

Using the Case Survey Method to Explore Engineering Practices in Software Start-ups

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Abstract—Software start-ups are a new and relatively unexplored field for software engineering researchers. However, conducting empirical studies with start-ups is difficult. Start-ups produce very little “hard” evidence, thus data collection methods are limited to interviews and surveys. These methods come with their limitations, namely interview studies are not scalable to a large number of companies, and surveys are not generally applicable for exploratory studies.

In this paper we present of a hybrid research method aimed to provide a compromise between breadth of a survey and depth of an interview study. The case survey method enables both qualitative and quantitative analysis of studied cases.

We adapt the case survey method for use in primary studies and report experience with its application. The case survey method was successfully applied to design and launch a large scale study into engineering aspects of start-ups.

We conclude that the case survey method is a promising research method to launch exploratory studies into large samples of start-up companies.

Index Terms—start-up;research method;case survey;

I. INTRODUCTION

Start-ups are becoming important suppliers of innovation, and new products and services. Many of products and services developed in these organizations depend on software components. However, engineering of these components is a complex endeavor as a start-up context pose a number of unique challenges to software engineers [1], [2]. Engineering challenges in start-ups have attracted attention of software engineering researchers [3]. However, there is a lack of empirical data on how software engineering is actually applied in start-up [4].

The start-up context poses several challenges to researchers. Small, dynamic teams, absence of documentation, time and resource pressure to start-up teams among other factors makes studying start-ups difficult. Most studies up to date into software engineering aspects of start-ups use data from a small number of cases, thus generalizability of these studies is rather limited.

To formulate relevant and focused research questions for exploring software engineering in start-ups a general understanding of the topic is required. However, lack of a understanding about software engineering state-of-the-practice in start-ups hinder further and more focused research attempts [5].

Recent empirical research into engineering aspects start-ups use interviews (for example Giardino et al. [6], [7], Terho et

al. [8], Melegati et al. [9]) and surveys (for example, Giardino et al. [2]) as data collection methods.

We explore use of a hybrid research method, case survey method, aimed to provide compromise between depth of an interview and breadth of a survey. The case survey method was initially aimed for secondary studies [10]. However we adapt the method for primary studies and apply it to explore software engineering state-of-the-practice in start-ups.

II. CHARACTERISTICS OF SOFTWARE START-UPS

Start-ups are small organizations created for a purpose to develop and bring to market an innovative product or service. Even though start-ups share many characteristics with small and medium enterprises, start-ups are different due to combination of challenges they face [11]. Start-ups are characterized by uncertainty, lack of resources, rapid evolution, immature team and time pressure among other factors. However, the start-ups are flexible to adapt new engineering practices, and reactive to keep up with emerging technologies and markets [1], [11].

Studying start-ups is difficult due to their characteristics and also their relatively short life span and little hard evidence produced during operation. Start-ups produce very little documentation and rely on a tacit knowledge about their product and organization [7]. Thus, data collection strategies are limited to methods eliciting information from the start-up team members, such as interviews and questionnaires.

III. CASE SURVEY RESEARCH METHOD

The case survey research method aims to combine benefits of a survey and a case study [10]. Traditional surveys are a relatively low effort method how to collect quantitative data from a large population. Case studies aim to collect primarily qualitative data from a single or a small number of cases [5]. The case survey method offers a compromise between the two and enables both qualitative and quantitative analysis of the data.

Larsson [10] proposes to use the case survey method to for secondary studies. The method originates from management research to analyze a large number of case studies, for example, Miska et al. [12] and Rosenberg et al. [13]. However, we adapt the method for use in primary studies and to collect data directly from people involved in the cases.

The case survey consists of a questionnaire capturing all relevant data about a case of interest. The questions could be both of quantitative and qualitative nature. The questionnaire is distributed within the target population and responses collected. The responses are analyzed by qualitative methods, e.g. coding, and by applying statistical methods. The exact procedure for applying the method is the following:

- 1) Design a data extraction form, i.e. questionnaire, to capture all the variables of interest from a case. The case could be, for example, an organization, a project, a process, or an event [5].
- 2) Spread the questionnaire among the target population, collect responses.
- 3) Screen the responses for including or excluding from further analysis. Candidates for exclusion are, for example, incomplete responses, and responses from cases that clearly does not fit aims of the study.
- 4) Design and apply a coding scheme to the data to convert qualitative data to quantifiable variables. The coding may be done in iterations beginning with basic techniques to capture overall themes, and followed by more in-depth interpretive codes to capture any emerging patterns [14], [15].
- 5) Statistically analyze the data.

A. Strengths of the case survey method

The main advantage of the method is its ability to capture more information about each case compared to a traditional survey and to study more cases than a traditional case study. Qualitative data from the cases enables discovery of previously unknown patterns. Cross-case analysis with statistical methods provide means to generalize the discovered patterns to a broader population [10].

Data in the case survey is collected and analyzed in a uniform way, thus the study can be easily repeated or extended with more cases [10].

Population sampling for a case survey is probabilistic, thus avoiding case selection based on availability and case elimination based on a-priori judgments [10].

