3rd International Workshop on Conducting Empirical Studies in Industry (CESI 2015) – Post-workshop Report

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ABSTRACT

Few would deny today the importance of empirical studies in the field of Software Engineering and, indeed, an increasing number of studies are being conducted involving the software industry. While literature abounds on idealistic empirical procedures, relatively little is known about the dynamics and complexity of conducting empirical studies in the software industry. What are the impediments when attempting to follow prescriptive procedures in the organizational setting and how to best handle them? This driver underlies the organization of the third in a series of workshops, CESI 2015, held on 18th May, 2015 at ICSE 2015. This report summarizes the workshop details and the proceedings of the day.

Keywords

Empirical studies, software industry.

1. INTRODUCTION

An *empirical study* is an investigation, using established procedures (also called "empirical methods"), for the purpose of gaining knowledge through observation. Empirical methods fall under the broad categories of case studies, scientific experiments and surveys. Investigative questions are determined and related data is gathered and analyzed to answer these questions. Briefly, with experiments [1], we are in search of quantitative, cause-and-effect relationships, involving control of treatment. Typically, experiments are carried out in laboratory settings where the few variables involved in the investigation can be manipulated as desired. With case studies [2], we are in search of qualitative or quantitative findings (or phenomena) among the identified variables in the case under study in a real-world setting. Because we are not looking for causal relationships in the case study, there is no "control" of treatment that forms a basis for such a causal relationship. With surveys [3], the aim is to seek qualitative or quantitative responses from a sample representative of the population under study. There are various "research designs" to cater for different investigative situations. Examples include: independent measures, repeated measures, matched pairs, etc; exploratory case studies, longitudinal case studies, ethnographic studies, action research, etc.; and online surveys, focus groups, interviews, etc. With empirical studies being widely entrenched in fields such as social sciences, psychology, management sciences, and medicine, there is obviously much more in the general literature on empirical studies than what is hinted above; still, this brief introduction will suffice for our purpose here.

In so far as Software Engineering (SE) is concerned, empirical studies lie at the heart of this burgeoning field. The quality of these studies is a determinant of the validity of the research findings, including that of the comparative analysis of competitive methods, tools and techniques. With increased awareness, more and more researchers are conducting empirical research in SE and, increasingly so, involving the software industry.

While there are established empirical procedures in the general literature, relatively little is known about conducting empirical studies involving the software industry. What pitfalls should be avoided when investigating phenomena in an organization; what challenges should be anticipated when evaluating the efficacy of methods and tools in actual projects; what are the Dos and Don'ts when conducting practitioner surveys? Such questions abound and formed the primary trigger for organizing this series of workshops. The chosen theme was thus "conducting empirical studies in industry", yielding to the CESI acronym.

Experience suggests that empirical studies conducted in industrial settings are particularly challenging because the actual environments are complex and what is first observable by researchers (typically from academia) may only be a tip of an iceberg. Yet, relevant investigative questions must be formulated, valid constructs need to be defined, trust needs to be in place, relevant data must be gathered within the small time-frames available, inaccuracies in data gathered (including missing data) needs to be managed, appropriate interpretations of the findings need to be made fitting the industry contexts, results need to be delivered in real-time, etc. In essence, researchers often need to be able to run while they are still learning how to walk.

2. WORKSHOP GOALS AND PROCEEDINGS

The goals of the CESI workshop series are:

- to deliberate on challenges and experiences in conducting empirical studies in industrial settings;
- to discuss strategies for overcoming impediments;
- to debate on the limitations of contemporary research methods;
- to project towards their resolutions; and
- to analyze results in the context of empirical studies conducted in the organizational setting (new in 2015).

Several mechanisms were used to realize these goals: the invitation of a keynote speaker and invited talks, paper presentations, and the not-so-common "wall of ideas" session.

