Questionnaire Approach for Assessing Software Engineering and Quality Assurance Practices

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Abstract—The industry-academia gap is one of the persistent challenges of Software Engineering education. Software development is a rapidly moving industry, and academia is not quick enough to adapt to the changing software engineering profession. To this end, this paper introduces a project that seeks to bridge the Software Engineering -related industry-academia gap in the Finnish region of South Savo. The project intends to bring together regional software engineering companies with teachers, developers, and students in higher education. The objective of such a community is to provide a platform for discussion and the development of collaborative models to improve education and interaction. As the first step towards building the community, we are building a better understanding of the software development companies in the region. In this paper, we describe our method of inquiry and early experiences for understanding companies' type of business, software engineering activities, and attitude towards collaboration. The preliminary results show that our method of inquiry was perceived as useful for both industry and academia. While we were able to gather useful information about the industry practices and feedback for higher education about the skills graduates should possess, industry representatives considered the data gathering as an opportunity for self-reflection.

Keywords—*software development; software testing; quality assurance; industry practices; survey*

I. INTRODUCTION

The gap between software engineering (SE) education and the software industry has been an important discussion topic in the SE community already for three decades [1], [2]. Characteristics to such gap, the industry expects competent graduates, while the students' initial experiences in the industry turn out to be rather different than their education [2]. Garousi and Felderer [3] have argued that currently, practices of industry and academia are "worlds apart" from each other.

Narrowing the industry-academia gap would provide significant benefits to both sides, improving innovation capacity for industry while bringing relevance for academia [2]. Despite such benefits, increasing industry-academia collaboration has been difficult [1]. While the software engineering profession has been able to quickly react to new platforms and trends, academia has struggled to be quick enough to incorporate the changes into its curriculum [2]. Furthermore, the challenges of creating realistic experiences in education have made it also challenging for the students to acquire the necessary soft skills for

the collaboration to develop large-scale software projects [2].

Close collaboration and co-production have often been offered as a remedy for the aforementioned challenges. For reducing the gap between industry and academia, the industry should spend more time with academia and communicate their real problems and share information about the latest methodologies, while academia should strengthen its ties to the industry to create an environment for real-life experience for its students [1], [2].

This paper describes our early efforts in reducing the gap between industry and higher education in the Finnish region of South Savo. As the first step, we are working towards building a better understanding of the software companies in the region by assessing the state of practice of regional SE companies. To this end, we describe our method of inquiry and early experiences for understanding companies' type of business, software engineering activities, and attitude towards collaboration.

The remainder of the paper is organized as follows. First, we explore similar work that has been carried out for assessing the state of the practice of software development companies (Section II). Section III then describes the context of our study in greater detail by introducing the Software Quality Assurance Workshop -project. In Section IV, we describe our questionnaire. Finally, in section V, we discuss experiences of the chosen way of assessing companies' state of the practice and conclude the paper (Section VI).

II. RELATED WORK

Efforts to build closer cooperation between software engineering professionals and educators are still rare [4], making it difficult for recent graduates to transition to the working life [5]. Nikula et. al [6] describes one example of earlier efforts to strengthen industry-academy collaboration and to assess SE practices of regional companies. Garousi and Felderer [3] have further identified testing and quality assurance as some of the topics where a substantial gap between industry and academia can be seen.

To better understand the industry practices, various studies have been conducted using the survey method to assess industry practices in testing and quality assurance. For example: Ng et al. [7] in Australia, Chen et al. [8] in

TABLE I
SECTIONS IN THE QUESTIONNAIRE

#	Section theme	Objective
1	Basic information about the organizational unit	To familiarize the researchers with the company. Questions included, for example, the personal and educational background of the respondent, size and organization of the company, and business activities
2	Information about the company's projects, products, staff, resource allocation	This section collects information on the companies' products and the resources used to produce them
3	Software development practices in the company (such as agile practices). Utilization of open-source software components	This section collects information on the current practices in the companies. These include the use of systematic approaches to software development (for example, agile practices, DevOps), continuous development and deployment, and use of open source software components
4	Use of automation, quality assurance practices, and tools	This section collects information about the tools and practices used to orchestrate the development pipeline and the tools used for different activities in the software life cycle related to software development and quality assurance. The activities ranged from static quality assurance methods to dynamic testing processes
5	Business development practices	This section collects information on the business development projects and practices. Additionally, the reasons to invest in business development and the obstacles that prohibit the company from doing so.
6	Co-operation and partnerships with higher education	The last section of the questionnaire contains questions about experiences of new hires and recent graduates, along with preferences companies have in terms of skills and knowledge that should be acquired during studies.

