Software Quality Assurance Audit Implementation in Industry: A Survey of Five Multinational Companies in Malaysia

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Abstract—Software quality assurance (SQA) is an umbrella activity that is applied to each step of the software development process. Among others, it includes audit activities, an objective examination of a work product or set of work products against specific criteria. Although the importance of software quality audit is undisputable, both theoretically and practically, its acceptance and application in the industry vary. In companies that do implement audit, the extent to which the audit process performed is comprehensive and up to the theoretically defined standard differs. To obtain an insight of the current software quality audit implementation in the industry, a study was performed involving five multinational companies in Malaysia using case study method. Different types of audits are then compared between each of the multinational companies. It was found that the most common audits being implemented across all multinational companies and are available in most of the phases in their SQA lifecycle are the configuration audit and the phase transition audit. In summary, configuration audit and phase transition audit could be the least kind of audit to be performed by software organizations that demand the best practice in the industry.

Index Terms—**Audit; CMMI; Software Quality Analyst (SQA); Software Quality Assurance (SQA).**

I. INTRODUCTION

As of now, most software development related companies in the industry are still struggling and competing with each other in developing software applications that meet quality standards, are within the given timeline and within budget constraints [2]. A definite way to achieve all these if through proper establishment of and compliance to the software quality assurance (SQA) activities. SQA as a function is not new as it is commonly established in multinational companies. The goals of SQA's functions in an organization are mainly to monitor the software and also the development process that produces it, to ensure the software and software process comply with the established standards, and to ensure that any shortfalls in either the product, process or standards are escalated to the management for resolution [1]. Thus, part of the SQA functions is to conduct random and scheduled audits to ensure that the necessary controls are in place [3].

However, each of these companies has different types of quality audit and as of now, it is not standardized across the companies. However, little is known about the current state of software quality audit implementation in these companies due to the limited study performed in the area. Therefore, this study explores the various audit types or activities performed across several multinational companies in Malaysia. The objective of this study is to identify the most common audit being performed across all multinational companies and such

audits are available in most of the phases in the SQA life cycle as a benchmark to other software organizations that demand the best practice in the industry. It would provide answers to the research question - "What are the common quality audit procedures implemented in the companies throughout the development of a software project?" The findings can be used as guidelines for other organizations in the software industry to plan for their mandatory quality audit at the very minimum by considering the most common audit being performed across all multinational companies that have adopted the best practices from CMMI. The rest of the paper is organized as follows. Section II provides brief overview on the role of SQA analyst in quality audit. Section III explains the method used in collecting the required data for this study. Results obtained from the data collection is presented in section IV and subsequently discussed in section V. Section VI describes related work in this area and finally, section VII concludes the paper.

II. SQA ANALYST AND QUALITY AUDIT

According to Galin (2004) and Godbole (2008), one of the functions of the Software Quality Assurance is to conduct random and scheduled audits to assure that the necessary controls are in place [3][2].

Software Quality Assurance (SQA) is an umbrella activity that is applied to each step of the software process [5]. The acronym (SQA) is used to denote either the person playing the role as a Software Quality Analyst or the function of Software Quality Assurance itself [1]. The involvement of the Software Quality Assurance process in a software development is continuous throughout the project, from the planning phase until the maintenance phase of a software development life cycle with specific controls and documentation requirements process helps to control and assure a quality outcome from a software development process such as zero defects [5]. In addition, the SQA process assures the successful development of the project by delivering the outcome on time and within the budget [5].

The role of the Software Quality Analyst involves activities such as monitoring the methods and standards that the software developers use and verifying that they have properly applied these methods to their work products [1]. Apart from that, activities such as audit, formal reviews, walkthroughs, testing, control of documentation, measurement, process checks and reporting (Pressman, 2005) are the detailed activities in the Software Quality Assurance (SQA) process [1][5]. Generally said, the functions of an SQA throughout the software development life cycle are, firstly, to assure that

the software project planning has taken place; secondly, to assure the conformance of user requirements to established standards and also conformance to user needs; thirdly, to assure that the methodologies are followed and the requirements are met by the design; fourthly, to assure that the coding standards, practices and guidelines are established and adhered to; fifthly, to assure that the software integrating testing has been planned, implemented and executed accordingly, and last but not least, to conduct random and scheduled audits to assure that the necessary controls are in place [5].

