Elaborating Software Test Processes and Strategies

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Abstract— This paper introduces the research topic of “Elaborating Software Test Processes and Strategies”, in which I with assistance from our research group conducted a qualitative study on software producing organization’s test processes. My goal is to develop a reference model for organizations to enhance and develop their test processes based on the upcoming ISO/IEC 29119 software testing standard by interviewing professional software developers from different phases of software process. The study focuses on the aspects that compose testing strategy; human resources, test tools, test case selection, testing methods and the role of the management in the test process to name few of the major components. Based on the preliminary results, there exists room for improvements in testability of the software products and focusing the available test resources, problems which could be addressed by means of systematic process improvement and defining test strategy for the organization.

Keywords— software testing, test process improvement, test strategy, empirical study

I. INTRODUCTION

In software development, the testing process is usually the most costly phase, which can be responsible for over 50 percent of the development costs [1]. However, even if the testing expenses may seem like a large investment, the testing process can be effective with only 20% of the optimal resources, if the test effort is correctly focused on the critical aspects [2]. Additionally, the test phase is also responsible for ultimately deciding whether the product is profitable [3]. When such testing-related concepts as quality assurance, customer satisfaction, and through assurance and satisfaction, public image, are taken into account, the incentive for measuring and developing test process becomes understandable. Besides public image and customer satisfaction, there also exists financial incentive in test process development [4].

The software test process and parts that constitute software testing has been defined in several models and certificates such as TMMi [5] or ISTQB [6]. In addition to these, there also exists draft for a new software testing standard, ISO/IEC 29119 [7], which defines the standard model for software testing process in organizations. The model defines four levels of test process; policies, strategies, management and practice, all which exist in test organizations.

In my research, the objective is to build a reference model for real-life organizations to apply the standard-based test process model to develop and observe the fitness of their testing activities. This research is based on practical experience in software industry; by interviewing professional software developers, my objective is to develop guidelines and reference models for the software organizations to achieve better output and cost/effectiveness ratio from their test process. The results so far indicate that the software test processes could be improved by developing software with better testability, applying better definitions for test resources, and overall, by developing better test strategy to use the given resources more efficiently.

Rest of the paper is constructed as follows: In Section 2, the approach to our research topic, and research questions, are defined. In Section 3 we define the research-related concepts and discuss the contents and demarcations of the topic. In Section 4 the current results and future plans are presented. Section 5 closes the paper with discussion regarding the research topic and areas of interest.

II. SELECTED APPROACH AND RESEARCH QUESTION

The approach to achieve this objective is to conduct a grounded theory [8, 9, 10] study on 12 different software-producing organizations. This selection of 12 different companies represents different polar points of the industry, from service-oriented consultants to multinational companies developing software for their own products. From these companies, our research group interviewed three professional developers each. These professionals worked in the organization either as a system designer, test- or project manager or tester, or in case no suitable position was used in the organization, the most fitting person such as programmer or developer who was responsible for testing tasks.

The actual focus was on organization units (OUs) from different companies. An organization unit, a part of organization that deploys one process, has coherent process context and set of business goals [11], was selected as our basic unit as it made comparison between different-sized companies possible: large companies consist of several OUs, while small companies may consist only one organization unit. From each participating company, one OU was selected to participate on our study, and the three interviewed persons were selected from this OU, giving several viewpoints to that particular unit.
A. Research method

In this study qualitative studies are based on the grounded theory research approach. Based on this methods, the participating OU:s were interviewed with questions related to the research topic, while the situation was recorded and transcribed. The answers were then coded with three-phased coding scheme, where themes and concepts were highlighted and later sorted for associations.

As for the grounded theory approach, the method is considered well-suited for this type of study; for example a book called “Basics of Qualitative Research” [9] by Strauss and Corbin defines the method and introduces how it can be applied. Their opinion is that the method is intended for research process, where underlying concepts are not definite, and prone for human-related variance. In this sense the method is similar to other approaches like ethnography or biography studies, applying several case study principles [10]. The grounded theory study consists of three phases:

- **Open coding** analyzes and highlights all the concepts, relations and classes found within the collected data.
- **Axial encoding** is used to establish dependencies and relations between classes and concepts.
- **Selective encoding** uses the established relations to separate and highlight the major concepts while defining the affect of secondary concepts in relation to the major ones.