China, Lee, Kang and Lee in South Korea [9], Garousi et al. [10], [11] in Canada, Torkar and Mankefors [12] in Sweden, and Hynninen et al. [13], Kasurinen et al. [14] and Taipale et al. [15] in Finland.

Previous studies have concluded that there is potential for improving testing and QA practices, but progress is often hindered by the lack of experienced developers [7]. Additionally, QA activities are likely to be downgraded in case of resource shortage [12]. These reported challenges suggest that testing and QA are fruitful topics for collaboration between industry and higher education.

III. SOFTWARE QUALITY ASSURANCE WORKSHOP PROJECT

The Software Quality Assurance Workshop project (SQAW) [16] focuses to increase software companies' QA competence by intensifying collaboration between software companies and higher education. The benefits of such an objective are mutual. Software engineering students will be able to learn real-life software development contexts and build ties with local software companies already while studying. Regional software companies, on the other hand, will benefit from students exploring the latest QA topics and technologies. The project focuses particularly to develop:

- new collaborative models between higher education and software companies in South Savo to share QA-related knowledge and to guide further exploration.
- virtual Software Quality Assurance Workshop that allows access for students and software companies to use QA-related tools.

The project has been awarded European Regional Development Funding by South Savo Regional Council, and is to be implemented between September 1, 2021 and June 30, 2023. In the long term, the project seeks to improve the viability of the software industry in the region and the ability for higher education to respond to the needs of regional software companies.

As a first step towards achieving the project goals, we have started to build a better understanding of the software development companies in the region. To this end, we have chosen to create a structured questionnaire for assessing companies' business and products, software engineering activities, quality assurance practices, and interest in collaboration. We decided to implement the structured questionnaire form in Microsoft Excel to have sufficient flexibility to manage and analyze gathered data. The questionnaire form was planned to be shown to all participants in the data gathering meeting and was intended to be filled collaboratively. Since one of our objectives is to get to know the companies, we decided to conduct the assessment at the premises of the company, whenever possible.

IV. QUESTIONNAIRE DESIGN

The questionnaire contains six sections and a total of 39 individual questions (Table I). Most questions were multi-choice, multi-item type questions with Likert scale answers. The design is based on experience in the field and software engineering literature, including the Agile Manifesto [17], SWEBOK [18], and the "Stairway to Heaven" [19]. Practices for testing and quality assurance were also sought from previous studies [13], [14], [15] and the ISO/IEC standard on software testing [20]. The full questionnaire is available in an online repository. [1]

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[1] http://tinyurl.com/bdekdzmw

TABLE II
AGILE PRACTICES ASSESSMENT

Agile values	Importance now	Importance ideally
Working software	1..5	1..5
Comprehensive documentation		
Customer collaboration	1..5	1..5
Contract negotiation	1..5	1..5
Responding to change	1..5	1..5
Following a plan	1..5	1..5
Individuals and interactions	1..5	1..5
Processes and tools	1..5	1..5
Delivering software frequently	1..5	1..5
Delivering a finished product	1..5	1..5

TABLE III
USE OF OPEN SOURCE SOFTWARE

Do you utilize open source software components? (yes/no)

We do not use open source software components
We investigate the potential to use open source software
We utilize open source software in our internal activities
We utilize open source software in our commercial activities
Our commercial activities are based on open source
We publish open source software
We participate in open source ecosystems

TABLE IV
QUALITY ASSURANCE PRACTICES

Which QA activities are employed?

Requirements management
Source code and version control
Code review
Test planning and management
Functional testing
Unit testing
Integration testing
Software delivery
Test environment management
Acceptance testing
Regression testing
Performance testing
Scalability testing
Stress testing
Interoperability testing
Security testing
Reliability testing
QA reporting
Task tracking and management
Defect management
Code coverage
Test data management
Software monitoring

Responses were collected on a five point Likert scale (0=Activity is not performed, 1=Activity is occasionally performed..., 4=Activity is well processed). Additionally the questionnaire asked if the activity is *automated* and what tools are used related to the activity.

