SPIALS-II: A light-Weight Software Process Improvement Self-Assessment Tool

[1]Disorn Homchuenchom, [2]Chayakorn Piyabunditkul,
[3]Horst Lichter, [4]Toni Anwar, [5]Apinporn Methawachananont,
[6]Chumphol Krootkaew, [7]Tisanai Krisanathamakul
[1,2,5,6,7]TGGS-NECTEC/NSTDA, chayakorn@nectec.or.th
[3]RWTH Aachen University, lichter@swc.rwth-aachen.de
[4]Faculty of Computer Science and Information Systems,
Universiti Teknologi Malaysia (UTM), Malaysia, tonianwar@utm.my

Abstract

In this paper we propose a tool-based approach called CMMIbyScrum to improve CMMI-based processes with Agile technique such as Scrum. This model was designed to be especially useful for VSEs/SMEs. If VSEs/SMEs are aware of the current capability status of their software processes and have an improvement guideline based on their quality targets, they might be able to substantially improve their processes. To support organizations on their way to better processes, we present the design of a generic tool (SPIALS: Software Process Improvement Adaptive Learning System) applicable to measure up organizations' process capability status. VSEs/SMEs can use the tool to perform a self-assessment thus reducing the complex appraisal process. The measurement represents trend of practices which VSEs/SMEs should implement or avoid. The presented tool-based assessment strategy is based on Standard CMMI Appraisal Method for Process Improvement (SCAMPI), which is well recognized for CMMI standard appraisal. In this version, we propose an enhancement of questionnaire framework based on a light-weight for Software Process Improvement Self-Assessment Tool called QF-SPISAT to help practitioner in assessment process. Thus, the completion of user interface, gap and software process improvement (SPI) proposal report are presented.

Keywords: *CMMI (Capability Maturity Model Integration), Scrum, light-weight self-assessment, SCAMPI (Standard CMMI Appraisal Method for Process Improvement), tool support, QF-SPISAT (Questionnaire Framework based on a light-weight for Software Process Improvement Self-Assessment Tool), gap report, software process improvement (SPI) proposal report*

1. Introduction

A key point to be competitive in the world trade market is to offer high quality products. Therefore especially VSEs/SMEs have to convince potential customers of the quality of their products. A popular approach to tackle this problem is to apply an international accepted improvement framework and to get some world-wide recognized quality certificate. For that reason lots of VSEs/SMEs invest to improve the quality of their development processes. The Capability Maturity Model Integration (CMMI) is a well-known and accepted process improvement approach, which can be used as a process quality measurement, too. CMMI is widely applicable; it can be applied to various aspects such as software development, service, or acquisition. The current process quality is assessed by means of the CMMI Appraisal Method SCAMPI which needs appraisers' experience to investigate the processes in depth for highly accurate assessment results. The assessment result shows satisfaction for all those process areas fulfilling the respective defined goals and practices.

An interesting issue for VSEs/SMEs is how to apply CMMI in a light-weight fashion and how to reduce the cost to apply it. National Electronics and Computer Technology Center (NECTEC) is a Thai R&D organization supporting VSEs/SMEs to develop high quality products. NECTEC aims to adopt agile techniques such as Scrum or XP to solve before mentions problems [1], [2]. Some measures have been established to compare the complexity between CMMI-based processes using different software development life cycle models (SDLC); NECTEC-CMMI Waterfall SDLC and CMMIbyScrum SDLC. Activities and related artifacts of both models are evaluated in quantity and complexity.

The development of a new CMMI-based model applying agile techniques is challenging because it has to map activities and artifacts of different development life cycles. The CMMI framework does not

specify concrete actions but defines only sets of practices which have to be implemented by an organization. An adoption without knowledge leads to unexpected workload for the developers. In this paper, we present a web-based tool based on our new CMMI-based model supporting VSEs/SMEs to perform a self-assessment which might be the starting point for process improvement without high consultancy expenses. Organizations then know their process status and how to improve it following the lightweight model. Furthermore, our tool is designed to be adaptable to other process improvement frameworks.

Many Thai VSEs/SMEs cannot invest in an expensive SPI assessment because of small budgets, limited personnel resources, lack of knowledge, or other specific organization constraints. As SPI is crucial for VSEs/SMEs as well there is a need for a new assessment approach that better fits to the typical constraints of VSEs/SMEs. In order to support VSEs/SMEs to start a continuous SPI program, we propose a tool based SPI self-assessment approach which on one hand is CMMI-SCAMPI conformant but on the other hand significantly reduces the assessment complexity and costs. SPIALS (Software Process Improvement Adaptive Learning System), the tool that we have developed is designed to simplify self-assessments. Moreover, organizations get individual self-assessment results customized according to SCAMPI which reflect their performance.

Hence, our approach and the herein presented tool should support VSEs/SMEs;

- To assess the current status of their software development process compared to international standard
- To get an appropriate individual guideline to improve their processes following an international framework
- To plan process improvement measures based on their goals and resources (time/cost/effort/tool/knowledge)
- To improve their organizational process by reducing cost for SPI implementation
- To reduce the risk to fail the official appraisal; so VSEs/SMEs have enough time to prepare for an official appraisal
- To improve their process following CMMI by using a light-weight model
- To flexibly change the improvement framework when technology trends are changing
- To offer an SPI opportunity for VSEs/SMEs which don't have much budget for this activity

2. Related Work and Background

As the central basis we are using the Capability Maturity Model Integration for Development (CMMI-DEV v.1.2) as our reference Process Capability Model (PCM). In addition, we use Standard CMMI Appraisal Method for Process Improvement (SCAMPI) as an assessment Process Capability Baseline (PCB) which contains data for each project to represent a snapshot of the capability of the process. Finally, we have integrated Scrum in our light-weight CMMI model for VSEs/SMEs (CMMIbyScrum) [13].

