4. Research Methodology

The Research Method

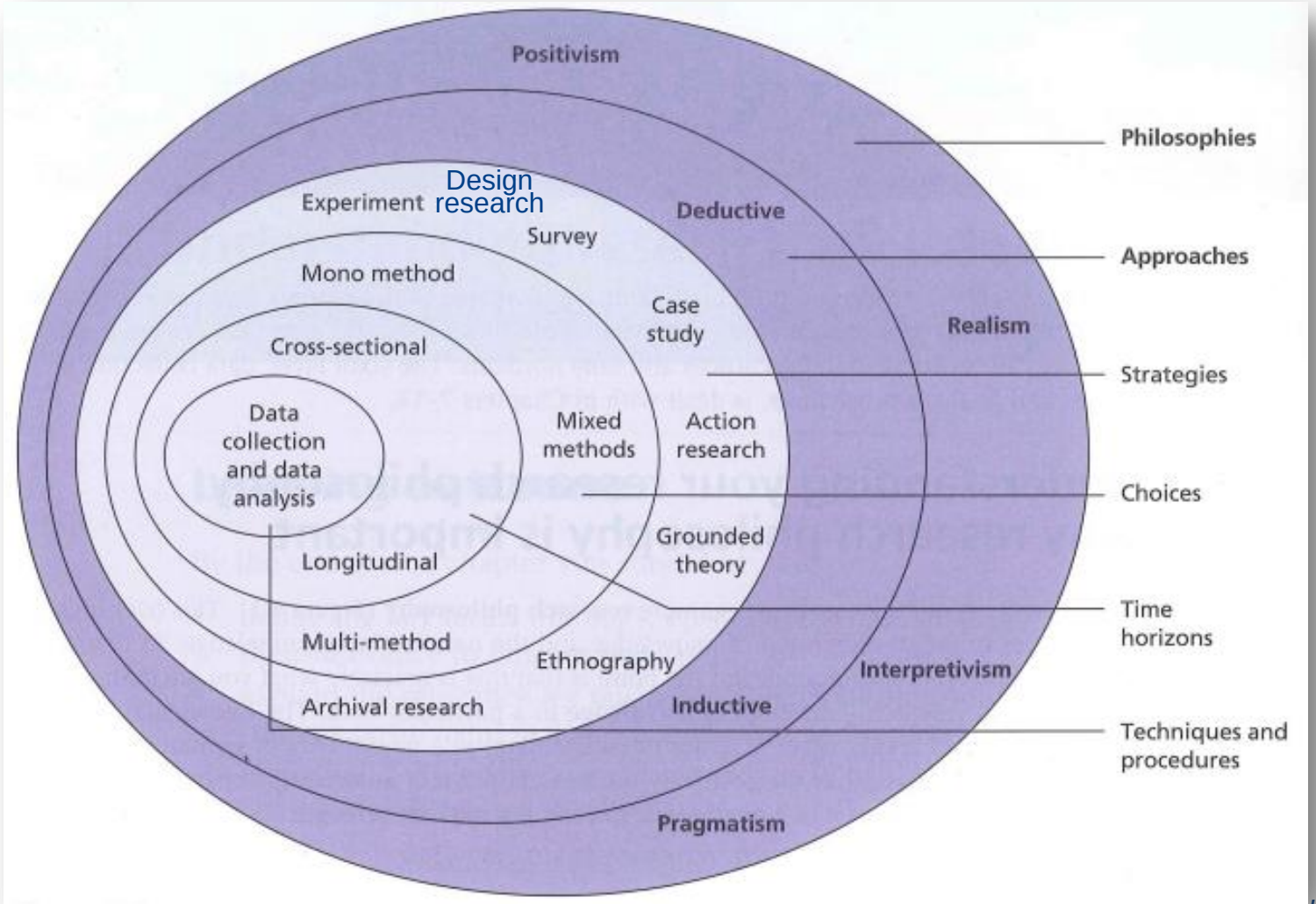
- Chapter mostly neglected by researchers.
- How can we ‘believe’ that the method is sound if you don’t tell us how you did it.
- Why do students find it so difficult to say how they solved a problem .. Is it possible to solve something if you don’t tell us how you did it? Or was your solution not based on real research?

Role of the Method

- A result can only be *accepted, rejected, checked, replicated or even understood in the context of how you got there.*
- …
- Your choice is part of your originality – but your method should be applicable.
  - ♦ You can not do design research when you are doing a case study.

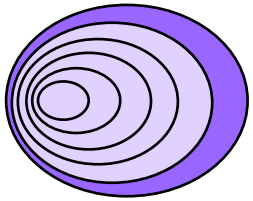
4.1 The Research Dimensions

Research Onion
Systematic Categorisation of Research



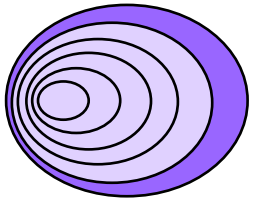
(Saunders et al. 2009)

Philosophy: Positivism vs. interpretivism



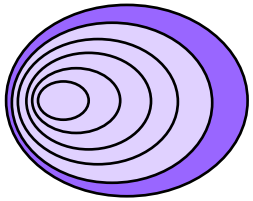
1. **Positivist:** believes in the possibility to observe and describe reality from an objective viewpoint
   - ***observe*** the world in some neutral and objective way, ***discover*** "general" relationships and "universal" laws, ***derive*** theories, ***test*** them
   - observations should be repeatable
2. **Interpretivist:** believes that it is necessary to understand differences between humans in their roles as social actors
   - understand the world from the point of view of the social actors, different interpretations are possible and thus are subjective
   - we interpret our everyday social roles in accordance with the meaning we give to these roles. In addition we interpret the social roles of others in accordance with our own set of meaning.

Positivism vs. Interpretivism



	Positivism	Interpretivism
Ontology: the researcher's view of the nature of reality or being	External, objective and independent of social actors	Socially constructed, subjective, may change, multiple
Epistemology: the researcher's view regarding what constitutes acceptable knowledge	Only observable phenomena can provide credible data, facts. Focus on causality and law like generalisations. reducing phenomena to simplest elements	Subjective meaning and social phenomena. Focus upon the details of situation, a reality behind the details, subjective meanings motivating actions
Data collection most often used	Highly structured, large samples, measurement, quantitative, but can use qualitative	Small samples, in-depth investigations, qualitative

Class Activity: Positivist vs. Interpretivist



Group 1: *we develop and introduce a new IT system that supports customer consultants in a bank in recommending financial products*

- Question: what will a positivist do? What will an interpretivist do?

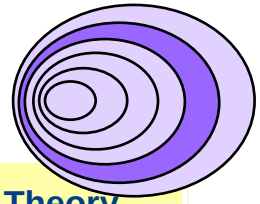
Group 2: *we develop and introduce a new IT system that takes into account organisational background knowledge to retrieve more relevant documents while maintaining a high precision*

- Question: what will a positivist do? What will an interpretivist do?

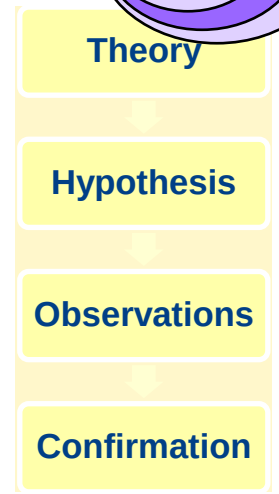
Why do we care for Research Philosophy?

