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A STUDY ON SOFTWARE PROJECT TRACKING AND OVERSIGHT PRACTICES AMONG SOFTWARE COMPANIES IN MALAYSIA

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ABSTRACT

This paper reports on the outcomes of a survey conducted on software project tracking and oversight (SPTO) practices. The study was carried out from 3 May until 29 December 2004 (eight months). It included designing a questionnaire form to conduct the survey on the SPTO practices currently being adopted by the companies that develop software systems in Malaysia. The survey investigated all the five areas of the basic SPTO practices of the Software Engineering Institute's Capability Maturity Model (SEI's CMM). These include commitment to perform, ability to perform, activities performed, measurement and analysis, and verifying implementation. Data gathered for the survey were analysed using Statistical Package for Social Sciences (SPSS), Release 12.0.0 and MS Excel, to investigate the number and percentage of companies that practice the processes investigated. The survey findings show the practices that most companies are committed to perform, and the practice that is performed by the least number of the companies surveyed.

Keywords: ***Software Project Tracking and Oversight Practices, SPTO, Capability Maturity Model, CMM, Software Companies, Malaysia.***

1.0 INTRODUCTION

As information technology (IT) hastens the transformation of the world into one global village, cooperation and collaboration among nations in the ASEAN region becomes more and more important. There is great potential for the software industries in the region to expand rapidly and globally due to the abundance of skilled and relatively inexpensive knowledge workers, the availability of relatively inexpensive computers, and the equally inexpensive media for data storage and telecommunication, which is the Internet. It therefore becomes imperative that we in the region gain insight into some of the problems of software development and training in this region, and propose some solutions to them.

A collaborative research project was initiated among five ASEAN Universities Network (AUN) member countries comprising the Philippines, Thailand, Vietnam, Malaysia and Singapore, to identify and analyse some of the software process strengths and weaknesses among software development firms in terms of the six key process areas (KPAs) of the Capability Maturity Model (CMM) comprising: requirements management, software project planning, software project tracking and oversight, subcontract management, software quality assurance and software configuration management [1]. The study was conducted using the survey method. Of the six main KPAs investigated in the companies surveyed in Malaysia, it is found that they are strongest in software project planning and weakest in the KPAs of software project tracking and oversight (SPTO) [2]. Thus, further study was carried out to investigate the SPTO best practices that are currently being applied and not being applied by the local companies that develop software systems. Software could be developed for internal use, for external customers or for export. The main objective of this research is to investigate the practices performed by the companies vis-à-vis the Capability Maturity Model's (CMM's) in five areas in software project tracking and oversight. These five areas are: Commitment to Perform, Ability to Perform, Activities Performed, Measurements and Analysis, and Verifying Implementation [3, 4, 5]. This paper highlights the AUN project study based on the survey findings of the five areas practised by the software companies in Malaysia only. The findings from the study will provide useful guidelines for the software developers in software project management.

2.0 RESEARCH METHODOLOGY

A questionnaire was first designed based on the five activities involved in software project tracking and oversight of the Capability Maturity Model (CMM). A pilot test was conducted prior to the actual survey. The purpose of the pilot test is to ensure that the questions are clear and arranged in logical order so that the respondents are able to answer them without difficulty.

The questionnaire consists of two main parts. The first part investigates the profile of respondent. The second part investigates the five areas pertaining to the CMM's software project tracking and oversight practices. Each area consists of one main question with varying number of sub-questions.

Altogether 160 sets of questionnaires were distributed to software companies in Malaysia. The first part of the study found that the majority of the respondents are from Kuala Lumpur and Selangor state, and hence, most of the questionnaires were distributed in these two areas. The questionnaires that were sent to the other five states – Penang, Perak, Pahang, Johor and Sarawak, involved only companies which responded in the first part of the study. Details of the distribution of questionnaires, the number of questionnaires received and the number of questionnaires that were used for analysis, are shown in Table 1.

Table 1: Questionnaire distributed and response

No.	State/City	No. of Questionnaire Distributed	No. of Questionnaire Received	No. of Questionnaire Used for Analysis
1.	Kuala Lumpur	76	20	20
2.	Selangor	77	15	13
3.	Penang	3	2	2
4.	Perak	1	0	0
5.	Pahang	1	0	0
6.	Johor	1	0	0
7.	Sarawak	1	1	1
Total		160	38	36

Of the 160 sets of questionnaires sent to companies, only 38 (23.8%) companies chose to participate in the survey. Although reminders were sent via email to those companies that failed to reply by the deadline, this low response rate indicates the lack of interest and cooperation among the software companies in Malaysia to this kind of study. Of the 38 sets of questionnaires answered, only 36 (94.7%) sets were used for analysis. Two sets of the questionnaires were discarded because some questions were not answered and one company declined to participate in the survey (unfilled questionnaire form returned by the company). The following sections describe the profile of the respondents and their respective companies.

2.1 Profile of Respondents

In this survey, the respondents are categorised into managerial, technical, research or software development personnel. Their positions include vice-president, chief operation officer (COO), project manager, IT manager, technical consultant, R&D manager, software engineer, systems analyst, just to name a few. The profiles of the respondents are analysed based on the number of years of working experience in the position indicated as well as in software project management.

a. Number of years of working experience in present position

Among the 36 respondents, 6 (16.7%), 16 (44.4%), 9 (25.0%), 4 (11.1%) and 1 (2.8%) respondents have less than 1 year, 1-3 years, 4-6 years, 7-9 years and 10 years and above of working experience in the position indicated, respectively (Fig. 1). This shows that the majority of respondents (16, 44.4%) possess 1-3 years of working experience only in their respective present management position.

