Course: Research Method in Software Engineering

WEEK 5 – Research Design Methods

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Week -5 Research Design Methods

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Learning outcome

- Understand the concepts of research design
- Describe the steps in research design process
- Describe the benefits of research design
- Understand how to choose the right research design
- Understanding the various types of research design methodologies

1. Introduction to Research Design

- Research design is a strategic framework for action that serves as a bridge between research questions and the execution, or implementation of the research strategy.
- When we discuss a strategy to collect, study, and evaluate data, we talk about research design.
- **Imagine doing research without a plan?**

Fig. IdeaScale, What is a Research Design? Definition, Types, Methods and Examples, IdeaScale. https://images.app.goo.gl/s4oLe8C5YeZwzRXm7/

[1]. QuestionPro, Research Design: What it is, Elements & Type, Adi Bhat,2024. https://www.questionpro.com/blog/research-design

1. Introduction to Research Design ….Cont'd

- A **well-planned research design** helps ensure that our methods match the **research objectives** and that use the right kind of analysis for our data.
- Impactful research usually creates a minimum bias in data and increases trust in the accuracy of collected data

What decisions should be made when creating a research design ?

- Decide overall research objectives and approach
- Determine whether we'll rely on primary research or secondary research
- Decide on sampling methods or criteria for selecting subjects
- Decide data collection methods
- The procedures we follow to collect data
- Decide data analysis methods

[1]. QuestionPro, Research Design: What it is, Elements & Type, Adi Bhat,2024. https://www.questionpro.com/blog/research-design.

2. Research Designing Process

Research design process

- Critical step in conducting research helps to ensure that researchers study is well-planned, ethical, and rigorous.
- It is essential to ensure that the study is valid, reliable, and produces meaningful results.

Step -1. Determine the research questions and objectives, and identify the theoretical framework and methodology for the study.

Step -2. Select the appropriate research design, such as experimental, correlational, survey, case study, based on the research questions and objectives.

[1]. QuestionPro, Research Design: What it is, Elements & Type, Adi Bhat,2024. https://www.questionpro.com/blog/research-design.

2. Research Designing Process …Cont'd

Research design process …Cont'd

Step-3. Identify and determine the target population and sample size, and choose the sampling method, such as random, stratified random sampling.

Step-4. Decide on the data collection methods, such as surveys, interviews, observations, or experiments, and select the appropriate instruments or tools for collecting data.

Step-5. Develop a plan for data collection, including the timeframe, location, and personnel involved, and ensure ethical considerations.

Step-6. Select the appropriate data analysis techniques, such as statistical analysis ,content analysis, and plan how to interpret the results.

3. Benefits of Research Design

A well-designed research plan has several **benefits** such as:

- **Clarity of research objectives:** Research design provides a clear understanding of the research objectives and the desired outcomes.
- **Increased validity and reliability:** To ensure the validity and reliability of results, research design help to minimize the risk of bias and helps to control unnecessary variables.
- **Improved data collection:** Research design helps to ensure that the proper data is collected and data is collected systematically and consistently.

[1]. QuestionPro, Research Design: What it is, Elements & Type, Adi Bhat,2024. https://www.questionpro.com/blog/research-design.

3. Benefits of Research Design …Cont'd

….Cont'd

- **Better data analysis:** Research design helps ensure that the collected data can be analyzed effectively, providing meaningful insights and conclusions.
- **Improved communication:** A well-designed research helps ensure the results are clean and influential within the research team and external stakeholders.
- **Efficient use of resources:** reducing the risk of waste and maximizing the impact of the research, research design helps to ensure that resources are used efficiently.

[1]. QuestionPro, Research Design: What it is, Elements & Type, Adi Bhat,2024. https://www.questionpro.com/blog/research-design

4. Characteristics of good Research Design

How to Choose the Right Research Design?

- Selecting the appropriate research method is crucial for achieving valid and reliable results.

