Case Study Research in Software Engineering

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Lund University

Who am I?

• Professor in Software Engineering, Lund University
• Leader for the Software Engineering Research Group at LU and the EASE industrial excellence center
• Sabbatical at North Carolina State University, 2011-12
• Sony Ericsson, part time 2010
• LU since 1998
• Q-Labs 1991-1998

SWELL - Swedish V&V Excellence
Research interests

- Reliability testing
- Inspection methods
- System validation
- Agile management
- Test management
- Unit testing
- Regression testing
- Product line testing

Advertizing

- **ICST** – 5th Int. Conference on Software Testing, Verification and Validation, Montreal, Canada, April 17-21, 2012
  CFP: October 28, 2011 (abstract)
  CFP: March 4, 2012 (abstract)
Case study

"Case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident"

Robert K. Yin, Case Study Research

Case study

"Case study is a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its context using multiple sources of evidence"

Colin Robson, Real World Research
Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Case study</th>
<th>Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Realism</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Design</td>
<td>Flexible</td>
<td>Fixed</td>
</tr>
<tr>
<td>Primary data</td>
<td>Qualitative</td>
<td>Quantitative</td>
</tr>
<tr>
<td>Case/subject selection</td>
<td>Intentional</td>
<td>Random</td>
</tr>
<tr>
<td>Primary objective</td>
<td>Exploratory</td>
<td>Explanatory</td>
</tr>
</tbody>
</table>

What makes Case Studies science?

1. Theoretical basis
2. Triangulation (data, observer, method, theory)
3. Chain of evidence
4. Full documentation
5. Iterative reporting

(Kyburz-Graber, 2004)
Guidelines for case studies

- Empirically derived and evaluated
- EMSE (2009) open access
- Wiley (2011)

Case study process

Design → Preparation → Collection → Analysis → Reporting

Purpose of a case study

- Understand
- Illustrate
- Evaluate
- Compare
- Improve
- Disseminate

Case study

Action research

Unit(s) of analysis

- event
- individual
- group
- process
- project
- product
- policy
- role
- technology
**Case selection**

- Typical
- Critical
- Revelatory
- Unique

(Benbasat 1987)

- Extreme/deviant
- Maximum variation
- Critical
- Paradigmatic

(Flyvbjerg 2007)

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**Generalization**

- Theory
- Rival theory

- SURVEY Population char’s
- CASE STUDY Case study findings
- EXPERIMENT Exp. findings

Sample

Subjects
Ethics

• Informed consent
• Confidentiality
• Handling of sensitive results (anonymity?)
• Decide on inducements
• Feedback results, in particular quotations

(Singer and Vinson, 2002)

Planning data collection

• What type of documents and databases do you need access to?
• Which activities do you want to observe or participate in?
• Who should be interviewed?
• When should data be collected?
Case study protocol

<table>
<thead>
<tr>
<th>Preparations</th>
<th>Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preamble</td>
<td>Purpose, data storage, publication</td>
</tr>
<tr>
<td>General</td>
<td>Overview of research project</td>
</tr>
<tr>
<td>Procedures</td>
<td>Detailed description</td>
</tr>
<tr>
<td>Research instruments</td>
<td>Interview guide, Questionnaire</td>
</tr>
<tr>
<td>Data analysis</td>
<td>Detailed description</td>
</tr>
<tr>
<td>Appendix</td>
<td>Invitation letter etc</td>
</tr>
</tbody>
</table>

(Pervan and Maimbo, 2005)

Qualitative analysis

Bring structure to the data
- Start by transcribing speech
- Find key words, either from the material or from theory
- Group and contrast statements
- Draw conclusions

- Coding
- Data reduction
- Data display
- Conclusion drawing

(Robson 2002, p.476)
Qualitative analysis  
– level of formalism

• **Quasi-statistical** – count occurrence and frequency of terms
• **Template based** – group statements to key words from theory
• **Editing** – create categories from the data itself
• **(Immersion)** – play with the data and draw conclusions

(Robson 2002 p.457)

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A Word of Warning

• Quasi-statistical methods do *not* imply *anything* beyond the population

“57% of the interviewees agreed/disagreed”
– Indicates that it might be worth understanding
– Says nothing about the general situation
Internal validity

How can I trust an analysis?