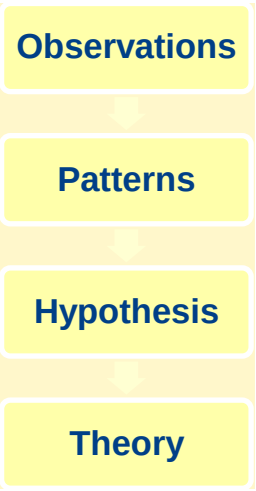
- The research philosophy makes you aware of limitations of your data and their analysis
- It is important when you write about the contribution and conclusion of your research
  - As an interpretivist you are aware that the results are not generally valid, you should specify the limitations
  - As a positivist research

Approach: Deductive vs. Inductive

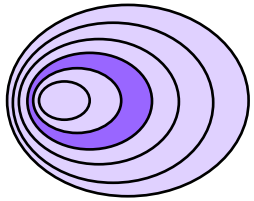


- Deductive approach: from general to specific
  - Develop a **theory** (out of previous findings (literature), experience, some first observations,…)
  - Derive a **hypothesis** from the theory
  - Make **observations**
  - obtain a **confirmation** or rejection of the hypothesis
- Inductive approach: from specific to general
  - Make **observations**
  - Find **patterns**
  - Create a **hypothesis**, explore/validate it
  - Form a **theory** out of hypotheses





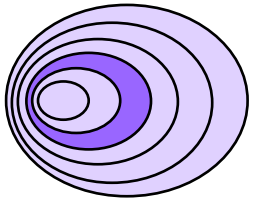
Choices: Quantitative vs. qualitative

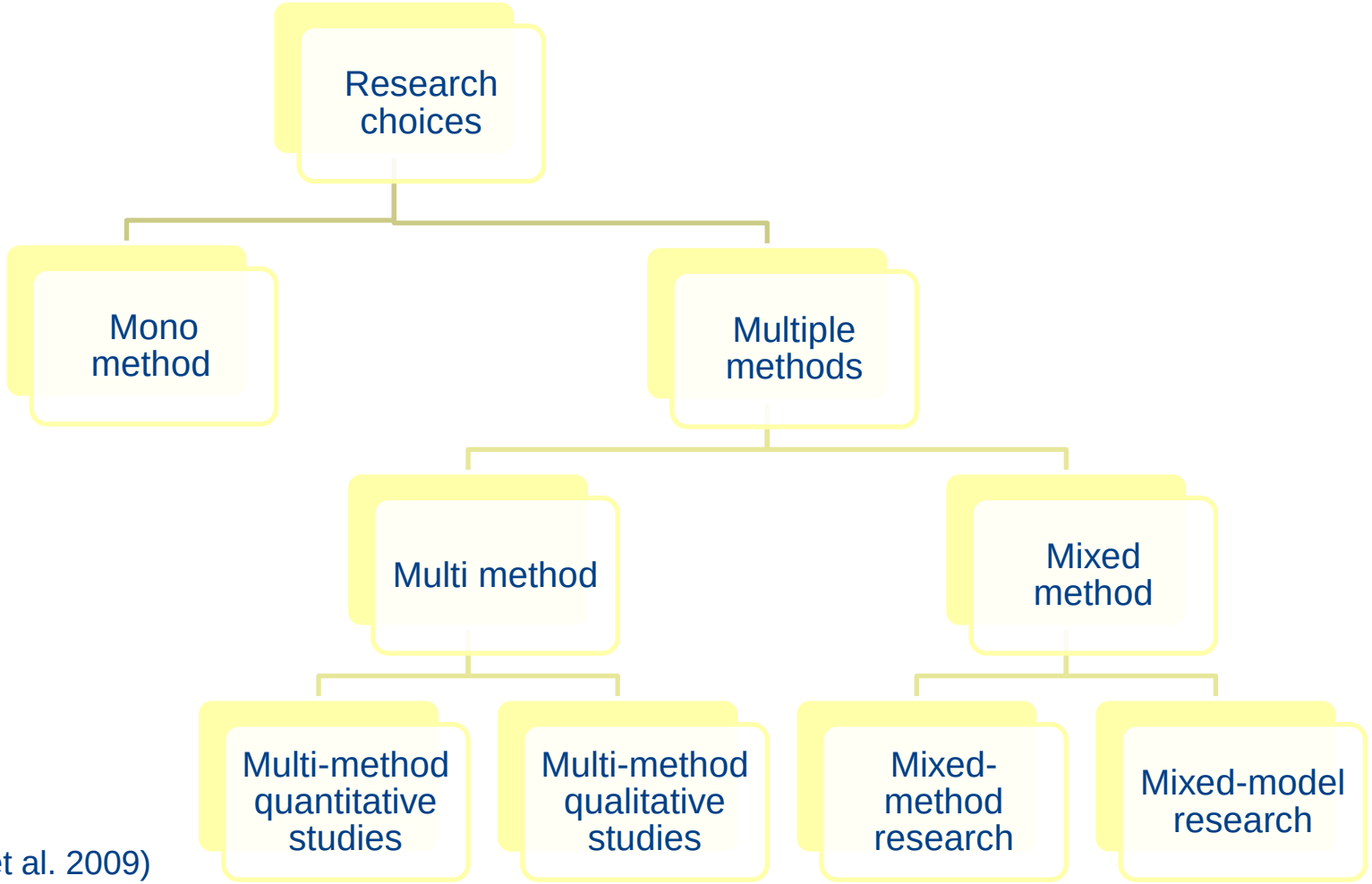


- **Quantitative research:**
  - ♦ focuses on verifying hypotheses (deductive) or finding patterns (inductive) using typically *large amounts of data*
- **Qualitative research:**
  - ♦ focuses on understanding the important characteristics of typically *small samples of data*

- **Example:** investigate users' response to an interface
  - ♦ quantitative approach: collect ratings, verify user acceptance
  - ♦ qualitative approach: understand *why* users interact with the interface in certain ways

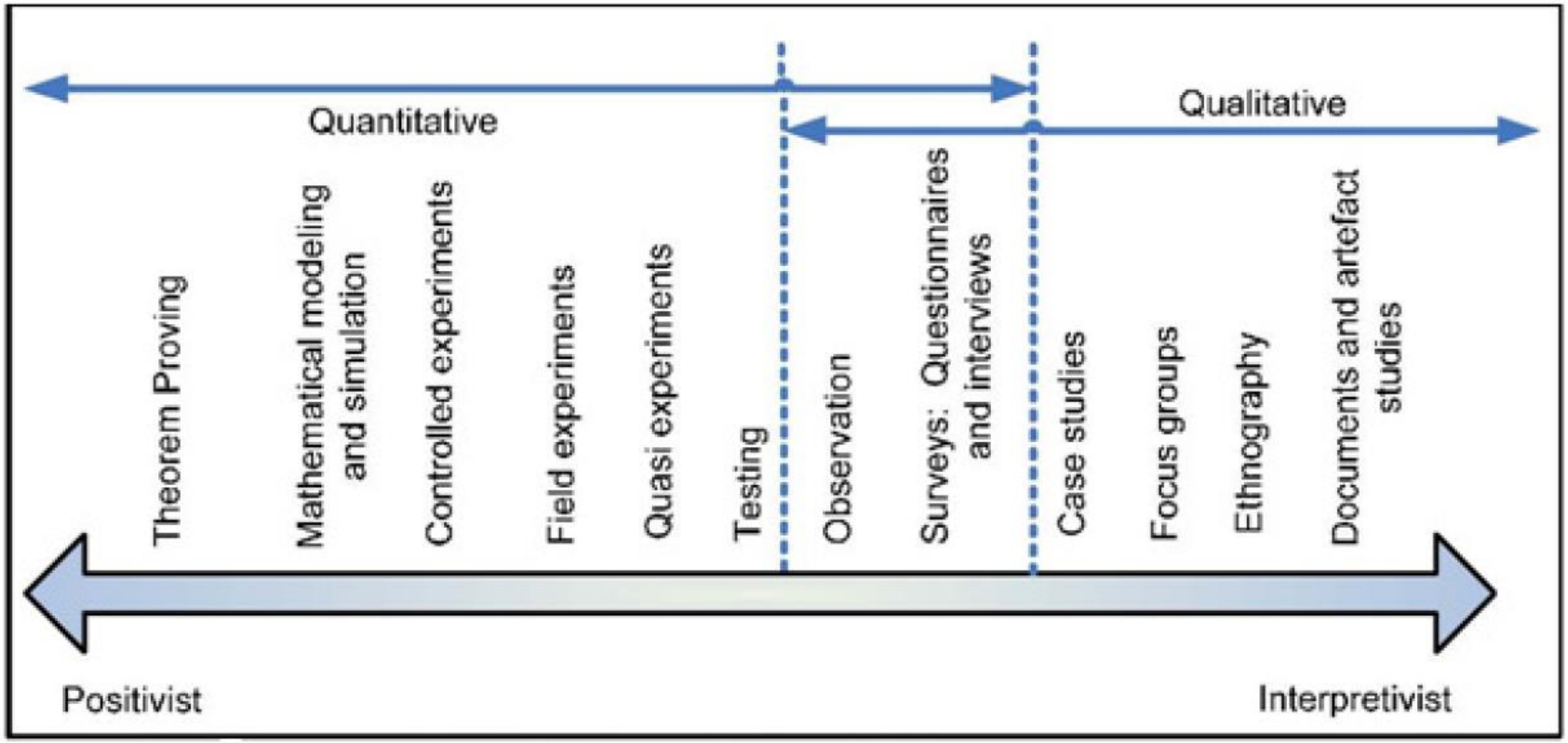
Research Choices





(Saunders et al. 2009)

