
Teaching Materials

Created by Professor Jan Recker
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# Overview

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Chapter 5: Research Methods
Procedures that feature research methods such as experiments or surveys and which are characterized by an emphasis on quantitative data (think of these procedures as having a focus on “numbers”).

Quantitative data are types of data whose value is measured in the form of numbers, with a unique numerical value associated with each data record.

Quantitative methods emphasize state-of-the-art analysis of such data to create valid and reliable general claims.
Quantitative methods emphasize (post-) positivist philosophy.
- Positivist researchers generally assume that reality is objectively given and can be discovered by a researcher and described by measurable properties independent of the observer (researcher) and his or her instruments.
- Interpretive researchers, on the other hand, start out with the assumption that access to reality (given or socially constructed) is only through social constructions such as language, consciousness, and shared meanings.

Ontologically, quantitative research is based on the idea that scientific theories can be proposed that can be falsified by comparing theory to carefully collected empirical data. The world has an objective reality that can be captured and translated into testable hypotheses, usually in the form of statistical or other numerical analyses.

Example: Einstein’s theory of relativity really became trusted when in 1919, Eddington’s eclipse observation showed that Einstein’s predictions were correct and Newton’s predictions incorrect.
1. Researchers posit a new theory in the form of one or more hypotheses (e.g., an alternative hypothesis that people with small hands type faster), expressed in contrast to a null hypothesis of no effect (e.g., people with small hands do not type faster).

2. They design an empirical study to obtain data (e.g., measures of typing speed and hand size).

3. They collect the data from a sample (e.g., a group of students or knowledge workers).

4. They test their hypotheses, by analyzing the gathered data and calculating one or another test statistic (e.g., a t-test comparing typing speed of those with large hands to those with small hands). They calculate a probability, the p-value, under the assumptions of a specified statistical model, that a particular test statistic (e.g., the average typing speed) would be equal to or more extreme than its observed value. Through this test, they examine in the data whether the null hypothesis holds true in the population (e.g., people with small and large hands type at the same speed). This prediction is called a null hypothesis because it typically assumes the absence of an effect (i.e., no difference in typing speed). The p-value—the probability of finding a difference in typing speed in our sample, assuming that there is no difference in the population—is then usually compared to certain thresholds (typically 0.05 or 0.01) known as the alpha protection level.

5. They interpret the results from the statistical tests. If the null hypothesis is rejected, researchers typically construe this result as denoting "accept" or "support" for their stated alternative hypothesis (that people with small hands indeed type faster).
The Importance of Measurement

Quantitative methods depend heavily on exact measurement. Measurement provides the fundamental connection between empirical observation and the theoretical and mathematical expression of quantitative relationships.
Measures and measurement

Conceptualization

Operationalization and data

Real-world domain

Theory

Instrumentation

Reality

Primary measure issue: shared meaning

Primary measurement issue: accuracy

Measure

Measurement

The variables that are chosen as operationalizations must also guarantee that data can be collected from the selected empirical referents accurately (i.e., consistently and precisely). This step concerns the **reliability** of measurement.

The variables that are chosen as operationalizations to measure a theoretical construct must share its meaning (in all its complexity if possible). This step concerns the **validity** of the measures.

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Validity

- Validity describes whether the operationalizations and the collected data share the true meaning of the constructs researchers set out to measure.

- Can be assessed theoretically and/or empirically.
Content validity

refers to the extent to which a researcher’s conceptualization of a construct is reflected in her operationalization of it, that is, how well a set of measures match with and capture the relevant content domain of a theoretical construct.

Content validity is important because researchers have many choices in creating ways to measure a construct. Did they choose wisely so that the measures they use capture the essence of the construct? They could, of course, err on the side of inclusion or exclusion.

Assessments may include an expert panel that peruse a rating scheme and/or a qualitative assessment technique such as the Q-sort method.
Construct validity

- is an issue of operationalization and measurement between constructs. The baseline issue here is whether different theoretical constructs are separable from each other.
- Convergent validity: Items or phrases in the instrumentation are not related in the way they should be or they are not related in the ways they should not be.
- Discriminant validity: Items or phrases in the instrumentation do not segregate or differ from each other as they should.
- Nomological validity: assesses whether measurements and data about different constructs correlate in a way that matches how previous literature predicted the causal (or nomological) relationships of the underlying theoretical constructs.
- Construct validity is typically assessed empirically through statistical, correlational logic.
Internal validity
assesses whether alternative explanations of the dependent variable(s) exist that have not been ruled out.

Factors:
- temporal precedence of IVs before DVs
- Covariation
- ruling out rival hypotheses

Typically assessed through the inclusion of statistical control variables such as firm size, experience, gender, etc.
Types of Validity

- Other types of validity
  - Manipulation validity
    - used in experiments to assess whether an experimental group (but not the control group) is faithfully manipulated and we can thus trust that any observed group differences are in fact attributable to the experimental manipulation.
  - Statistical conclusion validity
    - assesses the appropriate use of statistics to infer whether the presumed independent and dependent variables co-vary as predicted
  - Predictive validity
    - assesses the extent to which a measure successfully predicts a future outcome that is theoretically expected
  - Ecological validity
    - assesses the ability to generalize study findings to real-world settings
Reliability

- describes the extent to which a measurement variable or set of variables is consistent in what it is intended to measure.

- important to the scientific principles of replicability because reliability implies that the operations of a study can be repeated in equal settings with the same results.

- Sources of reliability problems often stem from a reliance on overly subjective observations and data collections.
Internal consistency

- measures whether several measurement items that propose to measure the same general construct produce similar scores.
- The most common test is through Cronbach’s (1951) alpha.
Interrater reliability

- is important when several subjects, researchers, raters, or judges code the same data
- When a range of individuals (multiple study subjects or multiple researchers, for example) all rate the same observation and we look to get consistent, consensual results
- Cohen’s (1960) coefficient Kappa is the most commonly used test.
Types of Reliability

- Other types of reliability
  - unidimensional reliability, composite reliability, split-half reliability, or test-retest reliability
  - See optional reading

Establishing reliability and validity of measures and measurement is a demanding and resource-intensive task.

The first rule should always be to identify and re-use where possible, existing measures and measurements that have already been developed and assessed.

Examples:

- the Inter-Nomological Network ([https://inn.theorizeit.org/](https://inn.theorizeit.org/))
1. Define the conceptual domain of a construct
2. Generate pools of candidate measurement items for each construct
3. Purify the list of candidate items through testing and revisions
4. Obtain statistical evidence for reliability and validity of the measures and measurements
# Types of Quantitative Methods

<table>
<thead>
<tr>
<th>General QtPR Research Approaches</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Descriptive research</strong></td>
</tr>
<tr>
<td>describes the current status of some identified variables to provide systematic information about some phenomena.</td>
</tr>
</tbody>
</table>
A non-experimental, observational research method that does not involve controlling or manipulating independent variables.

to gather information about the characteristics, actions, perceptions, attitudes, or opinions of a large group of units of observations (such as individuals, groups, or organizations), referred to as a “population”.

involve collecting data about a population from a random sample of that population through questionnaire-type instruments that can be distributed and completed via mail, online, telephone, or, less frequently, through structured interviews.

Traditionally, the dominant technique for data collection in IS.

Are preferable when

- the central questions of interest about a phenomenon are “what is happening?” and “how and why is it happening?” and
- when control of the independent and dependent variables is not required or not possible.

Can be used for at least three purposes:

- Exploration: to identify factors that appear relevant (e.g., success/failure factors)
- Description: to ascertain facts about the situations, events, attitudes, opinions, processes, or behaviors that are occurring in a population. (e.g., typical political polls)
- Explanation: to test theory and hypothetical causal relationships between theoretical constructs (the most common form)
Example: Survey research
Three determinants of continuance

- whether users form a positive belief about the actual use of a technique, viz., whether they find it useful and easy to use in actual process modelling practice, and
- whether users are able to confirm (or disconfirm) initial expectations from the pre-usage phase about a technique.

Measurement development

Instructions:

In the following, you will be given four definitions (of construct definition, redundancy, overlap, and excess) and for each definition a number of items contained in a table.

It is asked of you to assess these items, independently from each other, as to how well they fit the content of the given definition. In each case there appropriate you are free being used as a measurement instrument (using a Likert-scale) for the given definition. The assessment should be done using a scale from 1 (I strongly disagree) to 7 (I strongly agree).

Consider the following example: it was found that with respect to the definition of perceived usefulness (“the degree to which a person believes that using a particular system would enhance his or her job performance”), the item “Using the system increases my work productivity” fits the definition in the sense that it is appropriate for measuring an individual’s perception of the usefulness of a system using a 7-point scale with the endpoints “I strongly disagree” and “I strongly agree.”

The same principle applies to this text. To better understand this text, consider the following example that is based on the works of Davis (1986, 1989) and considers various aspects of the usefulness of an IT system. Note that the endpoints are given for illustrative purposes only and do not necessarily reflect an appropriate judgment.

