

Research & Design Methodology

Industrial Engineering and Management

Year 2, 2021

Notes based on lectures and book chapters

Includes:

Chapter 1: Project Design
Chapter 2: Research Objective
Chapter 3: Research Framework
Chapter 4: Research Questions
Chapter 5: Defining Concepts
Chapter 6: Research Strategies
Chapter 7: Research Material
Chapter 8: Research Planning
Appendix: Conceptual Model
Systems Thinking

Research & Design Methodology

Chapter 1: Project Design

Designing Research

Conceptual Design
what, why, how much?

Goal of the project
Objective (Project context)

Research Framework
what are the research phases

8 sub questions
Research Questions
Research Perspective

Technical Research design
How, where, when?

Conceptual Model

Theoretical Framework

2 parts of Project Design:

Conceptual Design determining what you want to achieve consist of 4 elements

1) **Research Objective** (goal of the research): the contribution the researcher wishes to make to solve a problem (external aim). It concerns the use of ^{the} knowledge produced. Derived & embedded into Project context

2) **Research Framework** schematic representation of the imp. research phases

3) **Research Questions** the answers to these questions provide knowledge to answer the research objective (internal aim). Determining which theoretical framework to use (Research Perspective)

↳ takes form in the conceptual model → set of assumed relationships

4) **Defining and Operationalising**: set of activities in which core concepts are defined, refined and made concrete.

Technical Research Design: How to realise the above during the implementation stage of the project (How, where, when?)

1) **Research Strategy**: breadth or depth? quantitative or qualitative?

2) **Research Material** data gathering → how can data be produced?

3) **Research Planning**: time schedules with deadlines for products/deliverables

Chapter 2: Research Objective

Project context: the subject of the research project is carefully defined and embedded in the wider context (project context). usually it is a set of problems. if too wide → isolation is needed.

Step by step approach

Step 1: Orientation

Theory oriented: the project is made up of ^{the} process and product of knowledge formation within the field of research

Types: Theory development, theory testing, empirical cycle, scientific method

Practice oriented: the project context is a practical problem in a private/public organization

Types: intervention cycle, problem solving cycle

Step 2: explore project context by answering:

- 1) What problems are involved within the project context
- 2) What is the background to these problems?
- 3) What solutions are stakeholders considering?

Step 3: Determine type of research

Step 4: Formulate the research objective

An effective research objective should be: Useful, Realistic, Feasible

The research objective is (a) by (realising, providing,) (b) (step 5) Clear & Informative

a: theory example: to further develop theory X of author Y, dealing with issue 2

practice example: to help improve the existing policy X dealing with issue 2

b: theory example: by testing a set of hypotheses, deduced from theory X

practice example: by making a comparison between...

Step 6: Check if research objective calls for reorientation

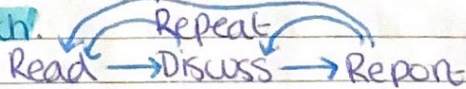
Why people fail to find effective solutions:

- 1) ~~Being~~ Not being methodical → way to tackle: A proper problem Statement
- 2) Lack of commitment to solve problem
- 3) Misinterpretation problem statement
- 4) Lack of knowledge of techniques & processes involved
- 5) Using inappropriate methods
- 6) Insufficient and inaccurate information to combine analytical thinking

Problem Statement:

- Its purpose is to focus the attention of problem solving team
- It is a concise description of issues to be addressed before solving the problem
- Ill-defined problems are complex because it is difficult to define each element of the problem space.

For theory oriented research:



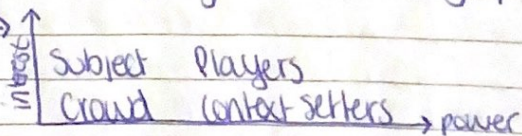
For practice oriented research: What-Why analysis

Up → broader problem: Why do we want to solve this problem?

Down → narrower problem: What is stopping us from solving problem?

