Dr. Norbert Cheung's Lecture Series

Level 5 Topic no: 39

Quantitative Methods and Mixed Methods

Contents

Reference

Engineering Research: Design Methods and Publication, Herman Tang, Wiley, 2021.

1. Qualitative Research

What is Qualitative Research?

Qualitative research involves the collection and analysis of nonnumerical data. That is, qualitative research is about argumentations rather than based on calculations. Using qualitative data, we can conduct a research project to solve problems or simplify information that does not require numbers, mathematical calculations, or tangle factors.

While quantitative and qualitative research differ in types of information, research methods, and objectives. The two types of research do have some overlaps (refer to Figure 6.1).

An overall purpose of conducting a qualitative study is primarily for exploration and explanation of a phenomenon, i.e. on the meaning without numbers. Qualitative research is usually applied in sciences when there is little understanding of a subject or phenomenon. To explore new things, we often start with qualitative research, which can lead to further research ideas. Qualitative research help build off a body of knowledge until the patterns are constant the subject may be studied quantitatively.

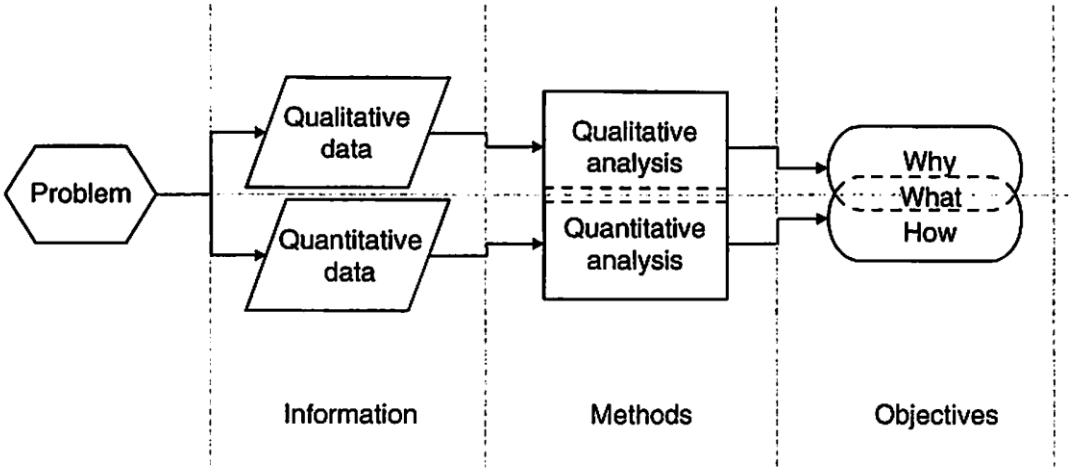

Figure 6.1 Methodology of qualitative and quantitative research.