Table:

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using an IT system improves my job performance</td>
<td>6</td>
</tr>
<tr>
<td>An IT system supports critical aspects of my job</td>
<td>5</td>
</tr>
<tr>
<td>Using an IT system saves me time</td>
<td>4</td>
</tr>
<tr>
<td>Using an IT system enables me to accomplish tasks more quickly</td>
<td>7</td>
</tr>
<tr>
<td>Using an IT system improves the quality of the work I do</td>
<td>3</td>
</tr>
</tbody>
</table>
Survey administration

- Population: all process and systems analysts
- Sample: convenience sample (all I could get)
- Administration: Web-based survey
- Sample size: about 600 if I remember correctly.
Intention to Continue to Use $R^2 = 0.40$

Perceived Ease of Use

Perceived Usefulness $R^2 = 0.42$

Confirmation

Satisfaction $R^2 = 0.55$

Intention to Continue to Use $R^2 = 0.40$

Key

<table>
<thead>
<tr>
<th><strong>p</strong></th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.001</td>
<td>***</td>
</tr>
<tr>
<td>0.01</td>
<td>**</td>
</tr>
<tr>
<td>0.05</td>
<td>*</td>
</tr>
<tr>
<td>Non Significant</td>
<td>ns</td>
</tr>
</tbody>
</table>

Statistical results about the hypotheses
R2 describes how much variance in the levels of the dependent variable is explained through the variance in the levels of the independent variable(s).
Reality is much more complex than our sets of 1, 2, 3, ..., explanatory variables.

Remember: Our measures always, invariably, contain error.
Guidelines for survey research

1. Carry out careful development and assessment of measures and measurements.
2. Pre- and pilot-test your survey instrument.
3. Disclose your sampling strategy.
4. Report a profile of the sample framework.
5. Include your instruments in your reports.
7. Establish validity and reliability.
8. Follow the latest guidelines for data analysis.
Example: experimental research
Experimental research

- Quantitative methods specifically intended to examine cause-and-effect relationships.

- Used to examine such relationships by imposing a **treatment** on one group of respondents (the treatment group) but not on another group (the control group) while **maintaining control** over potential confounding factors.

- Treatment: a manipulation that an experimenter administers to the treatment group so the experimenter can observe a response.

- Primary advantage: Internal validity

- Primary disadvantage: ecological validity

- Often considered “the gold standard”.

- Can take place in the laboratory (**lab experiment**) or in reality (**field experiment**)
Example: Skinner‘s Box
Basic experimental concepts

- Treatment manipulation
  - The control for the cause in cause-effect relationships by identifying the type and number of *stimulus levels* (provision versus non-provision, low/medium/high levels of stimulus, and so forth).
  - Experimental designs typically involve a phase prior to treatment manipulation called *pre-test measures*, and usually a phase after treatment manipulation called *post-test measures*.
Basic experimental concepts

- Experimental controls
  - mechanisms employed to ensure that the responses observed are due to the treatments and not because of confounding factors (e.g., placebo effect)
  - also used in experiments to rule out rival theories, that is, alternative explanations.
Basic experimental concepts

- Randomization
  - the process of selecting a sample from a population in such a way that personal characteristics and predispositions do not interfere with the treatment or the response to the treatment.
  - Through matched allocation (expensive and difficult) or random assignment (key for true experiments)

- Quasi-experiments lack random assignment of subjects to groups and hence are experiments with non-equivalent groups (e.g., males versus females)
True-Experimental Designs

1. Two-group Post-test-only Design

   R  T  O_post
   R  O_post  O_post
   (Treatment group)
   (Control group)

2. Two-group Pre-test-Post-test Design

   R  O_prev  T  O_post
   R  O_prev  O_post
   (Treatment group)
   (Control group)

3. Two-group Covariance Design

   R  C  T  O_post
   R  C  O_post
   (Treatment group)
   (Control group)

4. 2x2 Mixed Factorial Design

   R  T1  O_post  (Group 1)
   R  T2  O_post  (Group 2)
   R  T1  O_post  (Group 3)
   R  T2  O_post  (Group 4)

Legend:

- R: Random assignment
- N: Non-random assignment
- C: Covariate measurement
- T: Treatment administration
- O_prev: Pre-test observation measurements
- O_post: Post-test observation measurements
Quasi-Experimental Designs

Non-equivalent Two-group Design

| N | O_pre | T | O_post (Treatment group) |
| N | O_pre | O_post (Control group) |

Non-equivalent Two-group Switched Replication Design

| N | O_pre | T | O_post | O_post2 (Treatment group) |
| N | O_pre | O_post | T | O_post2 (Control group) |

Legend

R Random assignment
N Non-random assignment
C Covariate measurement
T Treatment administration
O_post Pre-test observation measurements
O_post2 Post-test observation measurements
Example: The impact of modeling grammar

Guidelines for experimental research

1. Carry out experiments only in the presence of strong theory.
2. Design your treatments carefully.
3. Perform manipulation checks.
4. Rule out alternative hypotheses.
5. Ensure ecological validity.
6. Check for the latest guidelines on experiments in the literature.
Qualitative Methods
Qualitative Research
Overview

- are strategies of empirical inquiry that investigate phenomena within a real-life context.
- are helpful especially when the boundaries between phenomena and context are not apparent, or when you want to study a particular phenomenon in depth.
- are well suited for exploratory research where a phenomenon is not yet fully understood, not well researched, or still emerging.
- are also ideal for studying social, cultural, or political aspects of a phenomenon.
- stresses on the “why” and “how” of things rather than the “what,” “where” and “when” of things. It involves detailed study of a small sample or group.
Examples


  - Peshkin studies the culture of Bethany Baptist Academy by interviewing the students, parents, teachers, and members of the community, and spending eighteen months observing, to provide a comprehensive and in-depth analysis of Christian schooling as an alternative to public education.

  - Paskin's work represents qualitative research as it is an in-depth study using tools such as observations and unstructured interviews, without any assumptions or hypothesis, and aimed at securing descriptive or non-quantifiable data on Bethany Baptist Academy specifically, without attempting to generalize the findings to other schools.
Other examples

- Victor of Aveyron
    - broke new ground in the education of the developmentally delayed.

- Piaget's Theory of Cognitive Development
  - [http://www.edpsycinteractive.org/topics/cognition/piaget.html](http://www.edpsycinteractive.org/topics/cognition/piaget.html)
    - Developed a constructivist theory of learning and instruction about the process of "coming to know" and the stages we move through as we gradually acquire this ability.
Scientific studies with procedures that feature research methods such as case study, ethnography or phenomenology and which are characterized by an emphasis on qualitative data.

(Think of these procedures as having a focus on “words”)

They emphasize understanding of phenomena through direct observation, communication with participants, or analysis of texts, and may stress contextual subjective accuracy over generality.
- **Natural setting**: performed in the field, studying a phenomenon in the context in which it occurs.

- **Researchers as a key instrument**: researchers collect data and information themselves, often through face-to-face interactions, observing behaviours, studying documents, or interviewing participants.

- **Multiple sources of data**: researchers typically gather a variety of data of different sorts, from interviews to documents to observations and so forth.
Basic principles

- **Inductive analysis**: emphasise bottom-up analysis of data and the build-up of patterns, themes, and concepts into increasingly abstract units from the data.

- **Evolutionary design**: follow an evolutionary research process in which a research plan, a theory, data collection, or analysis can unfold and change over time as the research progresses.
Often used terms and methods

- **Interviews**: Conversations with key informants
- **Observations**: observing phenomena/behaviors directly
- **Documentation**: studying documents, plans, schemes etc
- **Triangulation**: using multiple sources of data
- **Coding**: assigning tags or labels as units of meaning to pieces or chunks of data collected
- **Memoing**: a subjective commentary or reflection about what was happening at the time or place of the data collection
Popular Qualitative Research Approaches

- Ethnographic Research
  - Example: the study of a particular culture and their understanding of the role of a particular disease in their cultural framework.

- Grounded Theory
  - an inductive type of research, based or "grounded" in the observations or data from which it was developed

- Phenomenology
  - describes the "subjective reality" of an event, as perceived by the study population; it is the study of a phenomenon.

- Critical Social Research
  - used by a researcher to understand how people communicate and develop symbolic meanings.

- Ethical Inquiry
  - an intellectual analysis of ethical problems. It includes the study of ethics as related to obligation, rights, duty, right and wrong, choice etc.
Activist Research
- aims to raise the views of the underprivileged or "underdogs" to prominence to the elite or master classes, the latter who often control the public view or positions.

Historical Research
- to discuss past and present events in the context of the present condition, and allows one to reflect and provide possible answers to current issues and problems.

Visual Ethnography
- uses visual methods of data collection, including photo, voice, photo elicitation, collaging, drawing, and mapping.

