A comparative study of SPI Approaches with ProPAM

Paula Ventura Martins
INESC-ID, Universidade do Algarve
Campus de Gambelas,
8005-139 Faro, Portugal
pventura@ualg.pt

Alberto Rodrigues da Silva
INESC-ID /Instituto Superior Técnico
Rua Alves Redol, nº 9
1000-029 Lisboa, Portugal
alberto.silva@acm.org

Abstract

Software Process Improvement (SPI) is one of the main software development challenges. Unfortunately, process descriptions generally do not correspond to the processes actually performed during software development projects. They just represent high-level plans and do not contain the information necessary for the concrete software projects. This deficient alignment between the process and project is caused by processes that are unrelated to project activities and failure in detecting project changes to improve the process. Process and project alignment is essential to really find out how process management is important to achieve an organization's strategic objectives. Considering this approach, this paper presents a comparative study of some of the most recognized SPI approaches and a new software process improvement methodology proposed, designed by Process and Project Alignment Methodology (ProPAM). Our intention is to show the problems observed in existing SPI approach and recognize that further research in process and project alignment based on actor oriented approaches is required.

1. Introduction

Software process improvement (SPI) is a challenge to organizations trying to continually improve the quality and productivity of software and to keep up their competitiveness [1]. However, there has been limited success for many SPI efforts. Recent reports concluded that 70% of organizations attempting to adopt the CMM (Capability Maturity Model) failed in achieving the intended goals [2].

There is a vast literature about prescriptive process improvement approaches, such as: CMM [3], CMMI [4], ISO/IEC 15504 [5-7], BOOTSTRAP[8]. These approaches are very descriptive just explaining essential attributes that would be expected to characterize an organization at a particular maturity level. However, they don't tell though how to improve and which are the specific means to get into a particular maturity level. These approaches don't provide methods for process elicitation and modelling in order that projects follow specific development processes. They don't show how project practices and knowledge is gathered to contribute for process improvement. They don't explain the mechanisms of team members' collaboration to cope with changing contexts or react to existing problems. These are the main reasons for limited success in many SPI programs. Also important is the fact that some studies recognize the need of further research on implementing SPI [9].

The contribution of this paper is to present not only a new SPI approach, but also to discuss the advantages and disadvantages of other SPI approaches comparatively to ProPAM (Process and Project Alignment Methodology). ProPAM is a SPI approach based on process and project alignment for detecting misalignment between projects and supporting processes.

This paper is organized in the following sections. Section 2 presents a research review of software process improvement. Section 3 describes briefly the proposed ProPAM methodology. Section 4 compares ProPAM against other SPI approaches. Finally, Section 5 concludes and introduces future trends.

2. Related Work

The purpose of this section is to give a short overview of some of the most widely recognized SPI efforts to illustrate the problems that are most common. Such improvement paradigms are: ISO/IEC 15504 [5-7], CMMI [4] and SPIQ [10]. In 1997, the Productivity Consortium defined the framework quagmire proposing to help organizations understand which approaches were most important and how they are related to each other (figure 1).

ISO established the Software Process Improvement and Capability dEtermination project, SPICE [5], to support the development of an international standard for software process assessment that have been published as **ISO/IEC 15504** [5-7]. This approach puts more emphasis on software engineering processes, project and business organisation. **ISO/IEC 15504** organises and