Methods of Qualitative Research

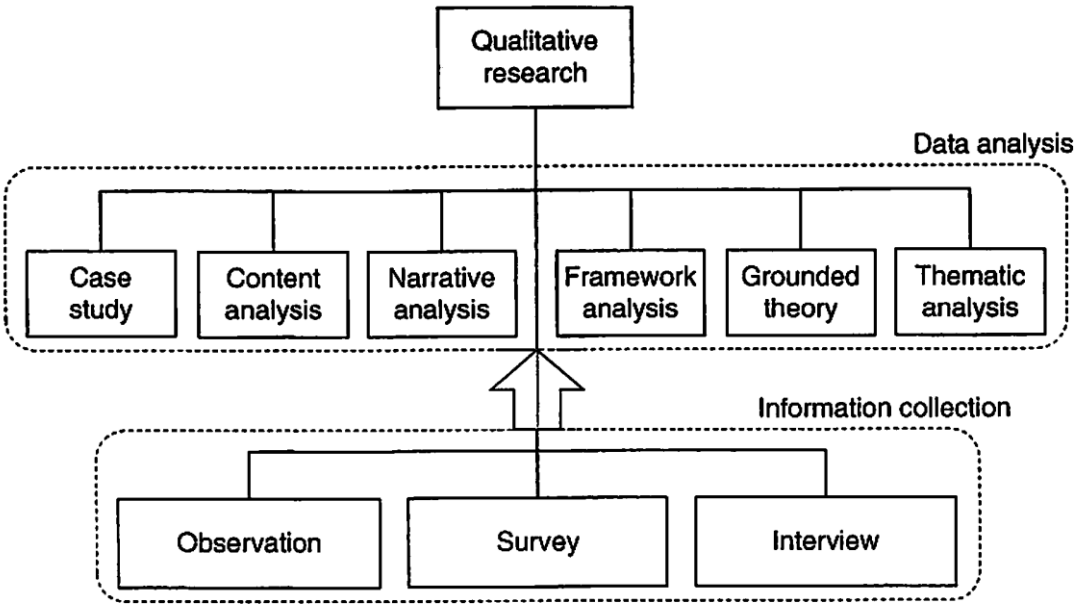

Figure 6.2 Methods of qualitative research.

Table 6.1 Basics of some qualitative analysis methods.

Method	Concept	Engineering example
Content analysis	To study documents, consisting of various formats, texts, pictures, video, etc., to examine patterns in a replicable and systematic manner	Software engineering (DeFranco and Laplante 2017)
Narrative (case) study	To study field texts, such as stories, journals, field notes, letters, conversations, and interviews, and understand the ways people create meanings in their lives	Computer science (Casebeer et al. 2018)
Framework analysis	To organize and manage research through the process of summarization, resulting in a robust and flexible matrix output for analyzing data	Manufacturing engineering (Gerritsen 2010)
Grounded theory	To gather, synthesize, analyze, and conceptualize qualitative data to develop theories	Architectural engineering (Wonoto 2017)

Purposes of Qualitative Research

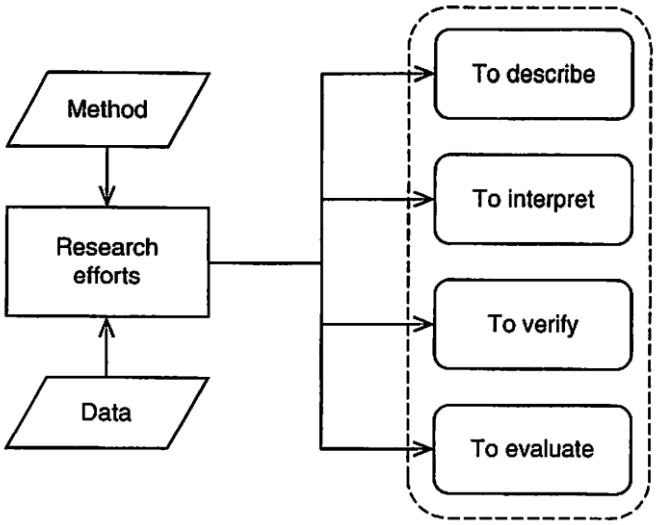

Figure 6.4 Purposes of qualitative research.

Qualitative research can have four kinds of purposes (see Figure 6.4.). For a particular study, it may focus on one purpose or have any combination of the four types.

Qualitative Research in Engineering

Since most engineers and technical professionals are trained primarily using quantitative methods, they may not be familiar with some norms of qualitative research.

In contrast to quantitative research, qualitative research is concerned with understanding and words, referring to the meanings, concepts, characteristics, metaphors, symbols, and/or description. For example, engineering design should be based on the requirements of customers, and we may use qualitative research to ascertain the requirements. Some cases may be good for qualitative research in engineering and technology, for example,

1. To generate knowledge or understanding of new or complex situations
2. To obtain the opinions from domain experts
3. To improve the understanding on a phenomenon

2. Mixed Methods Approach

Introduction

Using both quantitative and qualitative methods are called mixed methods or multimethods. As discussed, quantitative and qualitative analyses methods have their own characteristics (see Table 6.4). Mixed methods research may draw on potential strengths of both types of methods. Using a mixed method may, in principle, offset the weaknesses and allow both exploration and analysis in the same study. Mixed-method approaches may also provide additional evidence and support to research findings. We may contain the reduced personal biases and improved validity of results.