Autoethnography
- the study of self: a method in which the researcher uses their personal experience to address an issue.
<table>
<thead>
<tr>
<th></th>
<th>Quantitative</th>
<th>Qualitative</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose</strong></td>
<td>to explain &amp; predict; to test, confirm and validate theory</td>
<td>to describe &amp; explain; to explore and interpret; to generate theory</td>
</tr>
<tr>
<td><strong>Research Process</strong></td>
<td>focused; deals with known variables; uses established guidelines; static designs; context free; objective</td>
<td>holistic approach; unknown variables; flexible guidelines; 'emergent' design; context bound; subjective</td>
</tr>
<tr>
<td><strong>Form of Reasoning</strong></td>
<td>deductive - from general case (theory) to specific situations</td>
<td>inductive - from specific situation to general case</td>
</tr>
<tr>
<td><strong>Nature of Findings</strong></td>
<td>numerical data; statistics; formal and 'scientific'</td>
<td>narrative description; words and quotes; personal voice; literary style</td>
</tr>
<tr>
<td><strong>Researcher Beliefs</strong></td>
<td>there is at least some objective reality that can be measured</td>
<td>there are multiple, constructed realities that defy easy measurement or categorization</td>
</tr>
<tr>
<td><strong>Research Literature</strong></td>
<td>relatively large</td>
<td>relatively limited</td>
</tr>
<tr>
<td><strong>Research Question</strong></td>
<td>confirmatory or predictive</td>
<td>exploratory or interpretive</td>
</tr>
<tr>
<td><strong>Research Skills</strong></td>
<td>statistics and deductive reasoning, and able to write in a technical and scientific style</td>
<td>inductive reasoning, attentiveness to detail, and able to write in a more literary, narrative style</td>
</tr>
</tbody>
</table>

Why and when we choose qualitative research

Research Design Decisions

<table>
<thead>
<tr>
<th>Spectrum</th>
<th>One end of Continuum</th>
<th>Other End of Continuum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>Qualitative</td>
<td>vs.</td>
</tr>
<tr>
<td>Aim</td>
<td>Exploratory</td>
<td>vs.</td>
</tr>
<tr>
<td>Boundary</td>
<td>Case</td>
<td>vs.</td>
</tr>
<tr>
<td>Setting</td>
<td>Field</td>
<td>vs.</td>
</tr>
<tr>
<td>Timing</td>
<td>Longitudinal</td>
<td>vs.</td>
</tr>
<tr>
<td>Outcome</td>
<td>Descriptive</td>
<td>vs.</td>
</tr>
<tr>
<td>Ambition</td>
<td>Understanding</td>
<td>vs.</td>
</tr>
</tbody>
</table>

Quantitative
Explanatory
Statistical
Laboratory
Cross-sectional
Causal
Predicting
Genres of Qualitative Research


![Figure 2a. A Map of First-Generation Genres in Qualitative Research](image-url)
Inductive vs Deductive: Using Theory – or not

- **A priori theory**
  - Informs an understanding of possible answers to RQ before you do your study
  - Can be used to develop interview protocol
    - Identifies relevant concepts and relationships that you can develop questions about
  - Allows you to evaluate the theory based on the results
    - Do your interview findings resonate with the theory, confirm or disconfirm it?

- **No a priori theory**
  - You enter data collection with a “blank slate”
  - Avoids bias towards a certain perspective, idea or concept
  - No guidance on interview protocol focus
    - Needs to be broad, open and generative so you don’t “miss anything important”
  - Can lead to the generation of entirely novel theory
  - May lead to findings that have already been explained by existing theory
Two Primary Uses of Qualitative Methods

- In exploratory research: to **discover**

- Example

- In explanatory research: to **test**, **explain** or **compare**

- Example
A primarily inductive application of the case study method

Analysed data from a study of the pricing process of a large manufacturing firm

Compared the data to existing theories.

Then developed a new theory.

Then returned to the data to see how the emergent theory matched the data.

Finally returned to the theory for yet another revision

Compares three theories of resistance with the implementation of a computer system, using an in-depth case study to test the predictions of each theory:

- **Theory 1**: people resist change – people are the case of resistance
- **Theory 2**: resistance is determined by the environment of the technology – technology is the case of resistance
- **Theory 3**: interaction between characteristics of people and technology – both are the case of resistance

The case data is used to contrast the explanatory and predictive power of the theories.
Case study

- Case study research uses empirical evidence from one or more organizations where an attempt is made to study the subject matter in context. Multiple sources of evidence are used.


- Three important points:
  - In business, the case is very often a firm or organization even if the subject matter is not.
  - The difference to ethnography is that case study normally does not involve participant observation or fieldwork.
  - Case study research is per se philosophically neutral.
Qualitative Research

- Case Study Designs

Single-case designs

- Holistic (single unit of analysis)

Multiple-case designs

- Embedded (multiple units of analysis)
Single cases are often argued to be idiosyncratic – not affording great potential for development of abstract, generalizable theory.

However, they are still useful in many situations for purposes of knowledge contributions.

Often a particular rationale is needed for single-case designs:
- **Critical** case: case meets all conditions for testing a theory.
- **Unique** case: case is extreme or rare.
- **Representative** case: case is typical for everyday/commonplace situations.
- **Revelatory** case: case presents a previously inaccessible opportunity.
- **Longitudinal** case: case reflects the change of a subject matter over two or more different points in time.
Example Single Case Study

Multiple-case Designs

- Often presents more completing evidence → research appears more robust
- Rationales for single-cases often cannot be satisfied by multiple cases
- Require more extensive resourcing and time
- Require a replication logic (a heuristic to select the additional cases):
  - **Literal**: a case where similar results are predicted
  - **Theoretical**: a case where contrasting results for anticipatable reasons are predicted
Example Multiple Case Study

Embedded design means that there is more than one unit of analysis in a study of one or several cases related to the same object of investigation.

- allows a researcher to define an appropriate set of subunits and thereby add to the sensitivity of the investigation

Holistic designs characterize case studies that investigate a phenomenon on a more global level.

- advantageous either when no logical subunits can be identified or when the theory itself is of a holistic nature.
Qualitative Research Genres
- Case Study Procedures

- Planning refers to identifying the research questions and other rationale for doing a case study.

- Designing refers to defining the unit of analysis, the number and types of cases to be studied, and the potential use of theory or propositions to guide the study.

- Preparing involves taking the necessary steps to conduct high-quality data collection.

- Collecting means executing the case study protocol(s) and gathering data, preferably from multiple sources.

- Analysing consists of examining, categorising, coding, tabulating, testing or otherwise combining and studying the evidence collected to draw empirically based inferences and other conclusions.

- Sharing refers to bringing case study results and findings to a close by identifying and addressing relevant audiences and providing them with the findings through appropriate reporting or presentation.
Example: Positive Deviance
Planning: Case Study protocols

<Identifying Positive Deviance in Fresh Food>

BAKERY DEPARTMENT
(In-store (Full/Maxi) and Proprietary)

Plan for case site visits

Draft 24/07/2012

Jan Recker/Thomas Kohlborn/Tyge Kummer
Queensland University of Technology

Draft Observation Protocol

With the aim of gaining a comprehensive and detailed picture of each of the identified stores, the following activities need to be conducted:

- Observation / participation in the following processes
  - Supply process
  - Production process
  - Sales process
  - Cleaning process
  - Back office process

- Document analysis
  - For the above processes, any documentation that describes, prescribes, or documents the activities, roles, and card IT systems, will be useful for review in order to understand the processes in more depth. This documentation will be sourced from the internal WOOLworths platform (Access is already granted).

Draft Interview Protocol

Interviews are to be conducted with the following roles regarding the above processes focused on the stated questions above:

- Store Manager
- Department Manager
- Baker (where applicable)
- Baker’s assistants / train (where applicable)
- Apprentices (where applicable)
- Consumers through survey instrument (prochant online). This work builds on previous survey by the Woolworths’ Consumer Insight team and will likely be conducted after the case visits.
- Postrans (where applicable)
- Vendor representatives for proprietary bakery (where applicable)

As a person fulfilling one role may be involved in more than one of the above processes, the interview questions will be adapted and shaped accordingly.

Background information sought for all interviewees:

- What is your role/position?
- What are your duties and responsibilities?
- How long have you been working for Woolworths?
- How long have you been working in your current position in your local store?
  - Other position?
- In which one of these processes are you involved actively or passively? List processes and describe them.

Adapt questions based on given answers:
Designing: Case selection based on theoretical sampling

Positive Deviants
Designing:
Case selection based on theoretical sampling

Time plan for Site Visits
The following stores have been identified as candidates for visits. Average store have been identified based on location (vicinity to Norwest or Brisbane CBD) plus inclusion in 99% average performance bandwidth.

Grey highlighted names are stores that have been identified as not fully compliant with definition of positive deviance (e.g., criteria thresholds, cross-departmental validation and/or environmental scan). It can be decided to eliminate or replace these stores.