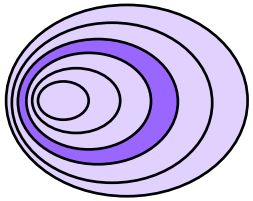
Research Strategies, Choices and Philosophy



(De Villiers 2005)

Research strategies

What is a research strategy?



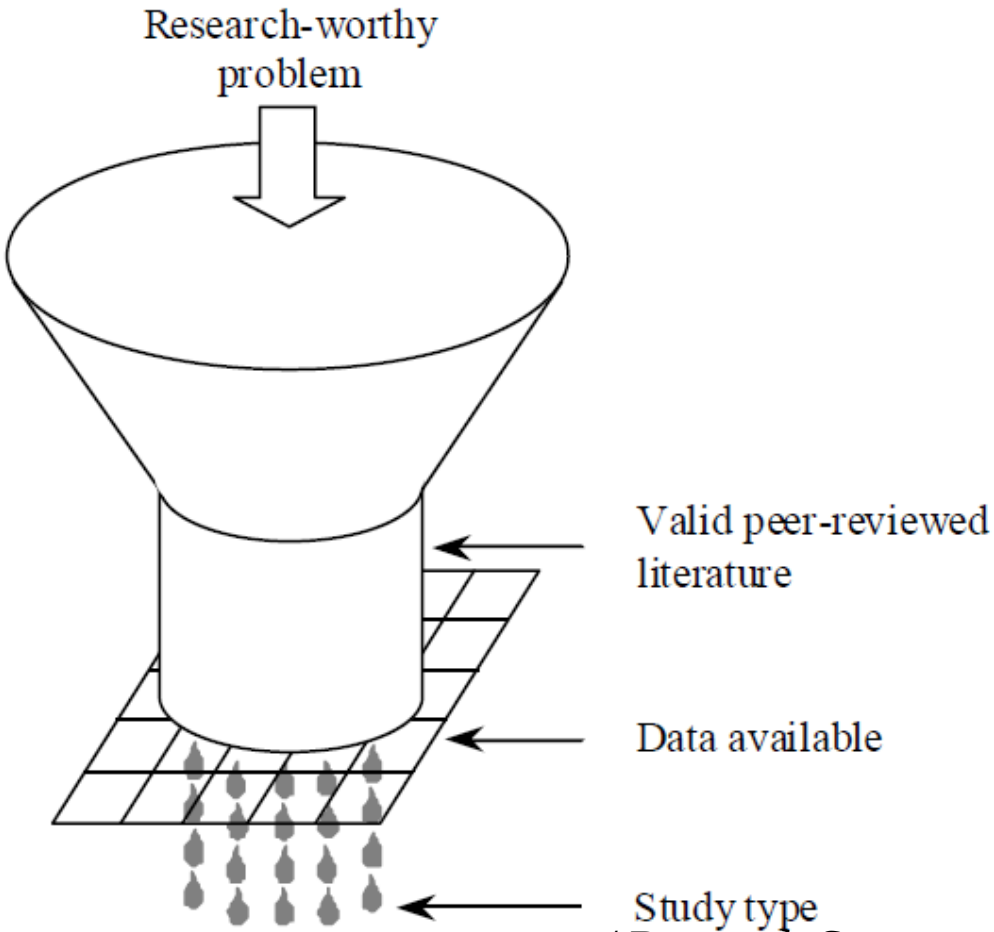
- A research strategy usually has
  - A goal: something it can be used for
  - A procedure: steps to follow to achieve results
  - A set of techniques involved in the procedures
- … and it is often based on a certain type of science (see previous slide block)

Key Categories of Research

Approach	Most common type of data	Stage of problem	Categories of Theory
Experimental	Quantitative	Evaluation	Testing or revising
Causal-comparative	Quantitative	Evaluation	Testing or revising
Historical	Quantitative or Qualitative	Description	Testing or revising
Developmental	Quantitative and qualitative	Description	Building or revising
Correlational	Quantitative	Description	Testing
Case study	Qualitative	Exploration	Building or revising
Grounded theory	Qualitative	Exploration	Building
Ethnography	Qualitative	Descriptive	Building
Action research	Quantitative and qualitative	Applied exploration	Building or revising

(Ellis & Levy 2009)

The Research Strategy depends on the Research Problem, the Literature and the Data



- The research-worthy problem (P) serves as the input to the process of selecting the appropriate type of research to conduct;
- The valid peer-reviewed literature (L) is the key funnel that limits the range of applicable research approaches, based on the body of knowledge;
- The data (D) available to the researcher serves as the final filter used to identify the specific research strategy.

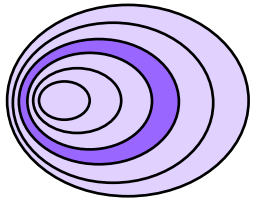
(Ellis & Levy 2009)

Information Systems …

- are socio-technical system consisting of
  - ♦ people (human agents)
  - ♦ information and communication technology (machine agents)
  - ♦ organisations (function, processes, management)
  - ♦ information (artifacts)

  and their relationships

Trends: Research in Business Information Systems



America: Information Systems Research

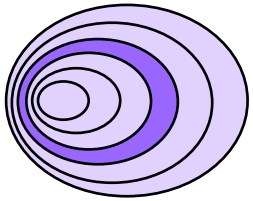
- Focus is „***Analysis***“
- Result: Explanation
  - Properties of Information Systems
  - Behaviour of users
- Social Sciences:
  - „Behaviourism“,
  - „Positivism“
- Strength: Scientific
- Problem: Relevance for practice

Europe: Business Informatics

- Focus is „***Design***“,
- Result: Artefacts
  - Methods, languages, algorithms
  - Models, instantiations, prototypes
- Engineering:
  - „Design Science Research“,
  - „Constructivism“
- Strength: Relevance for practice
- Problem: Research methodolgy

nach (Österle et al. 2010)