In the following we briefly introduce the main foundations of our approach.

2.1 Capability Maturity Model Integration (CMMI)

CMMI-DEV v1.2 is a collection of best practices for development and maintenance to improve quality of products and services [11]. The CMMI-DEV v1.2 constellation contains 4 process categories which cover process management, project management, engineering and support or 22 process areas that represent the core processes for software development. It is related to the CMMI formal assessment method SCAMPI.

2.2 The Standard CMMI Appraisal Method for Process Improvement (SCAMPI)

This is the official appraisal method of the Software Engineering Institute. It allows determining a rating of the CMMI maturity level or the CMMI capability level based on objective evidences which

are supported by CMMI goals and practices. This information is analyzed to produce an appropriate rating. The appraisal rules are defined in the Appraisal Requirements for CMMI (ARC) V1.2 [3] and in the Standard CMMI Appraisal Method for Process Improvement (SCAMPI) A, Version 1.2: Method Definition Document - MDD [4]. However, our approach is based on the Handbook for Conducting Standard CMMI Appraisal Method for Process Improvement (SCAMPI) B and C Appraisals, Version 1.1" [5]. Furthermore there is a questionnaire based method to perform self-assessment appraisals called "Self-assessment and the CMMI-AM – A Guide for Government Program Managers" [6].

2.3 Scrum

Originally, Scrum was invented to manage agile software development projects [7] [8] [9] [10], but it works well also for other complex, innovative projects. Scrum defines four important management elements which are sprint planning meeting, daily scrum meeting, sprint reviews meeting and sprint retrospective as well as the following artifacts; product backlog, sprint backlog, product and sprint burn down chart.

2.4 CMMIbyScrum

There are a couple of approaches to merge CMMI and agile methods [12]. The CMMIbyScrum model is focusing on the process areas Project Planning (PP), Project Monitoring and Control (PMC) and Integrated Project Management (IPM) and is based on the NECTEC-CMMI Waterfall SDLC. It contains six process guidelines and nine artifacts whereas Scrum SDLC defines four practices and three artifacts. We propose an approach to combine effectively both SDLCs (see Fig.1) in the context of CMMI.

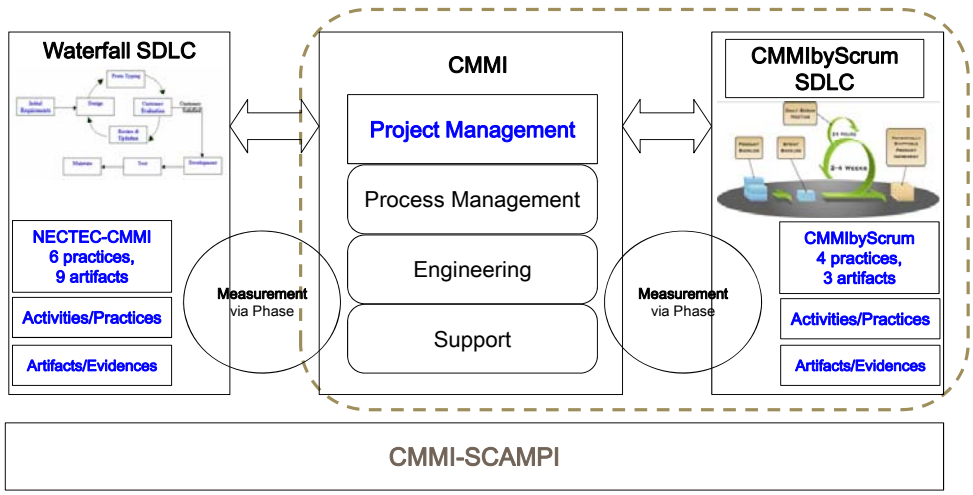


Figure 1. NECTEC-CMMI Waterfall and CMMIbyScrum Mapping Model

3. Software Process Improvement Adaptive Learning System (SPIALS)

The SPIALS (Software Process Improvement Adaptive Learning System) is a web-based tool supporting the self-assessment and presenting the results based on a specific SCAMPI customization. The benefit of using SPIALS for VSEs/SMEs is to easily get an individual self-assessment result which reflects its process status and performance. The tool serves mainly to analyze potential weaknesses and to define and perform improvement measures before investing in a formal SCAMPI certification assessment. Because approved SPI best practices should be applicable especially for VSEs/SMEs, SPIALS tries to collect such SPI information given by VSEs/SMEs for further analysis to improve the system itself but also to propose SPI road maps for VSEs/SMEs to gain more quality improvements in software industry.

As SPIALS is implementing the CMMIbyScrum model the process of its usage is based on its core elements (see Fig.2).