<table>
<thead>
<tr>
<th>PD Proprietary Bakery</th>
<th>PD In-store Bakery (MAXI)</th>
<th>PD In-store Bakery (FULL)</th>
<th>Ave Proprietary Bakery</th>
<th>Ave In-store Bakery (FULL)</th>
<th>Ave In-store Bakery (MAXI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYDNEY CBD MET CENTRE</td>
<td>LEURA</td>
<td>CARRNS</td>
<td>Albany Creek</td>
<td>Tahmoor</td>
<td>Burwood Plaza</td>
</tr>
<tr>
<td>ST GEORGES TERRACE</td>
<td>TOWN HALL</td>
<td>MACKSVILLE</td>
<td>Ashmore</td>
<td>Prospect</td>
<td>St Ives</td>
</tr>
<tr>
<td>MAROUBRA BEACH</td>
<td>CULBURRA BEACH</td>
<td>SWANSEA</td>
<td>Hillsdale</td>
<td>Manly West</td>
<td>Potts Point</td>
</tr>
<tr>
<td>FEUXSTOW S</td>
<td>MACQUIARIE FIELDS</td>
<td></td>
<td>Karalee</td>
<td>Stafford</td>
<td>Redfern</td>
</tr>
<tr>
<td>MARDEN</td>
<td>COLLINGWOOD PARK</td>
<td></td>
<td>Young</td>
<td>Morooka</td>
<td></td>
</tr>
<tr>
<td>CHRISTIES BEACH S</td>
<td></td>
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</tr>
</tbody>
</table>

Specific dates will need to be negotiated between Woolworths, QUT and stores. It is suggested to commence with site visits from 30 July onwards. The following table details the plan at present.
Collecting: Being In the field
Qualitative Research Genres - Action Research

- an interactive method of inquiry

- builds upon the idea of introducing changes or other sorts of interventions into a context and studying the effects of those actions

- distinctive feature of action research is the deliberate introduction of interventions by the researcher

1. **DIAGNOSING**
   - Identifying or defining the problem

2. **SPECIFYING LEARNING**
   - Identifying general findings

3. **ACTION PLANNING**
   - Considering alternative courses of action to resolve the problem

4. **EVALUATING**
   - Studying the consequences of the action

5. **ACTION TAKING**
   - Selecting a course of action
Advantages
- the opportunity to contribute to both academic knowledge and to solving a real-world problem.
- combines relevance and rigor in research.

Disadvantages
- doing action and research together is a challenging act for anyone, let alone an inexperienced scholar.
- assuming a position of a value-neutral, independent observer to the extent that it allows for critical reflection and analysis, while at the same time maintaining a role as an influencer and intervener.
- Access to participating organizations that put control to the researcher is hard to organize.
a type of qualitative research that relies on inductive generation (building) of theory based on (“grounded in”) qualitative data systematically collected and analysed about a phenomenon.

- The main purpose of the grounded theory method is theory building, not testing.
- Prior domain knowledge should not lead to pre-conceived hypotheses or conjectures about the research that the research then seeks to falsify or verify.
- The research process involves the constant endeavour to jointly collect and compare data, and to constantly contrast new data to any emerging concepts and constructs of the theory being built.
- All kinds of data are applicable, and are selected by the researcher through theoretical sampling.
Advantages

- tight and early immersion into data analysis – unlike, say, quantitative research where data analysis is typically conducted at a much later stage of the research process.
- encourages systematic and detailed data analysis and the literature provides ample guidelines for conducting these steps.

Disadvantages

- detailed and systematic bottom-up analysis of data: It is very easy to get bogged down in data analysis on a very low level of detail
- it is difficult to integrate data to higher levels of abstraction.
- dependent on both excellent and rich data – collected typically before knowing what to look for
- dependent on creative and critical thinking ability – a skill not easily learned or taught.
- particularly challenging method especially for early career researchers.

Qualitative Research Genres

- Grounded Theory
Traditional **secondary** data collection methods
- Archival analysis (review of documents or other media)
- Content from the Internet

Traditional **primary** data collection methods
- Interviews
- Focus groups
- Observations
- Open ended surveys
A method for data collection that is

- Targeted: the focus is directly on a selected topic,
- Insightful: can provide causal inferences as perceived by interviewees.
- allowing some level of control: the interviewee can use follow-up and probing questions to steer the conversation into certain areas of interest.
- flexible and responsive: can accommodate a range of research problems and can be used to explore additional research questions if they arise.
- allow the collection of rich and descriptive data
- a familiar method: a conversation with a purpose

### Format Advantages Disadvantages

<table>
<thead>
<tr>
<th>Format</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structured</td>
<td>Features consistency and reliability</td>
<td>Cannot follow emergent new lines of inquiry</td>
</tr>
<tr>
<td>Semi-structured</td>
<td>Combines strengths and minimizes risk</td>
<td></td>
</tr>
<tr>
<td>Unstructured</td>
<td>Allows free talk by interviewees about what they find important</td>
<td>Requires interviewee to be in a free-flowing, talkative mode. If too talkative, white noise data is generated.</td>
</tr>
</tbody>
</table>
Items to consider:

- Do you have predetermined topics/concepts you wish to ask questions about?
  - Topic guide format (semi-structured) or actual questions (fully structured)?
- How many questions will/can you ask?
  - Less is more
- What question will you ask?
  - Type (what/how/when/why/etc.)
  - Ending (open/closed)
  - Structure (unstructured/semi-structured/structured)
  - Probes (pre-determined/emergent)
Rough Procedure for Interviewing

- Entry: opening question
- Introduction: foster conversation
- Transition: move to key questions
- Core: 2-5 key questions
- Closure: ending the conversation
  - Summative statement (“all things considered…”)
  - Validation question (“so what I think you said was …”)
  - Summary question: (“anything else you want to add?”)
Qualitative Data Analysis Techniques

- Coding
  - organizes raw data into conceptual categories, where each code is effectively a category or ‘bin’ into which a piece of data is placed

- Memoing
  - a subjective commentary or reflection on what was happening at the time or place of the data collection

- Critical incident analysis
  - identifying series of ‘events’ or ‘states’ that occur (e.g., in chronological order) and the transitions between them
Example Coding
Example Coding in Practice
MEMORANDUM

Date: 27 November 2011
To: Jan Barker
From: Nia Buykwalid
Re: Observations from Interview with Adam Bennett

Purpose of Interview

The objective of the interview was to determine how Commonwealth Bank (CBA) managed its Core Banking Transformation as a business transformation initiative. The interview took place on 27 November 2011 with Adam Bennett, Chief Information Officer for Retail and Business Banking of CBA. The semi-structured interview comprised of 15 questions and lasted approximately 50 minutes. While the findings are summarized in the main interview summary, the reflective analysis is outlined below.

Observation #1: Interview Approach

• The sequence of the interview questions proceeded in accordance with intended protocol:
  • Reflects incorporation of lessons learnt from the trial interview with Michael Greenough.
  • Proposals were worked on well, i.e. standalone to visualize interview questions, list of management disciplines and timelines of CBT initiatives.
  • Interviewee appeared agitated halfway through the interview which may be mitigated with the following strategies:
    o Illustrate, on the props used, a timeline of transformation plan.
    o Inform throughout the interview the first part, second part, halfway through, second last question, last question, etc.

Observation #2: Interview Questions

• 2 questions were eliminated from list (total 14):
  1. Question 10 on what is the initiative was already answered in Question 4 (sub-questions)
  2. Question 15 on whether the interviewee would do the same thing & what would be done different was not answered—used to allow interviewees to take their
Qualitative Data Analysis

- **Data reduction**: organize and reduce massive qualitative data into key insights
- **Data display**: present rich data in accessible and varied form
- **Conclusion-drawing**: develop and verify conclusions based on data and notes
Example Data reduction


Design Methods
Procedures that feature methods to build and evaluate novel and innovative artefacts (such as new models, methods or systems) as outcomes and which are characterized by an emphasis on the construction of the artefact and the demonstration of its utility.

You can think of these procedures as having a focus on “artefacts”.

Design Methods
“We built this dashboard because we think it is important for the public to have an understanding of the outbreak situation as it unfolds with transparent data sources.”

- Used by billions of citizens
- Source of decision-making by policymakers and health professionals
- How good are the dashboards? Can they be made better?
Infections and deaths, by German states

Infections relative to population by German states (color coded)

Infections and deaths, and estimated recoveries, in total and by day

Date of infection (blue) and record generation (yellow)

Infections by age group (bars) and gender (color)

Infections, deaths, and estimated recoveries, by German states

Infections and deaths, by German states

Infections relative to population by German states (color coded)

Date of infection (blue) and record generation (yellow)
## Analysis of the RKI Dashboard

<table>
<thead>
<tr>
<th>Dashboard element</th>
<th>What is represented?</th>
<th>What information is conveyed?</th>
<th>What is the representation useful for?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top element on right hand side of Figure 1</td>
<td>Total infections, deaths, and recoveries (as numbers).</td>
<td>Numerical attributes convey the values of properties in general of the population of Germany (i.e., a system of things that share non-binding mutual properties).</td>
<td><strong>For representation:</strong> they <em>summarize</em> the state of a collection of people (Germany’s population) at some point in time (the time of visit).</td>
</tr>
<tr>
<td>Middle element on right hand side of Figure 1</td>
<td>Total infections (as numbers), by age group and gender (categories color coded).</td>
<td>Numerical and visual attributes convey the values of properties in general of some subsets of the population of Germany.</td>
<td><strong>For representation:</strong> they <em>summarize</em> the state of a subset of the collection of people (Germany’s population) that are of particular interest, because of presumed risk of infection, at some point in time (the time of visit).</td>
</tr>
<tr>
<td>Bottom element on right hand side of Figure 1</td>
<td>Sum of daily infections and daily reported data, by date (as numbers, the two types of data are separated visually through color cording).</td>
<td>Numerical and visual attributes convey the values of one property in general (infections) of the population of Germany by event (dates).</td>
<td><strong>For state-tracking:</strong> The inclusion of temporal event data (successive dates) allows <em>following</em> the change in infection or reporting data over time.</td>
</tr>
<tr>
<td>Left hand side element in Figure 1</td>
<td>Total infections, by state.</td>
<td>Numerical attributes convey the values of one property in general (infections) in different subsets (states) of the population of Germany.</td>
<td><strong>For representation:</strong> they <em>summarize</em> the state of the collection of people (Germany’s population) decomposed into sub-sets (by state), at some point in time (the time of visit).</td>
</tr>
<tr>
<td>Middle element in Figure 1</td>
<td>Total infections relative to population (categorized through color coding), by state (visual).</td>
<td>Visual attributes convey the values of one property in general (infections) in two different subsets of the population (state and population density) of Germany.</td>
<td><strong>For representation:</strong> they <em>summarize</em> the state of the collection of people (Germany’s population) decomposed into sub-sets (by state and population density), at some point in time (the time of visit).</td>
</tr>
</tbody>
</table>
Recommendations to Esri and RKI

1. It must at all times be possible to observe **relevant status indicators** for **particular** collectives of people.

2. It should be possible to **project relevant future states** based on extant transformation laws.

3. It must at all times be possible to **track external events** (e.g., political interventions such as lockdowns, release of new technologies such as vaccines, or change in season) and **map changes in state variables** (e.g., infection rate, death rate, etc.) to the occurrence of those events.