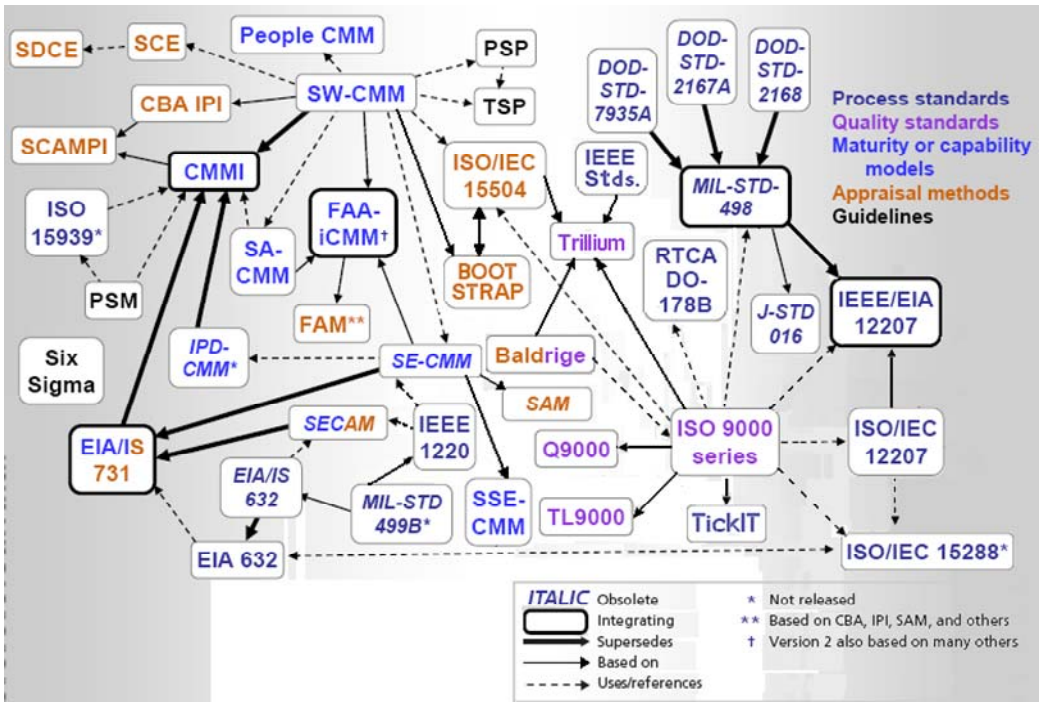

Figure 1. The frameworks quagmire (adapted from [11])

rates processes in a two-dimension process model with a fully independent process dimension and capability dimension. Each process area and/or practice has no longer a pre-allocated and fixed priority as those in CMM. The process capability scale is composed by a set of nine process areas at six capability levels.

It is interesting to note that, technically, **ISO/IEC 15504** has also absorbed the basic concept of the capability rating scale from CMM [3]; the software engineering process activities identified in ISO 12207 [12], Trillium [13], and CMM [3]; the attribute-based profile representation for process capability from BOOTSTRAP [8], and the general quality system management experience from the ISO 9000 [14, 15].

Despite the broad usage of Capability Maturity Model for Software (SW-CMM) [3], from 1998 SEI development efforts were directed to the Capability Maturity Model-Integrated (CMMI) [4]. **CMMI** integrates SW-CMM and Systems Engineering Capability Maturity Model (SE-CMM), the latter one was developed for assessing systems engineering processes. CMMI has adjusted the assessment approach according to ISO 15504 [5-7]. Now, **CMMI** recognizes two approaches to assessment and improvement: a staged model and a continuous model, allow working with only selected process areas. The Standard CMMI Appraisal Method for Process Improvement (SCAMPI) is the appraisal method associated with CMMI. The SCAMPI appraisal method is used to identify strengths, weaknesses, and ratings relative to CMMI reference approach. The CMMI embodies and promotes many software engineering practices, but does so without prescribing detailed technical procedures, criteria, or standards.

The Software Process Improvement for better Quality (**SPIQ**) is a major Norwegian software improvement program [10]. The overall goal of **SPIQ** is to increase the competitiveness and profitability of Norwegian IT-industry through systematic and continuous process improvement. **SPIQ** is based on the general process improvement principles of Total Quality Management (TQM) [16], GQM [17] and the experience factory. The SPIQ approach for process improvement builds on three main issues: (1) the PDCA – Plan, Do, Check, Act – cycle; (2) decisions should be based on facts – observations and experience; (3) developer participation is an essential part of all process improvement activities. To move from data and individual experience to shared explicit knowledge, SPIQ uses group processes which include interviews and feedback sessions.

Research on software development process intends to define the process elements that constitute good practices. Also important is the way processes evolve within the changing needs of the development organizations. Currently, there is a lack of support on how SPI approaches address the problem about how processes are effectively applied and improved using knowledge from projects. Another challenge is how to control and validate important project changes that must be integrated within the project. So, the main challenges are: process representation, project representation and process and project alignment. Based on this, we propose a new approach to SPI – ProPAM.

3. ProPAM Methodology

The proposed methodology supports SPI based on process and project management alignment. Process and project alignment is defined as the degree to which project goals and plans support and are supported by the process practices. Moreover, it involves a real match between process practices and project activities, work products and actors. However, several modifications in a project can cause misalignments with the development process. These modifications can be management innovations or changes in the way activities are executed. Furthermore, a modification may regard not only the considered activity, work product or actor but it could also affect other elements having a dependence relation with the modified one. So, keeping track on project execution, it is possible to detect changes in the project and propose improvements to the process considering that updates.