A. Section 1: Basic information about the company and interviewees

The questionnaire begins by gathering basic information about the interviewees (title, background, education) and the company (such as name, marketing channels, location, year of foundation). Next, information is asked about other offices of the company in the region/in Finland/abroad and the number of employees in each office. Then, more details are asked about the number and roles of employees at the interviewed office. The remaining questions of this section focus on understanding the business offering of the company (main products, sources of income).

B. Section 2: Information about the company's projects

This section begins by creating an understanding of project work carried out in the company with questions such as typical numbers of project members, projects annually, duration, and workload. Then we ask the interviewees to assess the success of the company's software development practices. Items in this question addressed the company's ability to meet the budget, schedule, required functionality, and desired quality in software projects. The items were assessed on a Likert scale from *-2 to +2 (-2=considerably worse than planned, -1=worse than planned, 0=according to plans, +1=better than planned, +2=considerably better than planned)*.

C. Section 3: Software development practices

This section begins with an assessment of values related to software development practices. To this end, the interviewees are asked to rate values in the agile manifesto based on the company's current values vs. what would be ideal for the company. Responses were collected on a five-point Likert scale (*1=Value is not very important, 5=Value is very important*). For example, one item to rate was "Individuals and interactions" and another was "Processes and tools" (as per the agile manifesto line "Individuals and interactions over processes and tools" [17]). The items in this question are listed in Table II.

The use of open-source software was also included in section #3 (Table III), with the purpose to assess how prevalent the use of open source components is, and to investigate how many companies base their business around open source. Additionally, this section contained questions related to the software development methodologies and principles, and how time is divided between different activities related to software development (project management/requirements engineering/programming/quality assurance/publishing).

D. Section 4: Quality assurance practices, tools, and automation

This section focused in detail on quality assurance practices. First, we asked how software releases are deployed and what tools or processes are related to the orchestration of the deployment. Next, we asked for information about the maturity, automation, and tools used in different QA activities. Table IV presents the different quality assurance related activities found in the literature. These activities were assessed on a 5 point Likert scale (*0=Activity is not performed, 1=Activity is occasionally performed.. 4=Activity is well processed*). Additionally, a checkbox could be marked if the activity is automated, and we also asked what tools are related to each activity.

TABLE V
ATTITUDE TOWARDS IMPROVEMENT ACTIVITIES

How well do the following statements describe your company? (1=Not at all, .. 5=Very well)
We follow the development of the software business and try to develop our own activities accordingly
We have separate business development projects
We develop business practices in tandem with software development
Business development is as important as software development projects

TABLE VI
THE SKILLS COMPANIES WANT FROM NEW DEVELOPERS

Which of the following skills are especially important with new hires? (1=Not at all important, .. 5=Very important)
Programming skills
Architectural know-how and object-oriented program design
Software engineering methods (for example, agile methods)
Quality assurance know-how
Problem solving and logical thinking skills
Teamworking skills

At the end of this section, we asked which of the QA activities listed in Table IV interviewee would wish to improve at the company in the near future.

E. Section 5: business development

This section begins by assessing the interviewee's stand towards improvement activities (Table V). We then ask about the drivers, obstacles, and enabling factors of business development practices in the company. We end this section by asking questions about business development objectives for the coming two years.

F. Section 6: cooperation possibilities between companies and higher education

The final section of the questionnaire addressed cooperation possibilities between the company and higher education. First, we asked what experiences the companies have with graduates in the region. Next, we asked the respondents to assess how important skills taught in undergraduate programmes are. Table VI lists the different SE skills. Finally, the questionnaire contained different collaboration models and asked how attractive they are to the company.