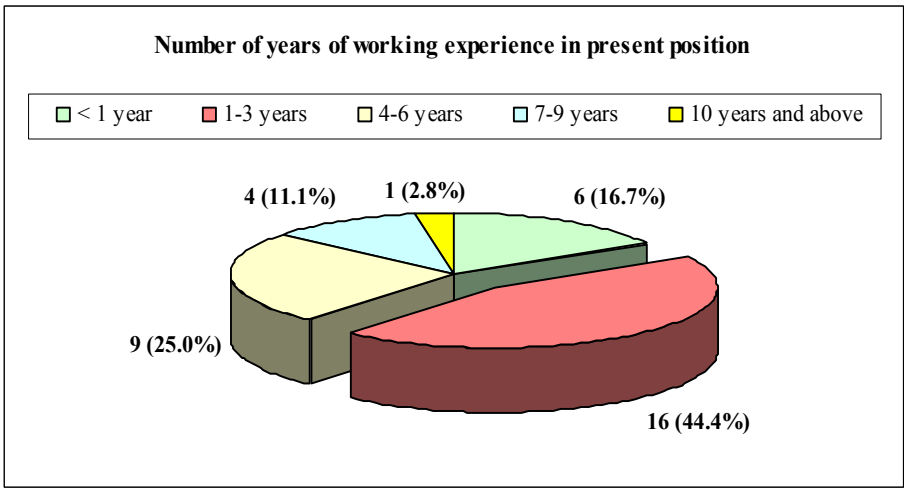

Fig. 1: Number of years of working experience in present position

b. Number of years of working experience in software project management

On the other hand, 1 (2.8%), 12 (33.3%), 16 (44.4%), 3 (8.3%) and 4 (11.1%) respondents have less than 1 year, 1-3 years, 4-6 years, 7-9 years and 10 years and above of working experience in software project management, respectively (Fig. 2). This shows that 16 respondents (44.4%) are experienced and 7 (19.4%) respondents are very experienced in software project management.

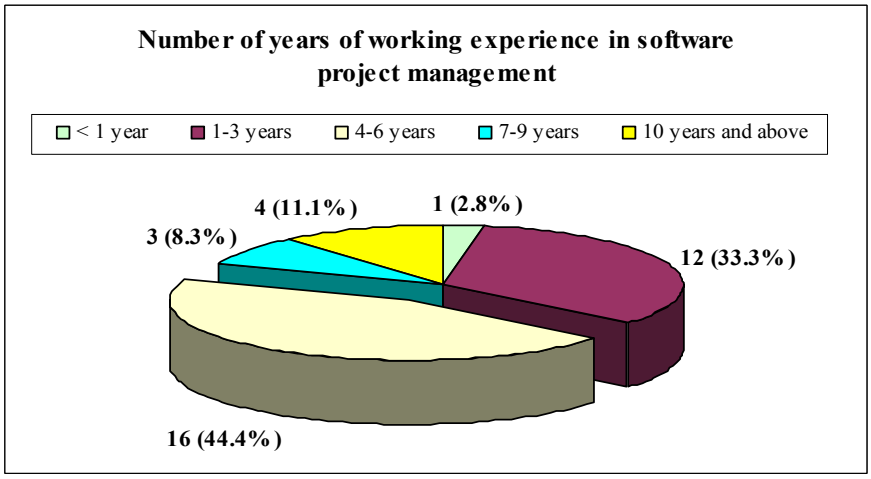

Fig. 2: Number of years of working experience in software project management

2.2 Profile of Respondent's Company

The companies that participated in this survey included those from the software development industry and banking sector. Analyses of the profile of the participating companies considered the size of the organisation, the standards, guidelines or best practices that a company adopts, and the purpose in software development.

a. Size of organisation

There are 9 (25.0%), 2 (5.6%) and 25 (69.4%) companies that have 10-50, 51-100, and more than 100 employees in their organisation. These are classified as small-, medium- and large-sized organisations. This implies that the majority of the companies (25 companies, 69.4%) that participated in the survey are large organisations (Fig. 3).

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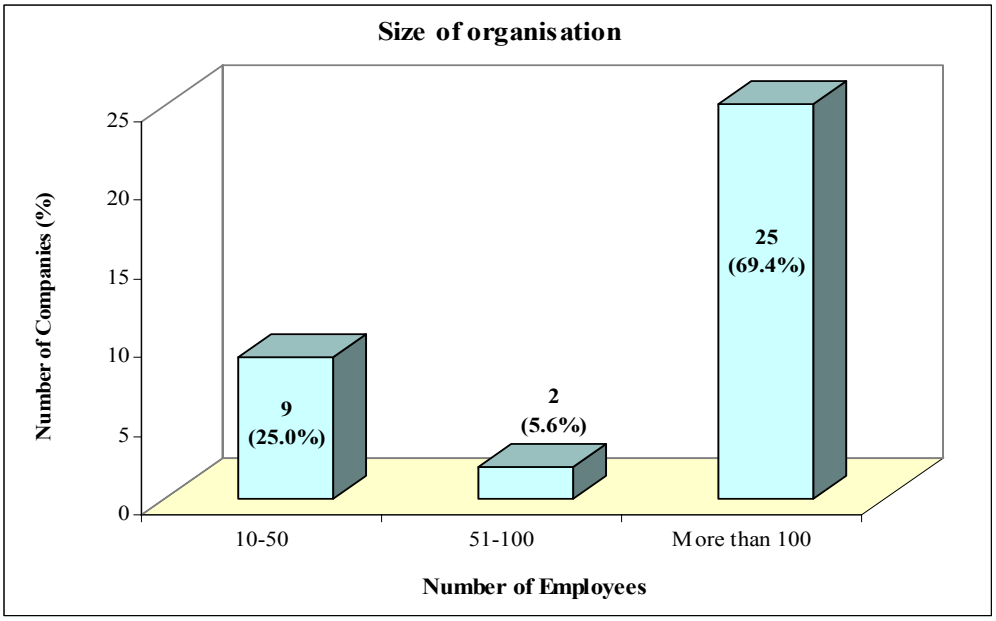


Fig. 3: Size of organisation

b. Standards, guidelines or best practices adopted by the company

Analysis on the standards, guidelines or best practices that the companies adopt indicates that 24 (66.7%) and 9 (25.0%) companies adopt one and more than one standard, guideline or best practice in managing software development projects, respectively (Fig. 4).