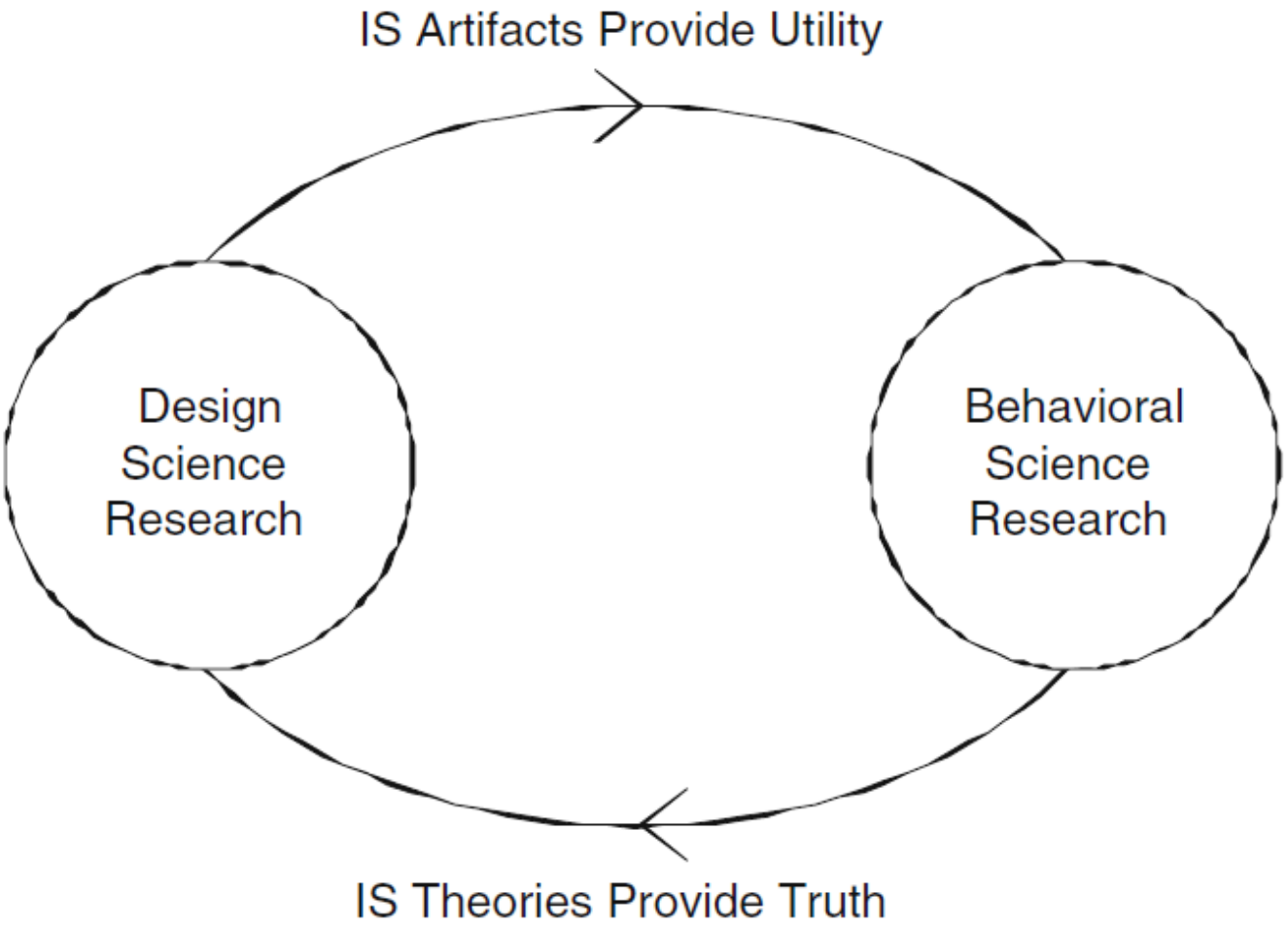
Goal of Research



- The goals of **design-oriented** research are
  - guidelines for the construction and operation of information systems
  - innovations of information systems (instances)
  - *methods similar as those from the engineering/technical sciences*
- The goals of **behavioristic/analytical** research are
  - analysis of information systems as a phenomenon (actual situations)
  - Understand properties of information systems and predict computer human interactions
  - cause-effect relationships in the use of information systems
  - *methods from the social sciences or behavioral sciences*

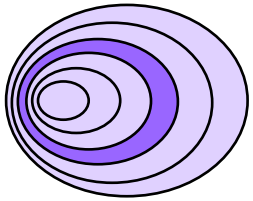
nach (Österle et al. 2010)

Complementary nature of design science and behavioral science research



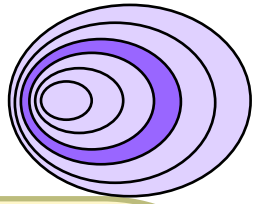
(Hevner & Chatterjee 2010)

Research methodologies – overview



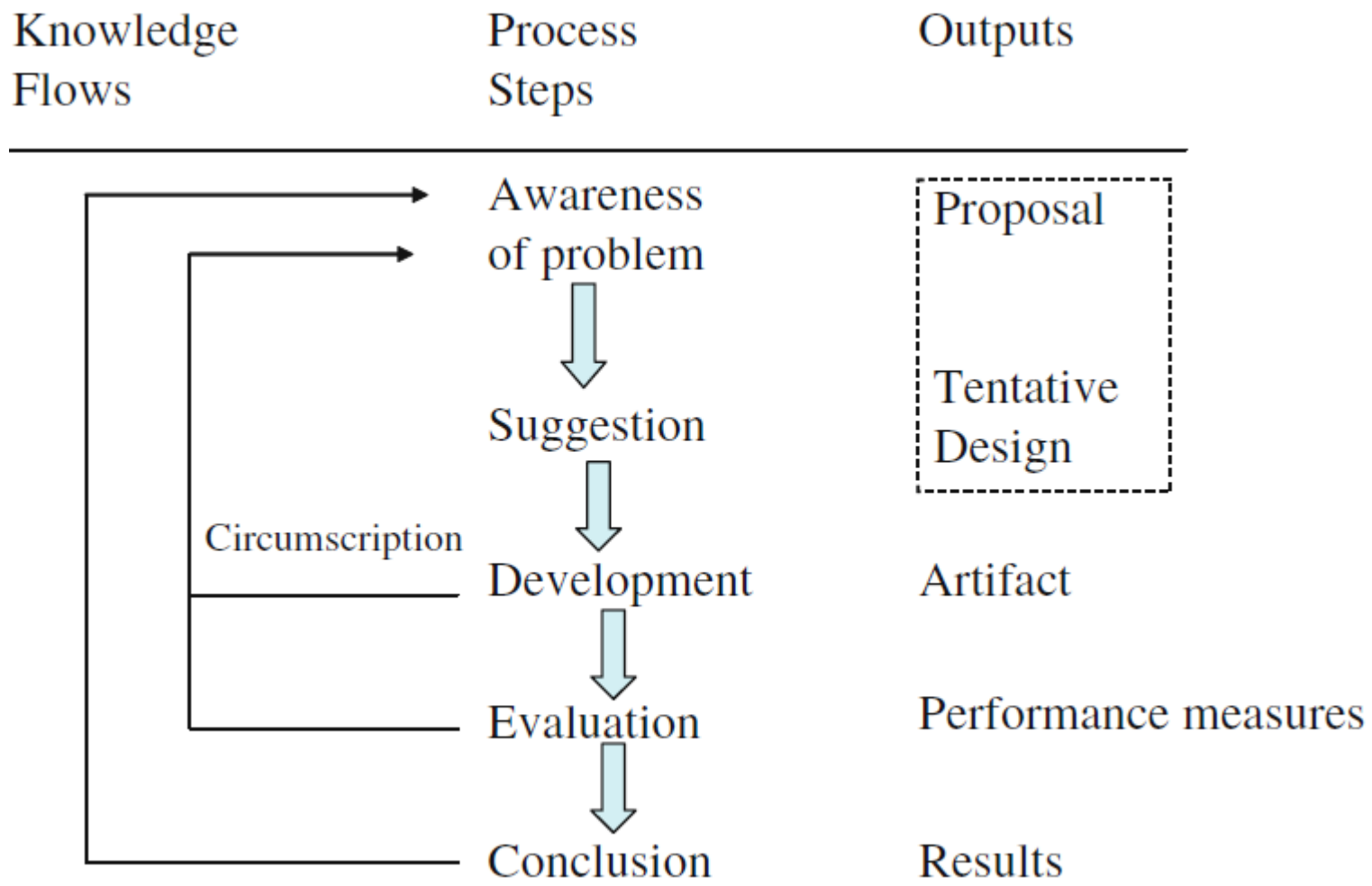
Strategy	Goal
Design research	generate an artefact
Case studies	study the characteristics of a real-life instance
Action research	iteratively solve a problem with a community of practice
Survey studies	find patterns in data
Experiments	test hypotheses

Design science research



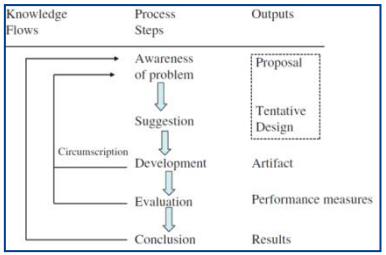
- **Goal:** designing and creating artifacts (constructs, models, methods, instantiations – see above)
- **Procedure:**
  1. Analysis: analyse problem and determine research goals
  2. Development
     a) develop artifact with recognized methodologies
     b) justify solution and differentiate from known solutions
  3. Evaluation: validate approach with respect to research goals
  4. Dissemination: publication, implementation organisations
- **Type of research:** interpretivist, constructive, qualitative