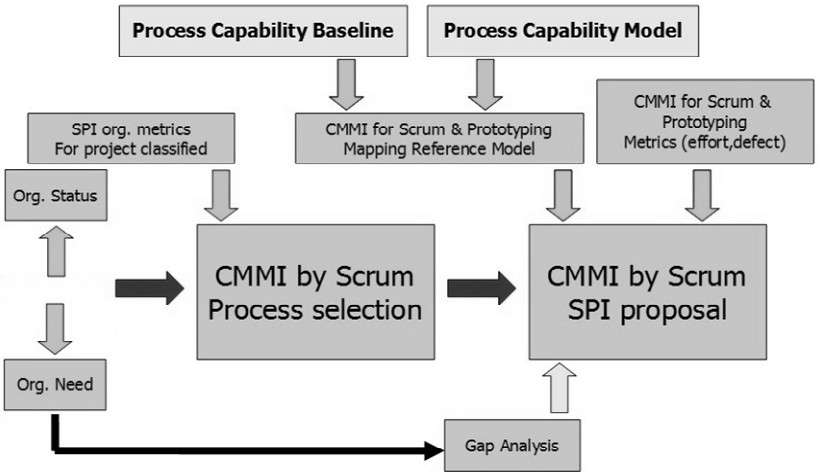


Figure 2. SPIALS – The Underlying Process

The organization status and needs are an initial and important input to classify an appropriate CMMIbyScrum approach which fits to the organization. As a result, SPIALS provides gap analysis information and also proposes individual SPI measures to achieve the VSEs/SMEs process improvement objectives. In the following sections we present some interesting aspects of SPIALS. At first we explain its design then we introduce the implemented assessment model. Finally, we briefly sketch the user interface of SPIALS.

4. The SPIALS Conceptual Design

SPIALS assists VSEs/SMEs to perform self-assessments. Its procedure is consistent to the SCAMPI principles including the three phases; Plan and Prepare for Appraisal, Conduct Appraisal, and Report Results. Fig. 3 depicts the main use cases identified for SPIALS.

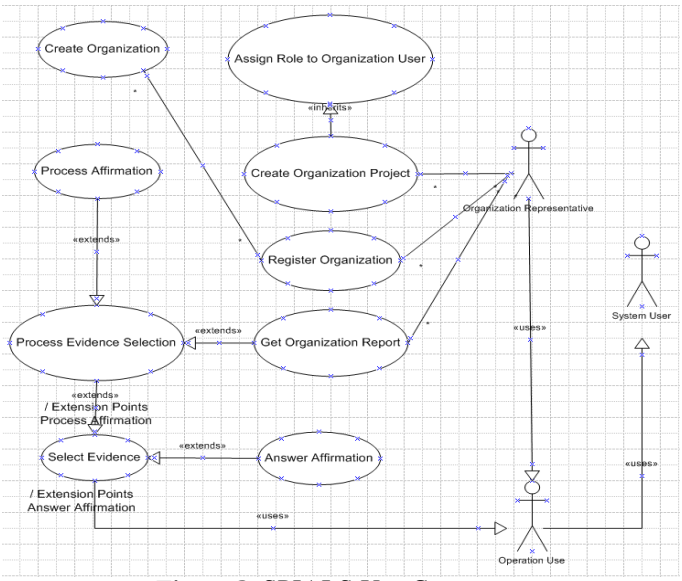


Figure 3. SPIALS Use Cases

SPAILS is assumed to be used by an organization's representative. At first projects to be evaluated have to be created. Then roles associated with the projects are assigned. Next systematic questions are defined and an evidence type is selected.

The core elements of the SPIALS self-assessment are questionnaires that have to be completed by the representatives of the organization. These questionnaires are generated based on the organization's input. All questionnaires conform to a common underlying model, shown in Fig.4.

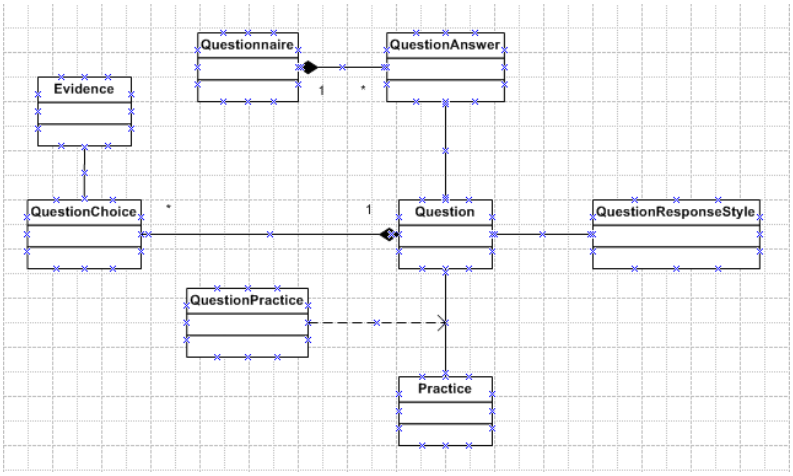


Figure 4. Questionnaire Model

The necessary input data is entered by an organization representative who defines evidences for respective software development processes. The result is reported automatically indicating acceptance in the selected process areas. However, collecting documents is not a focus because every organization has its own document types and standards. Therefore, only evidence names are collected. The system reacts immediately if the user enters mismatching data. Fig.5 presents the SPIALS work flow which is used as a filter to present only related evidence to the participants.

