

A Reflection on Case Study Research in Computer Science

MAP-i Seminar

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1 Introduction

During a Ph.D, work is mainly composed of research activities. In light of this, it makes sense to analyse known research methods in terms of applicability and suitability to the research instances of a specific thesis. However, due to the lack of a thesis theme, this reflection aims for a broader spectrum.

The main focus of this work is to reflect on whether the case research method is largely applicable to research in Computer Science (CS). The starting point for this reflection is some literature concerning the application of case research methods to the study of Information Systems (IS). Since IS and CS are closely related fields of study, it makes sense to consider what is already known in the former to try to draw conclusions on the latter. In the background section, brief definitions of the Computer Science and Information Systems fields are given, along with a distinction between qualitative and quantitative methods. The expressions “case research” and “case study method” will be used interchangeably from now on.

2 Background

In order to fully understand the focus of this paper, it is essential to define both Computer Science and Information Systems, along with the relationship between these two fields.

The knowledge area designated as Computer Science comprehends the study of the theoretical foundations of computation and information and also of the practical side of applying such theoretical constructs to the implementation of actual computer systems. Subareas include computer graphics, complexity theory, programming language theory, actual computer programming, distributed systems, human-computer interaction, communication and network protocols, computer architecture and cryptography, just to name a few. Information Systems can be thought of¹ as systems of people, data records and activities which

¹ http://en.wikipedia.org/wiki/Information_systems

process the data and information in an organization, including manual and automated processes. By restricting the term to computer-based systems, these consist of: application software, information resources (databases or knowledge bases) and user interfaces. In this sense, the Information Systems area is concerned with the organizational aspects of computer systems, where people must be taken into account.

Quantitative methods are designed to gather quantitative data, such as numbers and anything that can be measured. On the other hand, qualitative research methods, defined in opposition of quantitative methods, focuses on motivations and methods of participants in phenomena's particular contexts, instead of measurements. Also, in order for quantitative methods to be useful in a particular setting, the set of variables to be measure must be predetermined. If this is not the case, then the application of qualitative methods might be more appropriate and thus yield better or simple more useful results.

2.1 Case Research

It is also critical to contextualize the case research method regarding other methods.

Case research is in itself a qualitative research method. In [1], case research is defined as the study of phenomena in natural settings, gathering information on one or few entities, where no experimental control or manipulation are performed. The following characteristics are identified:

1. Phenomenon is examined in a natural setting.
2. Data are collected by multiple means.
3. One of few entities (person, group, or organization) are examined.
4. The complexity of the unit is studied intensively.
5. Case studies are more suitable for the exploration, classification and hypothesis development stages of the knowledge building process; the investigator should have a receptive attitude towards exploration.
6. No experimental controls or manipulation are involved.
7. The investigator may not specify the set of dependent and independent variables in advance.
8. The results derived depend heavily on the integrative powers of the investigator.
9. Changes in site selection and data collection methods could take place as the investigator develops new hypotheses.
10. Case research is useful in the study of "how" and "why" questions because these deal with operational links to be traced over time rather than with frequency or incidence.
11. The focus is on contemporary events.

The researcher (investigator) is considered to be an observer rather than a participant in the system. This aspect sets case research apart from action research.

From [1], another way to look at case research is by defining it in view of other methods in terms of prior knowledge and control over the system: in laboratory experiments, the system is examined in a controlled setting and clearly defined variables are measured; in field experiments, variables are also known *a priori*, but manipulated and measured in a natural setting; and in field studies, the manipulation is removed. In case studies, previous knowledge on which variables are to be considered and on how to measure them is assumed to be less than in field studies. However, it is also assumed that a number of research questions, to be answered during the course of research are known *a priori*. Case research is thus construed as an empirical study.

In spite of its usefulness, this method of research may lead to conclusions specific to the organization in study and so, not necessarily to generic knowledge. This last point is seen as one of the downsides of doing case research. In [5], these characteristics are identified as the major weaknesses of case research:

- an inability to manipulate independent variables;
- the risk of inappropriate information and
- the lack of repeatability and generalizability of the drawn conclusions.

On the other hand, in [1], these are noted as the major strengths of case research for IS:

- “... the researcher can study information systems in a natural setting, learn about the state of the art and generate theories from practice.”
- “... the case method allows the researcher to ask ‘how’ and ‘why’ questions, that is, to understand the nature and complexity of the processes taking place.”
- “With the rapid pace of change in the information systems field, many new topics emerge each year, for which valuable insights can be gained through the use of case research.”

In [1] and at a greater depth in [4], it is stated that qualitative and quantitative methods can be used in a complementary manner: using quantitative methods to obtain data and qualitative ones for providing explanation and testing hypotheses.

2.2 Method

Because of the features and drawbacks of case research, identified in Subsection 2.1, it is critical to analyse whether this approach is appropriate for a given instance. In order to determine whether the case research approach is useful to analyse a given phenomenon, the following questions are identified in [1]:

1. Can the phenomenon of interest be studied outside its natural setting?
2. Must the study focus on contemporary events?
3. Is control or manipulation of subjects or events necessary?
4. Does the phenomenon of interest enjoy an established theoretical base?

As stated in Subsection 2.1, case research is ideal for studying phenomena in natural settings, focusing on natural events, without manipulation or control, and with little *a priori* knowledge. In [2], the pragmatics for conducting case research within the field of IS are addressed. Also, in [3] common misunderstandings about case research are discussed, providing some insight on case selection and on some of the characteristics identified in Subsection 2.1.

3 A Case Study in Computer Science

In [7], a case study of a peer-to-peer network is presented. At first sight, it's hard to classify this work according to the chosen methodology. While, on one hand, the motivation of the study is to answer the formulated research questions in a natural setting, some target variables are defined from the get-go and the main contribution is described as a "quantitative evaluation". But, on the other hand, some theoretical conclusions are drawn from the observed data, and later validated by measuring new variables, supporting the idea of case research. Still, data analysis is done offline.

This example is paradigmatic of the use of so-called case studies in Computer Science research, which do not conform to common definitions, and for which the term case study is used loosely to refer to field experiments, field studies and case studies, or some mixture of methodology.

4 Reflections

In [6], Computer Science itself is viewed as an empirical science, identifying machines and programs are experiments.

While IS have already been the subject of a slew of scientific publications in research methods, the Computer Science field seems to be going by unnoticed. Some of the indifference towards it might be due to the assumption that IS research covers its needs. Or, it may be the case that the several different subareas of computer science need to be addressed independently.

In particular, the case study method seems to be hard to follow for the majority of Computer Science research, although some applications must undoubtedly exist. Still the case study example in Computer Science, hints that both quantitative and qualitative methods are to be used together.

Since in IS, the organizational component, along with the human component, are essential parts of systems, as opposed to CS, in general, this fact might be the main reason why a method that is focused on the "how" and "why" might not be suitable for most research purposes in this field (human-computer interaction excepted).

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