Design Cycle of the Design Science Research Framework (1)



(Hevner & Chatterjee 2010, p. 27)

Design Cycle of the Design Science Research Framework Framework (2)

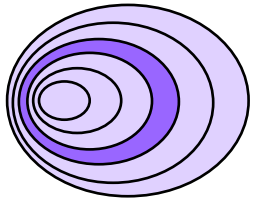


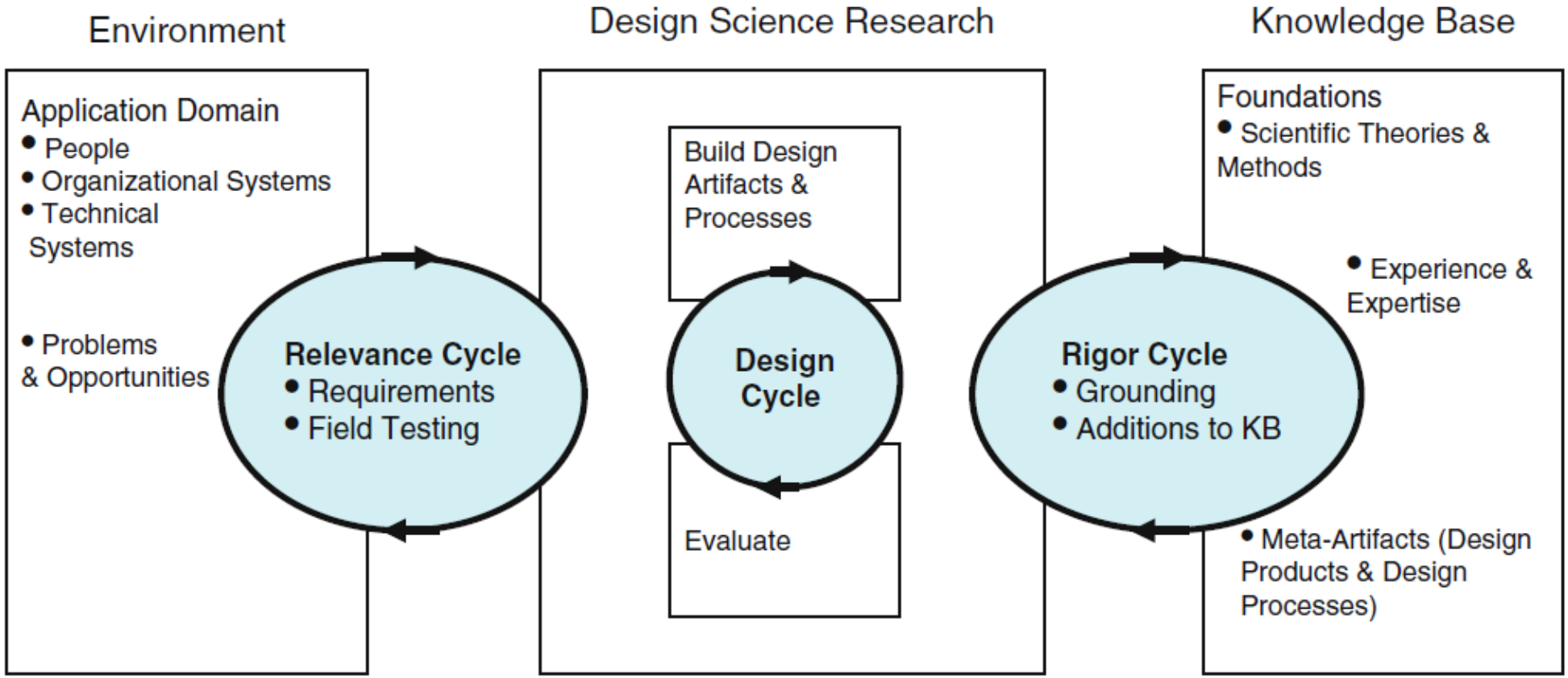
Phases of Design Science Research:

- Awareness of problem
  - recognition of a problem which can be solved by or using new artifacts
- Suggestion
  - discussing what kind of artifact might solve the problem
- Development
  - designing and creating the artifact
- Evaluation
  - checking whether the artifact solves the problem, analyzing its strengths and weaknesses
- Conclusion
  - compilation of results and future aspects such as open questions or plans for further development

(Hevner & Chatterjee 2010, p. 27), (Oates 2006, p. 111f)

Design Science Research Cycles

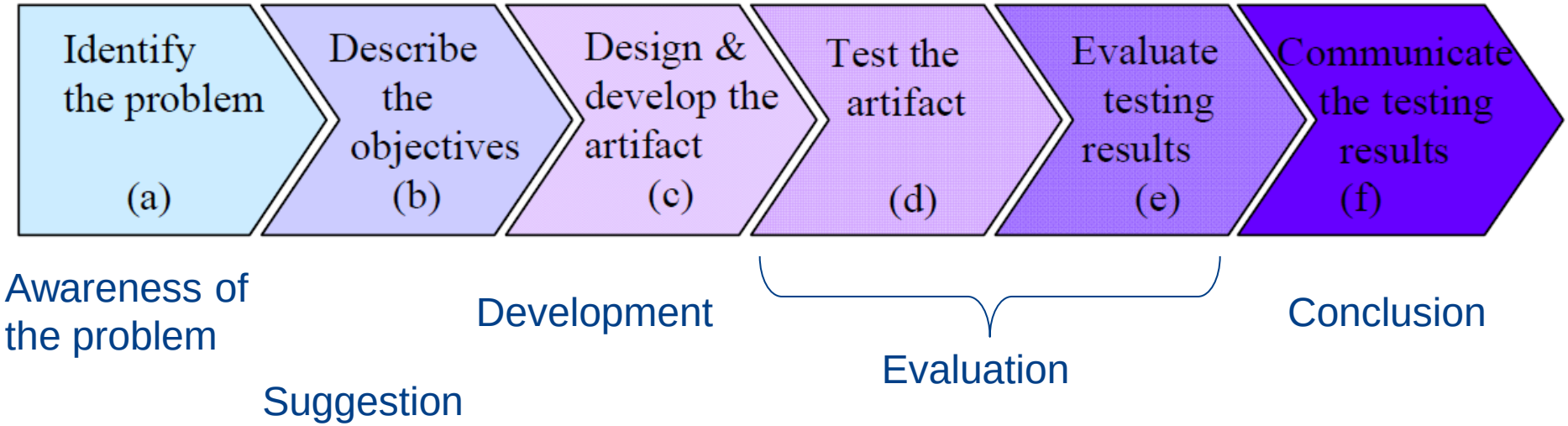




Relevance and Rigor Cycle refer to usefulness and novelty

(Hevner & Chatterjee 2010, p. 16)

The 6-phase design and development research approach



(Ellis & Levy 2010)

Artefacts in Information Systems Research

Specific Artefacts

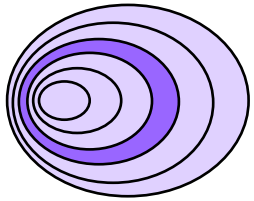
- constructs (e.g. formal languages, mathematical constructs like Petri nets)
- models (representations of existing or possible real-world systems)
- methods (processes, procedures, algorithms)
- instantiations (implementation examples of constructs, models, or methods)

Specific forms of research

- modeling
- prototyping
- developing algorithms
- mathematical proofs or applications of mathematical results
- experimenting
- conducting surveys
- case studies

adapted from Thomas Hanne

Novelty and usefulness of an artifact

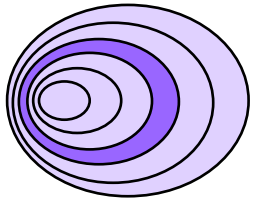


When does an artifact constitute research?

