

A study of software testing practices in Sri Lankan Software Companies

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Abstract—Software testing is a knowledge intensive and a collaborative activity, which mainly depends on knowledge and experience of the software testers. This study presents using an empirical investigation carried out in Sri Lankan software companies about the current status of software testing practices. The study focused on mainly testing methodologies and techniques, automated tools, testing metrics, testing training and academic collaboration with software industry. As reported from this study, Agile methodology became very popular in software companies for software development. As an overall analysis, there was a great interest in using tools such as Selenium for testing activities. Findings of this study emphasized that while software testing practices were considered to be important, training, money and resources were inadequate to address an effective management of software testing knowledge in these three software companies. Findings also presented a compelling evidence of the soundness for the need of knowledge management practices to manage software testing knowledge.

Keywords—software testing, software testing knowledge, testing practices.

I. INTRODUCTION

Software testing which is also a knowledge intensive and collaborative activity is a sub area of software engineering [1]. Since software development is an error prone task, in order to achieve quality software products, Validation and Verification should be carried throughout the development [2]. Software testing process contains Test Planning for planning tests, Test Case Design for test case construction, and test execution Test Execution for execution of test cases and producing Actual Result, and Test Result Analysis for analysis and evaluating the test results. In addition, software testing process includes Test Design Techniques, Test Levels, Artifacts, Test Environment (includes hardware, software and Human resources) and Static Testing Techniques [2], [3].

Many Sri Lankan software companies are leading worldwide provider of information technology (IT) consulting and outsourcing services. Therefore, to achieve global success, these software companies will have to meet or exceed quality standards of leading software publishers, especially in the fields of in banking and financial services, insurance, healthcare, telecommunications and media. In such situations, these offshore companies have to incorporate the technology advancement to use testing strategies, in order to achieve high quality and reliability software products. At present, software testing is considered as a process consisting of activities,

techniques, resources and tools. This motivates software companies making testing processes increasingly important and complex.

Software testing practices have been extensively researched and analyzed in many software companies around the globe [4]. In order to extend their study towards the current status of software testing practices in Sri Lankan software companies, the authors of this research intended to carry out a similar research work. Unfortunately, authors found that presently there is a gap in literature concerning the software testing practices in software companies in the context of Sri Lanka. Therefore, it is not possible to conduct an analysis or review. Such that, this study aims to reduce this gap by evaluating current status of software testing practices in Sri Lankan software industries using an empirical investigation. Towards this goal, the following research question (RQ) was formulated.

RQ: What is the current status of software testing practices in Sri Lankan software companies?

This study would synthesis variety of knowledge such as, a more complete description of the software practices, intellectuals responses and managerial and organizational issues. This will help the software companies, who are seeking job in the field of software testing not only to evaluate knowledge from an epistemological perspective, but more importantly in terms of its ability to address contextual and business-related problems such as managerial and organizational issues.

Importantly, it was reported from SLAASCOM (Sri Lanka Association for Software and Services Companies) that no investigation has been conducted by Sri Lankan software engineering industry or other Sri Lankan institutions for evaluating aspects of software testing practices in Sri Lankan software companies. The authors believe this experience can be widely used for reference and updating of promising practices in scientific knowledge and creativity support in software companies.

The remainder of this paper is organized as follows. Succinct analysis of related research is presented in the second section. Section 3 discusses the methodology in detail. The analysis of the results is discussed in Section 4. Finally, Section 5 concludes the paper and presents directions for

future work.

II. RELATED WORK

A number of surveys have been previously conducted on software testing practices in software companies in different countries and in different scales [4]–[7]. They have invited many experts from academia and industry to study the current status of software testing practices. Most of the research has study on (1) test process improvement, (2) testing automation and testing tools, and (3) standardization, (4) Test-Driven Development (5) test metrics (6) test management and training, (7) academia involvement.

It is interesting to see that most of these surveys have been conducted in the last decade (last survey in 2010). Since then the software testing methods and practices in industry have been upgraded with change of technologies, given the increasingly critical role of testing in newer software development methods.

III. RESEARCH DESIGN AND EXECUTION

The primary objective of this study is to provide a more complete description of the software testing practices applied in the Sri Lankan software companies by adopting an empirical research method. Quantitative research methods can be used statistically to generalize the findings from the large population [8], [9]. Since analysis, synthesis and reporting of qualitative study are more challenging than quantitative studies. Therefore, we have decided to conduct a quantitative study for this context.