V. DISCUSSION AND IMPLICATIONS

At the time of writing, we have contacted and interviewed ten software companies in the region. All companies that we contacted agreed to be interviewed, giving a 100% response rate this far. Thus, we can conclude that companies are interested in industry-academia collaboration, at least on a generic level. Although the results are preliminary and the inquiry is still ongoing, the results nevertheless seem promising. As one example, Figure 1 depicts an overview of the maturity levels of software quality assurance activities in the region and the level of automation used in the activities. This kind of information is useful both for industry and academia. While companies receive feedback on how their quality assurance practices compare with general maturity levels in the region, academia gains useful information on the particular activities and tools that needs attention when further developing education.

Even though we preferred to meet the company representatives in person at their premises, the current COVID-19 pandemic forced us to move some of the meetings online. We discovered that filling the questionnaire in a virtual meeting worked equally well, providing benefits for both academia and industry.

A. Benefits for the academia

Results from the first interviews indicate that there is both the need to invest in quality assurance practices and the will to engage more in industry-academia cooperation. This suggests that the SQAW project is timely and serves the needs of the regional companies. Although the project is aimed at regional development, the results are interesting to a wider audience.

Our project focuses on developing testing and QA practices. Based on the gathered data, it seems that this work is especially interesting to the smaller software companies, which have not yet had the chance to develop robust QA practices. Therefore regional cooperation, knowledge sharing, and new collaboration models with higher education were seen as worthwhile prospects. At the same time, these companies indicated that the scarcity of resources may be an insurmountable obstacle. These findings are in line with other studies in the field. For example, Souza et al. [21] found that startups aim to develop testing practices but DevOps, agile practices, design, and extreme programming often take priority over quality assurance.

On a more practical level, our first interviews have revealed a number of benefits. First, we are collecting a list of the different tools and methods employed by the software companies. This investigation benefits software engineering researchers and educators. The results will also benefit the companies themselves, as we will disseminate the results once data collection is completed. Thus, the companies can review their own practices and compare their position in comparison to others in the region.

The second main finding from the first interviews is that the tools used for automation, orchestration, review, and deployment of software projects vary between companies of different sizes and business domains. Traditional software development houses employ the most tools, they have streamlined the processes, and rely on automation in the orchestration of software and services. These companies organize their work in teams of multiple people working in software development (typically 5 person teams). Smaller companies (start-ups or self-employed developers, or a conglomerate between these) employ more ad-hoc practices.

Another insight from the interviews thus far is the need for improving testing tools and practices. Some respondents stated that all aspects of testing and quality assurance should be developed, others highlighted a need
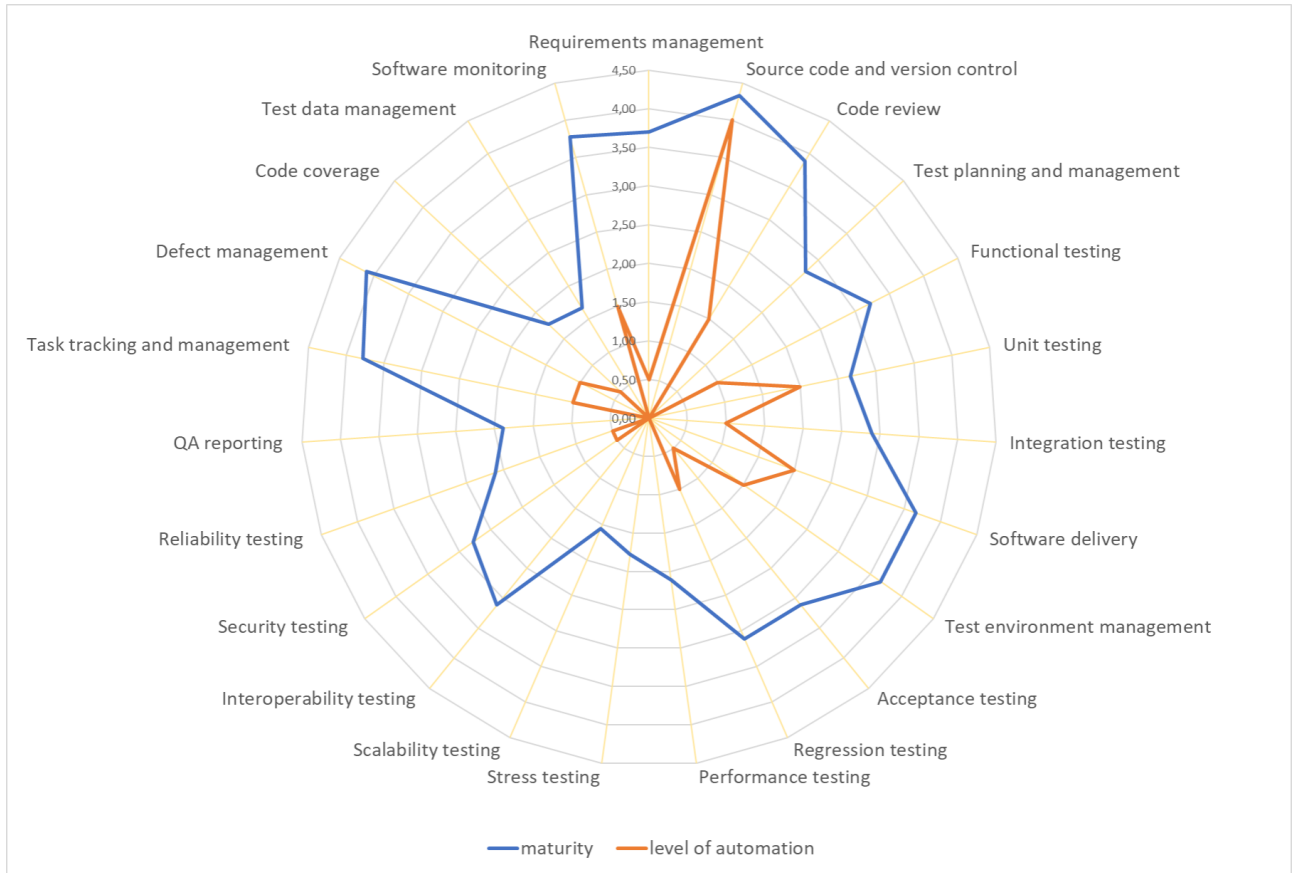
Fig. 1. Early results from the first interviews revealing maturity levels and the use of automation of software quality assurance activities