3. THE CESI WORKSHOP SERIES IN RETROSPECT

The first CESI workshop (http://www.essi.upc.edu/~franch/cesi2013) was held in San Francisco, USA, as part of ICSE 2013 [4]. The workshop started with a keynote by Barry Boehm, who talked about his life-long work in creating and evaluating the COCOMO family of cost models and comparing critical success factors for such models in the context of industry. Dewayne Perry, the respondent to Boehm's talk, cited examples from several empirical studies conducted at AT&T and Lucent. Following this, there were presentations: a mix of regular and short papers, and practitioner messages. The final session was an all-participatory Wall of Ideas (WoI), where participants posted their ideas on a wall in a pre-constructed matrix based on columns and rows of pertinent categories in the domain of conducting empirical studies in industry (e.g., Column: *Interpretation of results*; Row: *Stakeholder feedback* — see Section 7 for further details). We anticipated that the WoI would serve as a starting point for readers to explore issues that interest them.

The second edition (http://www.essi.upc.edu/~franch/cesi2014) was held in Hyderabad, India, as part of ICSE 2014 [5]. The workshop was opened by a vibrant keynote talk by Bill Curtis, who talked about his life-long experience (and the ooze) in conducting empirical studies in different industrial settings. Next, two invited talks were interwoven with presentations of accepted papers. In particular, Ipek Ozkaya and Ajith Nrayan shared their views on conducting empirical studies in industry. As in CESI 2013, the final session was devoted to the WoI.

Building on the results and momentum of the first two CESI workshops, the third CESI workshop was conducted at ICSE 2015, in Florence, Italy (http://www.essi.upc.edu/~franch/cesi2015). In addition to the methodological focus of the previous workshops, discussion on tangible results of empirical studies conducted in industry was sought. The idea behind this move was to: (i) further precipitate empirical research in the SE community, and (ii) engage industry participants from the point of view of the utility of the results emanating from empirical studies. The following sections of this report describe the 2015 workshop.

4. THE SUBMISSIONS AND REVIEW PROCESS

There were 16 submissions to the 2015 workshop, all of them pertaining to two categories: technical papers and experience reports. One of the papers was desk-rejected for being out of scope. Each of the remaining 15 papers was reviewed by at least three reviewers. Finally, 6 regular papers were presented at the workshop.

Below, we analyze the accepted papers from various dimensions:

1. *Demographic data:*
   - *Region*. Each accepted paper was authored or co-authored by academics and practitioners from the same country. We had papers with authors from Brazil [11], Canada [7], Germany [8], Ireland [10], Israel [9] and Spain [6].
   - *Industry or Academia*. Papers from academia were predominant: 6 papers had authors from academia; and no papers had authors only from industry, although there was one paper whose authors were with both research laboratory and academia [10].
2. *Type of study*. Half the papers (3) presented experience reports describing lessons learned, challenges, open issues, etc., from a series of primary studies [6,8,9]. The rest of the papers were of a technical nature, presenting conclusions emerging from empirical studies [7,10,11].
3. *Discipline of the study*. Although in most cases the studied discipline may not have influenced the observations, all the works referred to specific software disciplines. We had papers concerning development methods (2) [7,11], software architecture [9], pair programming [8], and software testing [6]. One paper didn't specify any particular discipline [10].
4. *Type of studies analyzed.* Half of the papers were focused on one particular type of study: experiments [6], exploratory case study [7] and surveys [9]. Two other papers [10,11] addressed multiple types of studies, while the last paper [8] was a general empirical study on factors determination.
5. *Own studies or studies from the community*. Majority of the papers reported on one's own work; one paper involved a systematic literature review [10].
6. *Number of primary studies*. As one would expect, the paper on a holistic literature review [10] involved the greatest number of primary studies (14). Also, we had 2 papers reporting on one study conducted in one company (1-1) [7,11] and 3 others reporting on a study repeated at many companies (1-n) [6,8,9].

The papers presented at the workshop are accessible through the IEEE Xplore Digital Library (references appear below).