TABLE I
PRELIMINARY DESIGNED QUESTIONNAIRE

| Construct | Number of items | Description |
|--|-----------------|--|
| Test Techniques | 2 | To extend to which software testing methodologies and techniques are used |
| Test Automation and Test Tools | 2 | What Automated test tools are used(Eg:- in house developed tools, commercial tools etc) |
| Test Metrics | 5 | To extend to which software testing metrics are used |
| Test Management | 5 | To extend to which testing is managed (Eg:- scales, terminating, completing, etc) |
| Test Training | 3 | To extend to what kind of software testing training are provided |
| Research and Interaction with Academia | 5 | How much collaborations are happening between both parties |

The questionnaire was improved and designed in English with seven sub sections based on the existing literature [3], [4]. Table I shows constructs, number of items and references used to adopt the items during the preliminary questionnaire design. Respondents profiles and demographics(RQ1), Test techniques (RQ2), Test automation and test tools (RQ3), Test metrics (RQ4), Test management (RQ5), Test training (RQ6) and Research and interaction with academia(RQ7).

Five-point Likert-type scale was introduced to capture respondents' self-reported attitudes where respondents had to make their level of agreement such as; Strongly Agree, Agree, No Idea, Disagree and Strongly Disagree. Scores 5, 4, 3, 2, and 1 were assigned respectively for the above-mentioned categories. Likert-items incorporating five response categories are typical, such that the middle category represents neither a negative nor a positive response. The mean value 3 was preferred as the decision criteria for this survey [8], [10].

The preliminary designed questionnaire was given to a group of software testing experts including two professors and two industrial senior level specialists in the field of software testing. To ensure the content validity, all the experts examined the items relevant to the software testing practices and checked that the survey items were clear, meaningful and understandable. Based on their constructive feedback minor modifications were made (such as formatting and wording). Then, the questionnaire was pilot tested [8], [11] with 10 software testing professionals from Sri Lankan software companies. They were asked to complete the survey, to provide comments on whether the questionnaire was readable, understandable and any other comments for improving the design of the questionnaire survey. Even though the questionnaire was well accepted and understood, certain terms however, were considered unduly technical and all the respondents were unable to understand the meaning of them and kept them unanswered. Thus, two questions were removed. Finally, the modified questionnaire was distributed online(<https://goo.gl/rGpebC>) for the study. During the pilot study, each company was concerned about their tight calendar with ongoing projects which were running behind the schedule. So, authors limited the time period to twenty-one (21) days to collect the data.

The authors contacted SLASSCOM to provide the list of IT companies in Sri Lanka. Based on the annual report produced in 2016 by SLASSCOM, authors communicated diverse companies which claim to apply software testing in their profiles and five companies had responded to the request. But, authors looked at those companies' profiles in detail which were included in their replies. Among them, three companies were selected. They claimed to have comparatively very large population with good hierarchy of different software testing designations, diverse of experienced employees and handling many similar software projects were selected. To adhere to the research ethics, companies were labeled as A, B and C.

IV. DATA ANALYSIS AND RESULTS

A total of 152 responses were received from those three companies (A=87, B=25 and C = 40).

A. Profiles and Demographics

The profiles and demographics of the participants in the survey, type of respondents (See TableII), academic degrees of professionals, software testing certification(s), Software development methodology and project experience in the industry were to be determined.

TABLE II
SUMMARY OF RESPONDENTS

| Type of Respondents | Number of Responses |
|--|---------------------|
| Tester/ Test Engineer | 82 |
| Associate Automation Specialist | 5 |
| Trainee Automation QA Engineer | 10 |
| Software QA Engineer | 5 |
| Quality Assurance Lead | 5 |
| Project Leader/Team Lead | 10 |
| Operations Manager | 5 |
| Internship Student | 10 |
| Engineer - Associate Consultant | 5 |
| Developer/ Software Engineer | 10 |
| Business Analyst/ Requirement Engineer | 5 |
| Total | 152 |

Tester/Test Engineer is mostly having all kind of experienced people, since they start their career mostly from this. As an Overall analysis stated in Figure 1, both Operation Manager and Tester/Test Engineer have more than 5 years of experience in these companies.

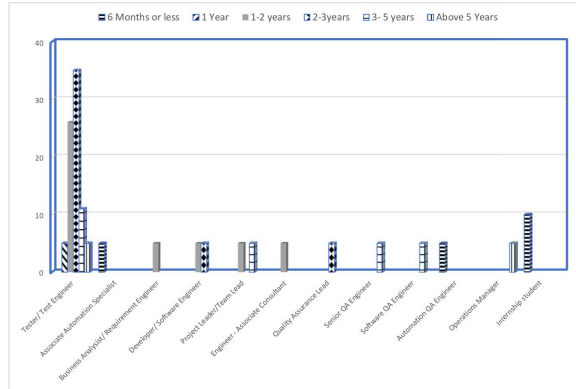


Fig. 1. Respondents Positions

Further, these companies are "developing customized software" for the clients need as shown in Figure 10.