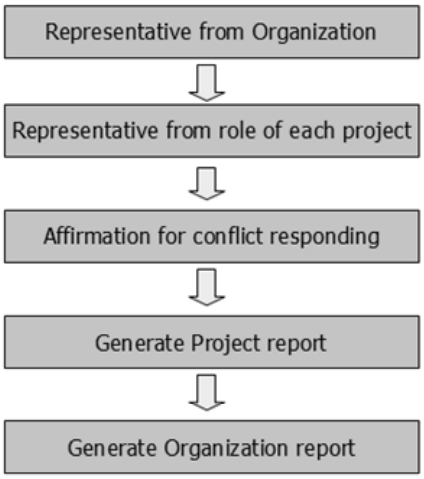


Figure 5. SPIALS Work Flow

SPIALS automatically processes evidence usage for every role, and then generates assessment results for the project. The selected evidence is a representative for a practice implementation indicator. The SPIALS approach to evaluate goals and process areas is presented in Fig.6.

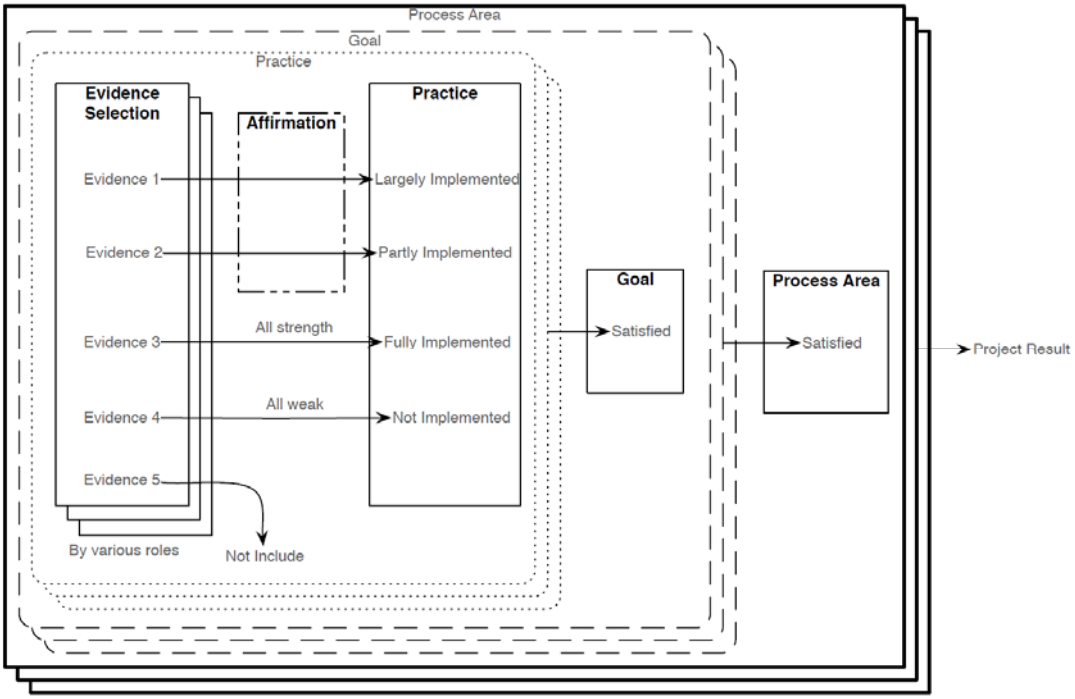


Figure 6. SPIALS procedure of evidence selection to indicate project result

5. The SPIALS Assessment Model

To generate the assessment result, many issues have to be concerned. According to SCAMPI, evidences are most important as the can imply the strength of a practice. Therefore we have precisely defined the meaning of the concepts Practice Implementation Indicator, Practice Characteristic, Goal and Process Area Satisfaction (see Tables 1-4). The number of strength practices implies the quantity of implemented practices for a goal. The number of goals with high quantity of implemented practices can imply the satisfaction of a process area.

Table 1. The Relation of Evidence Selection to Determine Practice Implementation Indicator

Evidence Selection (for All Related Roles or Majority after an Affirmation)	**Practice Implementation Indicator**
All roles: Use	Strength
All roles: Not use	Weak
All roles: Not available to use	Not Rated
Majority: Combination of evidence selection result	Ask for affirmations for those evidences. Then assumes an indicator value from a majority. If there is no majority, uses Weak.

Based on the values of the Practice Implementation Indicators the respective Practice Characteristics can be rated. We define:

Let *W*: number of Weak indicators
S: number of Strength indicators
NR: number of Not Rated indicators

Table 2. The Relation of Practice Implementation Indicator to Determine Practice Characteristics

Practice Implementation Indicator Condition	Practice Characteristics
W ≥ NR and S = 0 and W > 0	Not implemented
W > S and W > NR and S > 0	Partially implemented
S > W and S > NR and W > 0	Largely implemented
S ≥ NR and W = 0 and S > 0	Fully implemented
S = 0 and W = 0 and NR ≥ 0	Not Rated
NR > W + S and S ≥ 0 and W ≥ 0	Not Capable

Now we can use the PC values to rate the satisfaction of associated goals based on the following definitions:

Let *SI*: sum of Largely and Fully Implemented PCs
NSI: sum of Partially and Not Implemented PCs

Table 3. Relation of Practice Characteristics to Determine Goal Satisfaction

Practice Characteristics	Goal Satisfaction
SI > NSI	Satisfied
SI < NSI	Not Satisfied
SI = NSI	Not Capable