B. Limitations of the case survey method

Data from a case survey is only as good as the question formulations, respondent knowledge and commitment to answer all the questions to full extent. Therefore, prior to distribution the questionnaire need to be tested to ensure that the questions are understandable by potential respondents and answers they provide are relevant to answer the research questions. This is a drawback compared to interviews where the interviewer have a chance to explain, rephrase and ask additional questions.

The case survey typically requires more time and commitment from respondents than a traditional survey. Thus, attracting a sufficient number of complete responses could be challenging.

The coding procedure of assigning codes to qualitative data simplifies the complex phenomena being investigated and

could remove relevant information. This can be mitigated by applying different analysis and coding techniques [14].

IV. APPLICATION OF THE METHOD

In this section we present an application of the case survey methodology in an ongoing large scale study to explore software engineering practices in start-up companies. The focus of the study is explore what engineering practices, how and why, are applied in start-ups. The expected outcome is a set of best engineering practices in start-ups, and an improved understanding how start-up context influences what engineering practices are used.

The case survey is selected as data collection method for a number of reasons. First, the start-ups are diverse in their size, product domains, used technologies, life-cycle phases and other factors, thus a significant number of start-ups need to be studied to draw conclusions about a broader population. Secondly, at our current stage of research we are unable to formulate specific hypotheses that could be tested by pure quantitative means. Thirdly, aims of our study are rather exploratory of how and why engineering practices are used. To capture such data a qualitative exploration is required. To achieve balance between a number of studied cases and depth of the investigation we opted for the case survey method.

A. Questionnaire design

To suit our study goal the questionnaire had to cover a broad range of software engineering topics. The Initial scope of the questionnaire stem from the Start-up Context Map - a taxonomy of engineering practices, goals and environment factors [16]. For each factor from the taxonomy a question was added to the questionnaire. The intended audience for the questionnaire are lead software engineers who are currently working or have recently worked in a start-up.

The questionnaire was internally iterated multiple times between the involved researchers and the following improvements were made:

- 1) Complex and vague questions were broken down to more specific and therefore easier to answer questions.
- 2) Free text questions were replaced with multiple choice questions where possible. This was done to reduce effort of answering the questions and analyzing the answers.
- 3) The questions were divided into 10 distinct sections, respondent demographics, product demographics, company demographics, team, requirements engineering, architecture, user interface design, development practices, testing and management. This was done to add a logical flow to questions and to minimize cognitive context switching for the respondent.
- 4) A number of "If you could go back and change how X was done, what would you do differently?" questions were added to capture respondents insights about used practices.

After the internal reviews and improvements the questionnaire contained 89, both free-text and multiple-choice, questions.

B. Validation of the questionnaire

One important concern was whether the scope the questionnaire is sufficient to cover all relevant software engineering aspects of start-ups. We turned to a community of start-up researchers¹ and invited them to collaborate on our study. We conducted a joint workshop with a goal to review the questionnaire and to reach a consensus that it covers all relevant aspects of software engineering in start-ups. Participants of the workshop were first asked to review the questionnaire off-line and to provide suggestions for improvement. Then their feedback was compiled and unclear items discussed in an on-line meeting. A total of 10 researchers provided their input.

To ensure that the questions are understandable by the target audience and answers we got are relevant we conducted four pilots with start-ups. We scheduled an one hour long on-line meetings with engineers from the start-ups, asked them to fill in the survey and speak out loud their impressions. During the meeting we used a screen sharing feature to observe how respondents fill in their responses, e.g. what makes them stumble, what answers they provide etc. We discussed any issues as they arose and took notes on items that needed improvement. Formulations of many questions were revised and some questions removed altogether after the pilots. For example, none of the engineers were able to provide even an educated guess about number of source code lines in their products.

After series of improvements the final questionnaire contain 85 questions in 10 sections. A JSON data structure used to generate the survey is permanently available on-line².

C. Distribution of the questionnaire

The questionnaire is available on-line³ from Dec 1, 2016 to March 15, 2017. To attract responses we use several strategies, such as personal contacts, attending networking events, posts on social media, on-line forums and similar. We approached start-up communities, e.g. incubators, accelerators, co-working spaces, and asked them to distribute our survey within their community. Researchers from Software Start-up Research Network were invited to help spreading the questionnaire among their contacts.

V. CONCLUSION

Software start-ups pose challenges both to practitioners and researchers. Ever changing environment and absence of hard evidence makes large scale studies with start-ups difficult. Nevertheless, start-ups are new and exciting field for software engineering researchers. In this paper we present a promising research method for studying start-ups. The case survey method is a compromise between a traditional survey and a case study. The method can be easily scaled to serve large samples and allows to study the sample in both qualitative and quantitative way.

Preliminary results from our study show that the method to captures rich data from a diverse sample of start-ups. This would not be possible with traditional survey or a case study. We plan to close the questionnaire and start data analysis in late March, 2017. Full research design and results of the study will be published in a separate paper.

Eriks Klotins is a PhD student in Blekinge Institute of Technology. His research focus is software engineering practices in start-ups, and specifically, identification of best practices relevant for software engineering in start-up context. Before starting his PhD studies Eriks had worked in several start-ups as a lead engineer.

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¹The Software Start-up Research Network, <https://softwarestartups.org/>

²<http://startupcontextmap.org/uploads/scm-survey.json>

³<http://startupcontextmap.org/exp-survey/woifenw2?utm=ws>