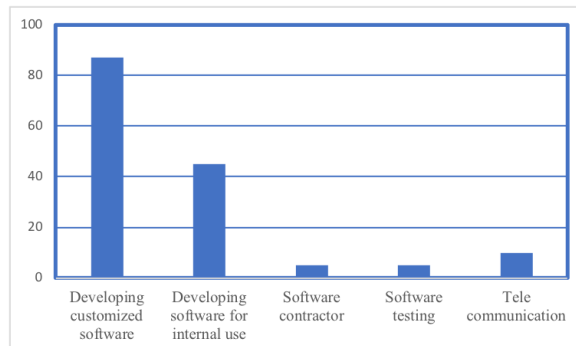


Fig. 2. Type of Software Projects handled

We can notice in this bar chart (See Figure 3) that Agile is mostly adapted in the software companies and among them.

Noted, Scrum is a very popular framework used in their projects. In contrast, a few software projects are using traditional methodologies, Kanban and their own adapted models.

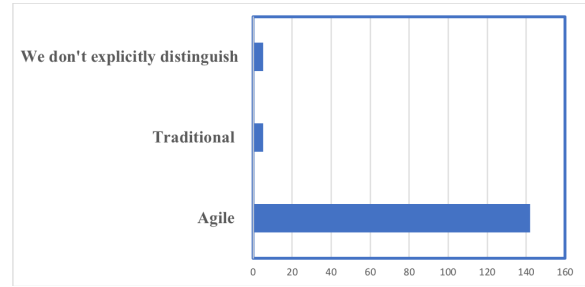


Fig. 3. Software Methodology

B. Test Level

Figure 4 illustrates the frequency of usage of different test types. Results illustrates that Unit testing, GUI testing and User Acceptance testing are the most common test types used in these companies. Interestingly, respondents from company B states that they run-through API Testing and web service testing too.

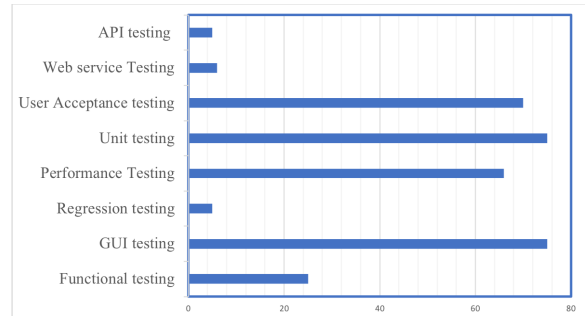


Fig. 4. Test Types

Participants were then asked about the type and phasing of their software development life-cycle processes and results are shown in Figure 5. The results indicate that Test-driven (first) Development (TDD) approaches are still much more popular than Test-last Development (TLD) (i.e., testing after development). A large portion of software testing groups employ the iterative testing approach also. A few a groups use the Behavior-Driven Development (BDD) approach.

C. Test Techniques

Test techniques refer to the methods that software developers use for generating test cases. Results are shown in Figure 6. The respondents use explicit test-case generation technique (i.e., black-box or white-box techniques). We can see that is Model Based techniques(e.g., based on UML models) is the technique reported to be used by most respondents Boundary values and Category partitioning is also used in higher rate. Even though, exploratory testing is broadly considered in

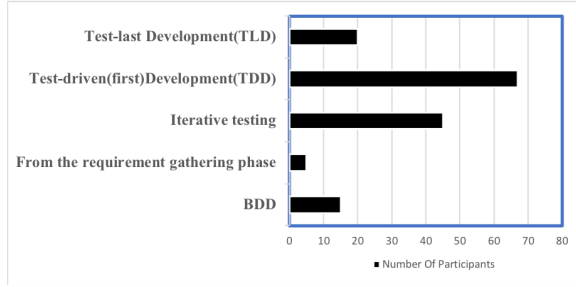


Fig. 5. Testing across the development life-cycle

Agile practices, but it appears that exploratory testing is not that popular in these Agile based software companies.