4. It must be possible to **track the sequence of relevant events** that occur.
“A research paradigm in which a designer answers questions relevant to human problems via the creation of innovative artefacts, thereby contributing new knowledge to the body of scientific evidence. The designed artefacts are both useful and fundamental in understanding that problem.”


“The research paradigm is about problem solving; it is about presenting solutions through systems and IT artifacts, broadly defined as constructs, models, methods, and instantiations. […] Design science is at the center of innovation creation and solution building.

Design Science Research is a pragmatic, problem-solving paradigm that seeks to contribute to human knowledge via the creation of innovative artifacts.

DSR is a prominent form of Engaged Scholarship, in which multiple key stakeholders (researchers, users, clients, sponsors, practitioners) collaborate to understand and address an important, complex problem/opportunity.

- Engaged scholarship: teaching and research that connect the resources of the university to our most pressing social, civic, and ethical problems.

Design Science is a creative, engaged research paradigm that informs multiple audiences:

- Researchers: Design principles and mid-range design theories
- Practitioners: Artifact (e.g., product and/or process) instantiations
- Managers: Work and application system controls
- Government: Economic and social welfare
History and Origins

Simon’s Nobel-prize winning work:

Our world is full with artefacts that are man-made, not naturally occurring.
- Artefacts as empirical phenomena are “artificial” rather than “natural.”

Because the artificial artefacts are human-created, the science of artefacts involves the study of the designs used to perform tasks or fulfill goals and functions with the artefact.
Historical Background

- Design has been prevalent throughout history
  - Engineering, Education, Anthropology, Architecture, Art, ...

- Design received scientific legitimacy through Simon’s work

- Design in Information Systems
  - Always prevalent in many European countries such as Germany and Scandinavia
  - Received global attention in Information Systems in the 1990s and 2000s
Main principle: Bridging SCIENCE ↔ TECHNOLOGY

- Technology Evolution (TE)
  - Very Rapid, marked by continuous improvements
  - Process driven by human and economic utilities

- Science Evolution (SE)
  - Slow, marked by paradigm shifts
  - Process driven by evaluation, gathering of empirical evidence, and hypothesis testing
  - See (Kuhn, *The Structure of Scientific Revolutions*, 1996)

- Technology Evolutions precede and drive Science Evolutions
- Science Evolutions ground and direct Technology Evolutions
the research interest is on creating or changing such artefacts with the aim of improving on existing solutions to problems or perhaps providing a first solution to a problem.

Different types of artefacts are conceivable:
- Constructs (vocabulary and symbols)
- Models (abstractions and representations)
- Methods (algorithms and practices)
- Instantiations (implemented and prototype systems)
- Design theories (improved models of design or design processes)
The designed artefact created through design research must provide **improved utility** beyond the current state of utility.

Three implications:
- a) the artefact’s demonstrated utility is novel.
- b) the utility of an artefact in comparison to existing work makes a positive difference.
- c) a thorough evaluation provides decisive evidence of the artefact’s superior utility.

Definition of utility can vary (e.g., performance, effectiveness, efficiency).
Design research framework (overview)

Design research framework (detailed)

Environment
- People
  - Roles
  - Capabilities
  - Characteristics
  - Experience
- Organizations
  - Strategies
  - Structure
  - Culture
  - Processes
- Technology
  - Infrastructure
  - Applications
  - Communications
  - Architecture
  - Development Capabilities

Relevance

IS Research
- Build
  - Design Theories
  - Artifacts
- Evaluate
  - Analytical
  - Case Study
  - Experimental
  - Field Study
  - Simulation

Rigor

Knowledge Base
- Foundations
  - Theories
  - Frameworks
  - Experimental Instruments
  - Constructs
  - Models
  - Methods
  - Instantiations
- Methodologies
  - Experimentation
  - Data Analysis Techniques
  - Formalisms
  - Measures
  - Validation Criteria
  - Optimization

Business Needs

Contributions to the Application Environment

Contributions to the Knowledge Base
Build (constructing the artefact) and evaluate (testing the artefact) are the core research processes in design research.

Environment
- the problem space in which the phenomena of interest reside.
- E.g., people, organizational structures, and existing digital information or communication technologies and infrastructures.
- Ensures relevance of the artefact

Knowledge base
- provides the materials from and through which design science research is accomplished;
- I.e., prior research and results from reference disciplines provide foundational theories, frameworks, instruments, constructs, models, methods, and instantiations that are available for use in the design phase.
- Ensures rigor of design science
Components of the framework

- The **relevance cycle** bridges the research project’s contextual environment and the design science activities.

- The **rigor cycle** connects the design science activities with the knowledge base of scientific foundations, experience, and expertise that inform the research project.

- The **design cycle** iterates between the core activities of building and evaluating the design artefact and the research processes.

- All three cycles must be present and clearly identifiable in a design science research project.
<table>
<thead>
<tr>
<th>Guideline</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Guideline 1</strong>: Design as an Artifact</td>
<td>Design-science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation.</td>
</tr>
<tr>
<td><strong>Guideline 2</strong>: Problem Relevance</td>
<td>The objective of design-science research is to develop technology-based solutions to important and relevant business problems.</td>
</tr>
<tr>
<td><strong>Guideline 3</strong>: Design Evaluation</td>
<td>The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods.</td>
</tr>
<tr>
<td><strong>Guideline 4</strong>: Research Contributions</td>
<td>Effective design-science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies.</td>
</tr>
<tr>
<td><strong>Guideline 5</strong>: Research Rigor</td>
<td>Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact.</td>
</tr>
<tr>
<td><strong>Guideline 6</strong>: Design as a Search Process</td>
<td>The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.</td>
</tr>
<tr>
<td><strong>Guideline 7</strong>: Communication of Research</td>
<td>Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences.</td>
</tr>
</tbody>
</table>

# The Artifact as Knowledge

<table>
<thead>
<tr>
<th>Contribution type</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>More abstract, complete, and mature knowledge</td>
<td>Level 3. Well-developed design theory about embedded phenomena</td>
</tr>
<tr>
<td>More specific, limited, and less mature knowledge</td>
<td>Level 2. Nascent design theory – knowledge as operational principles/architecture</td>
</tr>
<tr>
<td></td>
<td>Level 1. Situated implementation of artifact</td>
</tr>
<tr>
<td></td>
<td>Design theories (mid-range and grand theories)</td>
</tr>
<tr>
<td></td>
<td>Constructs, methods, models, design principles, technological rules.</td>
</tr>
<tr>
<td></td>
<td>Instantiations (software products or implemented methods)</td>
</tr>
</tbody>
</table>

Example level-2 contribution

DP 1: Provide novel information in the form of environmental facts, observations, or general behavior, so that the system affords users disruptive ambiguity and surprise in environmental sustainability transformations.

DP 2: Provide functions of storing and simple and unambiguous categorization of ideas, so that the system affords noticing and bracketing to users in environmental sustainability transformations.

DP 3a: Provide features for interactive communication, so that the system affords users to engage in an open and inclusive discussion in environmental sustainability transformations.

DP 3b: Provide users with an overview of all other users along with features for direct communication between users, so that the system affords users to engage in an open and inclusive discussion in environmental sustainability transformations.

DP 3c: Provide features to relate comments to other comments so that the system affords users to comprehend circumstances and turning them into words and categories on a social ground in environmental sustainability transformations.

DP 3d: Provide features to assign roles to users so that the system affords user specific actions, such as moderation of discussions in environmental sustainability transformations.

DP 4a: Provide features for categorization of action possibilities to distinguish presumptions from actual planned actions, so that the system affords users presumption and action planning in environmental sustainability transformations.

DP 4b: Provide features for dedicated feedback about the implementation and consequences of the implementation of actions in environmental sustainability transformations.

