



A Systematic Approach to Collaborate Quality Assurance Approaches

Adesh Patel*, Surendra Pal Singh
Department of Computer Science Engineering
Nims Institute of Engineering and Technology,
NIMS University, Jaipur, Rajasthan, India

Abstract- Due to the increasing size and complexity of software today, the amount of effort for software quality assurance (QA) is growing and getting more and more expensive. There are many techniques lead to the improvement in software QA. Static analysis can obtain very good coverage while analyze program without execution, but it has the weakness of imprecision by false errors. In contrast, dynamic analysis can obtain only partial coverage due to a large number of possible test cases. A major part of this thesis presents the systematic review that brings details discussion about state of the art on the approaches that combine static and dynamic QA techniques. The systematic review is aimed at the identification of the existed combined QA approaches, how to classify them, their purposes and input as well as introduce which combination is available. The results show that, there are two relations in the combination of static and dynamic techniques such as integration and separation. Besides, the objectives of combined QA approaches were introduced according to QA process quality and product quality.

Keywords— Static analysis, Dynamic analysis, Quality Assurance, Testing, Inspection. Systematic review.

1. INTRODUCTION

Building software products on time, within budget and with highest quality is the demand in the area of software quality assurance[1]. The significant cost for software development is for quality assurance activities. Studying the techniques that lead to improvement of quality assurance or testing effectiveness will helps to reduce cost and effort. Combined QA that use both static [2] and dynamic [3] QA techniques is one of the approaches. This master thesis will explore the quality assurance (QA) approaches that combine static and dynamic QA techniques. There are many techniques used to improve testing efficiency in software quality assurance. Quality assurance techniques are divided into 2 types: static and dynamic QA techniques. Static QA techniques is a technique which help to check the software without executing the system while dynamic QA techniques test the system by running it [5,6]. However, most of existing approaches is often performed static QA techniques separately from dynamic QA techniques that often lead to the waste of effort in software quality assurance. There are already significant empirical studies discussing about testing effectiveness and quality [1,2,3,5]but no systematic review have been done for summary and classification of all the combined approaches. In this thesis the state of art about combined software quality assurance will be presented. This thesis will cover the empirical research in this area. The state of the art will be examined on the principles of a systematic literature review from Kitchenham[19] to gain a solid overall impression.

This paper is organized as follows: Section 2 presents overview Research Methodology. Section 3 analyzes results and discussion. Section 4 concludes this paper.

2. Research Methodology

To answer the research questions in this topic, two research methods were used: literature review and systematic literature review.

Brief description of Research Methodology

This thesis conducts a systematic review on combined quality assurance approaches. The brief definition and the process of systematic review is given as following.

According to Kitchenham, Systematic review (also referred as a systematic literature review) is considered a secondary study which reviews all studies related to a specific research topic, to answer the research question by identifying, analyzing and interpreting all relevant evidence[14]. Systematic review is performed by following a well-defined methodology that is unbiased and (to some extent) repeatable. The most common reasons for performing a systematic review are: to summarize the existing evidence of the research question, to identify a gap in current research and to provide a background for new research activities. Kitchenham recommend three phases to do systematic review: planning the review, conducting the review and report the review. In first phase, the most important steps are to define the research question and develop a review protocol. Review protocol is the procedure and purpose to do the systematic review [15]. In conducting review phase, the main activities are selecting the primary studies based on defined search strategy, accessing the quality of the studies, extracting data from the studies for further analysis and synthesizing data to draw final answer for the research question. In the last phase, the review is documented in an appropriate format and evaluates the report to ensure the validity and the quality of report.

3. Systematic Review Planning And Conducting

The systematic review process consists of three phases. Those phases are: plan the review, conduct the review and document the review. The general information about systematic review procedure is explained in section 3.1. Section 3.2 is the design of this systematic review and section 3.3 is the details of systematic review conducting.

3.1 Systematic review process

Figure 1 illustrates in detail three phases of a systematic review applied in this thesis.

Planning the review

The first phase is planning the review. In this phase the plan of the complete process is made. There are 4 main steps in this phase.

- Identify the needs for a systematic review: In the beginning, researchers need to investigate whether a systematic review in the same research area has already been conducted before or not.
- Specifying research questions: The research questions of the systematic review are defined in this step. Primary studies identified in this systematic review and the final result must be able to answer these research questions.
- Development of the review protocol: In this step the review protocol is developed. It describes the details and methods with which the entire systematic review is conducted.
- Evaluating the review protocol: This step is to ensure that the review protocol has fulfilled certain quality criteria and the review is unbiased.