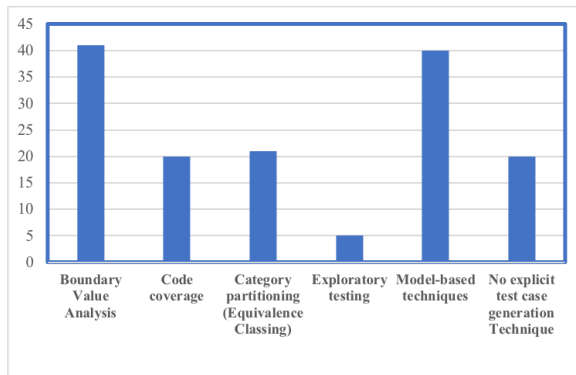


Fig. 6. Test-case generation techniques

In addition, many respondents were not familiar with mutation testing (fault injection) as shown in Figure 7.

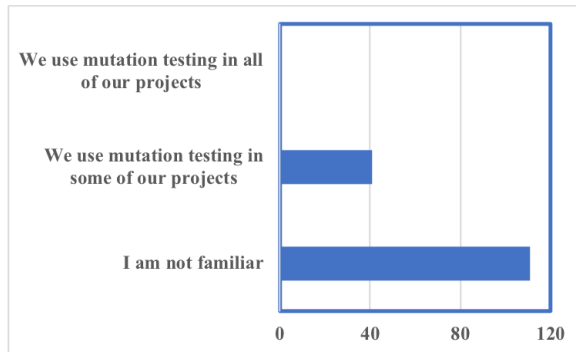


Fig. 7. Familiarity with mutation testing

D. Test Automation and Test Tools

Manual testing is taking the dominant position, given that most of the respondents mentioned that they perform more than 80% of their testing manually. Interestingly, most of the projects have been handled by the Selenium (See Figure 8, which is used to automate manual testing is very popular these days in the industry.

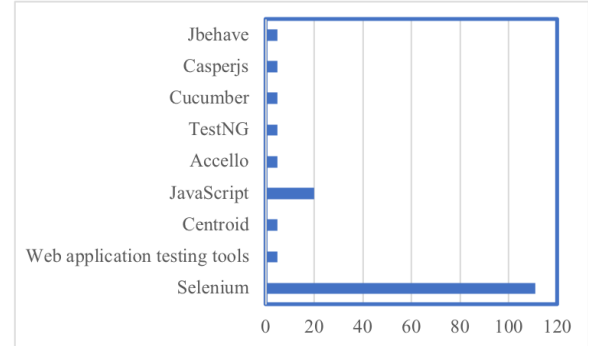


Fig. 8. Tools that are used in Testing

E. Test Metrics

From the bar-chart, we can see that decision (branch) coverage and condition coverage are two most popular coverage types among all the respondents. Line (statement) coverage also received more than 45 responses. Unfortunately, MC/DC is not scored anything here yet.

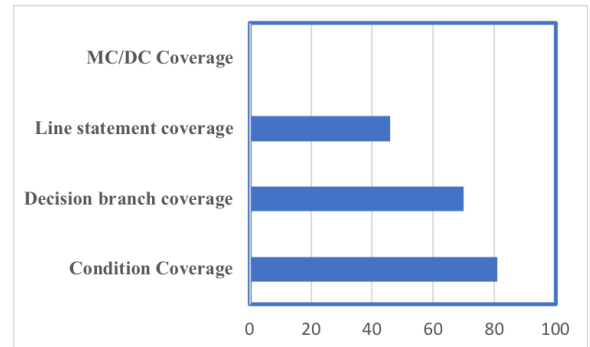


Fig. 9. Code(test) coverage metrics

Further, participants were also asked to select from a given list of other test and quality-related metrics that they used explicitly in their past and current projects (See Figure 10). Among all the listed metrics, the number of test cases executed within a period of time attracted the most votes, followed by Testers defect(bug) detection productivity. Even though no significance was given for user acceptance, probably the participated group of software testers could not be responsible for such test activities.

F. Test Management

Respondents were asked what their experience was with the various defect tracking and test management systems used in test management. Figure 11 illustrates that Jira is very popular in this case, followed by Testlink and BugZila. A few introduced new tools such as Rex, Rally, Zoho and Bug Tracker to the software testing community.

Further, the respondents were also asked about the barriers for adoption of testing methodology and tools in their projects.