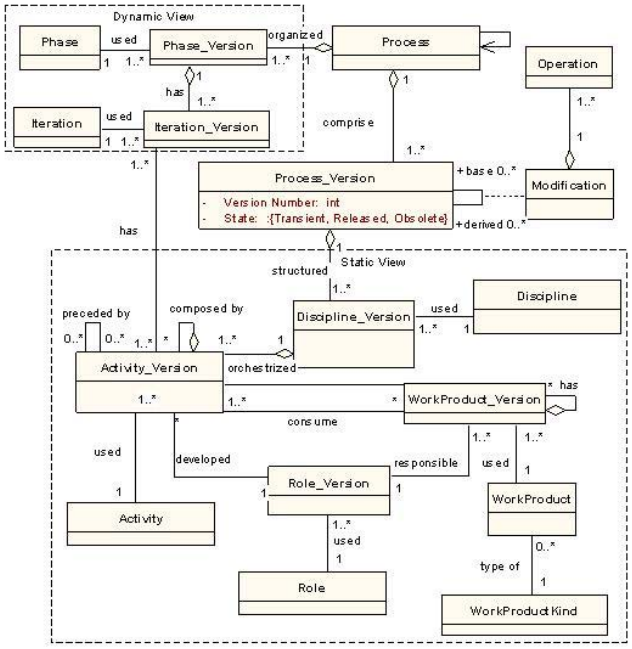

Figure 2. ProjectIT Process Meta-model

This section just presents a brief overview of ProPAM methodology, a detailed specification can be found in [18]. The proposed methodology shares the same ideas and objectives as the paradigm-based approach. The most recent approach to Situational Method Engineering as described in literature. The main idea is to adapt existing processes to specific projects situations [19]. ProPAM includes a set of modelling activities, where process and project modelling should be supported on a very high level of abstraction. The modelling activities are based on a set of meta-models developed to support process and project specification. Figure 2 shows ProjectIT Process Meta-model (PIT-ProcessM) that allows defining process models and also supports the versioning of process elements.

Figure 3 shows the relation between the four steps in the ProPAM methodology: (1) Process Definition; (2) Project Definition; (3) Project Monitoring and Control and (4) Process Assessment.

3.1. Process Definition

In ProPAM, a process is defined as an instance of PIT-Process meta-model [20]. A process is defined by a set of phases which are composed by several iterations. Disciplines and activities, work products and roles define the space of possible choices for projects within a given process. Activities can be defined according activity/sub-activities relationships represented in a hierarchical work breakdown.

3.2. Project Definition

In ProPAM, process models are used as templates for creating the definition of projects. The project consists of some project elements that are instances of elements from the base process. Not all process elements need to be included in the project, but all project elements should be instances of process elements. An exception is possible if an element is created as result of a change proposed by team members or process group. When a process element is assigned to a project, creating a new project element, all the information in the process element is copied to the project element, including a copy of all the associated elements.

In this methodology, after instantiating a process, the initial result is a project plan. This plan represents the initial step to start the project. Projects have certain administrative characteristics like schedule, milestones and deadline, resources, and structure i.e. phases and iterations of the project that will performed based on this initial plan. Team members are assigned to the project and gather information that is useful for the project, like work products, from the perspective of their current role.

3.3. Project Monitoring and Control

The third step consists in project monitoring and control. Updates and extensions to the initial project plan will be registered, always considering a base process model. Although most project elements are an instance of process elements, project team members have the liberty to create entities specific to a project. These changes are detected through the SPI actions performed by the process group. When a new process or new version is introduced,

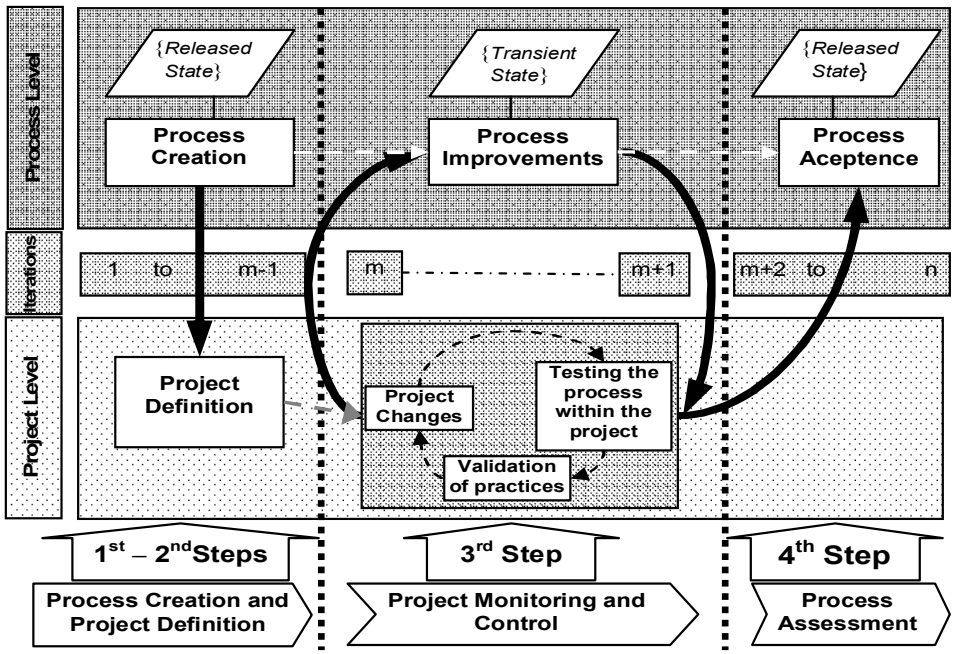

Figure 3. Process and Project Alignment Methodology

a validation phase is needed for monitoring their fitness and performance in the whole process. Thus, SPI actions subsume two problems: (1) process modification and (2) ensuring that projects and base process remain aligned with each other.