Conducting the review

The following phase is conducting the review. There are five steps that are required to be executed in sequence.

- Selection of primary studies: In this step, all studies extracted from the previous step are selected according to inclusion and exclusion criteria.
- Evaluate quality of primary studies: This step is about assessing the quality of the selected studies from the previous stage based on quality checklist or questions defined in the research protocol.
- Extract necessary data: In this step, the necessary in the selected studies is extracted for further analysis.
- Analysis and synthesis data: The gathered information in the extraction forms is analyzed and synthesized to answers the research questions.

Reporting the review

The final phase is reporting the review which mainly focus on prepare the results of the systematic review in an appropriate format.

3.2 Planning the review

The need of systematic review

To identify the need of this systematic review, a preliminary search on the topic was performed. The search tried to answer those questions:

- Were systematic reviews regarding combined quality assurance approaches already existed and to which extend?
- Were literature reviews regarding combined quality assurance approaches already existed and to which extent?

To answer these questions, searching on 2 databases Compendex and Inspec is conducted. The search strings were applied on the field: Subject, Title and Abstract ("WN KY" in the search strings). The synonyms for "systematic review" used in the search string. The results obtained 89 papers but none of them answer the research question. Here is the search string used to perform preliminary search: (((("systematic review" OR "research review" OR "research synthesis" OR "research integration" OR "systematic overview" OR "systematic research synthesis" OR "integrative research review" OR "integrative review") WN KY) AND ((inspection or review or "static analysis" or "static quality assurance") WN KY)) AND ((test* or "dynamic analysis" or "dynamic quality assurance") WN KY)).

3.3 Conducting review

Primary study selection

1. Extraction from digital resources

The next step in the systematic review is to retrieve papers for the selection of primary studies. The review team retrieved a total of 2012 papers from the resources. Particularly there are 929 papers from Inspec database and 1083 papers from Compendex. Those papers were reviewed through primary study selection. The reviewer utilized a reference management tool to handle resources such as bibliography generation, categorization of the papers, storage of downloaded full-text papers, sorting of papers in alphabetical order to identify duplicates, etc.

2. Papers selected for primary studies

After retrieving study from 2 data sources Compendex and Inspec, there are 2012 papers based on the search string in section.. and only in English. Search engine Engineering Village helped to discard all non-English papers by title. From 2012 papers, 307 duplicate papers were removed. The remaining 1703 studies were chosen based on title, abstract and full text respectively. Later, inclusion/exclusion criteria are applied on title of retrieved studies, 1597 papers were found irrelevant and 106 papers were chosen for further selection. The main exclusion criteria based on title are: studies which are published earlier than 1985, studies which are proceedings of the whole conference, studies which are published in irrelevant conference or journal, for instance related to hardware, microprocessor, electronics and etc. From 106 chosen papers, the inclusion/exclusion criteria again are applied on abstract, 46 papers were discarded and 60 papers were selected. The most common exclusion criteria based on abstract are: studies which are related to combined approach but not for quality assurance purpose. For example, the goal of integration is to improve design document.. And then, 60 remaining papers are reviewed based on full text and 48 papers are chosen. 12 papers were discarded because of their short content or non-English full text.