Example level-3 contribution

- **Belief formation** captures how beliefs, desires, orientations etc. about the natural environment are formed.
  - **Macro-level**: the ways an organization coordinates and divides labor and how the organization defines environmental expectations of its agents.
  - **Micro-level**: how an individual forms beliefs about the natural environment

- **Action formation** describes how psychic states about the natural environment translate into actions.
  - **Macro-level**: actions taken by an organization to affect the actions taken by its agents.
  - **Micro-level**: actions taken by agents

- **Outcomes** describe what the consequences of the actions are.
  - **Macro-level**: the measure of the environmentally functioning of organizations.
  - **Micro-level**: the measure of the environmental behavior of agents

- **Meta-requirement 1**: A Green IS must perform one or more of these functions.

---

Propositions of the Design Theory

- **Scope of operation**
  1. Any Green IS instantiation needs to operate at the level of belief formation, action formation, or outcome measurement.
  2. Green IS instantiations will be more effective if they operate at the level of belief formation, action formation, and outcome measurement rather than one of the levels only.

- **Level of operation**
  3. Any Green IS instantiation needs to operate at least at the macro or the micro level of organizations.
  4. Any Green IS instantiation will be more effective if they operate at both the macro and micro level rather than one level only.
Propositions of the Design Theory

- **Effective utility**
  5. To provide effective utility, any Green IS instantiation requires the provision of actualizable environmentally relevant functional affordances at either the macro or micro level.
  6. In any Green IS instantiation, environmentally relevant functional affordances need to be designed such that required material properties are accompanied by suitable symbolic expressions appropriate for the intended user groups.
How powerful are current “Green Systems”?  

- We searched all publications on “green/sustainability information systems”, across all sorts of publication databases  
- We found 416 in total since 2010; 74 that presented some sort of digital system artefact.  
  - 36 of these were able to measure and report environmental data.  
  - Only 6 of these can be used to change people’s attitudes and beliefs.  
  - Only 11 of these allowed the users to actually make green actions or decisions.
What are the knowledge contributions that are possible?

- **Improvement**: Develop new solutions for known problems
  - *Research Opportunity*

- **Routine Design**: Apply known solutions to known problems

- **Exaptation**: Extend known solutions to new problems (e.g. Adopt solutions from other fields)
  - *Research Opportunity*

- **Invention**: Invent new solutions for new problems
  - *Research Opportunity*

---

An invention is a radical breakthrough; a departure from accepted ways of thinking and doing

DSR projects in which little understanding of the problem context exists and no effective artifacts are available as solutions

Research contributions are usually novel artifacts or inventions, i.e., level 1 artifacts

The newness of artifact makes this research difficult
  - Insufficiently grounded in theory
  - Design is incomplete and not fully evaluated
  - Understanding is insufficient to provide new contribution to theory via the design

- Aim: produce an algorithm that generates all significant association rules between items in the database
- Practical importance: Allows organizations to find interesting relationships (e.g. shopping patterns)
- Theoretical significance (newness): Shows (Sect 5) that no other work has done same thing
- Description of new method: Shows requirements (Sect 1), new concepts (association rule, support, confidence), Formal Model (pseudocode) (Sects 2-3)
- Proof: Experiments (Sect 4)
An improvement is a **better** artifact solution in the form of more efficient and effective products, processes, services, technologies, or ideas.

DSR projects in which the problem context is mature but there is a great need for more effective artifacts as solutions

Improvement DSR is judged by:

- Clearly grounding, representing, and communicating the new artifact design
- Convincing evaluation providing evidence of improvements over current solutions

All levels of artifact knowledge contribution can be made
Many DSR projects in IS are in the Improvement Quadrant, for example:

- Better data mining algorithms for knowledge discovery (extending the initial ideas invented by Agrawal et al. (1993)); for example, (Fayyad et al. 1996; Zhang et al. 2004; Witten et al. 2011)

- Improved recommendation systems for use in e-commerce; for example (Herlocker et al. 2004; Adomavicius and Tuzhilin 2005)

- Better technologies and use strategies for saving energy in IT applications; for example (Donnellan et al. 2011; Watson and Boudreau 2011)

- Improved routing algorithms for business supply chains; for example (van der Aalst and Hee 2004; Liu et al. 2005)
An exaptation is the expropriation of an artifact in one field to solve problems in another field.

DSR projects in which the problem context is not well understood but there exist mature artifacts in other fields that can be exapted as effective solutions.

Exaptation DSR is judged by:
- Clearly grounding, representing, and communicating the exapted artifact design
- Convincing evaluation providing evidence of how well the new artifact solves the given problem

All levels of artifact knowledge contribution can be made.
Exaptation Examples

Exaptation DSR is employed when new technologies provide opportunities to solve new and/or different IS problems; for example:

- Codd’s exaptation of relational mathematics to the problem of database systems design leading to relational database concepts, models, methods, and instantiations (Codd, 1970; Codd, 1982)

- Berners-Lee original concept of the World Wide Web was one of simply sharing research documents in a hypertext form among multiple computers. In short time, however, many individuals saw the potential of this rapidly expanding interconnection environment to exapt applications from old platforms to the WWW platforms. These new Internet applications were very different from previous versions adding many new artifacts.

- Research by Berndt et al. (2003) on the CATCH data warehouse for health care information. Well-known methods of data warehouse development (e.g. Inmon, 1992) were exapted to new and interesting areas of health care systems and decision-making applications.
Professional design or system building to be distinguished from DSR

However, evolving or best practices may be observed and documented in “extractive case study” work (Van Aken)

- Study of best practices in routine design may lead to empirical generalization
- Example – Davenport’s observation of BPR (Davenport & Short SMR 1990)
## MISQ Papers mapped to Framework

<table>
<thead>
<tr>
<th>Knowledge Contribution</th>
<th>Article</th>
<th>Knowledge Contribution Claims</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improvement</td>
<td>A Multilevel Model for Measuring Fit Between a Firm’s Competitive Strategies and Information Systems Capabilities (McLaren et al., 2011)</td>
<td>There is a need for a more fine-grained model for diagnosing the individual IS capabilities that contribute to the overall fit or misfit between a firm’s competitive strategies and IS capabilities (p.2) (See also Table 4).</td>
</tr>
<tr>
<td>Improvement</td>
<td>Guidelines for Designing Visual Ontologies to Support Knowledge Identification (Bera et al., 2011)</td>
<td>There could be several ways to address OWL’s inability to show state changes… We have taken a different path, taking the view that we can keep the existing OWL syntax and improve the extent to which it supports knowledge identification (pp. 885-886).</td>
</tr>
<tr>
<td>Exaptation</td>
<td>Co-creation in Virtual Worlds: The Design of the User Experience (Kohler et al., 2011)</td>
<td>While Nambisan and his colleagues provide a useful framework for the online environment in general, little is known about designing co-creation experiences in virtual worlds (p. 774).</td>
</tr>
<tr>
<td>Exaptation</td>
<td>Design Principles for Virtual Worlds (Chaturvedi et al., 2011)</td>
<td>AllVWs comprise a new class of information systems... Thus, they require an extension of the corresponding information system design principles (p. 675)</td>
</tr>
<tr>
<td>Improvement</td>
<td>Correlated Failures, Diversification, and Information Security Risk Management (Chen et al., 2011)</td>
<td>While our model to estimate security loss due to unavailable (i.e., system downtime) is based on well-established queuing models, one innovation of our model is that the distribution from which the number of requests sent to the queue is drawn is endogeneous to system variables (p. 399).</td>
</tr>
<tr>
<td>Exaptation</td>
<td>The Effects of Tree-View Based Presentation Adaptation on Mobile Web Browsing. (Adipat et al., 2011)</td>
<td>Presentation adaptation has been studied in the desktop environment and has been proven beneficial ... However, research on adaptation of Web content presentation for mobile handheld devices is still rare (p. 100).</td>
</tr>
<tr>
<td>Improvement</td>
<td>Improving Employees’ Compliance Through Information Systems Security Training: An Action Research Study. (Puhakainen and Sipponen 2010)</td>
<td>There is a need for IS security training approaches that are theory-based and empirically evaluated. ... (p. 757). To address this deficiency ... this paper developed a theory-based training program ... This paper then tested the practical workability through an action research intervention (p. 776).</td>
</tr>
<tr>
<td>Improvement</td>
<td>The Design Theory Nexus. ( Pries-Heje and Baskerville, 2008)</td>
<td>The work suggests that the design theory nexus approach is more universal than previous approaches to contingency theory, because it can operate in both symmetrical and asymmetrical settings (p. 748).</td>
</tr>
<tr>
<td>Improvement</td>
<td>Process Grammar as a Tool for Business Process Design. (Lee et al., 2008)</td>
<td>The method improves on existing approaches by offering the generative power of grammar-based methods while addressing the principal challenge to using such approaches ... (p. 757).</td>
</tr>
<tr>
<td>Improvement</td>
<td>Making Sense of Technology Trends in the Information Technology Landscape: A Design Science Approach. (Adomavicius, et al., 2008)</td>
<td>Our approach may complement existing technology forecasting methods ... by providing structured input and formal analysis of the past and current states of the IT landscape (p. 802).</td>
</tr>
<tr>
<td>Improvement</td>
<td>CyberGate: A Design Framework and System for Text Analysis of Computer-Mediated Communication. (Abbasi and Chen 2008)</td>
<td>The results revealed that the CyberGate system and its underlying design framework can dramatically improve CMC text analysis capabilities over those provided by existing systems (p. 811).</td>
</tr>
<tr>
<td>Improvement</td>
<td>Using Cognitive Principles to Guide Classification in Information Systems Modeling. ( Parsons and Wand 2008)</td>
<td>Despite the importance of classification, no well-grounded methods exist ... (p. 840). We provide empirical evidence...that the rules can guide the construction of semantically clearer and more useful models (p. 858).</td>
</tr>
</tbody>
</table>
Challenges in doing design research