As mentioned earlier, the Software Quality Analyst's job is described as the main role that helps the IT businesses to ensure their software and software process comply with the established standards through the process of audit [3]. Originally, the concept of audit comes from the accounting profession [3]. The audit concept has been expanded into other areas of company operations in which various terms have been introduced, such as operations audit, management audit, program audit and performance audit. Although the terms vary, audit is actually referring to an independent review of operations with the objective of making the operations more effective and more efficient [3]. According to the glossary section in CMMI for Development, Version 1.3, the audit is an objective examination of a work product or a set of work products against specific criteria [4].

Basically, the Software Quality Assurance (SQA) functions are similar to the IT auditor in which both teams are concerned with the existence of standards, adherence to standards, and the documentation of deviations [5]. Since the SQA personnel are dedicated to Quality Assurance, they however perform more comprehensive checking of controls than the IT auditors (Weber, 1999) which, as a result, helps to eliminate defects, prevents ambiguous and changing requirements, which will ultimately improve customer satisfaction [5].

III. METHOD

This paper qualitatively identified types of audits performed in several multinational companies in Malaysia. Five multinational companies from different sectors of the industry have been selected as a case study. To obtain the required information, interview was performed with the SQA analysts from the selected companies focusing on quality process and types of audit being performed in each of the multinational companies that adopted CMMI as their best practices.

IV. RESULTS AND ANALYSIS

Based on the information obtained from the interview, overall, the QA process that is currently being implemented in the five selected companies consists of eight main activities which are plan QA activities, perform release readiness self-check, perform project audits, perform organization audits, communicate audit findings to related stakeholder, follow-up action items to closure, store audit results in a defined repository and analyze the audit results.

The QA activities plan includes activities at the organizational level. Software Quality Assurance (SQA) as a function has to plan for QA activities at the organizational level with input from the Software Process Improvement (SPI) Plan and 'Process Knowledge' repository, subsequently coming up with a QA Plan and checklist for an organization. On the other hand, the Software Quality Analyst as a dedicated QA personnel for a software development project is responsible for planning QA activities at the project level, subsequently coming up with a QA Plan and QA Checklist for the project. The QA Plan is a 'live' document that may need to be revised (if necessary) accordingly if there is a change in the project plan. Such change includes project scope, project schedule, and cost estimation.

Upon releasing the software product, a dedicated Software Quality Analyst is responsible of performing the release readiness check on the work products based on the QA Plan and Release Readiness Audit Checklist to prevent any incomplete work. On top of that, the Software Quality Analyst is also responsible for performing project audits as planned and scheduled in the QA Plan for each of the assigned projects and come up with the audit report(s) and proposed action items.

All audit findings must be communicated to the related stakeholders, especially the project team leader for action to be taken by the project team. Any irresolvable Noncompliance (NC) shall be escalated to the Quality Director or senior management for further action. Basically, once NC has been raised by a Software Quality Analyst, the project team will be given some duration of time to resolve the NC based on its severity level and at the same time the Software Quality Analyst will closely follow up on the NC until closure. Once all the NCs are resolved, the filled-up audit checklist and audit finding reports are stored in defined repositories and the audit results will be analyzed to look at quality trends and lesson learned for future reference.

A. Compliance with CMMI

Next, we further investigate the activities performed during the QA process in these companies with respect to its compliance with the Capability Maturity Model Integration (CMMI). CMMI for Development is a set of best practices that address development activities applied to products and services [4]. CMMI addresses practices that cover the product's life cycle from conception through delivery and maintenance by emphasizing on the work necessary to build and maintain the total product [4]. There is one specific process area in CMMI that focuses on Quality Assurance, called the Process and Product Quality Assurance (PPQA) process area [4].

The purpose of the PPQA process area is to provide the staff and management with objective insight into processes and associated work products [4]. In general, PPQA involves four main activities. Firstly, objectively evaluating performed processes and work products against applicable process descriptions, standards and procedures [4]. Secondly, identifying and documenting noncompliance issues [4]. Thirdly, providing feedback to project staff and managers on the results of quality assurance activities and finally ensuring that noncompliance issues are addressed [4].