Finally, we determine the process area satisfaction from the goal satisfaction values. Again we define:

Let SG: number of Satisfied goals
NSG: number of Not Satisfied goals
NCG: number of Not Capable goals

Table 4. The Relation of Goal Satisfaction to Determine Process Area Satisfaction

Goal Satisfaction	Process Area Satisfaction
SG > (NSG + NCG) and SG ≥ NCG	Satisfied
SG < (NSG + NCG) and NSG ≥ NCG	Not Satisfied
NCG > SG + NSG	Not Capable

6. The SPIALS User Interface

In this section, we present the structure of QF-SPISAT and descriptions of the SPIALS component. QF-SPISAT composes of five parts which show according A to E (see Fig.7); A. Organization's general information, B. Participant information, C. Project information, D. Assessment definition which include; D1.Assessment scope and D2.Participant's multi-roles in each project, and E. Appraisal's artifact confirmation which include; E1.Participant dashboard and E2.Artifact usage. The QF-SPISAT is based on SCAMPI appraisal theory with Scrum deployment. The confirmation of assessment use project's artifact as references

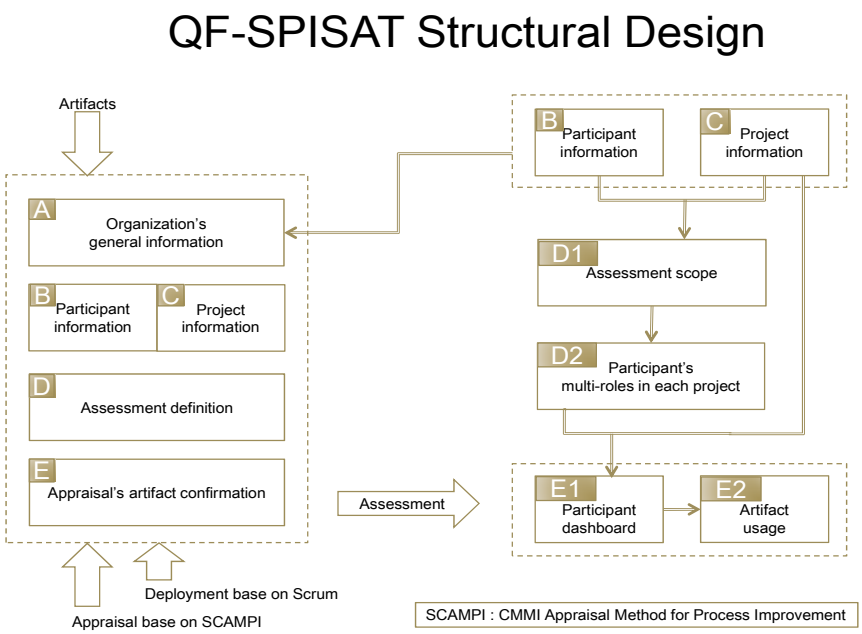


Figure 7. The QF-SPISAT Structure Design

Fig. 7 shows the steps of information preparing phase from A to C, then D1 to D2 are assessment defining phase for the assessment scope and participants' roles in each project. Finally, assessing phase in E (E1 to E2), each person has to answer questions base on their roles in every related projects. The questionnaire is answer in term of project artifacts as "Yes/No" questions order by process area which defines in D.Assessment definition. The result of appraisal is presented by organization's gap and software process improvement report.

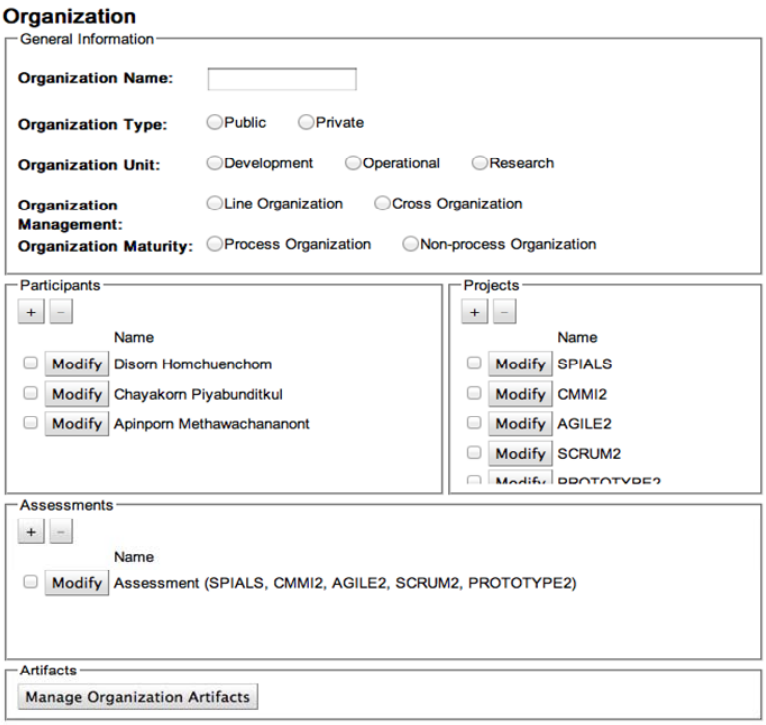


Figure 8. Organization General Information

At first, we illustrate the information flow of SPIALS. Organization has to be entered organization data and details for instance; participant's role, project, and also the assessment definition (maturity or capability) to be a criteria of automate questionnaire system which is confirm via artifact. (See fig.9-10)