Additionally, the method can be supplemented with quantitative data to establish classes and relations, or define dependencies or relations between classes. If all phases are completed in right manner, the study fulfills the requirements for scientifically approvable approach. In short, the grounded theory applies inductive reasoning and creates a systematical representation and theory from the analyzed data. A theory created with grounded theory differs from a non-scientific explanations on the ground that it is based on the concepts and observation-based relationships rather than plain application of themes to the open conclusions.

There is also another interpretation of grounded theory research, defined by Barney Glaser, discussed in [12]. This interpretation focuses on the open coding and observations while steering away from the categorization of classes with enforced relationships. Although merited on its own, for this project I decided to apply the Strauss and Corbin approach as I believe it is more suited for our research objectives.

Another related research method, action research [13], was also rejected. This was decided as the study focuses on existing, real-life industrial partners who have large variance in their operating methods and domains. Short time span of the research and limited abilities to affect the target organizations forced this research to reject the possibility to apply action research methods.

The practical application of grounded theory approach was to collect data from professional software-producing organization units. As a basis for the data collection and data analysis, our research group interviewed 12 organization units from different companies in three separate occasions. The interviews were semi-structured testing- and software production-themed interviews with designers, project managers and testers, one from each participating organization unit (OU). The themes for the interviews consisted from the software development and testing, consisting topics such as development processes, test phases, test tools, test automation, quality concepts, agile practices and outsourcing. The interview questions can be accessed at our project website (http://www2.it.lut.fi/project/MASTO/).

On the test- and project manager round the interview questions were supplemented with additional survey which was used to collect quantitative data on the software organizations. To validate the statistical approach, we expanded the amount of participating organizations to 31 organization units, with 12 participants from the other, solely qualitative study rounds, participating. The survey was designed and the collected data was statistically analyzed as a part of other PhD-study, but the results are used in my study as supplemental information for qualitative analysis as instructed in the [9].

On a qualitative study, there are threats to validity of the results [14]. To avoid such threats, the codification and analysis work was done by four researchers from our research group to avoid observational bias. Additionally, the qualitative- and quantitative results were compared to each other to validate the observed phenomena and look for relationships which would not have been evident from only one data set.

B. Research question

The general research question for my study is that How is the software test strategy constructed in practice?, and it can be further focused with following additional questions:

- Does the theoretical test strategy defined in several models (ISO/IEC 29119, TMMi2) translate to the practice?
- What is the application and availability level of test strategy-related aspects in the real software-producing organizations?
- Based on the practical observations, is it possible to define different strategy templates to enable organizations to enhance their test process?
- Are there any additional major influences besides those defined in the literature?

These research questions are used as a basis for the research process and were applied in creation of seed categories [10] for grounded theory study.

III. DEFINITION OF TEST STRATEGY

The testing process of a software-producing organization can be divided to several layers. For example, the draft of software test process standard ISO/IEC 29119 [7] calls these layers test policy, test strategy, test management and testing work. By this division, the actual tasks related to the testing are located at the bottom layer of the model, having management, strategy and policy above them, steering and managing the testing process.

The division of tasks between the upper layers is the key to researching test processes. For example, the ISTQ-B
glossary [6] of software engineering terms defines test management, test policy and test strategy as follows:

- **test management**, The planning, estimating, monitoring and control of test activities. Typically carried out by test manager.

- **test policy**, A high level document describing the principles, approach and major objectives of the organization regarding testing.

- **test strategy**, A high-level description of the test levels to be performed and the testing within those level for an organization or program (in one or more projects).

The relation between these terms is as follows; The policy level is the high abstraction level of testing, only defining broad principles, approach and objectives for the testing process. The test strategy is the operative plan to enforce the policy, describing the test levels, more commonly known as phases, which the test process applies and what sort of activities are done within those phases. Finally, the management layer is responsible for planning, monitoring and controlling the strategy-defined activities.

Based on the definition, the test strategy plays an interesting role on the total test process, as it has the opportunity to both define and interpret testing activities. The policy level has no practical restrictions on their definition work, but it lacks the ability to observe details and usually leaves practical solutions open for interpretation. Similarly in test management, the ability to observe details and react to the practical issues is immediate, but the available actions are restricted by the strategy and policies, which dictate what the management process should be doing.