- it must be sufficiently new - with respect to knowledge base
  - thus, it must sufficiently differ from existing artifacts
  - this can be proven by a careful literature review
- it must be sufficiently useful and relevant
  - others must be convinced of its usefulness, e.g.
    - by comparing it with existing artifacts used for the same or a similar purpose
    - by benchmarking it (see below)
    - by demonstrating its benefits in a real-life setting

adapted from Thomas Hanne

Research with a focus on artifacts

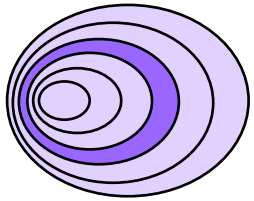


Types of research with a main focus on the developed artifacts

- artifact is something fundamentally new
  - e.g. a new computer language, a new modeling concept, a new method
- artifacts are used for an application in a new domain
  - e.g. an information system used in a new field
- artifacts demonstrate a novel application of a theory
  - e.g. a learning theory is demonstrated, analyzed, or supported by an e-learning package
- (artifact is a work of art)

adapted from Thomas Hanne

Research with a focus on artifacts (2)



Examples of artifacts in research

- the 97th e-business suite or the 317th enterprise resource planning system do not constitute research unless
  - there is a completely new functionality integrated in that software
  - it is an instantiation of a new development technique, software architecture, process model, etc.
  - it is shown that the system leads to better results in some aspect than existing systems (e.g. speed of computation, quality of results, ease of use), i.e. an additional research method is applied (see below for benchmarking)

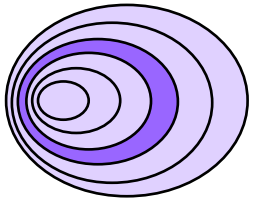
adapted from Thomas Hanne

Design Science Research Guidelines

Design as an Artifact	Design science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation
Problem relevance	The objective of design science research is to develop technology-based solutions to important and relevant business problems
Design evaluation	The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods
Research contributions	Effective design science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies
Research rigor	Design science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact
Design as a search process	The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem Environment
Communication of research	Design science research must be presented effectively to both technology-oriented and management-oriented audiences

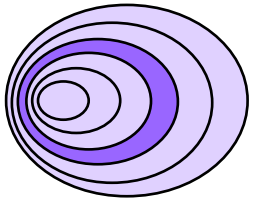
(Hevner & Chatterjee 2010)

Case studies



- **Goal:** study the characteristics of a real-life instance
- **Procedure:**
  1. select an instance to study
  2. collect data, analyse and interpret it in a systematic way
  3. understand the reasons for characteristics of the instance
- **Techniques:** interviews, discussions, observations, questionnaires
- **Type of research:** interpretivist, inductive, empirical, qualitative

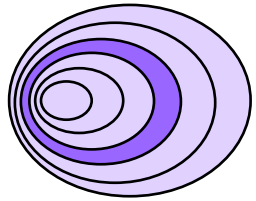
Case study approach



- empirical investigation of a particular contemporary *phenomenon* within its real life *context*
- gaining a rich understanding of the context of the research and the processes being enacted
- Triangulation: using multiple, different sources of data to ensure reliability, e.g. triangulating quantitative data from questionnaires using qualitative data from semi-structured interviews
- Four case-study strategies based upon two dimensions
  - ♦ single case vs. multiple case
  - ♦ holistic case vs. embedded case

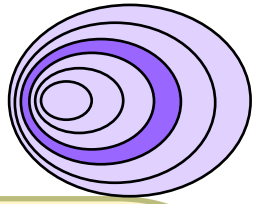
Saunders et al. 2009, p. 146f)

Case Studies and Design Research - Problem



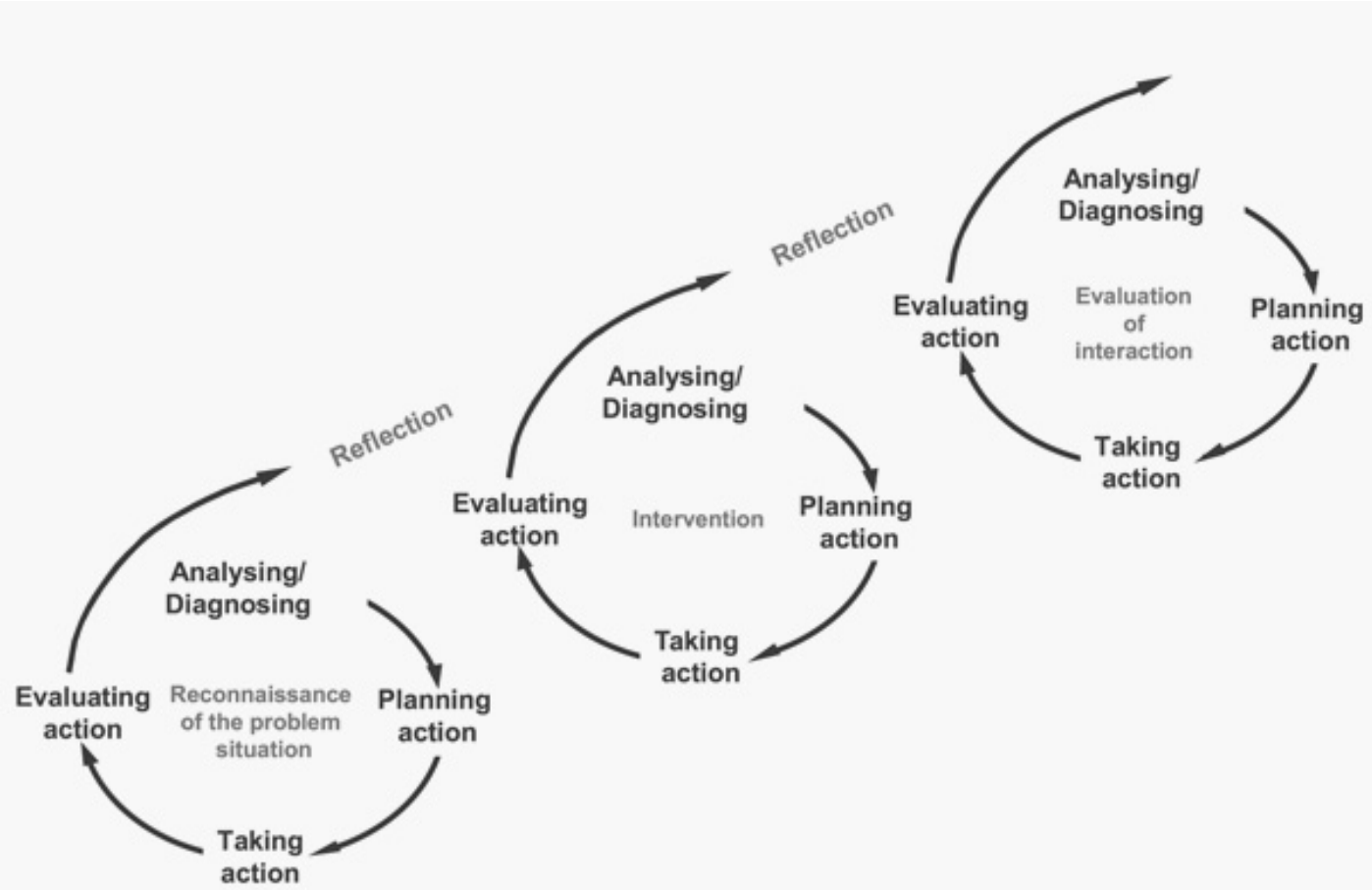
- By their nature, single case studies and design of instantiations do not meet our requirement of «generality» that we defined for research
- Possibilities for solving this problem
  - ♦ need to do multiple case studies for generalisable results
  - ♦ identify characteristics that justify generalisations
  - ♦ validate artifacts in several enterprises during evaluation

Participatory action research



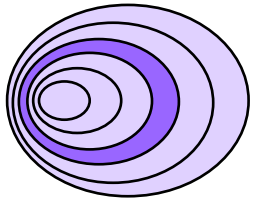
- **Goal:** iteratively solve a problem with a community of practice
- **Procedure:**
  1. Planning:
     a) analyse problem together with practitioners
     b) develop solution(s) with the help of theories, plan actions
  2. Action:
     a) implement solution/action, evaluate
     b) Learning: improve solution as required
  3. Reflection: derive design principle(s) from outcome
- **Type of research:** interpretivist, constructive, qualitative