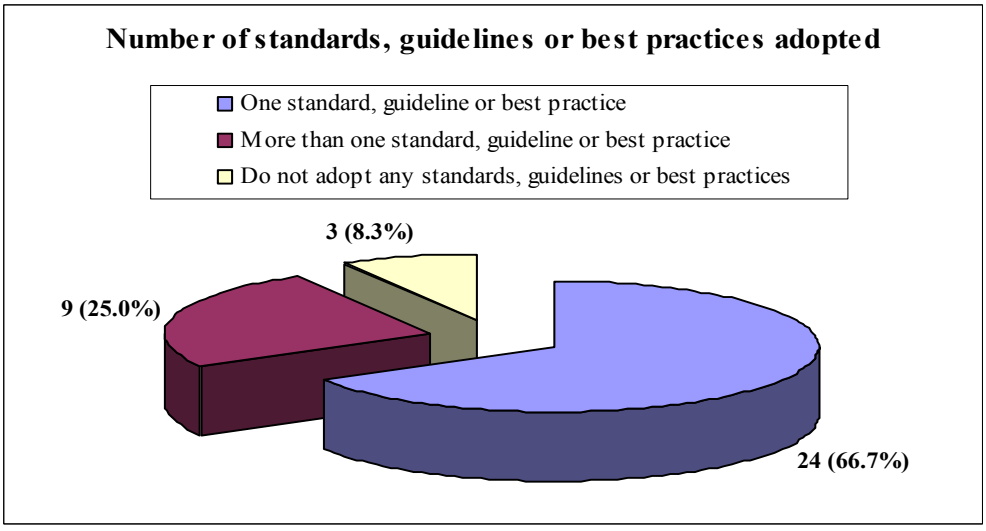
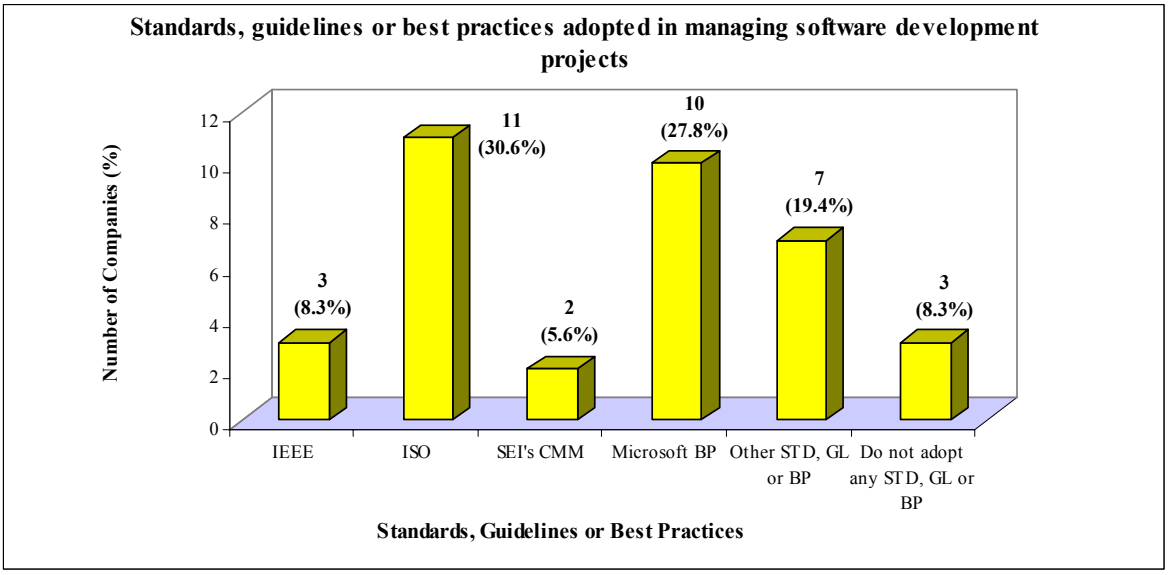


Fig. 4: Standards, guidelines or best practices the organisations adopt in managing software development projects

Of the 33 (91.7%) companies that adopt one and more than one standard, guideline or best practice, 3 (8.3%), 11 (30.6%), 2 (5.6%), 10 (27.8%) and 7 (19.4%) companies adopt IEEE Standards, ISO Standards, SEI's CMM, Microsoft Best Practices, and other standards, guidelines or best practices, respectively (Fig. 5). There are also 3 (8.3%) companies which do not adopt any standards, guidelines or best practices in managing software development projects. Further analysis of these three companies shows that two of them are small-sized companies with 10-50 employees and the remaining one company is a large-sized company with more than 100 employees.



Keys: STD – Standards GL – Guidelines BP – Best Practices

Fig. 5: Standards, guidelines or best practices adopted by companies in managing software development projects

Among the 7 (19.4%) companies that adopt other standards, guidelines or best practices, it is found that these standards, guidelines or best practices include:

a. Standards formulated by the consultants.
b. Company's own standards and guidelines.
c. Adaptive or agile software project management – a more practical approach.
d. Software development life cycle.

On the other hand, of the 9 companies that adopt more than one standard, guideline or best practice, 8 (88.9%) companies (indicated as Company A to Company H) adopt two standards, guidelines or best practices, and the remaining one company (Company I) adopts five (5) standards, guidelines or best practices in managing software development projects. Table 2 shows the specific standards, guidelines or best practices that these 9 companies adopt.

c. Purpose of software development

Of the 36 companies surveyed, 10 (27.8%) and 11 (30.6%) companies indicated that they develop software for internal use and external customers, respectively (Fig. 6). There are 10 (27.8%), 2 (5.6%) and 1 (2.8%) companies that indicated they develop software for internal use and external customers, external customers and export, and external customers and other purpose(s), respectively. The other purpose(s) indicated by the respondents refer to national development projects. Also, 1 (2.8%) company develops software for internal use, external customers and for export. One (2.8%) company develops software for internal use, external customers and other purpose(s). The other purpose(s) indicated by the respondent refer to developing software for its regional office in the Asia Pacific region.

Table 2: Standards, guidelines or best practices adopted by the companies in managing software development projects

No.	Company	Standards, guidelines or best practices adopted
1.	A	• IEEE Standards • Microsoft Best Practices
2.	B	• IEEE Standards • Other standards, guidelines or best practices (Company's standards and Catalyst 4D)
3.	C	• ISO Standards • Software Engineering Institute's (SEI) Capability Maturity Model (CMM)
4.	D	• ISO Standards • Microsoft Best Practices
5.	E	• Software Engineering Institute's (SEI) Capability Maturity Model (CMM) • Other standards, guidelines or best practices (CMM but customised based on needs)
6.	F	• Microsoft Best Practices • Infosys Best Practices
7.	G	• Microsoft Best Practices • Infosys Best Practices
8.	H	• Microsoft Best Practices • Other standards, guidelines or best practices (Company's IT Software Development Life Cycle)
9.	I	• ISO Standards • Software Engineering Institute's (SEI) Capability Maturity Model (CMM) • Microsoft Best Practices • Infosys Best Practices • Other standards, guidelines or best practices (CMMI)