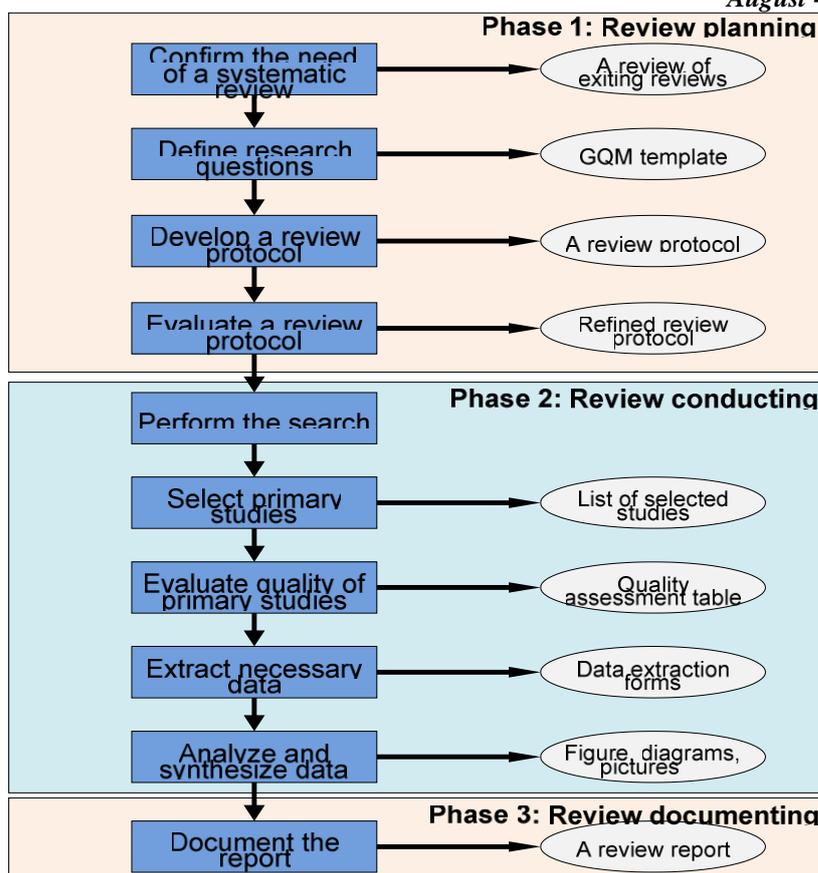


Figure 1: Systematic review process

3. Results Analysis

Five research questions will be answered in the following sections. Each of the research questions will have a “Results” section presenting the observations from the systematic review papers and an “Discussion” section giving an investigation based on the results obtained.

3.1 SQ1. What are existing approaches that combine static and dynamic quality assurance techniques?

There are three main categories for this classification: integration, separation and misc based on different behaviors of relationship between static QA techniques and dynamic QA techniques.

3.1.1.1 Integration relation

Combined QA approaches are the approaches in which static QA techniques and dynamic QA techniques are combined. That means during QA process, static techniques is applied on the result of dynamic techniques or vice versa. In other way, they consider the output of one technique as the input of the other. Therefore, all the QA approaches in which testing and dynamic QA techniques depend on each other or have constraint with each other.

3.1.1.2 Separation relation

Different from integration relation, static and dynamic analysis in separation relation support each other but does not depends on the process of each other. Because mostly they work in separate manner, there is no sequence for applying the techniques.

3.1.1.3 Misc

There are three more studies which discuss different combined quality assurance approaches from separation and integration relation. One use data collected from inspecting requirement or design specification to detect software defect content and estimate the testing effort

3.1.1.4 Discussion

There are 2 main trends for combining quality assurance approaches: integration and separation. One is separation relation which proposes using static and dynamic techniques with different purposes. The techniques can be applied to different type of documents or in different phases; as well as for finding different types of defects. In this relation, static and dynamic QA techniques do not affect to each other process or result.

3.1.1 Results

According to those criteria, the available Quality Assurance approaches which combine static technique and dynamic technique is classified as following.

Figure 2 depicts the classification tree of existing QA combination approaches. The top level is the QA combination approaches which have three child nodes representing 3 main categories in this classification. The child nodes are the sub-category for the parent node. The number in open bracket “()” shows the quantity of paper belonging to the category node itself while the number in square parentheses “[]” is the aggregated number of its child nodes.