The project monitoring and control step is composed by two different tasks. The first task (Project Iterations) is about getting knowledge through project change candidates to improve the process and is repeated in all project iterations and phases. The second task (Process Versioning) subsumes that changes are accepted and that it is necessary to keep historical information about several process versions. The versioning schema introduces some changes in the PIT-ProcessM meta-model (see figure 2). The meta-model was extended to support the versioning of process elements.

3.4. Process Assessment

At the end of the project, process improvements should be analyzed in a reflection and retrospective meeting. The main goal is to analyze all the improvement opportunities identified in the project and validate all the SPI actions accepted in workshops. Prospects for success in executing and improving software process activities rise significantly when decisions can be based on quantitative information which can only be obtained by observing and measuring the products, projects and resources involved. But as complex as software development is, there are potentially so many things to measure against organizations goals and plans. In ProPAM, process assessment occurs at two distinct levels: (1) project level and (2) process level.

At project level, SPI assessment in practice can be viewed as the acquisition of data (key indicators) in a project where the new process version was applied followed by data analysis and decisions about the further adoption of this development processes. Key indicators used to evaluate projects success are normally: staff productivity, software quality, cycle time, project costs and costumer satisfaction.

At process level, the entities to evaluate are the different phases of the development processes and the attributes of these phases which include cost, time, etc. In a measurement program, the organization has to identify the areas of measurement. The measurement objectives should be clear and well defined. Since project management is an important discipline in the proposed methodology, the key indicators must align with those used by the project manager to analyze and evaluate a project.

However, SPI key indicators may change and evolve. Over time, process changes can impact the way measurements are defined, the way measurements are collected, or the frequency of measurement collection and analysis activities. To facilitate this evolution and ensure that the measurements and indicators continue to provide meaningful information to managers, the continuous recording of project background information is important to: (1) facilitate the analysis and interpretation of measurements over time; (2) establish links between measurement data sets over time and (3) understand exactly how the measurements are evolving.

4. Comparative study of SPI approaches

SPI approaches such as the SPIQ [10], and standards such as CMMI [4] and ISO/IEC 15504 [7] focus on processes in order to produce quality software. Research shows that the effort put into these approaches can assist in producing high quality software, reducing cost and time, and increasing productivity [21-23]. However, little attention has been paid to the effective implementation of these approaches, which has resulted in limited success for many SPI efforts [24]. Considering these facts, we provide a comparative study of these approaches showing the most important similarities and differences. We intend to prove that these approaches are not appropriate for all situations, so other solutions must be investigated.

In our comparative study, we used a comparative framework based on the Conradi's taxonomy [25]. The main goal is to get a short tabular presentation about SPI approaches. These characteristics are organized in five categories (General, Organization, Process, Improvement and Empirical Evidence) that are presented in Table 1. The covered features are quite large, so we will not discuss all of them, only some of the most representative ones are discussed here. The categories under study are Process, Improvement and Empirical Evidence. For each of theses features, we will explain advantages and disadvantages of the analysed approaches.

The features from the other two categories (General and Organization) are proposed only to present an historical perspective and relations between ISO/IEC 15504, CMMI and SPIQ and other SPI approaches. The most recent SPI approaches were developed based on previously developed SPI approaches or quality principles (see figure 1). A base SPI approach was completed with additional ideas/principles in order to make the new proposal applicable and useful. Also important, it is the scope of an SPI approach, since it gives a good picture about its usage in terms of types of organizations have used it and to which countries it has spread its reach.

4.1. Process

ISO/IEC 15504 and CMMI are descriptive in the sense that they describe the characteristics of a typical organization at each level of maturity - through success stories, surveys or case studies. However, they are prescriptive in the sense that they present some normative model of how software development should be conducted and improved, or describing how an organization can improve its problem identification and problem-solving activities. These prescriptions mostly focus on organizational and management activities, particularly at low maturity levels where the technical advances are considered less important. At higher maturity levels, CMMI specify how technical activities should be carried out. There is a danger that these approaches don't fit the particularities of each organization applying it. Adapting these approaches to organization's specific needs is encouraged, but the problem is that there are no guidelines as for how this adaptation may be carried out. The SPIQ represents a completely descriptive approach to process improvement. There is no element of prescription on any level, except the responsibility of a project organization for characterizing its own environment.