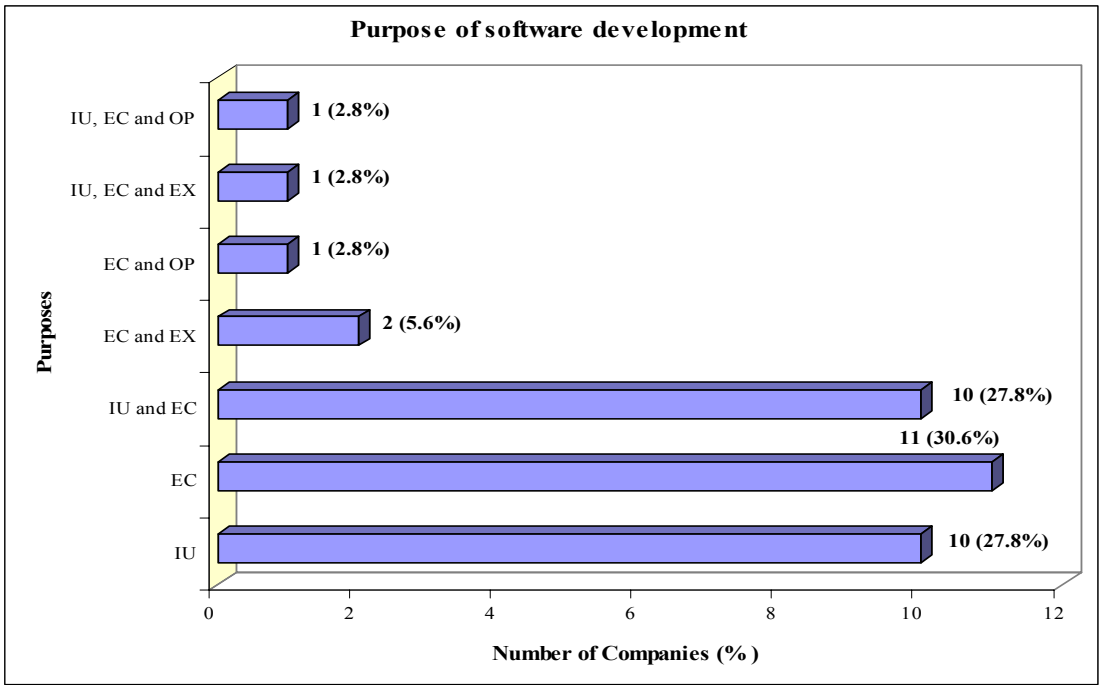


Fig. 6: Purpose of software development

2.3 Preference of Organisations in Adopting the Standards, Guidelines or Best Practices

This study investigated the preference of company in adopting the type of standards, guidelines or best practices to be used in SPTO activities based on the size of the company. Table 3 shows the results of crosstabulation between the size of the organisation and the type of standards, guidelines or best practices adopted by the organisations.

Table 3: Size of organisation * Standards, guidelines or best practices crosstabulation

		Standards, guidelines or best practices						Total (%)
		IEEE STD	ISO STD	SEI's CMM	Microsoft Best Practices	Other STD, GL or BP	Do not adopt any STD, GL or BP	
Size of organisation	10-50 employees (Small)	0	1	2	**3**	1	2	9 (25.0)
	51-100 employees (Medium)	0	2	0	0	0	0	2 (5.6)
	More than 100 employees (Large)	3	***8***	0	*7*	6	1	25 (69.4)
	Total (%)	3 (8.3)	11 (30.6)	2 (5.6)	10 (27.8)	7 (19.4)	3 (8.3)	36 (100.0)

Keys: STD – Standards GL – Guidelines BP – Best Practices

The outcomes show that ISO and Microsoft best practices are most preferred by large-sized organisations as shown by 15 (60.0%) companies out of the 25 large-sized companies surveyed. On the other hand, small-sized companies prefer to adopt Microsoft best practices rather than ISO Standards. This could possibly be due to the fact that the ISO Standards certification requires management commitment to quality, intensive training of workers, and setting and achieving goals for continual quality improvement all of which require human resources to perform continuous, proper and systematic documentation [6]. Besides, there is a large-sized company which does not adopt any standards, guidelines or best practices in SPTO activity.

2.4 Crosstabulation of the Size of Organisation with the Purpose of Software Development and the Type of Standards, Guidelines or Best Practices Adopted by the Organisations

This study investigated the results of crosstabulation of the size of organisation with the purpose of software development and the type of standards, guidelines or best practices adopted by the organisations (Table 4). The results show that of the 3 companies which do not adopt any standards, guidelines or best practices, one small-sized company develops software systems for internal use, one large-sized company develops software systems for external customers, and surprisingly, one small-sized company develops software systems for internal use, external customers and for export. Hence, it warrants further investigation pertaining to the ways this small-sized company is able to perform SPTO activities without adopting or complying with any standards, guidelines or best practices in software development.

Table 4: Size of organisation * Purpose of software development * Standards, guidelines or best practices crosstabulation

Standards, guidelines or best practices			Purpose of Software Development							Total
			IU	EC	IU and EC	EC and EX	EC and OP	IU, EC and EX	IU, EC and OP	
IEEE Standards	Size of organisation	S								
		M								
		L		1	1	1				3
	Total			1	1	1				3
ISO Standards	Size of organisation	S	1							1
		M	1		1					2
		L	1	4	3					8
	Total		3	4	4					11
Software Engineering Institute's CMM	Size of organisation	S			2					2
		M								
		L								
	Total				2					2
Microsoft Best Practices	Size of organisation	S		3						3
		M								
		L	4		2				1	7
	Total		4	3	2				1	10
Other standards, guidelines or best practices	Size of organisation	S		1						1
		M								
		L	2	1	1	1	1			6
	Total		2	2	1	1	1			7
Do not adopt any standards, guidelines or best practices	Size of organisation	S	1					1		2
		M								
		L		1						1
	Total		1	1				1		3

Keys: IU – Internal Use EC – External Customer EX – Export
S – 10-50 employees M – 51-100 employees L – More than 100 employees

3.0 SUMMARY OF SURVEY OUTCOMES

This section presents a summary of the survey outcomes according to the five areas of the basic software project tracking and oversight (SPTO) practices. It focuses on the issues pertaining to SPTO practices on the commitment to perform (Table A.1), ability to perform (Table A.2), activities performed (Table A.3), measurement and analysis (Table A.4), and verifying implementation (Table A.5). The 'Yes' and 'No' columns indicate the number and

percentage of companies that perform or do not perform the practices pertaining to the five sections investigated, respectively. The 'Findings/Remarks' indicate the survey outcomes of descriptive type of answers (i.e. other than 'Yes' or 'No' answers). These tables are included in Appendix A.