The first Specific Goal (SG 1) in PPQA is "Objectively Evaluate Processes and Work Products" [4]. This specific goal (SG 1) is about adherence of the performed process and associated work products to applicable process descriptions, standards, and procedures [4]. CMMI for Development provides two specific practices for SG 1, which are "Objectively Evaluate Processes (SP 1.1)" and "Objectively Evaluate Work Products (SP 1.2)" [4].

The second Specific Goal (SG 2) in PPQA is "Provide

Objective Insight" [4]. This specific goal (SG 2) is about the noncompliance issues being objectively tracked and communicated, and the resolution being ensured [4]. CMMI for Development provides two specific practices for SG 2, which are "Communicate and Resolve Noncompliance Issues

(SP 2.1)" and "Establish Records (SP 2.2)" [4]. Table 1 presents the result of compliance analysis. As can be seen from the table, there are eight common quality assurance activities across all five multinational companies.

Table 1
Common Quality Assurance (QA) process in Multinational Companies

#	QA Processes / Activities	Output	CMMI Mapping
1	Plan QA activities	• QA Plan • QA Checklist	PPQA-GP2.2, PPQA-GP2.3, PPQA-GP2.4, PPQA-GP2.5
	Manage QA Plan	Revised QA Plan	PPQA-GP2.8, PPQA-GP2.9, PPQA-GP2.10,
2	• Perform Release Readiness Self-Check • Perform release readiness check upon releasing the product	• Filled up audit checklist • Action items	PPQA-SP1.1
3	• Perform project audits • Perform process compliance audit • Perform configuration management audit • Perform phase audit • Perform release readiness audit	• Audit report • Action items	PPQA-SP1.1 PPQA-SP1.1, CM-SP 3.2 PPQA-SP1.2 PPQA-SP1.2
4	Perform Organization Audit	Audit report Action items	PPQA-SP1.1
5	Communicate audit findings to related stakeholder	• Audit Finding Report communicated to Project Team Leader • Irresolvable Noncompliance escalated	PPQA-SP2.1
6	Follow-up action items to closure	Noncompliance tracking sheet	PPQA-SP1.2
7	Store audit results in defined repositories	Filled-up audit checklist & audit finding reports are stored in defined repositories	PPQA-SP2.2
8	Analyze audit results	Quality trends	PPQA-SP 2.1

As can be seen from the analysis result presented above, performing project audits is one of the crucial activity in quality assurance process across all five multinational companies in this study. Thus, we further investigate on the different types of project audit. As illustrated in Table 2

which is based on information obtained from the five multinational companies, not all of these companies have adopted CMMI for certification purposes. Nevertheless, they have adopted CMMI as their process framework.

Table 2
CMMI Adoption among Multinational Companies

Company	A	B	C	D	E
Industry/Field	Sw. Dev. R & D for Tele-communications Industry	Sw. Dev. for Banking Industry	Sw. Dev. for Banking Industry	Sw. Dev. for Bio-medical Industry	Sw. Consultant Industry
CMMI Adoption	Yes	Yes	Yes	Yes	Yes
CMMI Certification	Yes	No	No	No	Yes

Sw – Software; Dev – Development

V. DISCUSSION

Audit activities in most multinational companies are established at the organization and project level. Audits at the organization level are performed to ensure that the practices of organization functions comply with the organization standard process. Audits at the organization level involve organization functions such as the Finance department, the Human Resource department, the Training department, the Software Quality Assurance (SQA) department, the Software Engineering Process Group department and the System Administration department. Since the SQA will also be audited as an organization function, the SQA will train other organization staff to perform the audit as the SQA is not allowed to audit themselves due to conflict of interests. Auditor training is part of the organization's training activity to train the trainer. On the other hand, there are several types of audits at the project level being performed for various reasons as the following:

A. Configuration Management Audit

The Configuration Management Audit is performed to ensure that the project repositories are in-sync with the Configuration Management (CM) Plan. The Configuration Management Audit is usually performed on all related documents especially on Configuration Items (CI) identified

in the CM Plan. For organizations that have other quality audits such as the Process Compliance Audit and Phase Transition Audit, the Configuration Management Audit is performed prior to the Phase Audit and the Process Compliance Audit. For the purpose of software release or for the Release Readiness Audit, the configuration audit will be performed only for engineering documents such as requirement specifications, design documents and code.