ProPAM is a descriptive process modelling approach. Like SPIQ, the main goal is to address the particularities of each organization, improve the process and get better quality products. However, ProPAM proposes a user-oriented approach for software process modelling. Based on it, software processes are viewed as a collaboration of a group of actors that know how to manage their activities.

The adaptability of a SPI model to specific organizational and business situations (tailoring) should be one of its main objectives.

CMMI approach claim to be flexible and tailorable to the goals of each organization. However, there is no support for tailoring, thus these improvement efforts cannot be considered adaptive. Another problem is that there is no guidance for how much tailoring is acceptable within the limits of the approach.

ISO/IEC 15504 two dimensions model (processes and capability) provide much greater flexibility than the CMMI because several processes can be managed at different capabilities levels. This standard is tailorable for different software life cycle models, and it is the organization's responsibility to map the activities of the standard into the chosen model. Several experiences, such as the experiences reported by Cass et al. [26], served as examples of the adaptation of the standard for particular industrial sectors and its extension into new domains.

The SPIQ improvement approach has been applied to a number of very different projects with respect to technology, people, products and processes. This shows that the approach is applicable in various environments. Second, the fact that the approach has been applied for 10 years shows that it is adaptable over time. As the goals of the organization change, so the improvement approach does. The SPIQ approach evolves according to goals based on the context. Here, adaptivity refers to evolution as well as suitability in different contexts.

A study by Kautz and Larsen [27] indicated that the use of comprehensive SPI approaches is still quite low, partly because of their rigidity. This suggests that adaptability is an important quality of a framework. ProPAM intends to fill this gap. Since no guidelines are imposed, the methodology suggests an adaptation to specific needs of an organization.

ISO/IEC 15504 and CMMI appraisal methods are mainly intended for people who have been trusted with the management of a large process initiative. They are important for staging and managing a successful

Table 1. Comparative study of four SPI approaches

Category	Characteristic	ISO/IEC 15504	CMMI v1.2	SPIQ	ProPAM
General	Geographic Origin/Spread	World/World	USA/World	Norway/Norway	Portugal/Portugal
	Scientific Origin	SW-CMM, Bootstrap, Trillium, SPQA	SW-CMM,ISSO/IEC 15504	TQM, ESSI model, EF	EF
	Development	1998	2000	2000	Under development
	Popularity	Moderate	Top (USA)	Norway	Some SME
	Software Specific	Yes	No	Yes	No
Organization	Actors	Management (senior manager, process owner, organizational unit)	Management	Customer, project team, sponsoring organization	Process group, project team
	Organization Size	All	All	Small and Medium	Small and medium
	Coherence	Internal and external	Internal and external	Internal and external	Internal
Process	Prescriptive/Descriptive	Both	Both	Descriptive	Descriptive
	Adaptability	Yes	Limited	Yes	Yes
	Philosophy	Goal – Oriented: Capability level	Goal – Oriented: Maturity or Capability level	Continuous	Continuous
	Assessment	Process Maturity	Organization/ Process Maturity	Costumer satisfaction	Process Metrics
	Comparative	Yes, capability level	Yes, maturity and capability levels	No	No
	Certification	Yes, Process Areas	Yes	No	No
	Appraisal Method	Spice Doc. Part 7	SCAMPI	Two-level PDCA	Two-level PDCA; Process and Project Modelling
	Analysis Techniques	Several (manual and automatic)	CMMI appraisal/ Questionnaire	GQM, group interviews, feedback sessions	Projects data, Iteration meetings and final meeting
	Assessor	Internal and external	Internal and external	Limited internal	Internal and external
Improvement	Perspective	Process	Organizational	Customer, all	Project Team members
	Improvement Initiation	Process Instance	Top-down	Top-down and iterative, bottom-up	Bottom-up
	Improvement Focus	Management Processes	Management Processes	Experience reuse	Projects
	Progression	Continuous (staged at process instance level)	Staged and Continuous	Continuous	Continuous
Empirical Evidence	Main Goal	Process assessment	Process improvement, supplier capability determination	Increased competitiveness and profitability	Process improvement, better product quality
	Process Artefacts	Process profile, assessment record	Process documentation, assessment result	Experience packages, GQM models, TQM tools	Process specification
	Empirical Validation	Document review, trials (surveys and case studies)	Survey and case studies	Experimental and case studies	Experimental and Case studies

program and represent a step towards an institutionalised Software Process Engineering system. The methods have certain strengths and weaknesses when compared to each other's. The strengths of the ISO 15504-7 are that the cycle itself is very elaborate and that the cultural issues have been given special attention. Initially, the main concern was the fact that the method hadn't been derived from actual industry cases – it was a theoretical model. After that, three phases of SPICE project user trials has provided further experience feedback into the development of ISO/IEC 15504. The approach also lacks insight to multi-site SPI program issues and thus is most suitable for local (single-site) operation rather than for a cross-site program, even though the material stakes a claim of being equally applicable at different organisational levels. In addition the monitor-phase implies an interrupted rather than continuous cycle, while the material starts with a claim that the cycle is continuous. While there is nothing wrong in this, it should be stated up front in respect to the single-site vs. cross-site issues - so that the people intending to apply the method would be aware of the potential shortcomings.