The survey findings show that 3 (8.3%), 11 (30.6%), 2 (5.6%), 10 (27.8%) and 7 (19.4%) companies adopt IEEE Standards, ISO Standards, SEI's CMM, Microsoft Best Practices and other standards, guidelines or best practices, respectively. There are also 3 (8.3%) companies that do not adopt any standards, guidelines or best practices in software development projects.

As only 36 sets of the questionnaires could be used for analysis, it is not suitable to study the correlation of the respondents' profiles and the companies' profiles with the SPTO practices. Thus, the study focused on the total number and percentage of software companies that perform the SPTO practices investigated in the questionnaire. The survey outcomes are summarised below according to the five sections of the questionnaire.

a. Section A: Commitment to Perform

All the 36 companies are fully committed to keep the project manager informed of the software project's status and issues. On the other hand, the activity that the companies are least committed to perform is that the senior management reviews all commitment changes. Only 27 (75.0%) companies are committed to perform this activity. It is found that 13 (36.1%) companies would adjust plans as the corrective action to be taken when targets of the software plan are not achieved.

b. Section B: Ability to Perform

The activity that most companies are able to perform is that the software development plan for the software project is documented and approved as reflected by 34 (94.4%) companies. On the other hand, the activity that the least number of companies are able to perform is to train the software managers in managing the technical and manpower aspect of the software project. This is reflected by only 19 (52.8%) companies that perform such training.

It is found that 13 (36.1%) companies indicate that the software manager assigns four types of responsibilities explicitly for software work products and activities. Also, the type of resource/funding that most companies provide to track the software product is the software managers and the software task leaders who are assigned specific responsibilities to track software projects. This is practised by 20 (55.6%) companies out of the 36 companies surveyed.

c. Section C: Activities Performed

There is only one activity performed by all the 36 companies surveyed. The activity is the software risks associated with costs, resources, schedule and technical aspects of the project are tracked. On the other hand, the activity that the least number of companies performed is to compare the actual size of codes to the estimated size as documented in the software development plan. This is reflected by 11 (30.6%) companies that performed this activity.

d. Section D: Measurement and Analysis

Three types of measurements were made and used to determine the status of the software project tracking and oversight activities – activity, resources, performance and quality. The survey findings show that most companies made five measurements and one measurement pertaining to activity (10 companies, 27.8%), resources (16 companies, 44.4%), respectively. Among the six activities and four resources investigated, most companies measure milestones completed and not completed (34 companies, 94.4%), and actual effort and remaining hours (27 companies, 75.0%), respectively.

On the other hand, most companies made four, five and six measurements pertaining to performance and quality (6 companies each). Also, among the ten performance and quality issues investigated, 29 (80.6%) companies measure test results. Indeed, the measurement and analysis practices are performed by 35 (97.2%) software companies surveyed.

e. Section E: Verifying Implementation

The survey findings show that 31 (86.1%) companies review the activities for software project tracking and oversight with senior management on a regular basis. Eight (22.2%) companies are found to review two aspects for software project tracking and oversight. Among the seven aspects investigated, 27 (75.0%) companies review the approved plan (baseline). Also, there are 11 (30.6%) companies conduct reviews on ad hoc basis.

On the other hand, most companies (9 companies, 25.0%) review one aspect for software project tracking and oversight with the project manager on both a regular and event-driven basis. The majority of companies (10 companies, 27.8%) conduct reviews once a week. Also, 11 (30.6%) companies are found to review and/or audit two or three activities or work products for software project tracking and oversight.

3.1 SPTO Practices Performed by the Most and the Least Number of Companies Surveyed

Further analysis on the survey outcomes show that not even one company from the 36 companies surveyed performs fully all the five areas of the SPTO practices. Nevertheless, it is encouraging to see that there are 10 practices from the five areas of SPTO practices performed by all the 36 companies surveyed, as shown in Table 5. This implies the importance of these 10 practices which must be carried out to track and manage the project's progress. Also, there are 42 practices performed by 26-35 (72.2-97.2%) of the 36 companies surveyed. Only 11 practices from the five areas of the SPTO practices are performed by 25 companies or fewer of the 36 companies surveyed. Of these 11 practices, 10 (90.9%) are practices of Section C and only 1 (9.1%) practice is from Section B. This implies that these practices are the processes that are being given the least attention by the companies in tracking and managing the project's progress. It is also obvious that the SPTO practices of Sections A, D and E are the main concern of the 36 companies surveyed.

Table 5: The SPTO practices performed by the most and the least number of companies

Section (No. of practices)	**SPTO practices performed by all the 36 companies surveyed (100.0%)**	**SPTO practices performed by 26-35 (72.2%-97.2%) of the companies surveyed**	**SPTO practices performed by less than 11-25 (30.6%-69.4%) of the companies surveyed (No. of company, %)**
A (6)	1b, 1c	1a, 1d, 1f, 1e	
B (5)	2b, 2c	2a, 2e	2d (19, 52.8%)
C (42)	3j	3a.i; 3.ii; 3h; 3k.i, part c; 3k.i, part a; 3k.i, part b; 3d; 3h.i; 3h.iii; 3i.i; 3a; 3b.i; 3b.iv; 3e; 3i; 3h.ii; 3i.iv; 3l.i; 3b; 3b.ii; 3b.iii; 3e.i; 3i.ii; 3k; 3i.iii; 3f; 3f.i; 3g; 3k.iii; 3l; 3m	3c, 3e.iii, 3f.ii, 3f.iii, 3k.ii (25, 69.4%), 3e.iv, 3f.iv (24, 66.7%), 3g.ii (22, 61.1%), 3g.i (20, 55.6%), 3e.ii (11, 30.6%)
D (3)	4a, part a; 4a, part b	4a, part c	
E (7)	5b.i, 5b.ii, 5c	5b, 5a.i, 5a.ii, 5a	

Based on Table 5, the SPTO practice that is being performed by the least number of companies is process 3e.ii of Section C, as it is performed by 11 (30.6%) companies only. This process requires an organisation to compare the actual size of codes to the estimates documented in the software development plan.

