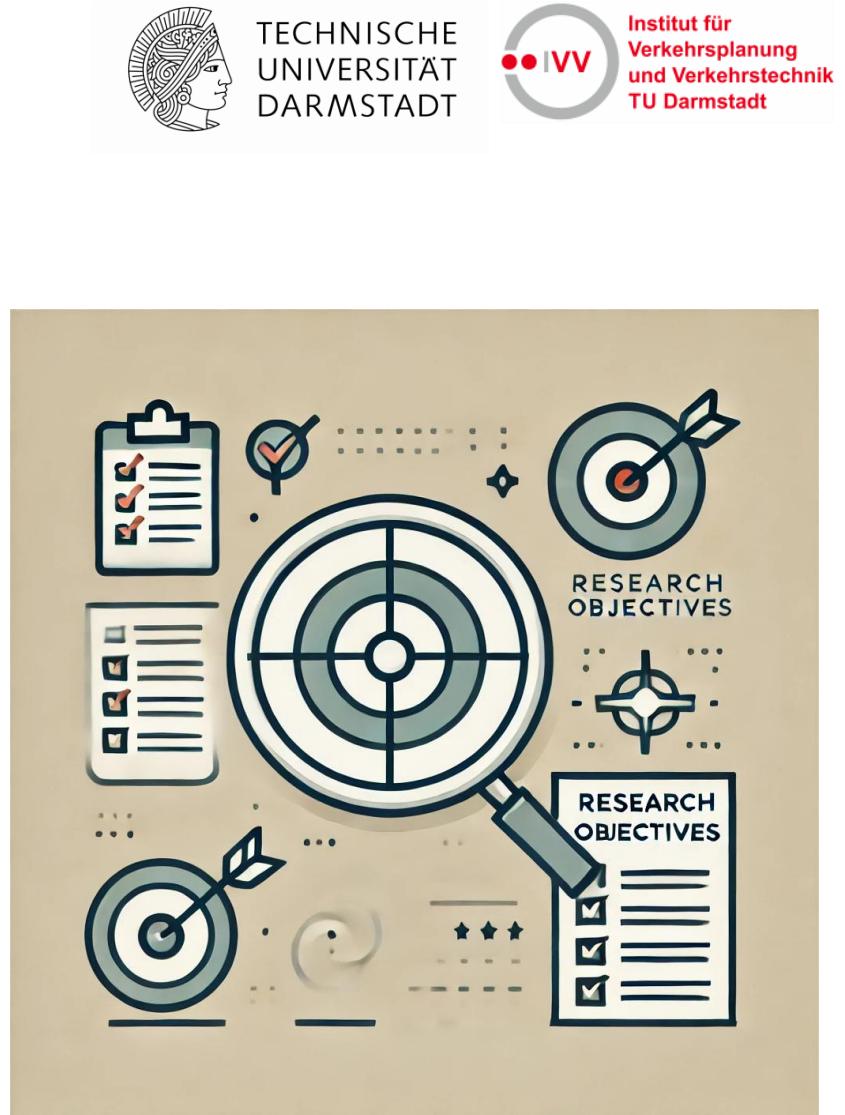
- The objectives are **specific steps or actions** you will take to achieve your research aim. They break down the aim into smaller, manageable components.

- Each objective should outline **what you plan to do**, such as collecting data, analyzing specific variables, or testing hypotheses.

- Objectives should be clear, concise, and achievable.

Example: The research objectives are:

1. To assess the current smart mobility solutions in Berlin.

2. To analyze real-world data and e-scooter usage patterns during high-demand periods in Berlin.

3. To assess how effectively e-scooters services contribute to easing urban traffic pressure.

- The research questions or hypotheses are **specific inquiries** or **predictions** that shape and guide your investigation. They are typically **derived from the research objectives** and help focus the direction of the study.

- Research questions should be **clear**, **concise**, and **closely aligned with the objectives**, addressing the key aspects you aim to explore. Hypotheses, on the other hand, are **testable statements** that propose expected outcomes based on existing knowledge or theory.