- Design research projects are usually:
  - Team-based
  - Longitudinal
  - Goal-driven

- All of these are difficult.
Challenges in doing design research

- Attempting to do good design research is an audacious venture
- It is not for those that value **optimal** and **repeatable** results
- Relying on existing theories often does not produce **predictable** results
- Multiple, rapid cycles of build and evaluate produce **emergent** and **satisfactory** results
- Even the most useful results might become eclipsed by rapid changes in the problem and solution spaces
Some Challenges to Doing Good DSR

1. Complexity
2. Confidence
3. Contribution
IS Research studies Complex Socio-Technical Systems (Sarker et al. MISQ 2019)

Information systems are complex artefacts:
- Diverse
- Interdependent
- Connected
- Adaptive

We attempt to Manage Complexity by Capturing/Representing the DSR Problem Space:
- Context (Domain, Stakeholders, Time, Space)
- Goodness Criteria (Goals, Evaluation Measures)
- Dancing Landscape (Emergent Behaviors, Self-Organization, Change)
The first step of any DSR project is understanding and representing the *Problem*.

“Every problem-solving effort must begin with creating a representation for the problem – a problem space in which the search for the solution can take place. … Occasionally, however, we encounter a situation that doesn’t seem to fit any of the problem spaces we have encountered before, even with some stretching and shaping. Then we are faced with a task of discovery that may be as formidable as finding a new natural law.” Simon 1996, p. 108

“This view can be extended to all of problem solving – solving a problem simply means representing it so as to make the solution transparent.” Simon 1996, p. 132

But: Problem of “The Dancing Landscape” – The introduction of a design solution into a problem space changes the problem space. The next DSR cycle faces a new problem.
The identification of DSR goals and their transformation into well-defined evaluation measures are understudied topics.

- What are the important goals of the different stakeholders and how do we reconcile conflicting goals?
- How can we prioritize and weigh goals in a problem ‘utility’ function?
- How do we measure the achievement of these goals?
- How do we evaluate the “goodness of fit” of a designed artifact as a solution in an application environment?
- How do we rank potential design candidates so as to select the best one for implementation as a solution?

Such questions require the DSR project team to define the goals and evaluation measures for the project and design rigorous methods for evaluating the design artifacts under these criteria. The rigor and credibility of a DSR project is determined by these evaluation decisions. 
## Design Evaluation Methods – The Toolbox

<table>
<thead>
<tr>
<th>Category</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Observational</td>
<td>Case Study – Study artifact in depth in business environment</td>
</tr>
<tr>
<td></td>
<td>Field Study – Monitor use of artifact in multiple projects</td>
</tr>
<tr>
<td>2. Analytical</td>
<td>Static Analysis – Examine structure of artifact for static qualities (e.g., complexity)</td>
</tr>
<tr>
<td></td>
<td>Architecture Analysis – Study fit of artifact into technical IS architecture</td>
</tr>
<tr>
<td></td>
<td>Optimization – Demonstrate inherent optimal properties of artifact or provide optimality bounds on artifact behavior</td>
</tr>
<tr>
<td></td>
<td>Dynamic Analysis – Study artifact in use for dynamic qualities (e.g., performance)</td>
</tr>
<tr>
<td>3. Experimental</td>
<td>Controlled Experiment – Study artifact in controlled environment for qualities (e.g., usability)</td>
</tr>
<tr>
<td></td>
<td>Simulation – Execute artifact with artificial data</td>
</tr>
<tr>
<td>4. Testing</td>
<td>Functional (Black Box) Testing – Execute artifact interfaces to discover failures and identify defects</td>
</tr>
<tr>
<td></td>
<td>Structural (White Box) Testing – Perform coverage testing of some metric (e.g., execution paths) in the artifact implementation</td>
</tr>
<tr>
<td>5. Descriptive</td>
<td>Informed Argument – Use information from the knowledge base (e.g., relevant research) to build a convincing argument for the artifact’s utility</td>
</tr>
<tr>
<td></td>
<td>Scenarios – Construct detailed scenarios around the artifact to demonstrate its utility</td>
</tr>
</tbody>
</table>
Selection of Evaluation Methods

- Match Evaluation Methods to:
  - Research Question
  - Goals and Evaluation Measures
  - Hypotheses and Dependent Variables
  - Application Context
    - Controls in the Application Context
  - Availability of Data Sources
    - Qualitative
    - Quantitative
    - Primary vs. Secondary
  - Research Team Evaluation Skills
  - Research Evaluation Tools

- Evaluation Methods will be different for Evaluation in Lab (Formative) vs. Evaluate in Context (Summative)
Contributions

- DSR must make contributions to the application environment and to the knowledge base (Hevner et al. 2004).

- The design artifact embodies new knowledge at varying levels of abstraction (Gregor and Hevner 2013).

- Design is also a verb, so we learn something about designing, as well.
Producing and Consuming Knowledge

Computational Methods
An umbrella term that describes a variety of software tools that assist with such research processes as data generation or discovery, data processing or cleansing, and data analysis or interpretation.

You can think of these procedures as having a focus on “digital trace data”.

Computational Methods
Evidence of activities and events that are logged and stored digitally.
- Many things people do these days involves or is mediated by digital technologies.

Historically, text data such as emails, transaction data from enterprise systems, and posts and comments on social media and networking platforms are all forms of digital trace data.

Today, bio health data recorded by wearables, logs produced by digital objects such as toothbrushes and energy meters, and traces generated by digital objects such as electric vehicles are also forms of digital trace data.
Examples: research with digital traces


- analyzed more than 23,000 tweets that carried the hashtags #oilspill or #bpoilspill

- First study that showed that individuals engaged in collective action by coproducing and circulating social media content based on an issue of mutual interest.
**Examples: research with digital traces**

<table>
<thead>
<tr>
<th>Stop the drill</th>
<th>Boycott BP</th>
<th>Hair and Fur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encouraging efforts to stop offshore drilling, often via the signature of online petitions.</td>
<td>Encouraging people not to remain customers of the company widely perceived as at the origin of the oil spill.</td>
<td>Encouraging the collection of hair and fur to create boons that absorb oil spreading in the sea.</td>
</tr>
<tr>
<td>“#oilspill knows no mercy for anyone or anything – national parks threatened by #oil <a href="http://bit.ly/bLijyf">http://bit.ly/bLijyf</a> #stopthedrill” “Yes! to a permanent FL drilling ban - Video: <a href="http://youtu.be/8L9ML1Qwvs">http://youtu.be/8L9ML1Qwvs</a> #oilspill #sayfie”</td>
<td>“Declare your Oil Independence on Independence Day Weekend. Boycott #BP. Oil Spill #boycottbp #oilspill” “If only the seafood in the Gulf/Keys were basting in olive &amp; not crude oil. But nooooo. #oilspill #FAIL #BoycottBP”</td>
<td>“Fight the #oilspill: cut your hair <a href="http://bit.ly/bWCqhi">http://bit.ly/bWCqhi</a> RT” “GREAT to SEE! People R clicking the link to donate hair or fur to save Gulf Coast wetlands <a href="http://bit.ly/oilboomhair">http://bit.ly/oilboomhair</a> #oilspill”</td>
</tr>
<tr>
<td>701 tweets, 500 tweeters</td>
<td>897 tweets, 602 tweeters</td>
<td>284 tweets, 258 tweeters</td>
</tr>
</tbody>
</table>
One day at the U. of Rochester dermatology clinic

Figuring out what’s going on.

Social Network
(relationships between involved actors)

Narrative Network / Process model
(relationships between involved actions)
Figuring out what’s going on.

Affordance Network
(actions carried out by actors using technologies)
Adding context unravels the graph.

(a) Affordance network
(b) Affordance network plus “location”
Digital trace data is difficult research data

- Digital trace data is **organic, not designed**: a byproduct of activities, not data generated for the purpose of research.
  - They appear organically and researchers “find” and collect them.
  - Researchers have less control over the validity of organic data than they do over designed research data because the data-generation process is opaque (or even unknown), and we have little to no control over that process.
  - For example, we do not know why, how, or in what context some Twitter posts in a conversation were made.
Digital trace data is difficult research data

- Digital trace can be both **heterogeneous and unstructured**: they often include text, images, video, or sound.
  - The richness of such data can be a strength because it expands the number of perspectives of a phenomenon
  - But it also makes the data more difficult to analyze.
Digital trace data is difficult research data

- Digital trace can be **enormous in volume**: it typically records fine-grained events and actions such as individual clicks, posts, and comments.
  - provides a more precise view of behaviors and occurrences than traditional modes of collection
  - But the sheer size of the data can also quickly become overwhelming for scholars.
    - Example: it is not feasible to manually code comments made by the 257 million followers of Cristiano Ronaldo on Instagram.
Digital trace data is difficult research data

- Digital trace is **inherently event-based**: it connects actions and behaviors that are enabled or mediated by digital technologies as they unfold at various points in time.
  - Time-stamps are great because they allow analysis of temporal aspects (dynamics, change, transformation, exceptions, etc.)
  - But it is also notoriously difficult to analyse with standard scientific analysis tools.
Techniques and tools that have in common that certain steps during data generation, processing, or analysis are carried out through—or with the help of—algorithms that either augment manual work or fully automate an otherwise manual activity.
Overview
Assist researchers in carrying out their work through dedicated research computer software.