B. Process Compliance Audit

The Process Compliance Audit is performed to ensure that the practices in the project comply with the organization's standard process and project-defined process. Usually, the Process Compliance Audit is performed by checking the existence of documents in the defined repositories and the integrity of its contents as well as by interviewing the process owners to confirm that the defined processes are performed. Apart from that, the Process Compliance Audit is also performed by collecting data and information on how the project is being executed to achieve the objective. Lastly, the Process Compliance Audit can be performed by evaluating whether the project approach and the actions would result in the project objectives being realized or not.

C. Phase Transition Audit

The Phase Transition Audit is performed to ensure that the

project satisfies the criteria of a phase and that work products meet their product standard. The Configuration Audit will be performed prior to the Phase Audit. The intent of the Phase Audit is to see whether the standards are being followed at each phase of the Software Development Life Cycle (SDLC) and to see whether the status is accurately reported.

D. Release Readiness Audit

The Release Readiness Audit is performed to ensure that the project work product is ready to be released and meets their product standards. The Release Readiness Audit is performed before Planned Product Release and before Planned Final Release. Usually for Maintenance Release, the Release Readiness Audit can be done once a month. The Release Readiness Self-Check is performed by the Project Team Leader before the audit is performed by the Software Quality Analyst (SQA). The SQA may sample product audits by executing sample test cases or by carrying out consistency checks that are deemed appropriate.

As can be seen above, most multinational companies with an established Quality Assurance program implement audit activities as listed in Sections A, B, C and D. However so, the type and number of audit activities performed for their organization vary from one organization to another. Each organization seemed to be rather selective and only performed certain particular audit activities. Table 3 summarizes the types of audits for every company in this case study. As shown in Table 3, the Configuration Audit and the Phase Transition Audit are the most common audits implemented in every multinational companies.

Table 3
Type of Audit in Five Multinational Companies

Company / Types of Audit	A	B	C	D	E
Configuration Management Audit	●	●	●	●	●
Phase Transition Audit	●	●	●		●
Process Compliance Audit	●	●	●		
Release Readiness Audit	●			●	●

● – Audit is implemented

VI. RELATED WORK

Though a number of studies that are related to the implementation of software quality assurance in the industry in Malaysia, studies that specifically look into the practice of software quality audit in software related companies in Malaysia is still nonexistent. Our exhaustive literature review found related work on software certification [12], software process improvement [9][10], software development process [11], requirements engineering [6][8] and requirements management [7].

VII. CONCLUSION

In conclusion, it can be said that the companies should perform all types of audits throughout the SQA life cycle, which consists of the SQA Initiation phase, the SQA Planning phase, the Requirements Assurance phase, the Design Assurance phase, the Development Assurance phase, the Testing Assurance phase, the Implementation Assurance phase and the SQA Closing phase [3]. In detail, the Configuration Audit and the Phase Transition Audit are recommended to be performed for every phase in the SQA

life cycle. Whereas, an additional audit which is the Process Compliance Audit should be performed during the Requirements Assurance phase and the Testing Assurance phase to check on the compliance of project team member's practices towards processes within the phase. Finally, it is recommended that after the implementation has been completed and before the software product is released, the Release Readiness Audit should be performed, which is at the Implementation Assurance phase, right before the SQA Closing phase. In summary, among all types of audits, the Configuration Audit and the Phase Transition Audit are the most common audits being performed across all multinational companies and are available in most of the phases in the SQA life cycle.

Finally, based on the observation, all types of audits discussed earlier are important and necessary to be performed by every software organization through their dedicated Software Quality Analyst. The main reason behind this is not only to verify that the organization has properly applied all methods and standards that have been established but most importantly to assure that the necessary controls are in place.

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