To estimate the size of codes, it is necessary to define the ways to calculate lines of code for a given program clearly [7]. Otherwise, the result of calculation could vary from one person to another as reported by Jones (1986) that one count can be as much as five times larger than another, simply because of the difference in counting technique [8]. Hence, this could possibly be one of the reasons why most companies do not practise this process as the definition of lines of code is doubtful and confusing. Different ways of counting program codes could result in incorrect calculation of programmer productivity and the need for storage space (resources) [7].

4.0 CONCLUSION

This paper presents the findings of a survey pertaining to the five areas that comprise 63 best practices in software project tracking and oversight (SPTO). A total of 36 local software companies participated in the survey. Among the five areas investigated, the main focus of the companies surveyed in performing SPTO practices are in the order of

(based on the least number of companies that perform the practices): perform measurement and analysis (35 companies, 97.2%), verify implementation (31 companies, 86.1%), highly committed to perform (27 companies, 75.0%), able to perform (19 companies, 52.8%) and have most activities performed (11 companies, 30.6%). The survey found that the best practice that is being performed by the least number of the 36 software companies surveyed is the process that requires an organisation to compare the actual size of codes to the estimates documented in the software development plan (11 companies, 30.6%). As the findings are based on 36 software companies only, the implications of the findings cannot be used to generalise the best practices perform by the software development industry in Malaysia.

Besides the SPTO best practices, the Project Management Institute (PMI) rolled out its second version of the "Organisational Project Maturity Model" in January 2004. This model is called OPM3™ and it has received a great deal of publicity [9, 10]. OPM3™ provides an alternative and an improved model for project management. According to some studies, OPM3™ offers best practices in software project management across the five maturity levels which could cater for today's project management trends and needs in order for the companies to operate in a multiproject environment, bringing the challenges of managing projects across differing organisation cultures and borders and reduce production time to market [10, 11]. Hence, the local software companies should consider the use and adoption of better project management models and best practices to keep up with today's shift from tactical to strategic management in software development.

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BIOGRAPHY

Siew Hock Ow received her PhD from University of Malaya in 2000. She has been a lecturer at the Faculty of Computer Science and Information Technology, University of Malaya since 1992. She has presented/published 25 research papers at both local and international conferences and published 13 research papers in local and international journals. Her research interests include software project management, computer-aided handwriting analysis, software metrics, computer-aided learning, development of software systems for the hearing-impaired, software quality assurance, social communication platform, CASE tools and forecasting models. She is a member of the Malaysian National Computer Confederation (MNCC), affiliate member of IEEE Computer Society, and member of the Malaysian Invention and Design Society (MINDS).

APPENDIX A – SUMMARY OF SURVEY RESULTS

Table A.1: Section A - Commitment to Perform

SPTO Practices	Yes (%)	No (%)	Findings/Remarks
1a – Is the documented software development plan used and maintained as the basis for tracking the software project?	34 (94.4)	2 (5.6)	
1b – Is the project manager kept informed of the software project's status and issues?	36 (100.0)	0 (0.0)	
1c – What corrective actions are taken when targets of the software plan are not achieved?	36 (100.0)	0 (0.0)	5 (13.9%) - adjust performance only. 13 (36.1%) - adjust plans only. 2 (5.6%) - take other corrective actions only. 9 (25.0%) - adjust both performance and plans. 4 (11.1%) - adjust plans and take other corrective actions. 3 (8.3%) - adjust performance, adjust plans and take other corrective actions.
1d – Are changes to the software commitments made with the involvement and agreement of the affected group?	33 (91.7)	3 (8.3)	
1e – Does the senior management review all commitment changes?	27 (75.0)	9 (25.0)	
1f – Does the senior management review the new software project commitments made to individuals and groups external to the organisation?	30 (83.3)	6 (16.7)	

Table A.2: Section B - Ability to Perform

SPTO Practices	Yes (%)	No (%)	Findings/Remarks
2a – Is the software development plan for the software project documented and approved?	34 (94.4)	2 (5.6)	
2b – What type of responsibility does the software manager assign explicitly for software work products and activities?	36 (100.0)	0 (0.0)	5 (13.9%) - assigns one responsibility. 8 (22.2%) - assigns two responsibilities. 7 (19.4%) - assigns three responsibilities. 13 (36.1%) - assigns four responsibilities. 3 (8.3%) - assigns five responsibilities. *Types of responsibilities that the software manager assigns explicitly for software work products and activities:* RP1 - The software work products to be developed or services to be provided. RP2 - The efforts and cost of the software activities. RP3 - The schedule for the software activities. RP4 - The budget for the software activities. RP5 - Others, please specify.
2c – What type of resources/funding are provided to track the software product?	36 (100.0)	0 (0.0)	25 (69.4%) - only one type of resource/funding is provided to track the software product. 11 (30.6%) - two types of resources/funding

			are provided to track the software product. *Resource/funding:* RF1 - The software managers and the software task leaders are assigned specific responsibilities to track software project. RF2 - Tools to support software tracking are made available. RF3 - Others, please specify.
2d – Are the software managers trained in managing the technical and manpower aspect of the software project?	19 (52.8)	17 (47.2)	
2e – Do first line software managers receive orientation in the technical aspects of the software project?	26 (72.2)	10 (27.8)	

Table A.3: Section C - Activities Performed

SPTO Practices	Yes (%)	No (%)	Findings/Remarks
3a – Is a documented software development plan used for tracking the software activities and communicating their status?	32 (88.9)	4 (11.1)	
3a.i – Are the work progresses updated to reflect accomplishments, particularly when milestones are completed?	35 (97.2)	1 (2.8)	
3a.ii – For whom is the software development plan readily prepared for?	35 (97.2)	1 (2.8)	6 (16.7%) - one group of personnel. 8 (22.2%) - two groups of personnel. 7 (19.4%) - three groups of personnel. 10 (27.8%) - four groups of personnel. 4 (11.1%) - five groups of personnel. 1 (2.8%) - does not have any group of personnel. *Groups of personnel for whom the software development plan is readily prepared:* G1 - The software engineering group. G2 - The software managers. G3 - The project manager. G4 - Senior management. G5 - Other affected groups.
3b – Is the project's software development plan revised according to a documented procedure?	29 (80.6)	7 (19.4)	
3b.i – Is the software development plan revised, as appropriate, to incorporate plan refinements and incorporate plan changes, particularly when there are significant changes?	32 (88.9)	4 (11.1)	
3b.ii – Is the software development plan updated to incorporate all new software project commitments and changes to commitments?	29 (80.6)	7 (19.4)	