Action research – procedure



Source: Adapted from Coghlan and Brannick (2001), p. 19; Cardno and Piggot-Irvine (1996), p. 19

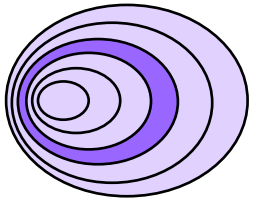
Action Research in Business Information Systems



- might be appropriate in many studies in information systems because
  - the researcher wants to solve a problem in real-life settings
  - not only the technical solution is in focus but also its consequences (e.g. in the social environment), e.g. to help a community address a certain type of problem better in the future.
- However, action research is often not applicable because
  - it is time-consuming and expensive
  - it requires to bring into practice and observe an information system and thus to re-organise an enterprise in several iterations which is not possible

adapted from Thomas Hanne

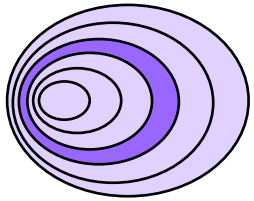
Survey studies



- **Goal:** find patterns in data
- **Procedure:**
  1. collect data from a large group of objects in a standardized and systematic way
  2. evaluate the data, e.g. by using statistical methods
  3. identify patterns, especially those which were not expected
  4. interpret results
- **Techniques:** measurement, questionnaires, literature research
- **Type of research:** inductive, empirical

adapted from Thomas Hanne

Survey studies – interpretation of data



- Qualitative analyses:
  - coding of open questions in a survey
- Quantitative analyses:
  - counting the frequency of specific events
  - observing the timing of specific events (requires some measurement)
  - counting the number of objects (e.g. persons in a queue)
  - descriptive statistics

adapted from Thomas Hanne

Selected Techniques for Data Collection

Evidence is based on Data and Analysis

- If you want your readers to accept or even consider your argument, you need
  - the **data** to substantiate your point and
  - provide **analysis** and argumentation that gives meaning to the data
- Your research will *provide you with relevant facts or data* that you can *analyse and use as evidence* to prove your thesis statement (resp. answer your research question)
- In the following we see some approaches for data collection.

(Hofstee 2006, pp. 146ff)

Primary Sources

- Primary sources are the *thing* that you are investigating. They have not been analysed or interpreted by someone else.
  - ♦ Quality of water in a dam: measurements from the dam
  - ♦ Company's financial practices: balance sheets
  - ♦ Market research: questionnaires.
- Primary data is considered to be stronger than secondary data.

Secondary Sources

- Secondary sources pertain to what you are investigating, but are based on primary data that someone else has interpreted or analysed.
  - Quality of water: article showing that recreational activities in that dam have negatively affected quality of the water;
  - Companies financial practices: article in business paper warning investors not to buy shares in that company because of dishonest financial statements:
  - Market research – a book on how to design questionnaires.

Primary Research

- Primary data that you collect depends on your thesis statement, your method, and on secondary sources.
- Define your goal clearly.
- Spend time on planning.
- Confirm that the data that you plan to gather do not already exist.
- Ask yourself:
  - Who is likely to be interested in the kind of data you are looking for?
  - Where is this kind of data likely to originate, be generated or stored.

Primary Research (Cont'd)

- Gather your own data – be careful to depend on someone else!
- Data needs to be organised, supplemented, and interpreted.
- Keep a lose eye on the quality of the data that you sourced.
- Types of data collection:
  - ♦ Measuring something, setting up a experiment, interviewing people, doing archival research, looking into company records
- Try to make the data collection worth while for the people or organization where you are doing your research.
- Keep notes on your techniques and your experiences.

Interviews

- Dialogue between people to obtain specific information
- Some advice:
  - make a plan for the information you want to elicit
  - get background information of the interviewees and their context
  - sometimes it's useful to send information to the interviewee in advance
  - schedule the interview (time, place, equipment)
  - make notes and/or record (audio, video) the interview
  - establish a convenient atmosphere, start with some small talk
  - ask open questions (why, what, how, …)
  - ask for examples/details
  - make sure you understand: rephrase what the interviewee said
  - postpone "critical" questions to a late phase of the interview

adapted from Thomas Hanne

Questionnaires

- Structured form of predefined questions
- Collects quantitative data from a number of individuals
  - statistical evaluation
  - detection of patterns, trends etc.
- Usage:
  - survey studies (see above)
  - Experiments (support or reject hypotheses)
- Can be used for objective or subjective (e.g. opinions) data

adapted from Thomas Hanne

Questionnaires – some advice

- Design of questions:
  - clear, unambiguous, as brief as possible
  - clear relation to research question/hypothesis (for the researcher!)
  - can be closed (yes/no, Likert scales) or open
  - questions should be logically ordered and/or grouped
- Self-administered vs. researcher-administered
  - self-administered usually through online surveys (e.g. surveymonkey)
  - researcher-administered:
    - pro: better control, more detailed information can be extracted, possibility to explain (ambiguous)questions
    - con: personal bias, time-consuming
- Should be pre-tested to detect flaws in design and estimate time required

adapted from Thomas Hanne

Observation

- Observe people in their environment
- Gives you the possibility to get first-hand impression
- Measures behavior directly, less dependent on subjective or selective view of other persons
- Usage
  - ♦ data that can be directly observed

Focus Groups

- A focus group is defined as a moderated discussion among 6–12 people who discuss a topic under the direction of a moderator
- Focus groups have been effective both as a self-contained means of collecting data (as a primary research tool) or as a supplement to other methods of research (as a secondary research tool)
- The focus group technique is useful as an
  - *exploratory method* when little is known about the phenomenon
  - as a *confirmatory method* to test hypotheses
- Thus, for design science research focus groups can be used in two stages:
  - before design is available: evaluate needs and requirements through *exploratory* focus groups
  - after design is complete and artifact is in use: conduct confirmatory focus group studies

The quality of your data will determine the quality of your dissertation ..

Designing your own Reseach Method

Design Research vs. Research Design

- Do not confuse design science research and research design
  - Design science research is a research modeling in which you develop artefacts
  - Research design is YOUR plan for doing research. It consists of choices for the layers of the research onion.