For both: Stakeholder analysis

Fishbone diagram



SMART Objective: specific, measurable, attainable, relevant, time-bound

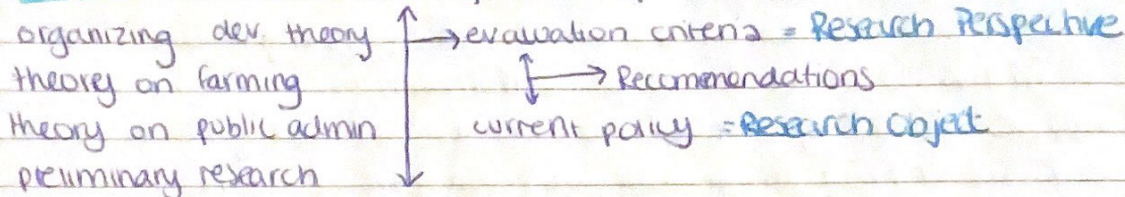
Chapter 3: Research Framework

↳ a schematic representation of the research objective and includes appropriate steps that need to be taken in order to achieve it.

Step by step approach

Step 1: Characterize research objective

Step 2: Determine the object or objects of the research project



Research Object: the phenomena in empirical reality that you are going to study
it is proposed to study this object from a research perspective

Step 3: Establish the nature of the research perspective

- Theory developing
 - Theory testing
 - Problem analysing
 - Diagnostic research
 - Design oriented research
 - Intervention-oriented research
- theory oriented
- practice oriented

Step 4: Determine sources

Choose the relevant literature by making a first selection of scientific articles and reports, and/or outline preliminary research, noting which experts to consult. Base these choices on the key concepts extracted from the research objective.

Step 5: make a schematic presentation → 3 steps to achieve this

- 1) The components of the research framework are represented (short tables)
- 2) tables are placed in framework
- 3) All frameworks are interconnected depending on the reciprocal confrontation of issues.

Step 6: Formulate the research framework

First phase: sources

second phase: to which research objects the research perspective is applied

third phase: in what way the individual research objective may be related

fourth phase: state research objective

Chapter 4: Research Questions

→ concerns the knowledge that is useful & relevant to achieve the research objective, may be unravelled with subquestions

Function requirements

Efficiency: the degree of knowledge that yields the answer to the questions contained & the degree to which the knowledge contributes to answering the research objective

Steering capacity: extent to which the set of RQ sheds light on the activities that need to be performed.

→ **Descriptive knowledge:** statements such as 'how reality is' or 'what it looks like' or 'how things work are descriptive statements

→ **Explanatory knowledge:** statements about 'why things are the way they are' belong to Explanatory statements

Avoid: 'how can' questions

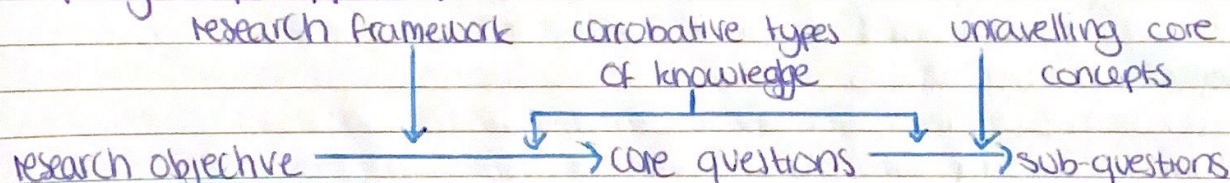
RQ's are focussed on the internal goal to achieve the external goal

Form Requirement: central question and subquestions

Central Question: What is needed to achieve research objective

Sub questions: What knowledge is needed to answer central Question

Step by step approach



1) Central Question (2 methods)

1) Subdividing research framework

2) Identifying corroborative types of knowledge

→ decide what types of knowledge is/are relevant for RO

→ formulate one or more central questions of this type of knowledge that play an immediate corroborative role in realising RO

2) Sub-Questions

1) Corroborative types of knowledge

→ for each central question find the corroborative knowledge and formulate sub-Q's of this type of knowledge.

2) Unravelling key concepts

→ select key concepts

→ use tree diagram, unravels each concept into its components

→ select aspects from tree diagram on the basis of feasibility of the research and formulate sub-Q from each component

Corroborative types of knowledge!

- 1) Descriptive knowledge
- 2) Explanatory knowledge
- 3) Predictive knowledge
- 4) Evaluative knowledge
- 5) Prescriptive knowledge

if central is explanatory,

subquestions should be descriptive

* Higher ranked types can play a corroborative role to create lower ranked knowledge

Chapter 5: Defining Concepts

The significance you attribute to the key concepts will strongly determine the type of material you need to gather

→ Shouldn't be postponed.