- Hypotheses are **optional**, but they are often useful.
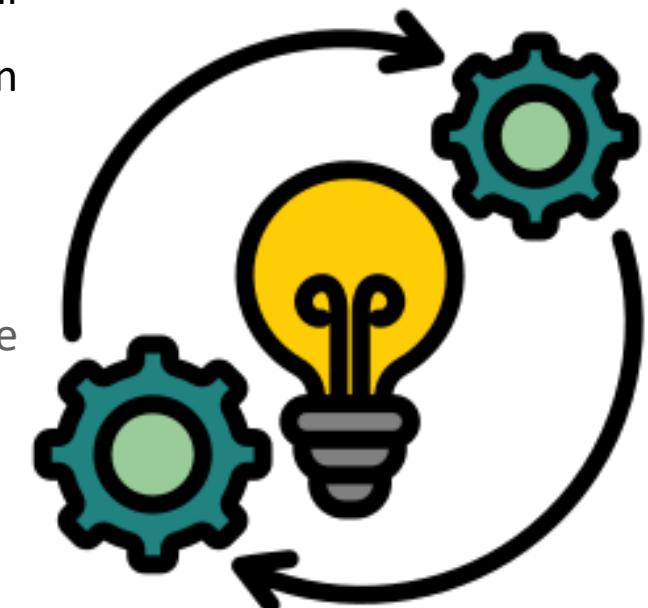
- **Example of Research Question**:

1. What smart mobility solutions are currently available in Berlin? (Objective 1)

2. What are the usage patterns of e-scooters during peak hours?

3. Which factors influence their use in Berlin? (Objective 2)

4. What are the measurable impacts of e-scooter use on overall traffic flow?

5. How effective are they in reducing congestion during peak hours? (Objective 3)

- **Example of Hypothesis**: "The implementation of e-scooters solutions will significantly reduce traffic congestion in urban areas."
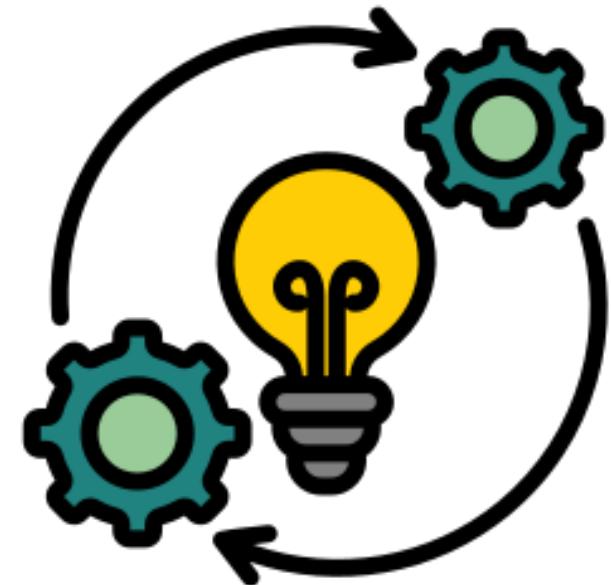
#4.7 Finding a Topic l Research Rationale

- The rationale explains **why the research is important, necessary, or relevant**. It connects your research to the broader field, **highlighting the significance of addressing the research gap.**

- The rationale should justify **why** this research is worth pursuing and how it will contribute to the existing body of knowledge. It can also address why your chosen research method is suitable.

- You can further break down and highlight the research rational and it is significance separately.

#4.7 Finding a Topic l Research Rationale

- The research rationale is to:

1. Address Traffic Congestion: Berlin faces peak-hour traffic challenges; alternative solutions are needed.

2. Evaluate Emerging Mobility: Limited research on the effectiveness of ride-sharing and micro-mobility solutions, specifically e-scooters in reducing congestion.

3. Sustainability Goals: Assess the contribution of e-scooters to sustainable urban mobility.

4. Optimize Mobility Systems: Identify areas for improvement in Berlin's transportation framework.

5. Support Policy Decisions: Provide data-driven insights for urban planning and mobility policy.

#5 Finding a Topic | Recap

Research Gap: Identifies what is missing in current knowledge

Research Focus: Zooms in on the specific part of the gap you'll study

Research Aim: Defines the overall goal of the research

Research Objectives: Breaks the aim into smaller steps. These tell how you will achieve the aim

Research Questions: Guides the investigation with specific inquiries

Research Rationale: Justifies why the research is important

References and Further Readings

Creswell, J.W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (4th ed.). Sage Publications.

Biggam, J. (2011). *Succeeding with Your Master's Dissertation: A step-by-step handbook.* Open University Press.

- **THANK YOU**
- **DANKE**