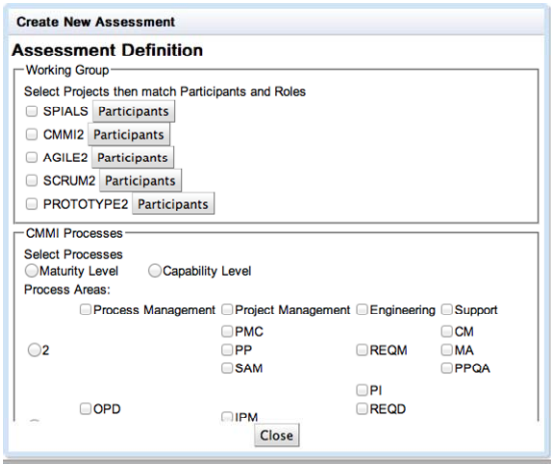


Figure 9. Assessment Definition

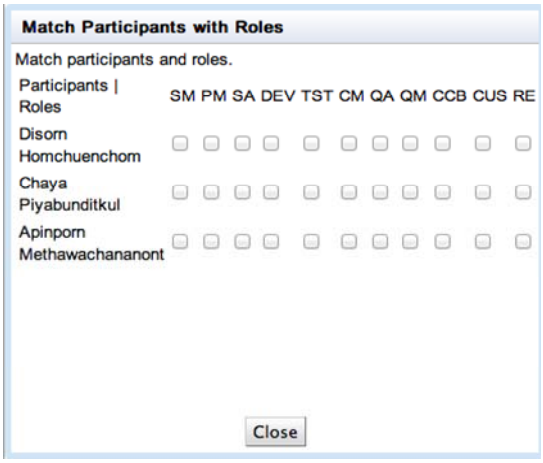


Figure 10. Match Participants with roles

Second, we use the information above to create a set of question which participants have to answer based on their roles, step by each process area (PA) upon organization's assessment definition. (See Fig 11-12).

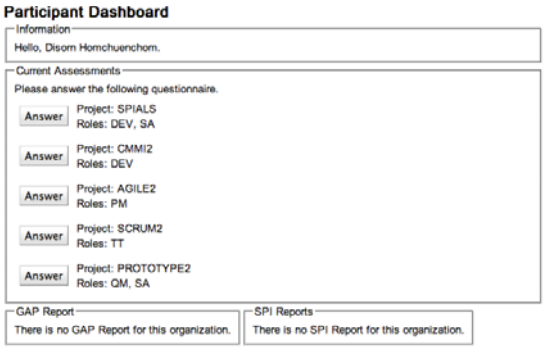


Figure 11. Participants Dashboard

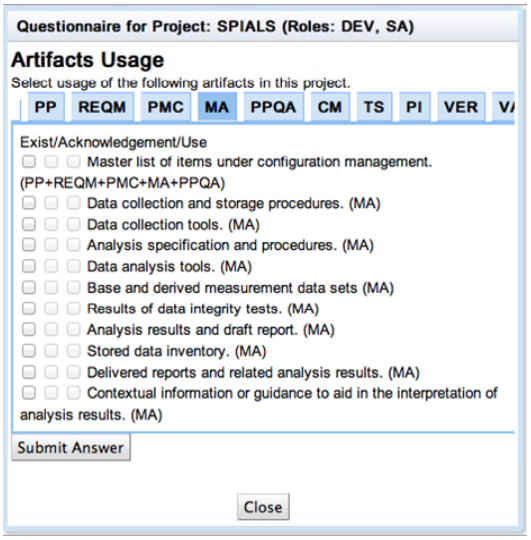
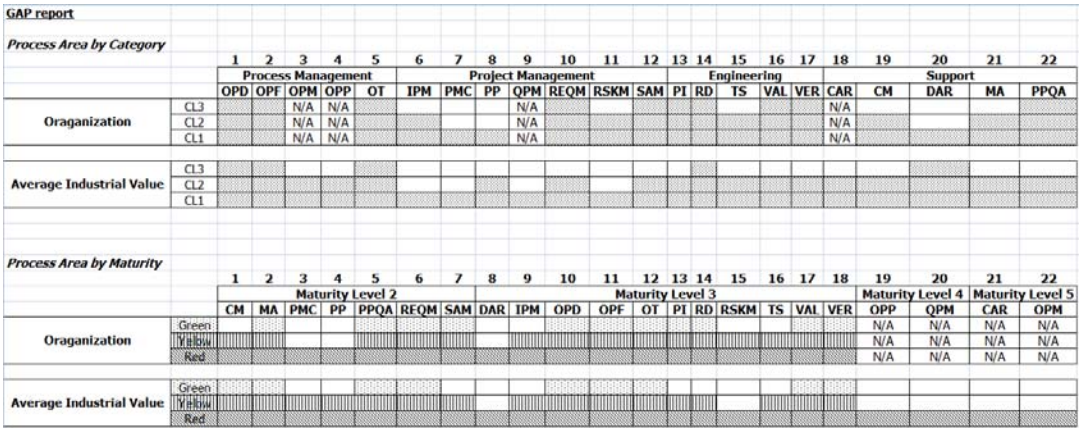


Figure 12. Questionnaire for Artifact Usage

Third, regarding from these inputs, SPIALS determines according to the CMMIbyScrum model to produce gap report and Software Process Improvement (SPI) proposal report which are present in 2 views; process area by category and process area by maturity. Gap report shows the organization's values and the comparison between organization and average industrial value based on its benchmark to show an organization point of reference based on industry database. (See Fig.13) The benchmark reference here is the data collection from organizations that use this SPIALS.