The software tools do not carry out the steps involved in the research but support scholars in carrying them out in the sense that they assist manual activities and make them easier or faster to complete.

Examples for data generation: Skype and Zoom can record video and audio streams digitally

Examples for data analysis: R, SPSS, LISREL, Nvivo, Atlas.TI
Software that is used to complement and amplify human activity, rather than to supplant it.

Example data analysis:
- statistical software packages such as LISREL automatically make suggestions for (re-) specifying a hypothesized model based on shared correlations between the latent constructs it discovers in the covariance matrix of observed data.
- Researchers may implement these suggestions or not; because the suggestions are empirically based, they may or may not be conceptually logical or plausible.

Example data generation:
- researchers often write scripts that help them process a web document and extract information from it (scraping) or assist them in iteratively finding and fetching web links beginning with a list of seed web domains (crawling).
Computational augmentation tool: Example LitSonar

- http://www.litsonar.com/

- A literature search algorithm that can scan millions of documents for the presence of keywords

- Helps researchers to identify related literature, but they must still read and assess the papers for relevance.
Computational augmentation tool: Example Leximancer

- [https://www.leximancer.com/](https://www.leximancer.com/)

- A text analysis for in-depth analysis of the text.

- Produces concepts mads that allows researchers to explore a concepts in texts.

- Researchers must still interpret the outcomes.
Computational augmentation tool: Example Leximancer

- [https://www.leximancer.com/](https://www.leximancer.com/)
- A text analysis for in-depth analysis of the text.
- Produces concepts mads that allows researchers to explore a concepts in texts.
- Researchers must still interpret the outcomes.
## Automated Concept Analysis: Example Leximancer

What do business journals publish?

<table>
<thead>
<tr>
<th>Fields and Journals</th>
<th>Years</th>
<th>No of Abstracts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Information Systems</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Management</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Accounting</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>8544</strong></td>
</tr>
</tbody>
</table>

Movement of themes over time
In IS journals 1977-1981
Movement of themes over time
In IS journals 1997-2001
Identifying concept drift

Figure 3a: Information Systems vs. Accounting and Management Journal Abstract Samples

- IS: $R^2 = 0.57$
- Accounting: $R^2 = 0.25$

Figure 3b: Management vs. Information Systems and Accounting Journal Abstract Samples

- Management: $R^2 = 0.25$
- IS: $R^2 = 0.71$

Figure 3c: Accounting vs. Information Systems and Management Journal Abstract Samples

- Accounting: $R^2 = 0.71$
- Management: $R^2 = 0.25$
Computational automation tools

- Software tools that carry out **algorithmic data generation, processing, or analysis** with little to no human intervention or oversight.

- Examples:
  - Text mining automatically extracts information from text through algorithms that extract and parse text, classify text, derive patterns in text, and evaluate and display text using statistics, graphs, and/or visual diagrams.
  - Social network analysis uses algorithms that automatically parse person-relational data, categorize them based on statistical properties, and display the information statistically and/or graphically.
  - Supervised or unsupervised machine learning algorithms can automatically find patterns and relationships in the data that would be unlikely to find manually.
Advantages and Challenges of Computational Methods

- **Advantages**
  - can substantially expand the reach and scope of research
  - can take substantially less time than manual execution of research tasks
  - can increase the reproducibility of data processing and analysis and help reduce human biases in these tasks

- **Challenges**
  - few clear and robust methodological guidelines available
  - make it challenging to focus on and account for the context(s) in which digital trace data were generated
  - Data validity threats from errors in algorithmic outputs, benign errors from relying on probabilistic algorithms such as random search, and lack of generalizability and replicability
Mixed Methods
A type of inquiry that features the sequential or concurrent combination of methods for data collection and analysis.

- Historically: mixing of methods from quantitative and qualitative research traditions
- Nowadays: increasingly also mixing of methods from other traditions, such as design plus quantitative methods or computational plus qualitative methods.
Aims of Mixing Methods

1. Strengthening inferences,
2. Providing a greater diversity of views, and
3. Enabling researchers to answer confirmatory and exploratory questions simultaneously (verifying and generating theory at the same time)

- In other words: Mixing methods tries to
  - leverage the complementary strengths of research methods and mitigate their weaknesses
  - offer deeper insights into a phenomenon than each of the methods alone could provide
Five Main Different Purposes of Mixing Methods

- **Triangulation**
  - establish convergence of, and corroborate results from, multiple methods and designs used to study the same phenomenon

- **Complementarity**
  - elaboration, enhancement, illustration, and clarification of the results from one method with results from another method

- **Initiation**
  - finds paradoxes and contradictions in one study that lead to a re-framing of the research questions using a different method

- **Development**
  - uses the findings from one method to help inform the other method.

- **Expansion**
  - used to expand the breadth and range of research by using different methods for different components of an inquiry

Mixed Method Designs

- Key design component: *Timing*
- the temporal ordering of the phases in which the methods are carried out:
  - **sequential** (one after another),
  - **parallel** (both separately but concurrently),
  - **conversion** (data from one method is transformed to be used with another method),
  - or **fully integrated** (all at once).
Remember: Positive Deviance
Study of Positive Deviance, Management and Leadership
Involved qualitative exploration of 19 stores across Australia
Measurement development and theorizing through engagement with literature
Cross-sectional multi-level survey (managers and dept. managers)
Sampling

Positive Deviants!
Conduct

Mixed Method Findings

Fig. 2. Mapping of substantive categories and open codes to the dimensions of the identified theoretical constructs derived from the literature.
Other important design decisions:

- **Weighing** (deciding whether to give the quantitative and qualitative components of a mixed study equal status or to give one paradigm the dominant status);
- **Mixing**, which can form a continuum from mono-method to fully mixed methods; and
- **Placing**, that is, deciding where mixing should occur (in the research questions, data collection, data analysis, or data interpretation).
Data transformation

- Data must be transformed between data formats to suit the differing analysis techniques.
- Typically needed in concurrent, conversion, and integration mixed method research.
- Examples:
  - Qualitative data (e.g., codes) may have to be quantified (e.g., by counting the frequency of occurrence in text).
  - Quantitative data may have to be qualified (e.g., annotated with text).
Data correlation

- Data about the same phenomenon collected using multiple methods must be compared with a view to identifying triangulation outliers that may require further analysis.
- Often achieved using a data matrix that combines a quantitative axis and a qualitative axis to identify similarities and differences.
Legitimation

the description of the steps undertaken to ensure the validity, accuracy, and/or plausibility of meta-inferences.

The quality of meta-inferences depends on the strength of inferences that emerge from the study’s individual methods.

- The individual inferences can be divergent, convergent, or complementary, each of which require legitimation.
## Strengths and Weaknesses of Mixed Method Research

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Words, pictures, and narrative can be used to add meaning to numbers.</td>
<td>It can be difficult for a single researcher to carry out both qualitative</td>
</tr>
<tr>
<td></td>
<td>and quantitative research, especially if two or more approaches are to</td>
</tr>
<tr>
<td></td>
<td>be used concurrently.</td>
</tr>
<tr>
<td>Numbers can be used to add precision to words, pictures, artefacts, and</td>
<td>The researcher has to learn about multiple methods and approaches and</td>
</tr>
<tr>
<td>narrative.</td>
<td>learn how to mix them appropriately.</td>
</tr>
<tr>
<td>The research can benefit from the individual strengths of different</td>
<td>Methodological purists contend that one should always work within either</td>
</tr>
<tr>
<td>research methods.</td>
<td>a qualitative or a quantitative paradigm.</td>
</tr>
<tr>
<td>The researcher can more easily generate and rigorously test a theory.</td>
<td>Mixed method research is typically more resource-intensive than research</td>
</tr>
<tr>
<td></td>
<td>that uses a single method and may require a larger research team.</td>
</tr>
<tr>
<td>Mixed method research can answer a broader and more complete range of</td>
<td>Mixed method research is typically more time consuming than mono method</td>
</tr>
<tr>
<td>research questions.</td>
<td>research.</td>
</tr>
<tr>
<td>Mixed method research can be used to provide stronger evidence for a</td>
<td>Some of the details of mixed research remain to be worked out fully by</td>
</tr>
<tr>
<td>conclusion.</td>
<td>research methodologists.</td>
</tr>
<tr>
<td>Mixed method research can be used to increase the generalisability of</td>
<td>Mixed method research can be difficult to publish (e.g., because it</td>
</tr>
<tr>
<td>results.</td>
<td>requires more space).</td>
</tr>
</tbody>
</table>
Examples of mixed method research


End of Chapter 5