Formulating stipulative definitions

Stipulative definition: definition in which a new/existing term is given a new specific meaning.

Conditions to be met:

1) Delineating the concept to manageable proportions

→ the action of describing or portraying something precisely

eg. Ravens are black

domain

assertion

Size = $D \times A$

2) Clarity on the question of which observable entities are covered by the definition

Steps: 1) Select indicators

2) Define instruments and instructions → Quantitative/Qualitative

3) Create an operational definition

3) Linking up to the research objective and the set of research questions

The definition must relate the selected research objective and the set of research questions pertaining to the research project.

In every research project additions concerning age and sex are required.

Appendix: Conceptual Model

A set of assumed causal relationships between core concepts

Composition of a conceptual model

consists of 2 sets of elements

1) **Core concepts** phenomena that occur in different variations or modalities
The term variables is often used → can take the form of
Modality or gradation → variation can be described as more or less
→ when there is distinct categories

2) Relationships

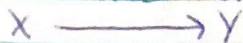
We define a relationship between 2 variables X and Y as a causal one if we assume, as a result of a manipulation of X, a change in Y will occur.

Direction: positive or negative causal effect

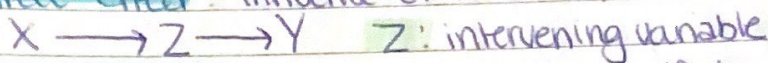
Strength: range from no effect, weak effect to strong effect

Basic patterns of causal relationships

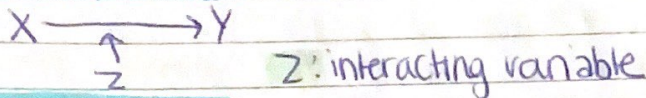
1) **Direct effect:** influence of X on Y



2) **Indirect effect:** influence of X on Z, which effects Y

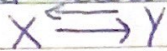


3) **Interaction effect:** Z interacts with the effect of X on Y

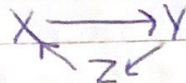


4) **Feedback Effect:**

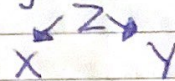
Direct Feedback effect:



Indirect feedback effect



5) **Confounding effect:** Z is the confounding variable causing the spurious relationship between X and Y



Different Uses of the conceptual model

Quantitative research: prefer concepts to have narrow & closed meaning

Qualitative research: prefer concepts to have global & broad meaning

Testing vs Exploration

Testing: distil from existing knowledge a conceptual model, and check whether the relationships in the model are not falsified by empirical data

Exploration: 1) further elaborate the conceptual model
2) start with a generic, more abstract model

Demarcation and Steering

• A well-thoughtout and well-demarcated set of core concepts forms the basis of a successful research project

• The designing process of a conceptual model starts by defining a **generic conceptual model**. The next steps involve a further **specification** of this generic model. The process ends with the construction of the **final conceptual model**, including the formation of assumed relationships to be studied.

Chapter 6: Research strategies → decisions concerning how to do research

5 Key decisions

1) **Breadth vs Depth** → aim for small-scale approach that yields knowledge that can be generalized to a lesser extent

↳ A large scale approach that enables a generalization of results

2) **Quantitative vs Qualitative** → a more contemplative with a preferable interpreting approach (reporting = verbal & contemplative)

↳ Research findings compiled in tables, charts, number calculations

3) **Empirical research vs Desk research** → make use of existing literature or data gathered by others

↳ Do research in the field, gathering data themselves to make judgements based on the analysis of this data

Other decisions

- Number and type of research units
- Method of unit selection
- Choice of sources and method to open up sources
- Way to process data and literature

Major strategies

1) **Survey**: breadth, quantitative, empirical, theory/practice orientated

Variants: Cross-sectional research, panel research, Time-series research

Advantages: large scope, large availability, methodological handbooks

Disadvantages: limited depth, no complete overview, less flexible

2) **Experiment**: quantitative, empirical, theory/practice orientated

always 2 groups → experimental and control group

Variants: lab experiment, Quasi-experiment, Imitation

Advantages: High degree internal validity

Disadvantages: external validity, not all intervention can be carried out

3) **Case Study**: depth, qualitative, empirical, theory-oriented

Variants: single case study, comparative case study

Advantages: gain general picture, no pre-structuring required, results accepted easier

Disadvantages: external validity often under pressure

4) **Grounded Theory approach**: qualitative, empirical, theory-oriented

Characteristics: inquisitive, continuous process, careful/consistent use procedures

primary/secondary empirical comparison ←

primary/secondary theoretical comparison ←

comparison of theories, deductive ←

comparison and inductive comp.