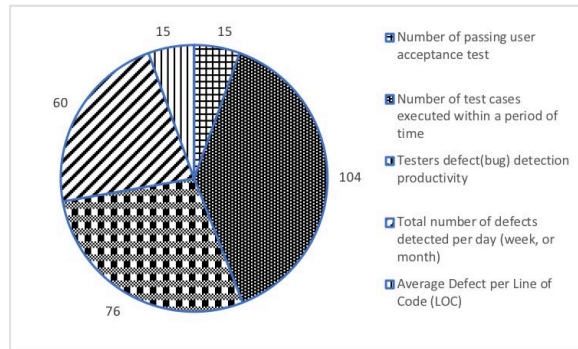


Fig. 10. Other test and quality metrics

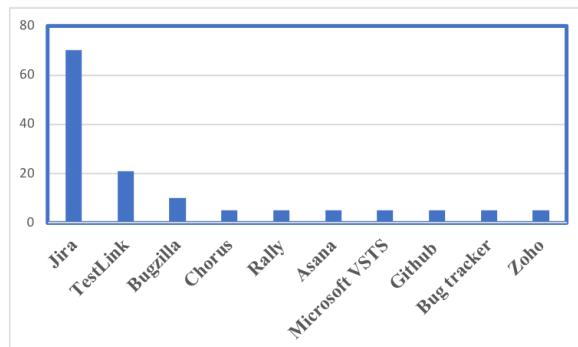


Fig. 11. Test Management Tools

Not surprisingly, cost, time and lack of resources were the three top responses for this question.

G. Test Training

Formal training provided by the software companies for software testing would usually provide a solid foundation for testers. Responders were asked about how many hours they spent per year and results are shown in Figure 12. importantly, some of the participants stated that no training was provided for them.

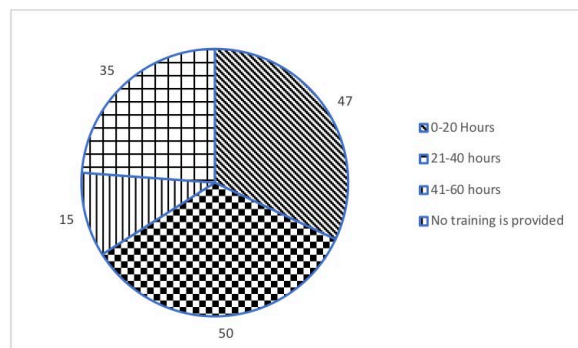


Fig. 12. Number of hours spent on test training per year

Further, the respondents were also asked about the barriers for adoption of software testing training by the companies. Not

surprisingly, once again cost, time frame and lack of resources were the three top responses for this question.

H. Research and Interaction with Academia

Respondents were asked whether their companies or themselves involved in any research to develop new test techniques/tools. 53.29% of the respondents said "No". Further, the respondents were also asked about the top three testing challenges that they have been seeing in their projects. The respondents highlighted Time, cost and Staffing and Training as the key challenges for them. We feel that the companies are targeting to use the existing tools, and knowledgeable employees who have testing professional certificates. In such situations, they don't much consider about research at this moment. But this would be verified in future research activities.

I. Threats to Validity

Due to the limitations of this research, there are several threats to the validity of the experimentation results. The following will be considered in future: (a) the sample size of this survey is not very high (See Table I), deviations might exist in the findings while comparing the responses of respondents from different backgrounds, (b) Increase the number of companies used in this study, (c) We will include the many participants from the same designations, from different companies too.

V. DISCUSSION AND CONCLUSION

In this paper, we presented a survey study about the current status of software testing in Sri Lankan Software companies. Seven research questions were defined and addressed investigating the facets.

Almost all three companies are using Agile software development and that represents a major departure from traditional, plan-based approaches to software engineering. These Agile teams tend to be small comprising of heterogeneous and capable of engaging in several distinct types of work such as analysis, development and testing together. Further, these companies are engaged with new automated tools introduced in the market to handle the manual testing and Selenium is highly recommended at these companies. Importantly, both Black-box testing and white-box testing are popular among these communities.

Most importantly, money, cost and lack of resources are the barriers for these companies to purchase or spend more time on systematic testing methodologies and testing tools. Further, these companies should involve in providing training to their employees. This is witnessed when respondents answered as No. They should focus on training programs targeting most of the test types, such as unit testing, Functional or system testing, performance testing and user acceptance testing.

Rather than attending conferences, it is much better to facilitate them with magazines related to software testing, providing free access to academic databases such as IEEE Xplore, Springer and Sciencedirect. Not only this would help them to reduce their time but also increase the update on testing

domain knowledge and adapt those advanced test techniques in their projects.

This study gives an idea, in the early phases, of shortcomings in existing evidence, which becomes a basis for future studies. The results of this study would help the three leading software companies, to recognize software testing practices which are needed for software development. Therefore, management should be sensitive to the testing activities that are already going on within the company and seek means to support them.

ACKNOWLEDGMENT

We thank these three software companies and its testing team members who were actively facilitating this research since beginning. We also thank both Academic Staffs who provided their immense support through expert evaluation. This work is partially supported by Sabaragamuwa University of Sri Lanka Research Grant SUSL/RG/2017/19.

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