5. SUMMARY OF PRESENTED PAPERS

In [6], Vegas, Dieste and Juristo report the perceived difficulties in running the same experiment in several different companies, which are classified according to company involvement, experiment planning and design, performed data analysis, and reporting. Their observations were collected by replicating the same experiment to examine workload, external quality and productivity using TDD (test-driven development) versus ITL (incremental test last) in three universities and five different sites belonging to three companies. The authors conclude that industry participants behavior has been idealized in the literature and that reporting in scientific conferences and journals is not the ideal dissemination and transfer media.

Lavallée and Robillard [7] make a set of recommendations for constructing exploratory experiments with industrial partners. They argue that, despite the high number of uncertainties, it is possible to plan for the unknown, although some level of flexibility is also required. They present the lessons accumulated in ten months of a non-participatory exploratory study in a two year project of a large scale telecommunications company. Those lessons are compiled to define a prototypical exploratory study process.

Prechelt, Zieris and Schmeisky identify in [8] the recurring difficulties that arise not only in the formulation of research questions but also in the formulation of design in empirical studies. They use ideation and knowledge extraction to identify potential difficulty factors, expert discussion to understand them in detail and concept analysis to propose a taxonomy. Their taxonomy is exemplified and validated in two industrial studies. They suggest that successful research designs should have successful outweighing difficulty factors.

In [9], Unkelos-Shpigel, Sherman and Hadar suggest that professional interest groups in social networks could be used as a way to conduct cross-organizational empirical research. Their idea is validated by running an experiment to recruit participants for a large scale online survey using LinkedIn. As a conclusion, social networks were found to be a powerful research tool, which could not only serve as a source of empirical research data, but also as a wide spectrum link to industry.

Stol and Fitzgerald develop in [10] a holistic overview of research methods, pointing out their strengths and weaknesses, so as to offer guidance for software engineers in conducting primary research. The suggested methods are field studies, experiments and simulations, as well as laboratory experiments, judgment tasks, sample surveys, formal theory and computer simulations. Such methods are framed according to their occurrence settings, such as material and contrived, apart from independence and no empirical setting at all.

Finally, in [11], Ribeiro and Travassos apply a method for reaching corporate-wide alignment of source code quality factors based on surveys for problem understanding, systematic literature reviews on target quality requirements, focus groups, quantitative data analysis and reporting for final corporate-wide alignment. They illustrate and validate their method with a study performed in an embedded software development company that was continuously refactoring source code due to recurring failures of compliance with quality standards.

6. SUMMARY OF KEYNOTE SPEECH AND INVITED TALKS

In CESI 2015, the keynote presentation was given by Dieter Rombach (Technical University of Kaiserslautern; Fraunhofer Institute for Experimental Software Engineering – IESE, Germany) [12]. Rombach begun his presentation by posing the following provocative questions to justify his view that SE cannot be Engineering without *empirical studies*: What is SE if not Engineering? And what is Engineering if not

Applied Science? And what is Applied Science if not Empirical Studies? In the remainder of his presentation, Rombach described the maturation of *empirical studies* in SE, centered around the equation involving the goals or question under investigation, on the one hand, and, on the other, product or process characteristics with their respective contexts. He noted the need for theory building as a vehicle for advancing the body of knowledge on conducting empirical studies in SE. He finally sketched a vision of future development of a Theory of Software Engineering Evidence, including a research, teaching and technology transfer agenda.

Following this keynote talk, an award ceremony was held. IESE was selected to receive the 2015 IEEE Computer Society Technical Council on Software Engineering Synergy Award as a recognition for its leadership in developing long term industry-academic cooperative activities. Prof. Dieter Rombach received the award on behalf of the institution.

The workshop also had two invited talks, by Tony Gorschek (Blekinge Institute of Technology, Sweden) [13] and by Alistair Mavin (Rolls-Royce PLC, UK) [14].

Gorschek suggested some guidelines to increase the chance to transfer research to practice, arguing that research can be characterized as a cooperative activity leading to long term continuous win-win relationships. He presented a process of cooperative research that begins with problem understanding and goes on with problem formulation, state of the art study, selection of a candidate solution, validation with the academia, static and dynamic corporate validation and the solution release.