3b.iii – Is the software development plan reviewed at each revision?	29 (80.6)	7 (19.4)	
3b.iv – Is the software development plan managed and controlled?	32 (88.9)	4 (11.1)	
3c – Are software project commitments and changes to commitments made to individuals and groups external to the organisation, reviewed with senior management according to a documented procedure?	25 (69.4)	11 (30.6)	
3d – Are the approved changes to commitment that affect the software project communicated to the members of the software engineering group and other software-related groups?	33 (91.7)	3 (8.3)	
3e – Is the size of the software work products (or size of the changes to the software work products) tracked, and corrective actions taken, as necessary?	32 (88.9)	4 (11.1)	
3e.i – Are the sizes for all major software work products tracked?	29 (80.6)	7 (19.4)	
3e.ii – Is the actual size of codes compared to the estimates documented in the software development plan?	11 (30.6)	25 (69.4)	
3e.iii – Are the actual units of delivered documentation compared to the estimates documented in the software development plan?	25 (69.4)	11 (30.6)	
3e.iv – Are changes in the size estimates of the software work products that affect software commitments negotiated with the affected groups documented?	24 (66.7)	12 (33.3)	
3f – Are the project's software effort and costs tracked and corrective actions taken, as necessary?	27 (75.0)	9 (25.0)	
3f.i – Are the actual expenditures of effort and costs over time and against work completed compared to estimates documented in the software development plan to identify potential overruns and under runs?	27 (75.0)	9 (25.0)	
3f.ii – Are software costs tracked and compared to the estimates documented in the software development plan?	25 (69.4)	11 (30.6)	
3f.iii – Are efforst and staffing compared to the estimates documented in the software development plan?	25 (69.4)	11 (30.6)	
3f.iv – Are changes in staffing and other software cost that affect software commitments negotiated with the affected group and documented?	24 (66.7)	12 (33.3)	
3g – Are the project's critical computer	27	9	

resources tracked and corrective actions taken, as necessary?	(75.0)	(25.0)	
3g.i – Is the actual and projected use of the project's critical computer resources tracked and compared to the estimates for each major software component as documented in the software development plan?	20 (55.6)	16 (44.4)	
3g.ii – Are changes in the estimates of critical computer resources that affect software commitments negotiated with the affected groups documented?	22 (61.1)	14 (38.9)	
3h – Is the project schedule tracked and corrective actions taken, as necessary?	35 (97.2)	1 (2.8)	
3h.i – Is the actual completion of software activities, milestones and other commitments compared against the software development plan?	33 (91.7)	3 (8.3)	
3h.ii – Are the effects of late and early completion of software activities, milestones and other commitments evaluated for impacts on the future activities and milestones?	30 (83.3)	6 (16.7)	
3h.iii – Are software schedules revisions that affect software commitments negotiated with the affected groups and documented?	33 (91.7)	3 (8.3)	
3i – Are software engineering technical activities tracked and corrective actions taken, as necessary?	32 (88.9)	4 (11.1)	
3i.i – Do the software engineering groups report their technical status to their managers on a regular basis?	33 (91.7)	3 (8.3)	
3i.ii – Are software release contents for successive builds compared to the plans documented in the software development plans?	29 (80.6)	7 (19.4)	
3i.iii – Are problems identified in any of the software work products reported and documented?	28 (77.8)	8 (22.2)	
3i.iv – Are problem reports tracked till closure?	30 (83.3)	6 (16.7)	
3j – How are the software risks associated with costs, resources, schedule and technical aspects of the project tracked?	36 (100.0)	0 (0.0)	19 (52.8%) - use only one way. 14 (38.9%) - use two ways. 3 (8.3%) - use three ways. *Ways to track software risks associated with costs, resources, schedule and technical aspects of the project:* TR1 - The priorities of the risks and the contingencies for the risks are adjusted as additional information becomes available. TR2 - High-risk aspects are reviewed with the

			project manager on a regular basis. TR3 - Others, please specify.
3k – Are actual measurement data and re-planning data for the software project recorded?	29 (80.6)	7 (19.4)	
3k.i – What information is recorded?	34 (94.4)	2 (5.6)	*a. Activity* 1 (2.8%) - records milestones completed. 3 (8.3%) - record two items of information. 5 (13.9%) - record three items of information. 11 (30.6%) - record four items of information. 12 (33.3%) - record five items of information. 2 (5.6%) - record six items of information. *Activity information:* AC1 - Actual effort. AC2 - Number of tasks completed. AC3 - Milestones completed. AC4 - Actual task start and finish dates. AC5 - Earned value analysis (% complete). AC6 - Others, please specify.
	34 (94.4)	2 (5.6)	*b. Resources* 5 (13.9%) - record actual effort. 3 (8.3%) - record actual costs. 2 (5.6%) - record critical computer resources. 15 (41.7%) - record two items of information. 8 (22.2%) - record three items of information. 1 (2.8%) - records four items of information. *Resources information:* RS1 - Actual effort. RS2 - Actual costs. RS3 - Critical computer resources. RS4 - Others, please specify.
	35 (97.2)	1 (2.8)	*c. Performance and quality* 1 (2.8%) - records 'Number of component parts completed'. 2 (5.6%) - record 'Test results'. 4 (11.1%) - record two items of information. 4 (11.1%) - record three items of information. 7 (19.4%) - record four items of information. 6 (16.7%) - record five items of information. 6 (16.7%) - record six items of information. 3 (8.3%) - record seven items of information. 2 (5.6%) - record eight items of information.
			Performance and quality information: PQ1 - Current mean time between failures

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			(MTBF). PQ2 - Lines of code generated. PQ3 - Number of reworks. PQ4 - Number of changes put through change control. PQ5 - Actual size of work products. PQ6 - Number of component parts completed. PQ7 - Test results. PQ8 - Number of issues raised/discussed. PQ9 - Number of action items. PQ10 - Others, please specify.
3k.ii – Are the software re-planning data managed and controlled?	25 (69.4)	11 (30.6)	
3k.iii – Are the software re-planning data and the actual measurement data archived for use by on-going and future projects?	27 (75.0)	9 (25.0)	
3l – Does the software engineering group conduct periodic internal reviews to track technical progress, plans, performance and issues against the software development plan?	27 (75.0)	9 (25.0)	
3l.i – Who conducts these reviews?	30 (83.3)	6 (16.7)	6 (16.7%) - project manager conducts the periodic internal reviews. 2 (5.6%) - project leader conducts the periodic internal reviews. 9 (25.0%) - two personnel conduct the periodic internal reviews. 5 (13.9%) - three personnel conduct the periodic internal reviews. 6 (16.7%) - four personnel conduct the periodic internal reviews. 2 (5.6%) - five personnel conduct the periodic internal reviews. *Personnel who conduct internal reviews:* P1 - Project manager. P2 - Project leader. P3 - Software manager. P4 - Software review team. P5 - SQA team. P6 - Others, please specify.
3m – Are formal reviews to address the accomplishments and results of software projects conducted at selected project milestones according to a documented procedure?	27 (75.0)	9 (25.0)	