Overall, the test strategy should define following answers in all testing-related software production phases: “What should be tested in different phases, by whom, by which method, by what tools, in what kind of environment”. By generalizing from the TMMi and ISO29119 overlaps, it would seem that the test strategy is meant to define at least following aspects:

- testing tools (including regression and automation)
- testing methods (including regression and automation)
- testing personnel (responsibilities and levels of independence in the organization)
- test case design and -selection methods
- quality criteria (for entry- and exit criteria, including standards that has to be complied with)

…for each phase of the testing, in accordance to the test policy, defined by the upper corporate level management, while leaving the implementation and practical details to the test management level.

An on-line article by Johnson [15] summarizes the test strategy even further, deducting that the strategy is a roadmap that answers the questions how, where, who and when. It does not have to be complete, unchangeable monolith, but rather a book or best practices and common guidelines.

IV. CURRENT RESULTS AND FUTURE CONTRIBUTIONS

My research project has been active for over a year at this point, and the data collection and preliminary analysis are completed. The research focus has been on analysis of test process problems, based on our research group’s prior observations from preceding project, from which the results are presented in [16]. The central findings on this topic were that the testability in software architecture is central aspect that is usually neglected, the testing resources should be separated from the development resources and that the usability and configurability are two central issues on testing tools and -environments.

Currently, my research is focused on the test resource allocation, applicability of test automation in the test process and test case selection methods. By focusing on these aspects, my objective is to find traces for developing categories for the template approaches and subsequent reference model for test process. Most of the data and research publications are currently in progress, but some preliminary results and observations have been introduced in [17] and [18].

These findings do suggest that there is still room for process improvement in testing. In many cases, testing resources are limited, and limitations in testing infrastructure hinder test activities. Additionally, the test strategy or systematic development of test plans for projects seems to be something that could be improved upon.

The long-term objective of this study is to build a reference model for practical application of test strategy defined in the ISO/IEC 29119. To achieve this objective, my research strategy is to find answers to following questions and based on the answers, create reference model and test process templates for different organizations:

- **How influential are the different aspects which define the test strategy?**
- **Are there any other aspects that affect the strategy effectiveness in the practice?**
- **How the case organizations apply the model in practice with different aspects and environments?**
  - Can the practical applications be used to define different “template models”?
  - If so, what are the environmental requirements for these templates?
- **Can these templates be generalized or abstracted to compose reference model?**

By observing the real-life scenarios and defining different practical applications of test strategy it is our goal to define different “template models” for companies and organizations. Ideally, if organization can identify their test process approach from the template models, it would then enable them to develop their test processes based on the reference model. The reference model should consist of guide of different model practices for different types of organizations, with guidelines on deciding which model the organization should follow, and how to implement different concepts such as test automation or agile practices, while avoiding the common pitfalls derived from the literature or observed from interviewed organizations.
The developed reference model will be tested on field tests later in the research process. The current concept is to validate the model by interviewing other organizations in the fourth round to analyze if the reference model could be abstracted and fitted to other organizations.

V. DISCUSSION AND CONCLUSIONS

As for the research approach in software test strategy, the impact of different aspects - tools, methods, personnel, test case design and quality criteria - should be further investigated as major areas of interest. One feasible approach seems to be to analyze the practical impact of different areas of interests to the test process, and determine how the test strategy differs in different types of organizations. Especially, is there a way to determine suitable test strategies for certain types of organizations, or is there a distinguishable group of “prototype-strategies”, which can be generalized to different template models for test strategy?

This seems plausible, as there already exist the concept of “Generic Test Strategy” [19], which is used to define general approach on test process, and establish fixed control points. The generalization may have benefits, but developing the concept further to offer “prototype-strategies” and possibly identify selection criteria for organizations should be beneficial. This way the theoretical ISO/IEC 29119 model and practical testing done in organizations could be adjoined. Organization looking for practical improvement could then refer to the reference model, which could offer enhancement proposals for efficiency in testing, while avoiding the common process enhancement pitfalls.

To achieve this goal, this study pursues strategy of observing and defining the impact of each area of interest defined in literature, while supplementing it with concepts derived from real-life organizations. The current strategy is to refine these observations into general strategies with variables for affecting factors. The organizations can be classified based on how their test organization operates with different variables, also defining the prerequisites to pursue the observed strategy. By defining the template models, organizations which aim to develop their test process could then pursue one of them by adopting the defined methods and approaches, or simply adjust their existing process based on the better practices suggested by the model.

REFERENCES