- **The right choice of research design involves the following factors :-**

  - ✓ Understand the research question and goals → design should align with objectives.
  - ✓ Evaluate the resources available, including time, funding, and technical expertise.
  - ✓ Consider ethical implications→ Make sure the research design meets the ethical standards in the field .

[2]. IdeaScale, What is Research? Definition, Types, Methods and Process, Nick Jain. https://ideascale.com/blog/what-is-research/

4. Characteristics of good Research Design ..Cont'd

- Successful research studies provide insights that are accurate and unbiased.

Four key characteristics of good research design:

1. Neutrality: We may have to make assumptions about the data we expect to collect thus, the results projected in the research should be free from research bias and neutral.

2. Reliability: With regularly conducted research, the researcher expects similar results every time.

- We only be able to reach the desired results if our design is reliable.

[1]. QuestionPro, Research Design: What it is, Elements & Type, Adi Bhat,2024. https://www.questionpro.com/blog/research-design

4. Characteristics of good Research Design ..Cont'd

Four key characteristics of good research design …cont'd

3. Validity: There are multiple measuring tools available. However, the only correct measuring tools are those which help a researcher in evaluating results according to the objective of the research.

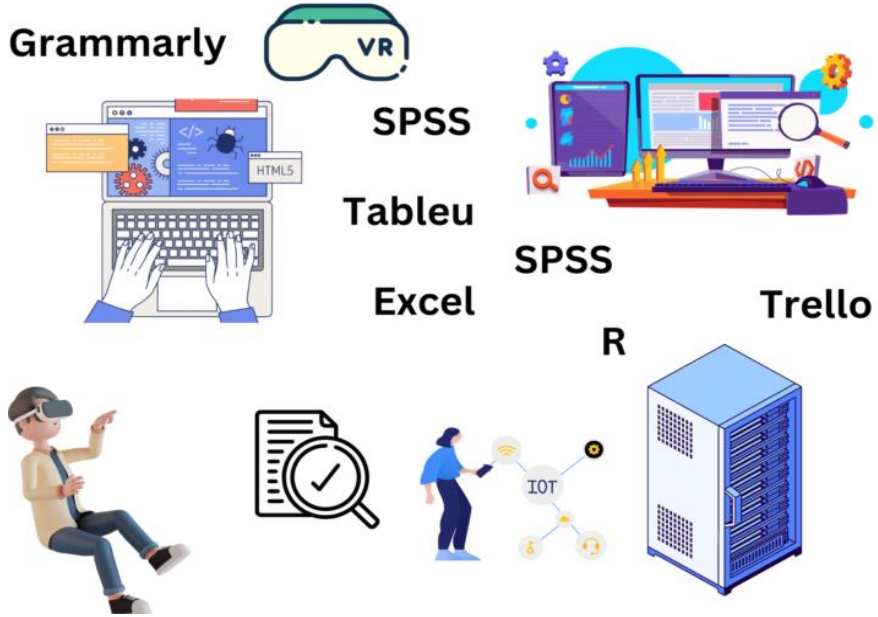

Fig. Researchvoyage. https://images.app.goo.gl/3aKoDtkyXMh1XrcEA

4. Generalization: The outcome of our design should apply to a population and not just a restricted sample.

- A generalized method implies that our survey can be conducted on any part of a population with similar accuracy

4. Characteristics of good Research Design ...Cont'd

Research Design Vs. Research Method? [3]

- Research design is a **plan** to answer our research question. - E.g. A survey research design
- A research method is a **strategy** used to implement that plan. - E.g. A questionnaire

Research design	Research methodology
Concentrates on the end result of the study. The central question in this regard is what type of research is to be executed and what type of research findings are expected	Concentrates on the entire research procedure and instruments to be employed to carry out the study. The focus is around data collection
Research design is geared towards addressing the 'research question'	Research methodology focuses on the gathering of data and draws a sample for the study
Concentrates on the logical order of the study. Among other things, a research design plans the type of evidence relevant to the study	Concentrates on the unit of analysis

Table. ResearchGate, Teaching the Philosophy of Science to Public Administration Students in South African Universitie, NBreakfast, G Bradshaw, R Haines, https://images.app.goo.gl/CPdjuZGuY74Esb766

5. Research Design Methodologies

- Understanding the various types of research methods is crucial for selecting the most appropriate approach to answer research questions effectively.
- This guide investigates into the major research methods, their applications, and tips on choosing the best one for our study.