→ Sensitising concepts & open coding

→ Axial coding

→ Selective coding

Advantage: used to develop a theory, enables gaining overall view of complex

Disadvantage: risk at getting lost in complexity

5) Desk Research: theory-oriented

Characteristics: use existing material, no direct contact with object, diff perspective for material

→ Literature

→ Secondary data

→ Official Statistical material

Variants: literature survey, secondary research

Advantage: use of a large amount of data

Disadvantage: researched used was intended for other purpose, consequences for RO

Chapter 7: Research Material

What kind of material is needed and how and where to gather it.

General aspects of research material

- 1) In general there is an abundance and diversity of available material to choose from
- 2) One needs to be resourceful to come up with interesting material
- 3) It is necessary to make choices and delineate the research project
- 4) Different motives can play a part in making these choices within the limits of the research goal.
- 5) There is often a great freedom in choosing from the options available
- 6) The set of (sub) questions can be redefined
- 7) Designer must be aware of the (dis)advantages

Sources Available

The following questions must be answered:

- 1) What is the main categories of research objects that can be distinguished?
- 2) What types of information on these objects are relevant to the research project, and how can this information be identified?
- 3) Where this information can be gathered or how it can be generated?

Source 1: People

advantages: diversity, quick way to gather information, steering ability
→ respondent, informant, expert

disadvantages: strongly subjective answers, people find it difficult to speak out

Source 2: Media → printed or electronic

advantages: high information density, high level topicality with wide geographical scope

disadvantages: not all research can be linked to relevant media

Source 3 Reality

advantages: direct measurements have high degree of objectivity

disadvantages: only serve as data source, not knowledge source

Source 4: Documents

advantages: great quantity, wide variety, inexpensive, little skills needed to use, durable, behavioural responses are not provoked

disadvantages: overwhelming amount of information

Source 5: Literature

various forms: monographs, editorial volumes, specialist journals, hand books

advantages: as a knowledge source: it already has insight (no need to start over)

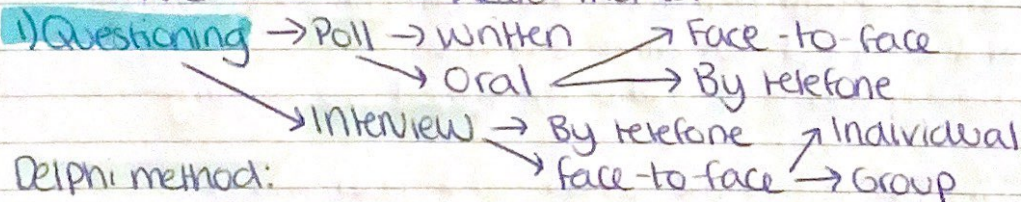
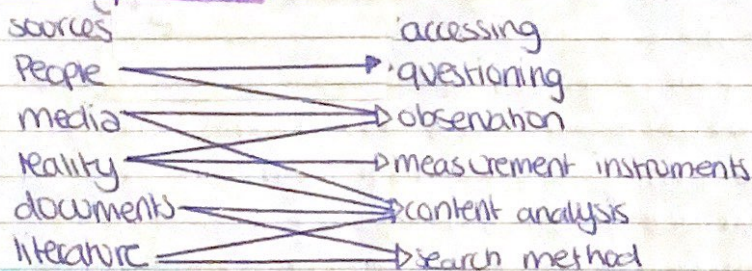
as a data source: researcher doesn't need to go to great length to gather

disadvantages: exclusion of authority & researcher follows author too closely

Mainly data sources: People, media, documents, reality

Mainly knowledge sources: literature

Accessing sources



Delphi method:

resembles a group interview and written poll

2) Gathering observational data

participant observation: if the researcher participates in daily activities of the group in order to prevent people from behaving differently

Timekeeping: participants keep track of their own activities

3) Measurement instruments: a mechanism, an object or a procedure by means of which we can directly quantify or qualify phenomena

4) Content Analysis: generating data from document, media, reality and literature