As mentioned to ISO/IEC 15504, little attention has been paid to the support of process improvement in multi-site, multi-organization software development projects. SCAMPI, the CMMI appraisal method, covers a multi-site organization with numerous projects. As Gary Salisbury mentioned: SCAMPI and Practice Implementation Indicator Databases (PIIDs) "on-line" have made electronic verification of process deployment simple and effective in a multi-site organization [28]. Another key strength in the SCAMPI appraisal process is a review prior to the appraisal on-site period to determine readiness to proceed with verification based appraisal as planned. Additionally, instruments can support the SCAMPI method emphasis on verification-based appraisals and minimize the need for on-site discovery of objective evidence, thus helping to facilitate efficient appraisal performance.

In the presented appraisal approaches, improvement is addressed through preventative and corrective actions, but there is little support for measurement of improvement as a part of the standards. The problem of measuring improvement is relevant because actions that result in an improvement in one context may have the opposite effect in other environments.

On the contrary, bottom-up approaches start with understanding the processes that the organization owns. A process improvement is conducted based on measurement and experience. The SPIQ approach belongs to this group, since it is difficult to reuse the mechanisms and knowledge of bottom-up without huge experience base. The SPIQ starts measurement from the beginning, and applies it for checking whether goals are reached through the GQM approach.

Nevertheless, GQM does not provide any guidelines or methods for identifying problems and goals as perceived by project team members. Our approach intends to provide a systematic method that allows project team members detect problems. ProPAM is an approach based on process and project alignment to detect problems and analyse the impact of the proposed solutions. Like SPIQ, ProPAM proposes a two-level PDCA program but also suggests an assessment method to analyse the impact of the new/updated software process against previous versions.

There are various philosophies underpinning SPI. Key categories of SPI philosophy are: goal-oriented process improvement, benchmark-based process improvement, and continuous process improvement. ISO/IEC 15504 and CMMI use goal-oriented process improvement, the most widely adopted philosophy. In this SPI philosophy, process system capability is improved by moving towards a predefined goal, usually a specific process capability level. Due to their prescriptive nature on the management level, ISO/IEC 15504 and CMMI can be used for comparing and assessing organizations. For example, two organizations assessed using the staged CMMI can be compared on the basis of their maturity levels, i. e. the one with the higher maturity level is assumed to have the higher process quality as well.

Another problem is that since staged CMMI describes general levels of maturity, there will be some competition among organizations in order to advance to as high a level as possible because the levels serve as a framework for comparing software developers. Thus, an organization may become more interested in satisfying the requirements of the staged CMMI rather than satisfying the needs implied by the organization's particular situation.

On the other hand, SPIQ is typical component of continuous process improvement philosophy by which a process system is required to be improved all the time, and toward ever higher improvement levels. It is this assumption that change is normal that is in tune with modern management theory. However, SPIQ don't provide mechanisms to allow process definition, and consequently, projects are not obligatorily aligned with a base process. Project knowledge acquisition and representation are not supported too.

Considering that continuous SPI has been proven effective in engineering process optimization and quality assurance, ProPAM also follows this philosophy. Daily project activities performed by project teams are a good basis to continuously detect problems and propose new or improved development processes. Since, ProPAM supports process modelling and project definition considering a base project, these are the infra-structures that allow the retrieve project and process

knowledge. Also important is the way how project teams collaborate to

CMMI, ISO/IEC 15504, SPIQ and ProPAM are different with respect to modifications of the organization. To change people's behaviour requires a cast of characters that, at times, performs cross-functional roles above and beyond the day-to-day mission to implement the SPI program. CMMI and ISO/IEC 15504 propose a "shadow" organization that functions on the peripherals of the normal management chain.

In CMMI, process improvement can be conducted either internal to an organization or a more formal process involving process support personnel like: (1) Executive Council (EC); (2) Process Improvement Advisory Council (SPIAC); (3) Management Steering Group (MSG); (4) Software Process Engineering Group (SEPG) and (5) Technical Working Group (TWG).

There is no actual infrastructure model for process assessors in the ISO 15504-7, but the material does describe the managerial responsibilities of certain organisational elements and through these an underlying organisational infrastructure can be deduced. The only broader concept presented of the infrastructure is the statement that the improvement infrastructure should be able to involve the entire organisation, if the improvement is to be performed effectively.

SPIQ model is based on organizational knowledge creation theory, presented by Nonaka and Takeuchi as a continuous and dynamic interaction between tacit and explicit knowledge [29]. The organization cannot create knowledge on its own without individual initiative and interaction at the group level (project teams) play a central role in the knowledge creation process since they provide a shared context in which individual developers can interact with each other. Consequently, SPIQ main focus is on software development teams.