GAP report

Process Area by Category

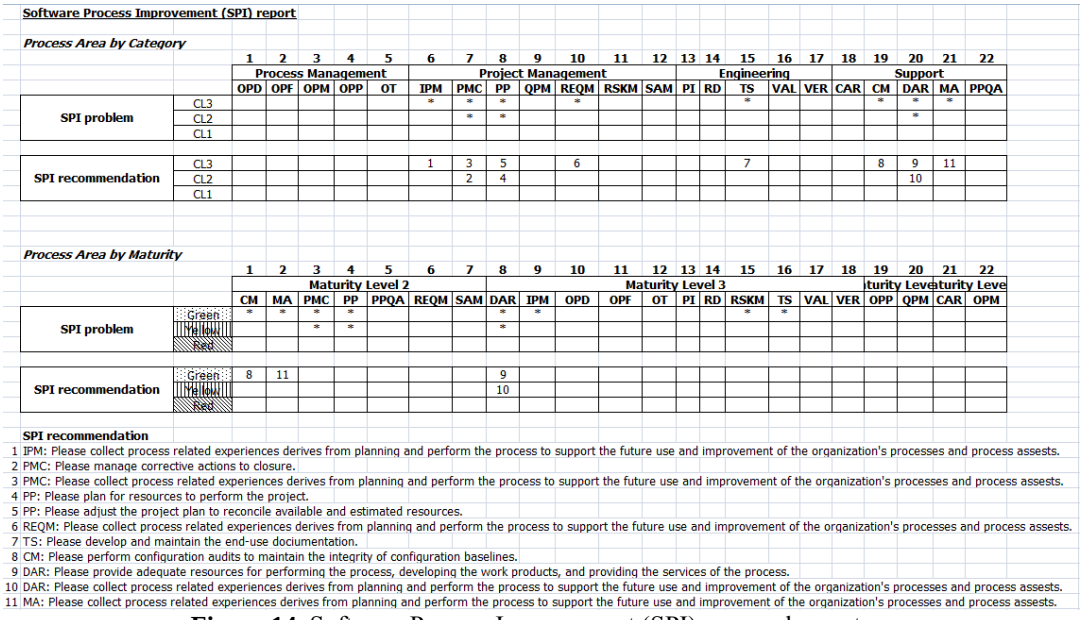
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
		Process Management					Project Management							Engineering						Support			
		OPD	OPF	OPM	OPP	OT	IPM	PMC	PP	QPM	REQM	RSKM	SAM	PI	RD	TS	VAL	VER	CAR	CM	DAR	MA	PPQA
Oraganization	CL3			N/A	N/A					N/A									N/A				
	CL2			N/A	N/A					N/A									N/A				
	CL1			N/A	N/A					N/A									N/A				
Average Industrial Value	CL3																						
	CL2																						
	CL1																						

Process Area by Maturity

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
		Maturity Level 2							Maturity Level 3											Maturity Level 4		Maturity Level 5	
		CM	MA	PMC	PP	PPQA	REQM	SAM	DAR	IPM	OPD	OPF	OT	PI	RD	RSKM	TS	VAL	VER	OPP	QPM	CAR	OPM
Oraganization	Green																			N/A	N/A	N/A	N/A
	Yellow																			N/A	N/A	N/A	N/A
	Red																			N/A	N/A	N/A	N/A
Average Industrial Value	Green																						
	Yellow																						
	Red																						

Figure 13. Gap report an evidence selection to indicate project result

Finally, SPI proposal report depicts to advise the possibility solution to solve the non-conformity which implements SPI program based on SPIALSs recommendation. The recommendation follows the SCAMPI appraisal requirements for CMMI. (See Fig.14)



Software Process Improvement (SPI) report

Process Area by Category

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
		Process Management					Project Management							Engineering					Support				
		OPD	OPF	OPM	OPP	OT	IPM	PMC	PP	QPM	REQM	RSKM	SAM	PI	RD	TS	VAL	VER	CAR	CM	DAR	MA	PPQA
SPI problem	CL3						*	*	*		*					*				*	*	*	
	CL2							*	*												*		
	CL1																						
SPI recommendation	CL3						1	3	5		6					7				8	9	11	
	CL2							2	4												10		
	CL1																						

Process Area by Maturity

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
		Maturity Level 2							Maturity Level 3											turity Leve		aturity Leve	
		CM	MA	PMC	PP	PPQA	REQM	SAM	DAR	IPM	OPD	OPF	OT	PI	RD	RSKM	TS	VAL	VER	OPP	QPM	CAR	OPM
SPI problem	Green	*	*	*	*				*	*						*	*						
	Yellow			*	*				*														
	Red																						
SPI recommendation	Green	8	11						9														
	Yellow								10														
	Red																						