Mavin shared his perspective on the effective application of research in projects: to focus on stakeholders' basic requirements; to understand limitations of the adopted approach; to aim at adding value to the client, illustrating this by presenting the corresponding return on investment; to take into account that the real world is considerably more complex than the laboratory environment; and to evaluate whether the produced solution is truly simple and whether it scales up.

7. THE WALL OF IDEAS

In the afternoon, we had the session called "Wall of Ideas". Here, all the participants were invited to post their ideas, asynchronously, on the *Wall of Ideas* – a structured wall (a matrix of columns and rows) for capturing the subject matter. The wall had the following columns and rows:

- **Columns (technical categories):**

  Design of study
  Recognising the need for a study
  Defining a research question
  Data access & gathering + Data cleanup
  Threat identification
  Validation of results
  Interpretation of results + transfer of results
  Getting Industry commitment

- **Rows (concerns, tool support, Dos and Don'ts, etc.):**

  Alignment with business goals
  Stakeholder motivation and commitment
  Challenges, barriers, etc.
  Tips, lessons learnt & solutions
  Feedback to and from the stakeholders
  Industry setting
  Principles & fundamentals
  Tool support

As can be easily visualised, a 8 by 8 matrix is quite large and, indeed, a substantial number of points were posted on the wall during the session. Due to time constraints, however, only a selected few points from the matrix were discussed by the originators of these points in a plenary discussion session.

In Table 1, we give an illustrative column "Data access and Gathering & Data Cleanup" with example rows of ideas as posted by the participants.

Table 1. An excerpt of the Wall of Ideas

Row headers	Column "Data Access and Gathering + Data Cleanup"
Alignment with business goals	A. Sell the study better; get more data.
Stakeholder motivation and commitment	B. Danger of missing values.
Challenges, barriers, etc.	C. Finding the right person to talk to. D. So much work! Often resources are lacking. E. Find non-intrusive methods of data collection; use GQM! F. Dealing with confidential data. G. Motivating participants. H. How much does using the correct statistical procedures matter?
Tips, Lessons Learnt, Solutions	I. If you have a result that is better and a respected champion that uses it. J. How to explain the area of interest to the interviewee without influencing the answers. K. How to record, make them available and cite interviews without transcribing. L. Recognise it will be hard to predict adoption.

8. SUMMARY

The organizers of the CESI (*Conducting Empirical Studies in Industry*) series of workshops started out with a premise that while an increasing number of empirical studies are being carried out in the field of software engineering, relatively little was known about the impediments faced by empiricists in the design and conduct of their studies. The workshop series was proposed to deliberate on pertinent matters on conducting studies in industry. CESI 2015 was the third in the series of the workshops.

We had presentations from authors from many different parts of the world, reporting on their studies on distinct software engineering subjects, using a variety of empirical research methods (see Section 5 for more details). We also had a keynote (by Dieter Rombach) on the *maturation of empirical studies* in software engineering, and two invited talks (by Tony Gorschek) on *technology transfer* and (by Alistair Mavin) on *conducting effective research in industry* (see Section 6 for more details). The structured talks were complemented by an asynchronous session, called the "Wall of Ideas", where participants posted their thoughts and ideas, in parallel, in a large matrix created on the wall (see Section 7 for more details). Feedback from the attendees was that, for junior researchers, the CESI series of workshops was a valuable opportunity to expose their work and share ideas; whereas, for more experienced researchers the series depicted the evolution of the workshop's subject of "conducting empirical studies in industry".

A long-term goal of the series of CESI workshops is to create a vibrant research and practice community with a focus on conducting disciplined empirical studies in industry hoping that their results will lead to improved software engineering practices, techniques, methods, processes, technologies, products/systems and services. The empiricists in the SE community are invited to write to the authors of this report concerning future considerations for the CESI workshop.

9. ACKNOWLEDGMENTS

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