ProPAM, also believes in building knowledge from individual to group and vice-versa. However, in order to avoid chaos, a middle-manager is necessary to filter the relevant data and coordinate the interaction. Project team members may be tasked to develop recommended solutions for improvement problems, but it is the middle manager who is responsible to approve the solution and act as the change agent to ensure targets successfully implement the solution.

4.2. Improvement

CMMI emphasizes mainly the important management issues in software processes, such as the organizational process, software development management processes, project planning and project management. They are most management oriented because they address management activities, and they emphasize a management view of quality, control and predictability. CMMI is partially claiming that customer satisfaction is the ultimate goal and partially that the goal is to improve the organizational capability by applying statistical process control. The strong focus on defect prevention indicates that avoiding defects is an important goal, while it is also emphasized that the error rate only partially represents the customer's view of quality. Thus, there is some confusion about what the goal really is.

The ISO/IEC 15504 puts more emphases on software engineering process, and project and business organization. This model is most process-oriented. One of the main advantages of this standard is that the organisation can concentrate on the required process areas for improvement according to its business needs when compared to a step-by-step evolutionary approach, like the staged CMMI.

In SPIQ, one of the fundamental differences is the goal for improvement, this model is clearer on this matter because the responsibility of setting goals is left entirely to the organization. Thus, the SPIQ by itself is not a way of achieving a predefined set of goals. The SPIQ approach is oriented towards reusing experiences to reach goals. The model is built upon the view that goals and potential improvement actions develop and evolve over time.

As SPIQ, in ProPAM the responsibility of setting goals is left to the organization. This approach is also experience-oriented, the main difference is the support chosen to get data and knowledge to improve the process. While SPIQ supports its decisions on interviews and post-mortem feedback sessions, ProPAM gets data directly from projects and promotes iteration meetings to continuously improve the process. It also includes a final retrospective and feedback session to evaluate the improvement introduced during the project.

4.3. Empirical Evidence

CMMI and ISO/IEC 15504 are based on the way successful organizations have achieved software process improvement. Thus, it represents a common view of how engineering practices and management practices should be applied in order to produce quality software. However, little is said about the organizations that were the role models for these approaches. There has been a lack of investigation of how successful ISO/IEC 15504 and CMMI have been in improving the software process. The evidence that validate these approaches is mainly comprised by a number of case studies and a survey of a number of organizations that have been using improvement programs for some time. There is little internal validation - i.e., whether the improvement approach actually is beneficial in each case is not considered. For CMMI, there is some external validity in that it is applied in various application domains

showing similar results. However, this has little effect as long as internal validity cannot be convincingly demonstrated.

The most important strength of the SPIQ is that the reliance on experiments and studies within the particular and relevant environment ensures that the process improvement actions that are carried out really do lead to an improvement. This indicates that the SPIQ is internally valid. However, it does not indicate any external validity. This does not mean that it would work in other contexts where the organization, application domain and technology might be different.

Several case studies in a software development organization are using ProPAM. This case studies help to improve and review the proposed methodology. Further research is required to validate this approach.

5. Conclusion

In this paper, we have discussed the ISO/IEC 15504, CMMI, SPIQ and the new ProPAM approach. We showed that approaches, like ISO/IEC 15504 and CMMI, are not specific enough to catch the needs of certain type of organizations, its business needs and its business goals. The prescriptive nature of ISO/IEC 15504 and CMMI, and the associated investment necessary to implement SPI programs are the main reasons for further researches on SPI approaches based on experience, such as SPIQ and ProPAM.

ProPAM and SPIQ can provide a better context to SPI in cases where organizations intend to define/improve their development process according to their needs. Furthermore, since ProPAM emphasises process and project alignment, suggesting an alternative method to capture information and customise the development process. ISO/IEC 15504, CMMI and SPIQ analysing techniques are just supported by questionnaires and individual or group interviews. Additionally, ProPAM proposes an analysing technique that includes daily project data given by project team members.

Currently, ProPAM methodology concepts as well as all meta-models that support the approach are defined. Initial experience with the ProPAM methodology was well succeeded and it is reported in [30]. Now, the focuses of our work is on refining and continue validating the methodology through several case studies.

The purpose of this paper was to give an overview of the critical problems relevant to some of the most widely used SPI approaches, to justify a new emerging SPI approach based on process and project alignment – ProPAM.

6. References

[1] O. Salo, "Improving Software Development Practices in an Agile Fashion," in *Agile Newsletter 2*, Agile-ITEA ed, 2005, pp. 8.

[2] H. Krasner, "Accumulating the body of evidence for the payoff of software process improvement-1997," Krasner Consulting 1997.