for improving test automation. Specific areas for improvement included unit and integration testing automation, UI-testing, system testing, functional testing, regression testing, and security testing.

B. Experiences from the industry

At the end of the questionnaire, we asked for feedback from the interviewees. The responses from the industry were positive without exception. The industrial representative welcomed our objective of building closer ties with them and expressed their interest to work towards such a goal. The interviewees also gave positive feedback on our data gathering method. They liked the structured questionnaire and felt that this provided them a good opportunity to assess their current state of the practices.

VI. CONCLUSION

In this paper, we presented the preliminary results from the Software Quality Assurance Workshop project. The project aims to develop new collaborative models between industry and higher education and to develop a virtual Software Quality Assurance Workshop to facilitate the collaboration. As the first step toward a better understanding of the collaboration opportunities, we designed a questionnaire for assessing the software testing and quality assurance practices in the industry. Preliminary results from interviews using the questionnaire were presented.

A. Recommendations for data collection

In addition to the questionnaire instrument itself, this paper presents recommendations for best practices from the experience of the authors.

First, we recommend that the data collection be conducted as a face-to-face interview. While web-based surveys are more convenient, a web survey does not add much value and can lose some richness in the data. In our experience companies are very welcoming for researchers to conduct interviews while a long web survey may only get a few responses. For example, in [13] the sample of the web survey was only 33 respondents. Conducting the surveys in person, on the other hand, can yield as many responses. Thirty or forty interviews is not a difficult task even for a single researcher. The additional benefit of interviews is that the respondents can offer additional information during the session.

Second, statistical mean values do not yield meaningful conclusions from the data. More rich qualitative data can emerge from the interviews even if the questions are not open-ended.

B. Limitations and future work

The scope and limitations of the current study warrant some discussion. This work employs a qualitative research approach. The findings are exploratory and do not yield strong conclusions. However, we feel that the experiences

presented in this paper are robust enough to warrant dissemination. While the number of responses has been low (10 responses), the fact that the interviews were conducted in person or in a virtual meeting provides added qualitative value to the reliability of the findings.

The work in the SQAW project is ongoing and we have only presented preliminary results. In the future, we will collect more data to investigate the state of the SE and QA practices in the region.

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