

The Art and Science of Transportation Research in the AI Era

Key Concepts in Research Design and Methodology

Meng Cai



Learning goals



TECHNISCHE
UNIVERSITÄT
DARMSTADT



Institut für
Verkehrsplanung
und Verkehrstechnik
TU Darmstadt

#1 Understand key concepts in research design and methodology

What we did in previous weeks



TECHNISCHE
UNIVERSITÄT
DARMSTADT



Institut für
Verkehrsplanung
und Verkehrstechnik
TU Darmstadt

https://transport.ec.europa.eu/news-events/news_en

👉 **DO THIS:** Here is an example project. We would like to find out what the European Union has done recently (let's say since 2024) to advance sustainable mobility and transport. One possible data source is the news we just scraped, but we need more information other than the title of the news.

So now please write some code to collect **the date, the title, the short description, the news type, and the link to the full text** of all news in 2024. Save the data to a **csv** file.

#1 What is a research question



TECHNISCHE
UNIVERSITÄT
DARMSTADT



Institut für
Verkehrsplanung
und Verkehrstechnik
TU Darmstadt

- A clear, focused, and answerable question that guides the research process.

- Our example:

- **General question:** What has the European Union done recently to advance sustainable mobility and transport?

- Broad and exploratory
- Initiate an inquiry

- **Research question:** How do the European Union's mobility and transport initiatives align with the United Nations Sustainable Development Goals?

- Precise
- Guide the research

#2 What is an operational definition

- Operational definitions clarify how abstract concepts are measured and observed within the context of a study.
- Our example:
 - Mobility and transport: The projects, policies, programs, or actions related to mobility and transport as reported in the news articles.
 - Sustainability: the United Nations Sustainable Development Goals (no poverty, zero hunger, good health and well-being, etc).



TECHNISCHE
UNIVERSITÄT
DARMSTADT



image source: <https://ifapa.net/new-un-enable-webpage/sdgwheel1/>

#3 What is a unit of study

- It is the primary element that is observed, analyzed, or measured in a study.
- Our example:
 - The unit of study is each individual news article (specifically, its title and short description) published on the European Union's mobility and transport news website.

TECHNISCHE UNIVERSITÄT DARMSTADT

Institut für Verkehrsplanung und Verkehrstechnik TU Darmstadt

European Commission

EN

Search

Mobility and Transport

Home Ukraine Transport modes Transport themes EU Mobility & Transport achievements 2019-2024 News & Events Facts & Funding

Home > News & Events > News

News

Filter by

Keywords

News type

Select

Subject

Select

Search Clear filters

News (1247) RSS

Showing results 1 to 10

News article | 11 November 2024

[EU and Philippines team up to boost seafarers' training, certification and labor conditions](#)

Today, the Government of the Philippines and the European Union have launched a Technical Assistance Project to improve seafarers' training, education and working conditions in the Philippines.

2 min read

image source: https://transport.ec.europa.eu/news-events/news_en

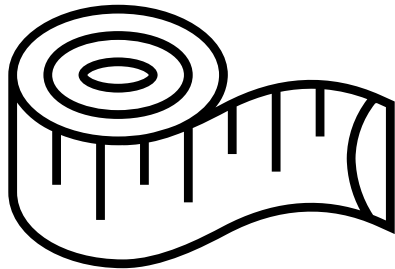
#4 What is measurement



TECHNISCHE
UNIVERSITÄT
DARMSTADT



Institut für
Verkehrsplanung
und Verkehrstechnik
TU Darmstadt



- Measurement is the systematic process of assigning numbers or labels to objects according to specific rules. In other words, it's about deciding *what* we are going to count, observe, or record in a study and then doing so in a systematic way. This process allows us to quantify abstract concepts based on their operational definitions.
- Our example:
 - The measurement is the frequency of each SDG appearing in the news titles and descriptions on the EU's transport website.

#5 What is reliability

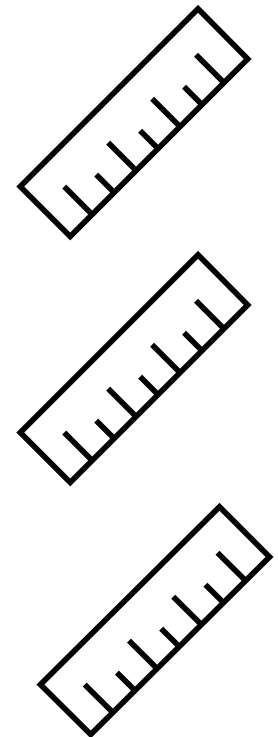


TECHNISCHE
UNIVERSITÄT
DARMSTADT



Institut für
Verkehrsplanung
und Verkehrstechnik
TU Darmstadt

- Reliability is the **consistency** of a measure; if a study is repeated under the same conditions, it should yield the same results.
- Our example:
 - Reliability would be achieved if seesus, the computational tool we used, consistently labels the same news items with the same SDGs every time it is applied.



#6 What is validity



TECHNISCHE
UNIVERSITÄT
DARMSTADT



Institut für
Verkehrsplanung
und Verkehrstechnik
TU Darmstadt

- Validity is the degree to which a study **accurately** captures what it intends to measure. It's about how “true” or accurate the findings are concerning the real-world concepts being studied.
- Our example:
 - Validity means that the methodology we used to identify alignment with the SDGs accurately reflects the EU’s actual priorities in mobility and transport initiatives.

