CASE STUDIES FOR METHOD AND TOOL EVALUATION

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- Empirical Investigation Methods
- Case Study Guidelines
- Sample Case Studies
- What Is A Good Case Study?

EXPERIMENT

A formal experiment requires appropriate levels of replication, and experimental subjects and objects that are chosen at random with the constraints of an experimental design.

Particular Situation: Experiments are essential if you are looking for results that are broadly applicable across many types of projects and processes

Pros:

- self-standing tasks can be isolated from the overall product-development process and investigated formally without being unrepresentative of the way they are actually performed;
- the results of self-standing tasks can be judged immediately, rather than awaiting the results of a long development process, so that the experiment does not delay project completion;
- the results of self-standing tasks can be assessed in isolation from other project processes, so that small benefits can be identified and distinguished from other variables
- Replication

Cons:

- must be carefully controlled
- experiments are often small, which is a problem when you try to increase the scale from the laboratory to a real project
- formal experiments do not generalize outside the controlled experimental conditions.

EMPIRICAL INVESTIGATION METHODS

SURVEY surveys try to capture what is happening broadly over large groups of projects: "research-in-the-large."

Particular Situation: Surveys can be used to ensure that process changes are successful throughout an organization, because they collate experience from several different projects.

Pros:

- combining the advantages of case studies(applicability to real-world projects) with those of experiments(replication that minimizes the problems of un usual results)

Cons:

- data collection can take a great deal of time, and the results may not be available until after many projects are completed.

- difficult to find comparable experimental objects, because software measures are not used consistently, and because there is no framework to review and collate experimental results.

CASE STUDY

Case studies usually look at what is happening on a typical project: "research-in-the-typical."

Particular Situation: 1. the process changes are very wide-ranging; 2. the effects of the change cannot be identified immediately.

Pros:

- avoid scale-up problems.
- easier to plan than experiments.

Cons:

- harder to interpret and difficult to generalize
- it cannot be generalized to every possible situation.

> No One Type Of Empirical Study Is Better Than Any Other; Each Is Appropriate In Particular Situations.
>
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CASE STUDY GUIDELINES

R.K. Yin, Case Study Research Design and Methods, Sage Publications, Beverley Hills, Calif., 1984.

4 CRITERIA FOR RESEARCH-DESIGN QUALITY:

- Construct validity. Establish correct operational measures for the concepts being studied.
- Internal validity. Establish a causal relationship and distinguish spurious relationships.
- External validity. Establish the domain to which a study's findings can be generalized.
- Experimental reliability. Demonstrate that the study can be repeated with the same results.

7 STEPS

- Define the hypothesis.
- Select the pilot projects.
- Identify the method of comparison.
- Minimize the effect of confounding factors.
- Plan the case study.
- Monitor the case study against the plan.
- Analyze and report the results.

1. DEFINE THE HYPOTHESIS

- Defining the effect you expect the method to have. make clear what measurements are needed to demonstrate the effect.
- Defining what is not expected to happen. we can never prove hypotheses, we can only disprove them, so we state a null of the organization is central to the hypothesis to say that there is no difference between treatments.

2. SELECT THE PILOT PROJECTS

- Typical. the pilot projects you choose must be representative of the type of projects your organization or company usually undertakes. You can describe projects in terms of significant characteristics, such as application domain, programming language, design method, and degree of reuse, and then use this state-variable information to select projects
- Frequency. consider not only project type but also the frequency with which each type is developed.

3. IDENTIFY THE METHOD OF COMPARISON

- Select a sister project with which to compare. The case study involves two projects, one that uses the new method and another that uses the current method. Each project should be typical of your organization, and both should have similar characteristics according to the state variables you have chosen.

- Compare the results of using the new method against a company baseline. You can compare the response-variable values from your case study, which involves a single project using the new method, to the corresponding variables from previous projects or a subset of similar projects.

- If the method applies to individual components, apply it at random to some product components and not to others. This kind of study is useful for methods that may be applied to different degrees.

4. MINIMIZE THE EFFECT OF CONFOUNDING FACTORS

- Learning how to use a method or tool as you try to assess its benefits. Avoid: you must separate activities aimed at learning how to use a new technology from those aimed at evaluating it.
- Using staff who are either very enthusiastic or very skeptical about the method or tool. Minimize: you must staff a case study project using your normal staff-allocation method.
- Comparing different application types. For example, the productivity of real-time system developers is usually lower than for data-processing systems. Avoid: case studies should not compare across application domains.

- involves designing a multi-project case study in which the different projects experience different conditions.
- measuring the confounding factor and adjusting the results accordingly.