Examples : Types of research methodologies

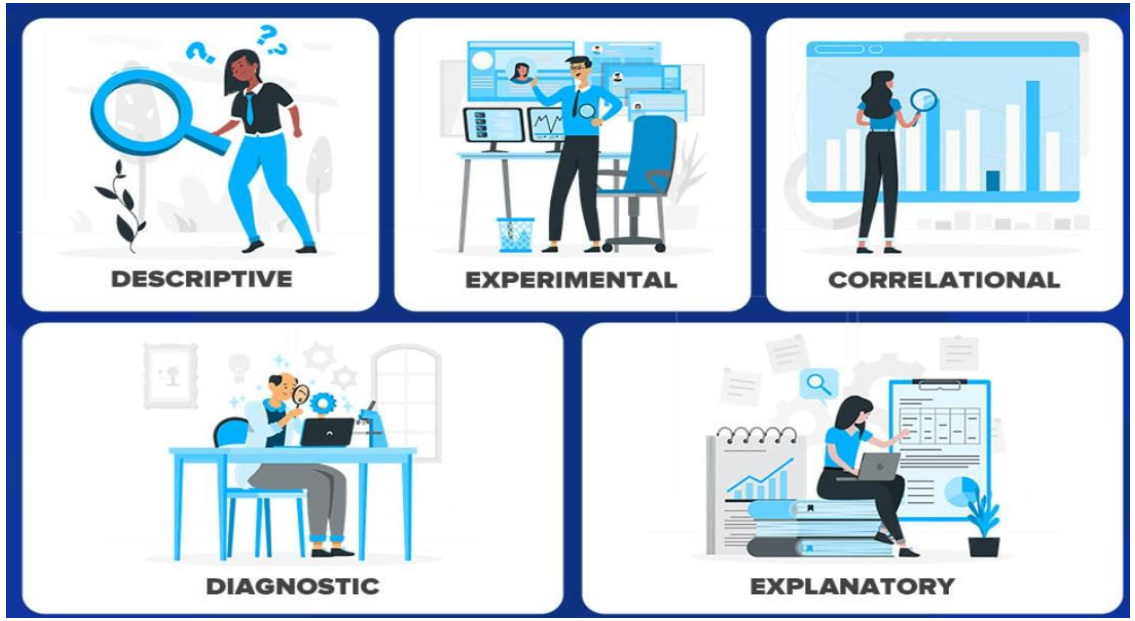

Fig. QuestionPro, Research Design: What it is, Elements & Types, QuestionPro. https://images.app.goo.gl/YDPsPytZkoHEpuMc8

5. Research Design Methodologies ….Cont'd

1. Surveys Research [4]

- It play a prominent role in the research method. Helps to collect a vast amount of real-time data and helps the research process.
- It is done cheaply and is usually faster than any other method.
- Can be conducted in both quantitative and qualitative methods.