• **Quantitative** – appropriate methods, fulfilled assumptions, significance

• **Qualitative** – reported methods, clear viewpoints, traceable conclusions

External validity

• Generalization: Drawing conclusions about phenomena outside the studied setting
  
  – **Statistical generalization** – “inference… about a population on the basis of empirical data collected about a sample”
  
  – **Analytic generalization** – “a previously developed theory is used as a template…to compare the empirical results of a case study”

(Yin 2003 p. 32-33)
Report audiences

• Academic colleagues
• Policymakers, practitioners, …
• Dissertation committees
• Funders of research

Convince reviewers and editors

"The paper is based mostly on interviews with little quantitative project data to back any observation or conclusion. Such papers are not suitable for a journal like TSE.”

Editor of IEEE TSE

"The study was very well designed. The design approach is backed up by literature and a description of subjects, research strategy, research methods, how the analysis was done, the threats to validity and how they were addressed are all presented.”

Reviewer of EMSE
Checklists

<table>
<thead>
<tr>
<th>Researcher’s checklist</th>
<th>Reader’s checklist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case study design (1-10)</td>
<td>39-50 with pointers to 1-38</td>
</tr>
<tr>
<td>Preparation for data collection (11-15)</td>
<td></td>
</tr>
<tr>
<td>Collecting evidence (16-21)</td>
<td></td>
</tr>
<tr>
<td>Analysis of collected data (22-27)</td>
<td></td>
</tr>
<tr>
<td>Reporting (28-38)</td>
<td></td>
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</table>

(Höst 2007, Runeson 2009, 2011)

Case Study Example

How do Agile Methods coexist with Stage-Gate Project Management?

(Karlström and Runeson 2005, 2006)
Cases and units of analysis

Context – XP in stage-gate
Case
Unit of analysis = ABB

Unit of analysis = ERICSSON

Context – introduce agile

Case = Unit of analysis = VODAFONE

Data collection and analysis

• Semistructured interviews
  – 18 persons
    • Engineers
    • Managers
    • Product Mgmt
    • Project Mgmt

• Transcription + Coding
• Qualitative analysis
Selected key findings

<table>
<thead>
<tr>
<th>Area</th>
<th>Agile feature</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning and prioritisation</td>
<td>Most important feature first Micro planning</td>
<td>+ Early feedback on features + Avoid req’s cramming + Little long term planning</td>
</tr>
<tr>
<td>Communication and follow-up</td>
<td>Small manageable tasks Automatic testing</td>
<td>+ Feeling of being under control + Communication of change</td>
</tr>
<tr>
<td>Process model and roles</td>
<td>Customer involvement Documentation tasks</td>
<td>+ Continuous feedback +/- Prioritization</td>
</tr>
<tr>
<td>Project management</td>
<td>Engineering level empowerment Focus</td>
<td>+ Engineers feel motivated ! Managers afraid initially + Engineering/mgmt +/- Early technical issues</td>
</tr>
</tbody>
</table>

"In control"

Citation: “...you have everybody’s work under control...The short cycle time is the biggest advantage and that we always – and now I exaggerate slightly – but we have always something executable."

Conclusion: “All people involved in the projects have a strong feeling of being in control, with the exception of management”
Management reactions

Citation: “The worked in a manner that was not described in any process description. That implied that our line managers, SQA and others had no reference to measure against.”

Conclusion: “Management perceived that they lost some control, as they did not recognize their usual planning models…”

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Combining agile methods with stage-gate project management

Daniel Karlström & Per Runeson

Abstract Agile methods have evolved as a bottom-up approach to software development. However, as the software in embedded products is only one part of development projects, agile methods must coexist with project management models typically at the stage-gate type. This paper presents a qualitative case study of two large independent software system projects that have used eXtreme Programming (XP) for software development within contexts of stage-gate project management models. The study is comprised of open ended interviews with managers as well as practitioners, followed by a structured, fully transcribed, qualitative analysis. We conclude that it is possible to integrate XP in a gate model context. Key issues for success are the interfaces towards the agile subproject and management attitudes towards the agile approach.
Summary:
Case study research in SE

• Software engineering and software process improvement
  – are complex activities
  – success or failure depends on many interrelated factors
  – cannot be fully studied in isolation
  – needs empirical studies in real world settings.

Literature