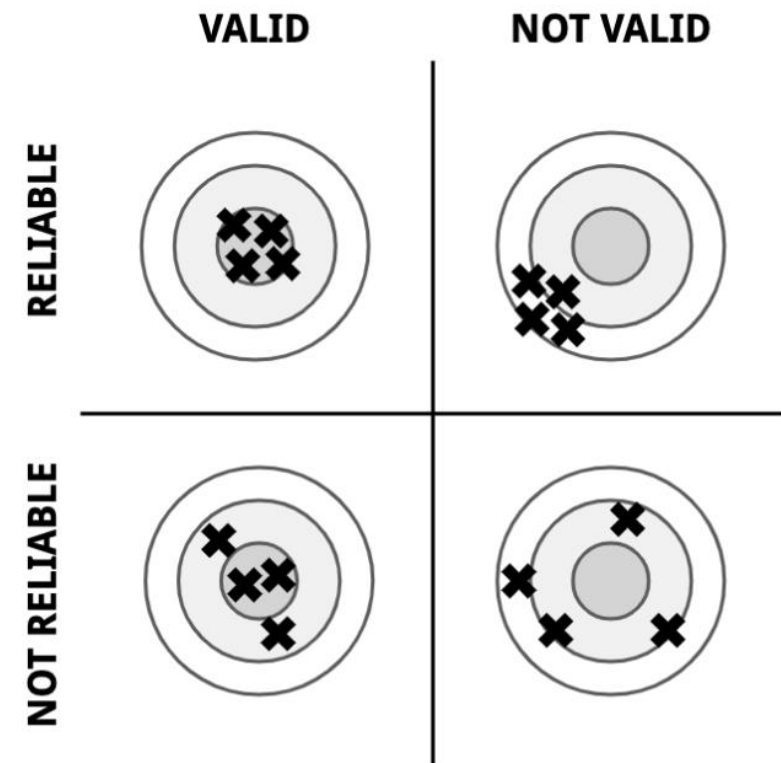


image source: <https://nesslabs.com/validity-reliability-mental-models>

#7 What is generalizability

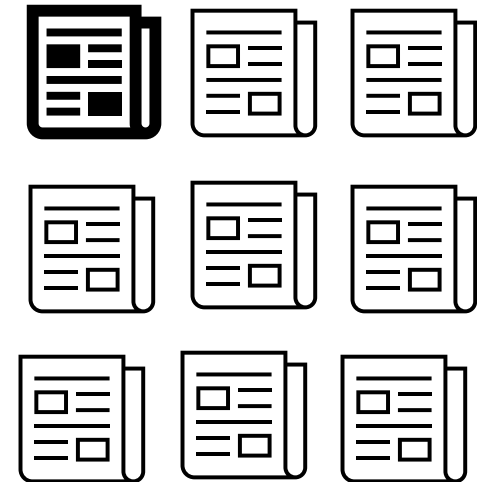


TECHNISCHE
UNIVERSITÄT
DARMSTADT



Institut für
Verkehrsplanung
und Verkehrstechnik
TU Darmstadt

- Generalizability is the extent to which the findings of a study apply to contexts beyond the specific data or sample analyzed. It is about how well the results might represent a larger population or different settings.
- Our example:
 - Generalizability depends on whether the news data from 2024 and 2025 represents the EU's overall transport and sustainability goals beyond this specific time frame (i.e. if these years are reflective of longer-term patterns in EU policy).



#8 What is bias



TECHNISCHE
UNIVERSITÄT
DARMSTADT



Institut für
Verkehrsplanung
und Verkehrstechnik
TU Darmstadt



- Bias refers to **systematic** errors in a study that can lead to incorrect or skewed results. Bias can come from the data, analysis methods, or researcher expectations.
- Our example:
 - Bias occurs if certain SDGs are more likely to be identified than others because of the matching algorithms of seesus. In addition, if the news focuses more on the positive aspects, the results are biased.

#9 What is a limitation



TECHNISCHE
UNIVERSITÄT
DARMSTADT



Institut für
Verkehrsplanung
und Verkehrstechnik
TU Darmstadt

- A limitation refers to any factors or constraints that impact the study's design, implementation, or interpretation. Limitations are factors that researchers cannot fully control, but that may affect the validity, reliability, or generalizability of the findings.
- Our example:
 - The data is only the news articles available on the transport.ec.europa.eu website, which may not cover all EU activities related to sustainable mobility and transport. In addition, the reliance on published news articles may introduce a bias toward topics deemed newsworthy by the EU's communication department. Furthermore, the analysis is constrained by the depth of the information in the news, which may not capture the full scope of all initiatives.



TECHNISCHE
UNIVERSITÄT
DARMSTADT



Institut für
Verkehrsplanung
und Verkehrstechnik
TU Darmstadt



John Attridge
@John_Attridge



This paper aims to make a major contribution to our understanding of a problem which I have invented

6:40 AM · Jul 24, 2024 · **212K** Views



18



852



6.2K



332



Source: https://x.com/John_Attridge/status/1815970347965165649



TECHNISCHE
UNIVERSITÄT
DARMSTADT



Institut für
Verkehrsplanung
und Verkehrstechnik
TU Darmstadt

Special thanks to Prof. Noah Durst, Michigan State University,
for sharing his teaching materials on this topic!