Some Examples of Mixed Methods

We may exam the research subject and data availability based on the six scenarios (Creswell and Clark 2011) to decide the mixed methodology usage and justify the appropriateness.

1. To explain initial results with another type of data
2. To use one type of data source
3. To generalize exploratory findings with a quantitative study
4. To enhance a study with a second method
5. To be required for a theoretical stance
6. To understand an objective through multiple phases

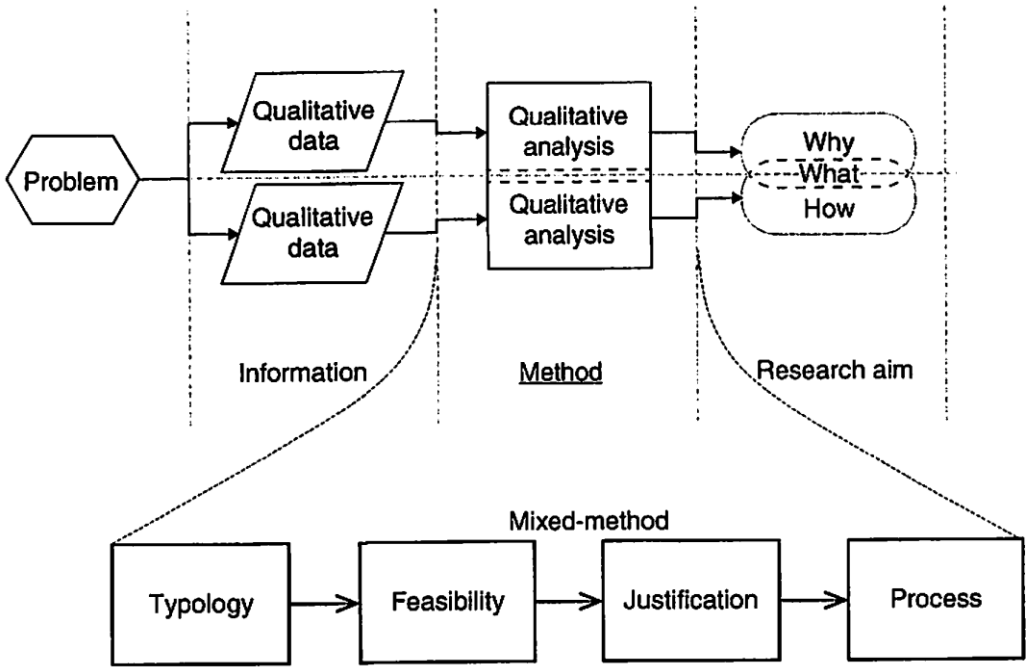

Figure 6.15 Considerations for mixed method research.

Three Methods a Comparison

	Quantitative	Qualitative	Mixed
Advantages	To define and describe the facts in a quantitative way To have accurate estimations More objective	Often, relatively easy and inexpensive	Offset the weaknesses of the both methods More comprehensive understanding Better methodological flexibility Strengthened validity
Differences between Quan. and Qual.	Data collection (instruments) Deductive reasoning Focusing on individual More on theory testing Presentation (charts and tables) High generalizability Math-intensive data analysis Predetermined method	Data collection (survey, interview, etc.) Inductive reasoning Focusing on collections More on theory/understanding building Normally transcript presentation Results normally specific Simple data analysis, summary Emerging method	
Disadvant-ages	Analysis results maybe unexplainable Often more expensive	No accurate estimation Cost–benefit not clear More subjective Possible small, nonrepresentative samples	Complex designs More time and resources (cost) required Possible discrepancies in finding and interpretation More researcher's skills (training) needed

Table 6.6 Examples of mixed method studies in engineering research.