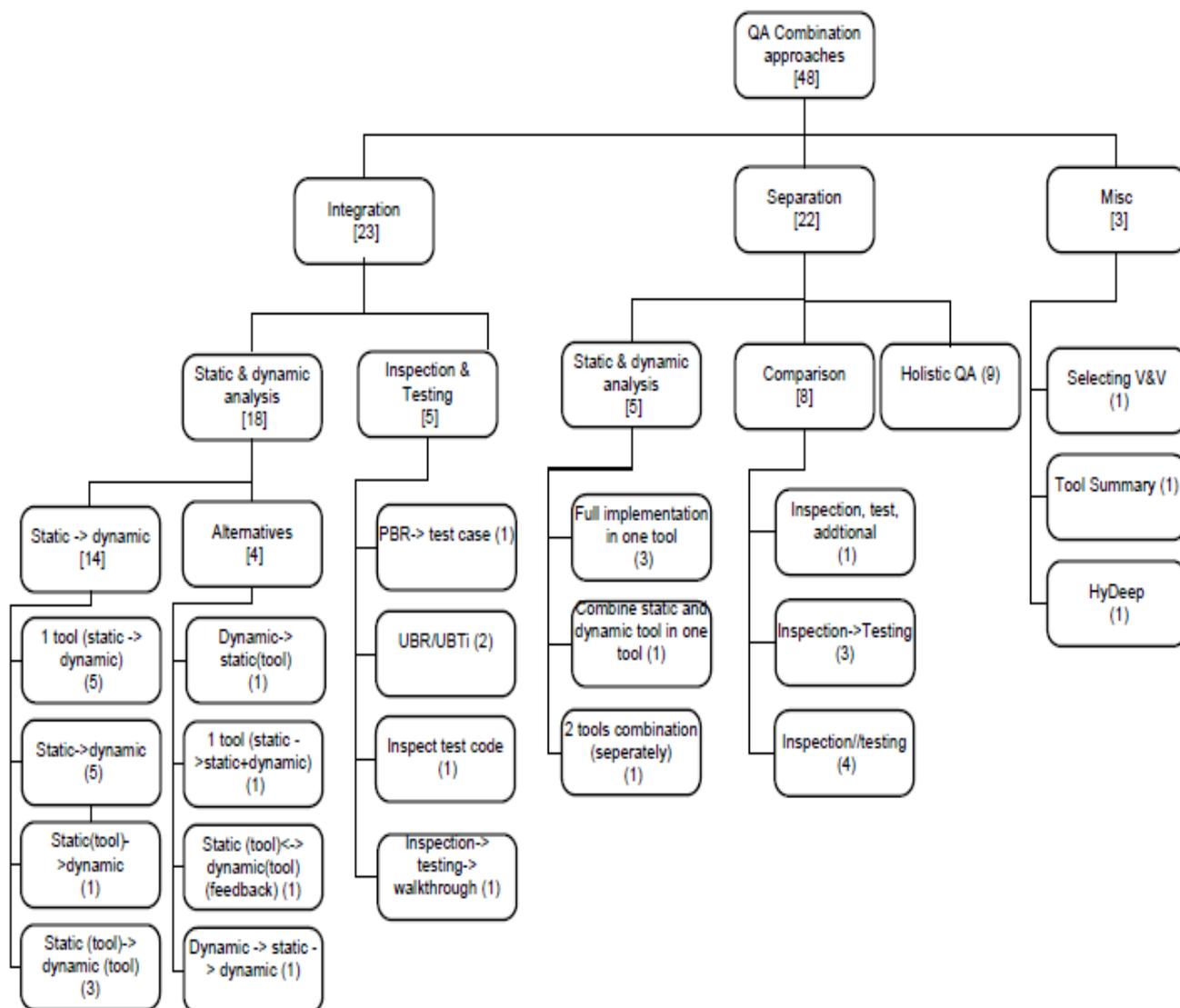


Figure 2: Classification of Combined Quality Assurance approaches

4. Result Analysis And Discussion

We carried out simulations on Opnet simulator 14.5. The results show differences in performance between considered routing protocols, which are the consequence of various mechanisms on which protocols are based. We carried out our simulations with 30 nodes. Figures 3,4,5,6 and 7 depicts the throughput, delay and network load, jitter and mos of this network with respect to total simulation time which is taken as 30 minutes for which the simulation was run. In this simulation, the network is set to 15 and 30 nodes, the traffic is VOIP mode, the data transmission rate is 11 Mbps and the simulation time is 30 minutes.

4.1 Delay

The maximum network delay variation for 15 and 30 nodes a scenario is shown in respectively figure 3. Calculate average packet end-to-end delay of each transmitted packet during the simulation time period in 30 nodes and 15 nodes of MANET network. From the graph, it is observed that AODV average delay performance is less, nearly 9.5s, than that of OLSR and TORA which is nearly 1.4s and 1s for GSM voice traffic data. We see that average packet delay increases with increase in number of nodes. The end to end delay in OLSR and TORA is lower side and is maximum in AODV.

4.2 Network Load

The maximum network load variation for 15 and 30 nodes a scenario is shown in respectively figure 4. Based on wireless LAN load Networks load represents the total load bit/sec submitted to wireless LAN layer, when there is more traffic coming into the network, it is difficult for the network to handle all this traffic, An efficient network can easily cope with large traffic coming in, and to make the best possible network. fig 4 shows that, for different number of nodes, loads are varying compared to each other for 30 nodes initial network load for AODV network is high, but decreases sharply with 15 nodes. On the other hand, for any load, TORA and OLSR are showing a considerable good performance which is 900 kbps and 700 kbps for both 30 and 15 nodes of MANET network respectively.