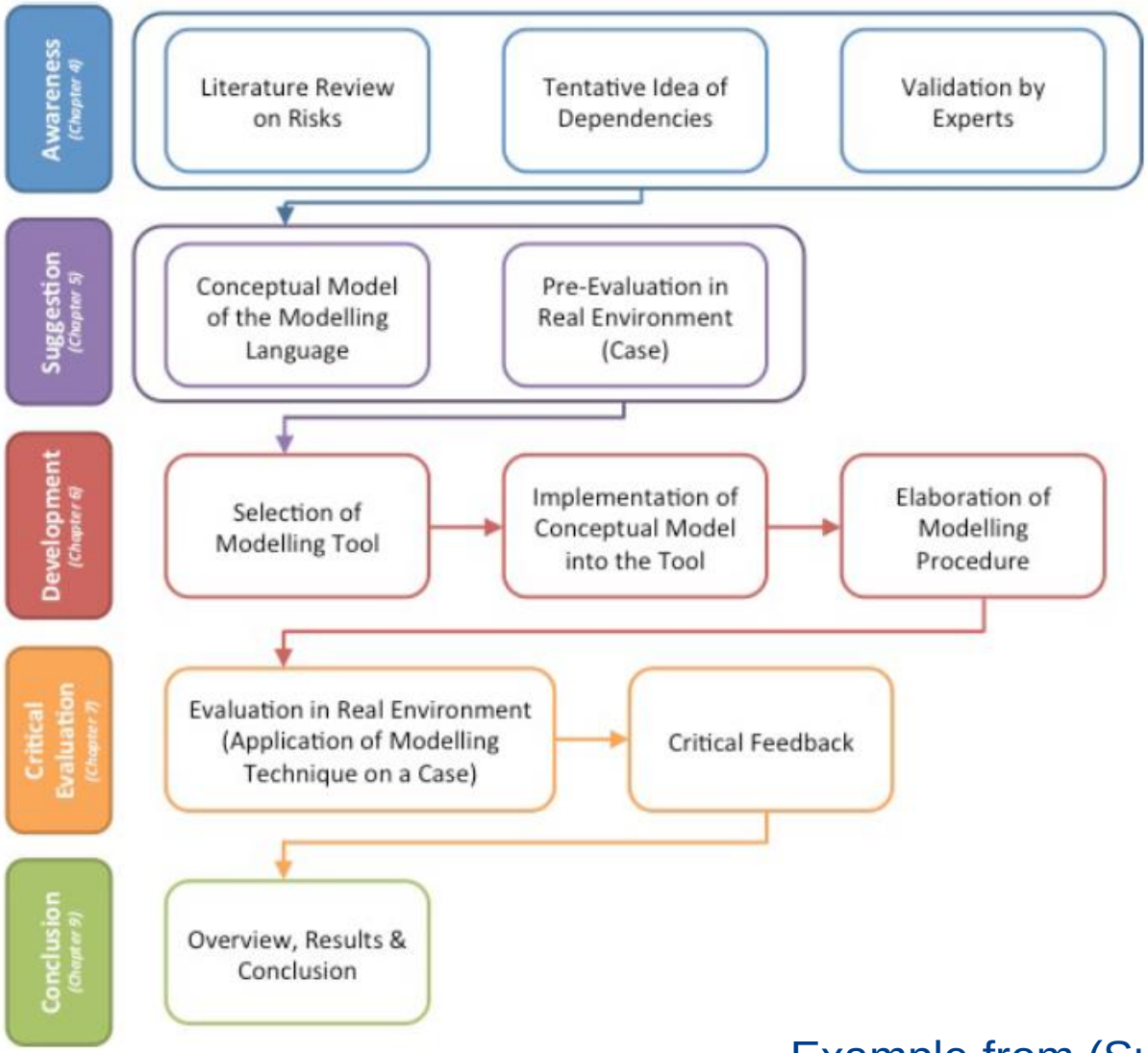
The Chapter on Research Methodolody

- Your thesis should contain a dedicated chapter about research methodology in which you explain and describe your research design
- The research design gives your choice of research philosophy and research approach
- For your research strategy you determine the data collection relevant to answer each research question

Design Science Research – specifying each phase

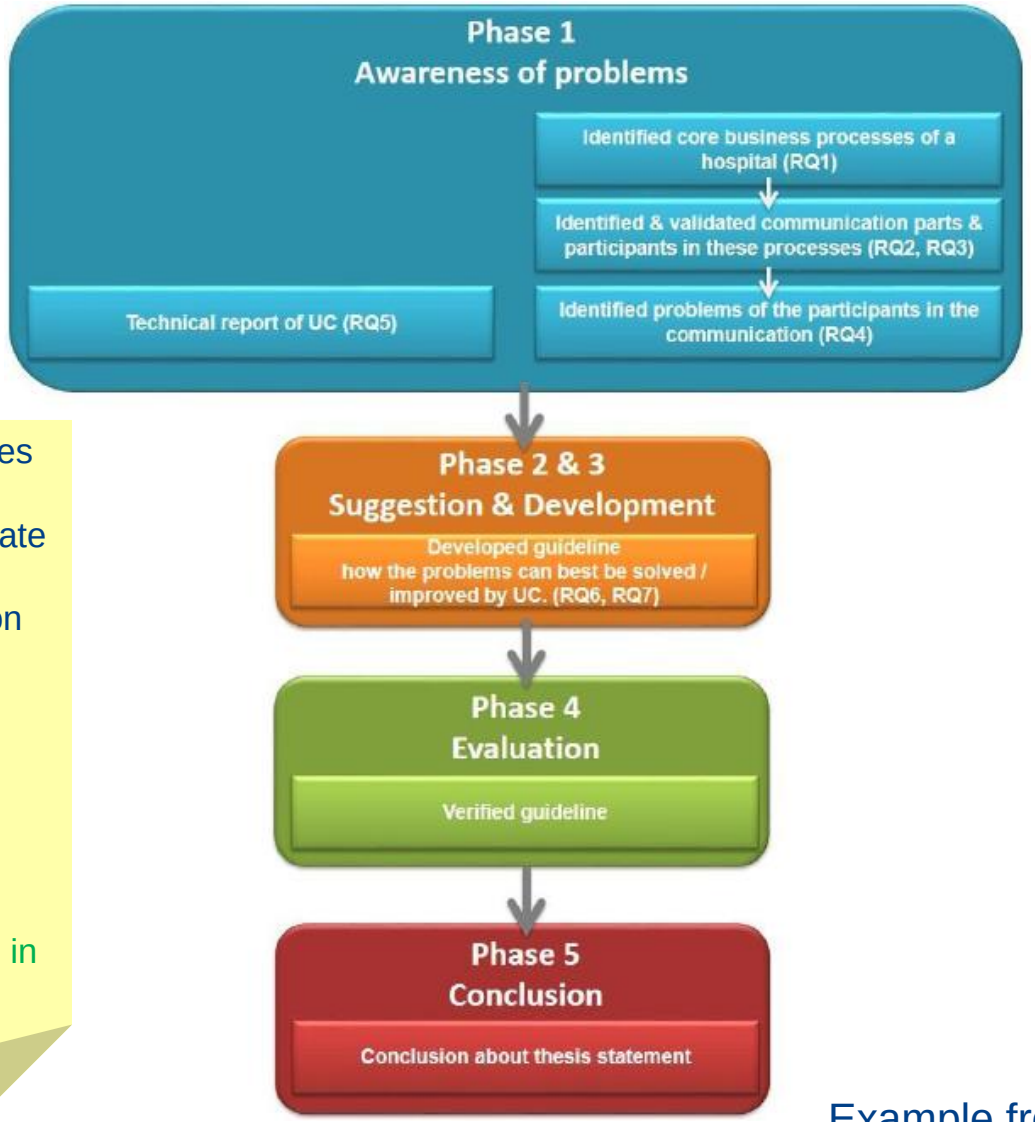
- In design science research you will specify **for each phase** the way of data collection and analysis
  - What information and data is needed to understand the problem?
  - How can I make a good choice of the approach to be developed?
  - How can I develop the artefact?
  - How can I evaluate the artefact?
- Be aware to take into account for each phase
  - environment (relevance cycle)
  - body of knowledge (rigor cycle)

Graphical Representation of the Research Design



Example from (Sudakova 2014)

Graphical Representation of the Research Design

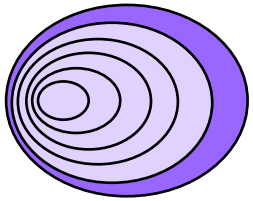


1. What are the core business processes of a hospital?
2. Where do people have to communicate in these processes?
3. Who is involved in the communication part?
4. What are the problems in the communication?
5. What are the functionalities and advantages of UC?
6. How can the identified problems be improved by UC?
7. What are the success factors for UC in a hospital?

Example from (Lam 2014)

Exercises

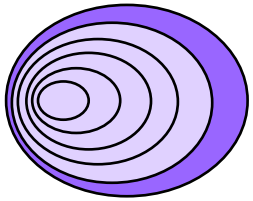
Class Activity: Positivist vs. Interpretivist



Example: *we develop and introduce a new IT system that supports customer consultants in a bank in recommending financial products*

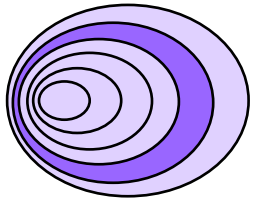
- Question: what will a positivist do? What will an interpretivist do?

Class Activity: Positivist vs. Interpretivist



Example: *we develop and introduce a new IT system that takes into account organisational background knowledge to retrieve more relevant documents while maintaining a high precision*

- Question: what will a positivist do? What will an interpretivist do?



- **Question:** If you've read literature (=theory?), does that mean automatically that your approach must be deductive??