Engineering	Method	Topic
Mechanical	Parallel	Qualitative evaluation of modeling the aramid fabric elementary cell in the piercing process with a 9 mm full metal jacket projectile (Pyka et al. 2019)
Computer	Quan–Qual	The effects of modularization in a telecommunication sector – a case study of telenor (Lindholm and Feratovic 2017)
Electrical	Qual–Quan	Ecosystem effects of the Industrial Internet of Things on manufacturing companies (Arnold and Voigt 2017)
Industrial	Quan–Qual	Business model innovation and strategy making nexus: evidence from a cross-industry mixed methods study (Cortimiglia et al. 2015)
Civil	Qual–Quan	The impact of airport performance toward construction and infrastructure expansion in Indonesia (Laksono et al. 2018)
Manufacturing	Parallel	Analysis of Overall Equipment Effectiveness (OEE) within different sectors in different Swedish industries (Cheh 2014)
Chemical	Parallel	Mixed method research: a comprehensive approach for study into the New Zealand voluntary carbon market (Birchall et al. 2016)

(a) Quantitative > Qualitative
(b) Qualitative > Quantitative
(c) Quantitative and Qualitative go in parallel

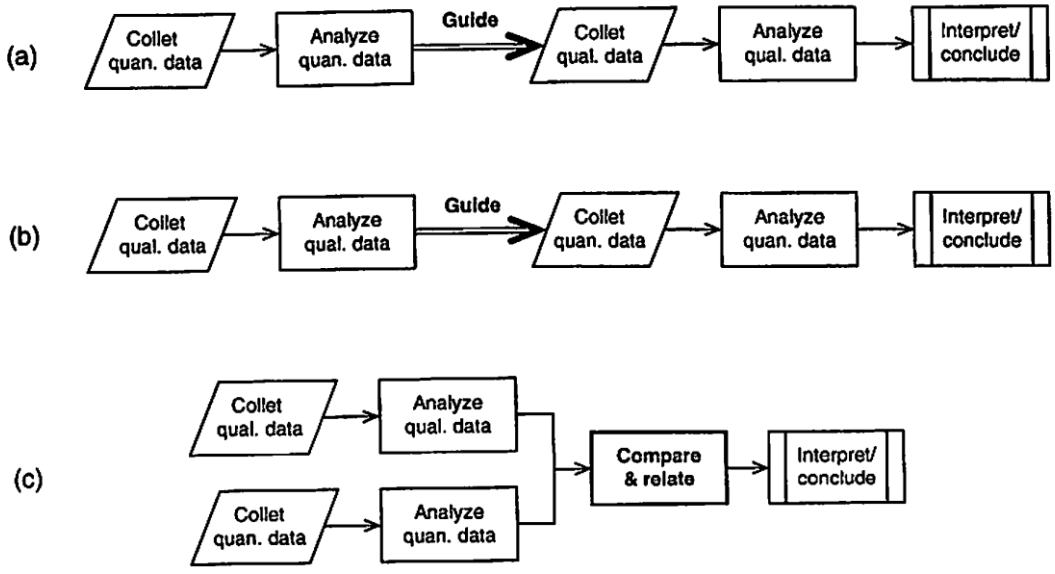

Figure 6.16 Three types of mixed method arrangements.

3. Summary

1. Qualitative research involves the collection and analysis of nonnumerical data and information, which is often applied to when there is little understanding of a subject or phenomenon.
2. Common qualitative information comes from surveys, interviews, and observations. Qualitative methods include case study, content analysis, narrative analysis, framework analysis, grounded theory, and thematic analysis.

Mixed Method Approaches

17. Quantitative and qualitative methods can be jointly used in a study.
18. The method combination may be in different ways in terms of order (sequential or parallel) and significance (equal or one dominative).
19. Using a mixed method can take the advantages of each method, but make the research project more complex.

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