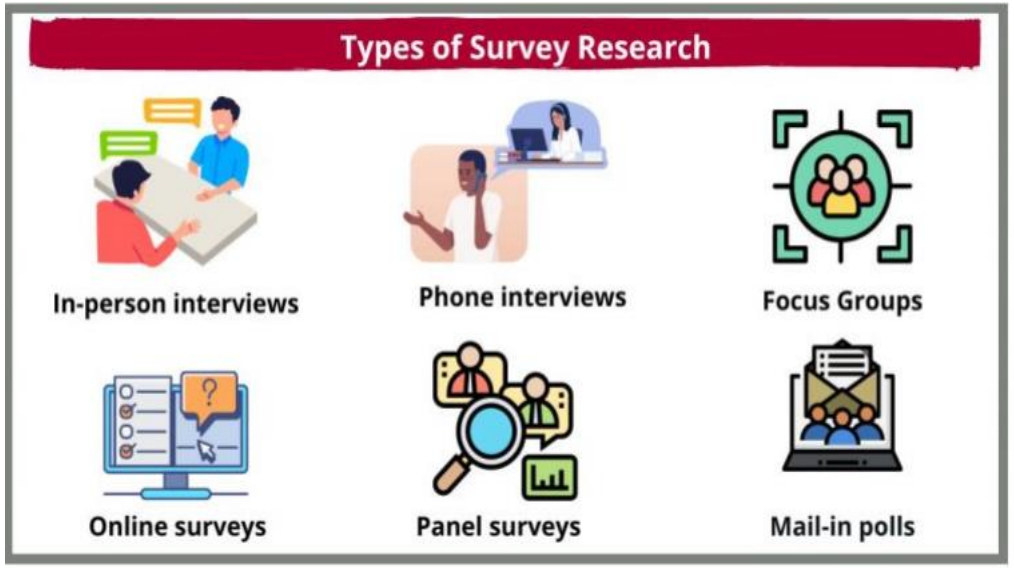

Fig. Enago Academy, Exploring the Power of Survey Research: 10 Best Practices, Enago Academy. https://images.app.goo.gl/P6rEvqXE1zw1JLEy9

5. Research Design Methodologies ….Cont'd

1. Surveys Research [4] ……Cont'd

- Questionnaires and interviews are two of the most common types of surveys.
- While interviews are conducted in person to reflect on feelings and experiences and explore issues with a greater emphasis, researchers use questionnaires to acquire information quickly.

Example:

Research Topic : Survey on Agile Methodologies and Software Quality

Research Objectives

- ✓ To understand the perceptions of software developers regarding the effectiveness of Agile methodologies on software quality.
- ✓ To identify specific Agile practices that contribute most significantly to perceived quality improvements.

[3].Thesismind, Types of Research methods or Methodology, Thesismind. https://thesismind.com/types-of-research-methods-or-methodology/

5. Research Design Methodologies ….Cont'd

2. Experiment Research

- It is any research conducted with a scientific approach, where a set of variables are kept constant while the other set of variables are being measured as the subject of experiment.
- In a situation when we don't have enough data to support our decisions, we need to carry out experiments to discover the facts.
- Experimental research should establish a cause and effect of a phenomenon, i.e. effects are observed from an experiment due to the cause. The simplest example of an experimental research is conducting a laboratory test.
- A true experimental research is considered to be successful only when the researcher confirms that a change in the dependent variable is solely due to the manipulation of the independent variable

[3].Thesismind, Types of Research methods or Methodology, Thesismind. https://thesismind.com/types-of-research-methods-or-methodology

5. Research Design Methodologies ….Cont'd

2. Experiment Research ….Cont'd

Experimental Research in Software Engineering

Example : The Impact of Agile Practices on Software Quality

- Ho : Agile practices do not significantly improve software quality compared to traditional methods.
- Ha : Agile practices significantly improve software quality compared to traditional methods.

Experimental Design:

- **Independent Variable:** Development methodology such as Agile vs. Traditional.
- **Dependent Variable:** Software quality measured by defect density and user satisfaction scores.

5. Research Design Methodologies ….Cont'd

3. Case studies Research

- Case studies aim to analyze **specific issues** within the boundaries of a specific environment, situation or organization.
- Various methods of data collection and analysis are used but this typically includes observation and interviews and may involve consulting other people and personal or public records.
- The researchers may be interested in a particular phenomenon (e.g. coping with a diagnosis or a move into residential care) and select one or more individuals in the respective situation on whom to base their case study/studies.
- It has a very narrow focus which results in detailed descriptive data which is unique to the case(s) studied.

5. Research Design Methodologies ….Cont'd

Case studies Research in software Engineering

- Case studies play a vital role in software engineering research by providing rich, qualitative insights into specific phenomena.

Example : - Case Study on DevOps Practices

Objective

- To analyze how the adoption of DevOps practices impacted software delivery time and quality in a mid-sized software company.