3.2.2 SQ2. Which input is used for static techniques in CQA Approaches?

3.2.2.1 Result

Which kind of input that static techniques use for CQA approaches is the meaningful knowledge that we want to know. Figure 3 shows the input for applying static techniques in CQA approaches. Significantly percentage is source code and after that in sequence there are requirement specification, misc, test code and design specification. Misc is the special input for specific approaches like protocol invariant, aspect specification or binary code. There are few approaches in which the static techniques require more than one input.

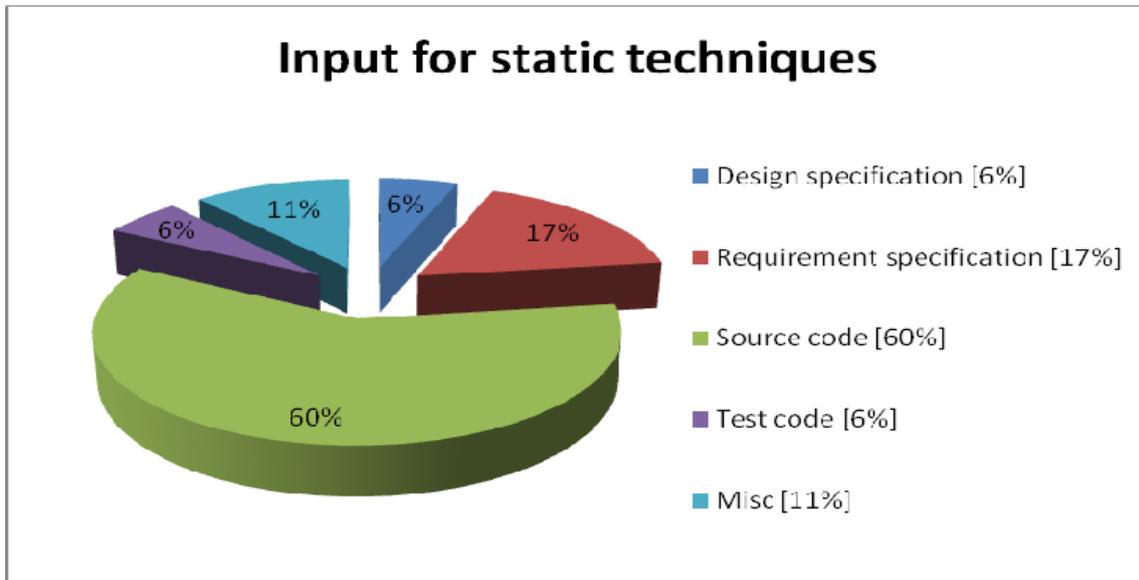


Figure 3: Input of static techniques

3.2.2.2 Discussion

Inspection and static analysis can be performed very early in development life cycle, in design phase or requirement phase to detect defect in their specification. Static techniques are also can applied for implementation and even after testing phase by analysis source code and test code. The input for static techniques is various but source code is the most common input for static technique in CQA. The design specification, requirement specification and test code are also important input for CQA.

4. Conclusion

This section is to summarize the work done in the thesis, interpret contributions of the thesis and naming some possible future work

4.1 Summary of findings

4.1.1 SQ1. What are existing approaches that combine static and dynamic quality assurance techniques?

There are 2 main trends for combining quality assurance approaches: integration and separation. For the separation, static and dynamic techniques can be applied to different type of documents or in different phases or for finding different types of defects. In this relation, static and dynamic QA techniques only support and do not affect to each other process or result.

4.1.2 SQ2. Which input is used for static techniques in CQA approaches?

The input for static techniques is various but source code is the most common input for static technique in CQA.

4.2 Interpretation

The results of this thesis can be considered as cornerstone for further study in the area of combined quality assurance. Practitioners and researcher can use our empirical results in two ways: either as a guideline for selecting strategic defect detection techniques and QA approaches or a map to do further research on CQA e.g. proposing new CQA approaches.

4.3 Future work

The results of this thesis can be considered as cornerstone for further study in the area of combined quality assurance.

4.3.1 Create a framework to select suitable quality assurance strategy

The framework will provide more details on how the concepts are implemented. The framework should also provide step-by-step guidelines on how to apply it to select the suitable quality assurance strategy based on the given context. Such a framework would be an additional contribution to the area of combined quality assurance and provide more practical application from the approach classification in this topic.

4.3.2 Extension of the systematic review

An extension of the systematic review involving more database and more keywords, especially keywords about others static and dynamic techniques, could gain more knowledge which lateron can be used to refine the classification.

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