Table A.4: Section D - Measurement and Analysis

SPTO Practices	Yes (%)	No (%)	Findings/Remarks
4a – What type of measurements are made and used to determine the status of the software tracking and oversight activities?	36 (100.0)	0 (0.0)	*a. Activity* 3 (8.3%) - measure the milestones completed and not completed. 6 (16.7%) - made two measurements. 9 (25.0%) - made three measurements. 8 (22.2%) - made four measurements. 10 (27.8%) - made five measurements *Activity information:* AM1 - Actual effort and remaining effort (in hours). AM2 - Number of tasks completed and not completed. AM3 - Milestones completed and not completed. AM4 - Actual task start and finish dates. AM5 - Earned value analysis (% complete). AM6 - Others, please specify.
	36 (100.0)	0 (0.0)	*b. Resources* 9 (25.0%) - measure the actual effort and remaining hours. 5 (13.9%) - measure actual costs. 2 (5.6%) - measure critical computer resources. 12 (33.3%) - made two measurements. 7 (19.4%) - made three measurements. 1 (2.8%) - made four measurements. *Resources information:* RM1 - Actual effort and remaining hours. RM2 - Actual costs. RM3 - Critical computer resources. RM4 - Others, please specify.
	35 (97.2)	1 (2.8)	*c. Performance and quality* 5 (13.9%) - made one measurement. 3 (8.3%) - made two measurements. 4 (11.1%) - made three measurements. 6 (16.7%) - made four measurements. 6 (16.7%) - made five measurements. 6 (16.7%) - made six measurements. 3 (8.3%) - made seven measurements. 1 (2.8%) - made eight measurements. 1 (2.8%) - made nine measurements. *Performance and quality information:* PQM1 - Current mean time between failures (MTBF).

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			PQM2 - Lines of code generated. PQM3 - Number of reworks and adherence to quality criteria. PQM4 - Number of changes put through change control. PQM5 - Actual size of work products. PQM6 - Number of component parts completed. PQM7 - Test results. PQM8 - Number of issues raised/discussed. PQM9 - Number of action items. PQM10 - Others, please specify.

Table A.5: Section E - Verifying Implementation

SPTO Practices	Yes (%)	No (%)	Findings/Remarks
5a – Are the activities for software project tracking and oversight reviewed with senior management on a regular basis?	31 (86.1)	5 (13.9)	
5a.i – What aspects of the activities are reviewed?	33 (91.7)	3 (8.3)	7 (19.4%) - review one aspect. 8 (22.2%) - review two aspects. 5 (13.9%) - review three aspects. 7 (19.4%) - review four aspects. 3 (8.3%) - review five aspects. 2 (5.6%) - review six aspects. 1 (2.8%) - reviews seven aspects. *Aspects reviewed with the senior management on a regular basis*: AR1 - Approved plan (Baseline). AR2 - Risk management. AR3 - Quality assurance (QA). AR4 - Change management process. AR5 - Configuration management. AR6 - Subcontract management. AR7 - Others, please specify.
5a.ii – How often are these reviews conducted?	33 (91.7)	3 (8.3)	6 (16.7%) - conduct reviews once a week. 4 (11.1%) - conduct reviews once a fortnight. 2 (5.6%) - conduct reviews once a month. 11 (30.6%) - conduct reviews on ad hoc basis. 1 (2.8%) - conducts reviews at other intervals. 9 (25.0%) - conduct reviews more frequently. *Review frequency of software project tracking and oversight with the senior management:* F1 - Once a week. F2 - Once a fortnight. F3 - Once a month.
			F4 - Ad hoc basis.

			F5 - Others, please specify.
5b – Are the activities for software project tracking and oversight reviewed with the project manager on both a regular and event-driven basis?	35 (97.2)	1 (2.8)	
5b.i – What aspects of the activities are reviewed?	36 (100.0)	0 (0.0)	9 (25.0%) - review one aspect. 4 (11.1%) - review two aspects. 7 (19.4%) - review three aspects. 6 (16.7%) - review four aspects. 5 (13.9%) - review five aspects. 4 (11.1%) - review six aspects. 1 (2.8%) - reviews seven aspects. *Aspects reviewed with the project manager on both a regular and event-driven basis:* R1 - Approved plan (Baseline). R2 - Risk management. R3 - Quality assurance (QA). R4 - Change management process. R5 - Configuration management. R6 - Subcontract management. R7 - Others, please specify.
5b.ii – How often are these reviews conducted?	36 (100.0)	0 (0.0)	10 (27.8%) - conduct reviews once a week. 2 (5.6%) - conduct reviews once a fortnight. 1 (2.8%) - conducts reviews once a month. 9 (25.0%) - conduct reviews on ad hoc basis. 3 (8.3%) - conduct reviews at other intervals. 11 (30.6%) - conduct reviews more frequently. *Review frequency of software project tracking and oversight with the project manager on both a regular and event-driven basis:* T1 - Once a week. T2 - Once a fortnight. T3 - Once a month. T4 - Ad hoc basis. T5 - Others, please specify.

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5c – What does the software quality assurance group review and/or audit the activities and work products for software project tracking and oversight and reports the results verify?	36 (100.0)	0 (0.0)	1 (2.8%) - reviews and/or audits the scope variance. 5 (13.9%) - review and/or audit the quality variance. 9 (25.0%) - review one activity or work product. 11 (30.6%) - review two activities or work products. 11 (30.6%) - review three activities or work products. 5 (13.9%) - review four activities or work products. 3 (8.3%) - review and/or audit other activities and work products only. 27 (75.0%) - review and/or audit more than one activity and work product. *Activities and work products that the software quality assurance group reviewed and/or audited:* A1 - Scope variance. A2 - Quality variance. A3 - Schedule variance. A4 - Budget variance. A5 - Others, please specify.