5) Search Methods: selecting appropriate literature

- search based on key words
- consult (abstracts) extracts and reviews
- screen specialist journals
- use snowball principle

Advantages & Disadvantages

Interview vs Poll

Advantages: Poll is less time consuming
Poll has larger number of research units
Interview deals with more complicated issues

Disadvantages: Interview has less reach
Telephone int. ~~make~~ are less emotionally intense
Poll has higher non-response rate
Chances of receiving evasive/strategic answers are high in questionnaire

Interview vs Other techniques

Advantages

Interview: learn motives of behaviour

Observation: more suitable to map actual behaviour, risk of strategic answers reduced
no channel of expression, no risk of bias

Content Analysis: little distortion due to strategic answers

Disadvantages

Interview: easier to obtain perspectives, memories and intention compared to actual behaviour
interview assumes interviewee can express their thoughts & feelings
risk of strategic answers, natural behaviour interviewee is disregarded,
offer little or unreliable information regarding physical & social context

Observations: not able to learn motives of behaviour, time consuming,
controllability of outcome is limited

Content Analysis: Documents and media are subject to editing

Chapter 8: Research planning → the when and how much

Seen as 2 items: 1) designing and stimulating tool
2) efficient design → activity plan & time schedule

Characteristics of planning

Planning a research project should be understood as follows:

- an overview of activities to be carried out (planning process)
- including the sequence and timeline (planning product)

2 different notions

- 1) monitoring function
- 2) design function → feasible harmonious design
→ when and in which order
↳ Serial or Parallel

Activity plan

Planning is defined as an overview of activities and its products
subjected to a time schedule → 2 groups of activities

1) Research Trajectory

2) Writing Process

2 parallel processes at the start

1) Research process: body of activities concerning gathering, processing and analysing research

2) Writing process: study of research material and finding of answers to the research questions from this material

Conceptual Writing

- must precede communicative writing
- about developing clear thoughts
- combine thoughts into a line of reasoning

designing a research plan

(research trajectory)

(writing process)

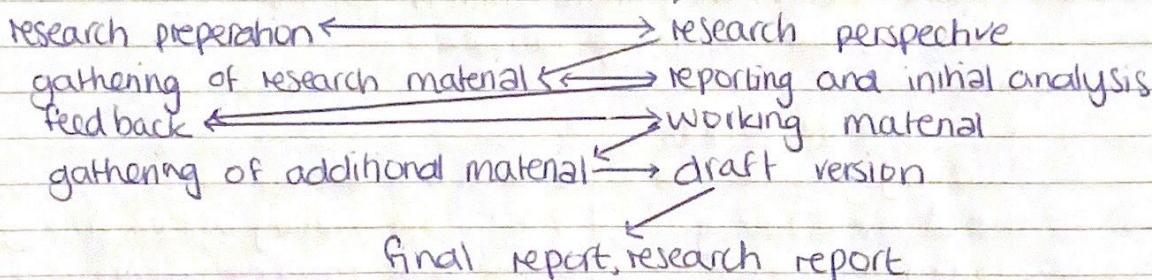


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Chapter 2: elaboration theories used, answer to 1st central Q

Chapter 3: Methodological justification

Chapter 4: Results

Chapter 5: Conclusion & Recommendations

Time schedule

A way to represent a time schedule is with a time axis

advantage: at a glance we see what activities & products must be completed at various stages

disadvantage: doesn't show parallel planning

To show parallel planning, use a histogram

Systems Thinking

Why Systems language

- emphasis on holism offers a useful corrective to the reductionism
- emphasis on process & structure
- Transdisciplinary
- Suitable for getting grips with real-world problems

Soft Systems Thinking

- problem context are **plonst** and provide recommendations for analysis and intervention on that basis
- The notion that it was possible to assume easily identifiable, agreed-on goals **is abandoned**
- Notion that could not be used to provide an objective account of the system and its purposes

Hard Systems Thinking

- Participants defined as being in a unitary relationship have similar values, beliefs and interests. They share common purposes
- Problem contexts are not extremely complex

System Approaches

		Participants		
		Unitary	Plonst	coercive
system	Simple	Hard Systems Thinking	Soft systems Approach	emancipatory systems thinking
	Complex	System Dynamics, organizational cybernetics, complexity theory		post modern systems thinking

Formulating & Research methodology