5. PLAN THE CASE STUDY

- An evaluation plan. This plan identifies all the issues to be addressed so that the evaluation runs smoothly, including the training requirements, the necessary measures, the data-collection procedures, and the people responsible for data collection and analysis.
- The evaluation should also have a budget, schedule, and staffing plan separate from those of the actual project. Clear lines of authority are needed for resolving the inevitable conflicts of interest that occur when a development project is used to host an evaluation exercise.

6. MONITOR THE CASE STUDY AGAINST THE PLAN

- Progress. ensure that the methods or tools under investigation are used correctly.
- Results. any factors that would bias the results are recorded (such as change of staff, or a change in the priority of the case-study projects).

- It is essential that you audit conformance to the experimental plan and record any changes.
- At the end of the study, you should write an **evaluation report** including recommendations for changes in procedures.

7. ANALYZE AND REPORT THE RESULTS

- If your case study compared treatments assigned to components at random, you can use standard statistical methods, such as analysis-of-variance and contingency tables.
- If you can not guarantee that the data is distributed normally (according to a bell-shaped Gaussian curve), then you must use nonparametric tests such as the Kruskall-Wallis method, which bases the analysis on rank rather than on raw data.
- If you have only one value from each method or tool being evaluated, no analysis techniques are available; you can only present the results as we describe next.

ANALYSIS METHODS FOR CASE STUDIES

Once you have designed your case study and collected the data, you must analyze it to determine what has happened and if the results are significant.

Frequency plot:

- useful for depicting the distribution of discrete state-variable values for an organization

Boxplot:

- When you have state variables that cover a wide range of values (such as counts or ratios), a boxplot can help you evaluate the distribution of data values, particularly when data values are skewed.
- Boxplots give a simple visual display of the distribution of a data set and help you see how representative a single point is.
- Boxplots are also useful for constructing a company baseline.

CHECKLIST FOR CASE-STUDY PLANNING

This checklist, along with the seven steps to design and administer case studies, will help you undertake a valid investigation.

Case study context

1. What are the objectives of your case study?
2. What is the baseline against which you will compare the results of the evaluation?
3. What are your external project constraints?

Setting the hypothesis

4. What is your evaluation hypothesis?
5. How do you define, in measurable terms, what you want to evaluate (that is, what are your response variables and how will you measure them)?

Planning

6. What are the experimental subjects and objects of the case study?
7. When in the development process or life cyle will the method be used?
8. When in the development or life cycle will the response variables be measured?

Validating the hypothesis.

9. Can you collect the data you need to calculate the selected measures?
10. Can you clearly identify the effects of the treatment you want to evaluate and isolate them from the other influences on the development?
11. Have you taken adequate procedures to ensure that the method or tool is being correctly used?
12. If you intend to integrate the method or tool into your development process, is the method or tool likely to have an effect other than the one you want to investigate?
13. Which state variables or project characteristics are most important to your case study?
14. Do you need to generalize the result to other projects? If so, is your pro posed case study project typical of those projects?
15. Do you need a high level of confidence in your evaluation result? If so, do you need to do a multiproject study?

Analyzing the results

16. How are you going to analyze the case study results?
17. Is the type of case study going to provide the level of confidence you require?

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CASE STUDY 1

Aim: investigate if Fagan inspections would increase software quality without resulting in a decrease in productivity.

Method of Comparison: Compared differently treated components.

Problems

- This pilot project was chosen because the team wanted to participate. There was no formal selection to ensure that the pilot was representative of typical ICL projects.
- Nonrandom selection of modules. The development staff members themselves decided which modules would be given detailed inspections,and they selected only those that were difficult.
- Lack of planning.several other response variables were collected but could not be properly interpreted because there was no basis of comparison.

CASE STUDY 2

Aim: investigate whether Fagan inspections would increase software quality through a cost-effective detection of defects.

Method of Comparison: used a company baseline.

Problems

- The pilot project was not chosen using any formal selection process.
- The construction of the baseline would have been greatly improved by using a boxplot to indicate the extent of natural variability.
- Actual quality depends on the defects found during use, but the analysis was based on the defects found during in-house testing. Thus the conclusions may be misleading.

CASE STUDY 3

Hypothesis: inspections increase time to market and do not affect quality.

Method of Comparison: involved sister projects.

Special

- many of the typical problems with case-study control and variation were absent because the same personnel were involved, the same development environment was used, and the applications were related.

Problems

- The study was not planned in advance.
- The quality measure was based on prerelease rather than postrelease defects, again reflecting a developer's rather than a user's view of software quality

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GOOD CASE STUDIES INVOLVE:

- Specifying the hypothesis under test.
- Using state variables for project selection and data analysis.
- Establishing a basis for comparisons.
- Planning case studies properly.
- Using appropriate presentation and analysis techniques to assess the results.

THANK YOU