Findings:

- Reduced deployment times and increased frequency of releases, along with improved communication between development and operations teams.

5. Research Design Methodologies ….Cont'd

Methodology :- The case study conducted by considering :

- Data collection methods (e.g., interviews, observations, document analysis).
- Participants involved (e.g., developers, project managers, end-users).
- Duration of the study should be specified

Finally , the findings and analysis of the research includes:

- Present the key findings from the data collected.
- Analyze the findings in relation to the research questions and relevant literature.
- Discuss patterns, themes, and insights gained from the study.

- ***Disadvantages of case study:*** *lack of rigor, challenges associated with data analysis and very little basis for generalizations of findings and conclusions.*

[3].Thesismind, Types of Research methods or Methodology, Thesismind. https://thesismind.com/types-of-research-methods-or-methodology

5. Research Design Methodologies ….Cont'd

Types of research methods based on aims

Basic vs Applied Research

- **Basic research** aims to develop knowledge, theories and predictions, while **applied research** aims to develop techniques, products and procedures.
- **Applied research** is also referred to as an action research, and the fundamental research is sometimes called basic or pure research.
- Similarities between applied and fundamental (basic) research relate to the adoption of a systematic and scientific procedure to conduct the study.→ What we should consider is whether to expand scientific understanding or solve a practical problem.

[4]. Dovetail, Basic vs. Applied Research: Key Differences, Dovetail Editorial Team. https://dovetail.com/research/basic-vs-applied-research

5. Research Design Methodologies ….Cont'd

Applied research

- Studies particular circumstances to apply the information to real-life situations. It helps improve the human condition **by finding practical solutions for existing problems**.
- Applied research builds off facts derived from basic research and other data to address challenges in all facets of life.
- Instead of exploring theories of the unknown, applied research requires researchers to use existing knowledge, facts, and discoveries to generate new knowledge.
- *Solutions derived from applied research are used in situations ranging from medical treatments or product development to new laws or regulations.*

[4] Dovetail, Basic vs. Applied Research: Key Differences, Dovetail Editorial Team. https://dovetail.com/research/basic-vs-applied-research

5. Research Design Methodologies ….Cont'd

Applied Research in Software Engineering

- It plays a crucial role in advancing the field by directly addressing the needs and challenges of practitioners.
- Through systematic investigation and implementation of practical solutions, it helps improve software development processes, tools, and practices, ultimately contributing to the success of software projects in various domains.

Example : Improving Software Development Processes:

- **Objective:** To enhance the efficiency of a software development process in a specific organization.
- **Approach:** Analyze the current workflow, identify bottlenecks, and implement Agile methodologies. Measure improvements in delivery time and software quality.

[4]. Dovetail, Basic vs. Applied Research: Key Differences, Dovetail Editorial Team. https://dovetail.com/research/basic-vs-applied-research

Summary

- Research design is a strategic framework for action that serves as a bridge between research questions and the execution, or implementation of the research strategy.
- Impactful research usually creates a minimum bias in data and increases trust in the accuracy of collected data.
- A well-designed research plan has several benefits such as: Clarity of research objectives, Increased validity and reliability, improve data collection , Better data analysis, improve communication and Efficient use of resources.
- Good research design incorporate the following characteristics neutrality , reliability, Validity and generalization.
- Understanding the various types of research methods is crucial for selecting the most appropriate approach to answer research questions effectively.

References

1. QuestionPro, Research Design: What it is, Elements & Type, Adi Bhat,2024. https://www.questionpro.com/blog/research-design

2. IdeaScale, What is Research? Definition, Types, Methods and Process, Nick Jain. https://ideascale.com/blog/what-is-research/

3. Thesismind, Types of Research methods or Methodology, Thesismind. https://thesismind.com/types-of-research-methods-or-methodology/

4. Dovetail, Basic vs. Applied Research: Key Differences, Dovetail Editorial Team. https://dovetail.com/research/basic-vs-applied-research

Thank you !