SPI recommendation

1 IPM: Please collect process related experiences derives from planning and perform the process to support the future use and improvement of the organization's processes and process assests.
2 PMC: Please manage corrective actions to closure.
3 PMC: Please collect process related experiences derives from planning and perform the process to support the future use and improvement of the organization's processes and process assests.
4 PP: Please plan for resources to perform the project.
5 PP: Please adjust the project plan to reconcile available and estimated resources.
6 REQM: Please collect process related experiences derives from planning and perform the process to support the future use and improvement of the organization's processes and process assests.
7 TS: Please develop and maintain the end-use documentation.
8 CM: Please perform configuration audits to maintain the integrity of configuration baselines.
9 DAR: Please provide adequate resources for performing the process, developing the work products, and providing the services of the process.
10 DAR: Please collect process related experiences derives from planning and perform the process to support the future use and improvement of the organization's processes and process assests.
11 MA: Please collect process related experiences derives from planning and perform the process to support the future use and improvement of the organization's processes and process assests.

Figure 14. Software Process Improvement (SPI) proposal report

7. Conclusions and Future Work

Our approach defines a minimal software process improvement self-assessment for VSEs/SMEs supported by a web-based tool. One next step is to integrate other techniques or methods such as eXtreme Programming, Rational Unified Process by mapping artifacts and activities based on our CMMIbyScrum mapping model.

By mean of a controlled research experiment we plan to optimize resources from alternative SDLCs to fit to the needs of VSEs/SMEs by deploying selected best practices, and also to reduce the effort for producing required artifacts based on a Process Capability Model.

Thus, the comparison of effort to deploy various established SDLCs and methods in organizations based on their requirements will reflect and propose a SPI guideline to respond to needs and to return benefits for the VSEs/SMEs investments in SPI approaches.

8. References

[1] Chayakorn Piyabunditkul, Apinporn Methawachananont, Sompol Chaimongkhon, Boonchai Charoendouysil, "Accelerated Adoption CMMI by Agile Methodologies", TGGS-RWTH Aachen-NECTEC, In Proceeding(s) of the ProMAC Symposium 2009 (ProMAC2009), Bangkok, Thailand, October 28-30, 2009.

[2] Chayakorn Piyabunditkul, Nithipat Wongchingchai, Apinporn Methawachananont, "Step forward CMMI-Project Management by optimized Scrum", TGGS-RWTH Aachen-NECTEC, In Proceeding(s) of the 5th International Conference on Project Management (ProMAC 2010), Makuhari Messe, Japan, October, 13-15, 2010.

[3] SCAMPI Upgrade Team. "Appraisal Requirements for CMMI. Version 1.2 (ARC, V1.2) Technical Report", CMU/SEI-2006-TR-011, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, PA, 2006.

[4] SCAMPI Upgrade Team, "Standard CMMI Appraisal Method for Process Improvement (SCAMPI) A. Version 1.2: Method Definition Document", CMU/SEI-2006-HB-002, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, PA, 2006.

[5] Will Hayes, Gene Miluk, Lisa Ming, Margaret Glover, "Handbook for Conducting Standard CMMI Appraisal, Method for Process Improvement (SCAMPI) B and C Appraisals, Version 1.1", CMU/SEI-2005-HB-005, December 2005.

[6] Stephen Blanchette, Jr., Kristi L. KeelerSelf, "Assessment: The CMMIAM–A Guide for Government Program Managers", Software Engineering Institute, Carnegie Mellon University, Pittsburgh, PA, August 2005.

[7] Schwaber, Ken, "Agile Project Management with SCRUM", Microsoft Press. ISBN 978-0-735-61993-7, February 2004.

[8] Schwaber, Ken, "SCRUM Development process", Proceedings of the 10th Annual ACM Conference on Object Oriented Programming Systems, Languages, and Applications (OOPSLA), Austin, Texas, 15-19 October 1995.

[9] Jeff Sutherland, "The Scrum Papers: Nut, Bolts, and Origins of an Agile Process", CTO and Worldwide Scrum Consulting Practice Manager, 2007.

[10] Md. Junaid Arafeen, Saugata Bose, "Improving Software Development Using Scrum Model by Analyzing Up and Down Movements on The Sprint Burn Down Chart: Proposition for Better Alternatives ", JDCTA: International Journal of Digital Content Technology and its Applications, Vol. 3, No. 3, pp. 109-115, 2009.

[11] Fatemeh Kafili Kasmaee, Ramin Nassiri, Gholamreza Latif Shabgahi, "Achieving CMMI Maturity Level 3 by Implementing FEAF Reference Models", IJACT: International Journal of Advancements in Computing Technology, Vol. 2, No. 4, pp. 115-122, 2010.

[12] Ana Sofia C.Marcal, Bruno Celso C.de Freitas, Felipe S.Furtado Soares, Arnaldo D.Belchior, "Blending SCRUM Practices to CMMI Project Management Process Areas", University of Fortaleza-CE, Brazil and C.E.S.A.R, Recife-PE, Brazil, Innovations Syst Softw Eng (2008) 4:17-29.

[13] Disorn Homchuenchom, Chayakorn Piyabunditkul, Horst Lichter, Toni Anwar, Apinporn Methawachananont, Chumphol Krootkaew, Tisanai Krisanathamakul, "SPIALS: A light-weight Software Process Improvement Self-Assessment Tool", In IEEE Proceeding(s) of the 5th Malaysian Conference in Software Engineering (MySEC), Johor Bahru, Malaysia, 2011.