[3] SEI, "Capability Maturity Model for Software (CMM), Version 1.1," Carnegie Mellon University 1993.

[4] SEI, "Capability Maturity Model Integration (CMMI), Version 1.2," Software Engineering Institute, USA 2002.

[5] ISO/IEC, "15504-2 Information technology - Software process assessment – Part 2: A reference model for processes and process capability," July ISO/IEC TR 15504-2, 1998.

[6] ISO/IEC, " 15504-5 Information technology – Software process assessment – Part 5: An assessment model and indicator guidance," ISO/IEC JTC1 / SC7, 1998.

[7] ISO/IEC, "15504-7 Information technology – Software process assessment – Part 7: Guide for use in process improvement," International Organization for Standardization ISO/IEC TR 15504-7, 1998.

[8] P. Kuvaja, J. Simila, L. Krzanik, A. Bicego, G. Koch, S. Saukkonen, *Software Process Assessment and Improvement: The BOOTSTRAP Approach*, Blackwell Publishers, 1994.

[9] K. El Emam, P. Fusaro, B. Smith, "Success Factors and Barriers for Software Process Improvement," *Better Software Practice For Business Benefit: Principles and Experience*, Publisher, City, 1999, pp. 355-371.

[10] H. J. Lied, T. Stålhane, "Experience from process improvement in a SME," presented at EUROSPI'99, 1999.

[11] S. A. Sheard, "Evolution of the Frameworks Quagmire," *IEEE Computer*, Publisher, City, 2001, pp. 96 – 98.

[12] ISO/IEC, "12207 Information technology – Software life cycle processes," International Organization for Standardization, Geneva, Switzerland 1995.

[13] F. Coallier, N. Gammage, A.V. Graydon, "Trillium - Software Process Self-Assessment Capability Assessment," Bell Canada, Bell Northern Research, Northern Telecom PI QOOS, Issue 4.0, 1993.

[14] ISO-9001, "ISO-9001: Quality systems - Model for quality assurance in design, development, production, installation and servicing," International Organization for Standardization 1993.

[15] ISO, "ISO 9000-3: Quality management and quality assurance standards - Part 3," International Organization for Standardization 1990.

[16] K. Uchimaru, S. Okamoto, B. Kurahara, *TQM for technical groups - Total Quality Principles for Product Development*, Productivity Press. Portland, Oregon, 1993.

[17] Basili, V. R., "Software Modelling and Measurement: The Goal/Question/Metric Paradigm," University of Maryland UNIACS-TR-92-96, 1992.

[18] P. V. Martins, A. R. Silva, "ProPAM: SPI based on Process and Project Alignment," presented at 2007 IRMA Internacional Conference, IGI Publishing, Vancouver, 2007.

[19] M. Bajec, D. Vavpotic¡, M. Krisper, "Practice-driven approach for creating project-specific software development methods," *Information and Software Technology*, Publisher, City, 2007, pp. 345-365.

[20] P. V. Martins, A. R. Silva, "PIT-P2M: ProjectIT Process and Project Metamodel," in *Lecture Notes in Computer Science*, Springer Berlin / Heidelberg, vol. 3762, *On the Move to Meaningful Internet Systems 2005: OTM Workshops*, Z. Tari R. Meersman, P. Herrero, Ed. Agia Napa, Cyprus, 2005, pp. 516-525.

[21] Butler, K., "The economics benefits of software process improvement," *CrossTalk*, Publisher, City, 1995, pp. 14-17.

[22] Pitterman, B., "Telcordia technologies: The journey to high maturity," *IEEE Software*, Publisher, City, 2000, pp. 89-96.

[23] Yamamura, G., "Software Process Satisfied Employees," *IEEE Software*, Publisher, City, 1999, pp. 83-85.

[24] D. R.Goldenson, J. D. Herbsleb, "After the Appraisal: A Systematic Survey of Process Improvement, Its Benefits, And Factors That Influence Success," Software Engineering Institute, USA. 1995.

[25] C. P. Halvorsen, R. Conradi, "A Taxonomy to Compare SPI Frameworks," presented at Proceedings of the 8th European Workshop, EWSPT 2001, LNCS, Witten, Germany, 2001.

[26] A. Cass, C. Völcker, P. Sutter, A. Dorling, H. Stienen, "SPiCE in Action - Experiences in Tailoring and Extension," presented at Euromicro Conference, Dortmund, 2002.

[27] E. Å. Larsen, K. Kautz, "Diffusion and Use of Quality Assurance and Software
Process Improvement Approaches in Norway: A Survey-Based Study," Norwegian Computing Center/Applied Research and Development, Oslo 906, April 1996 April 1996.

[28] Salisbury, G., "CMMI: Does it Help Us Perform?." Denver, 2005.

[29] I. Nonaka, H. Takeuchi, "The Knowledge-Creating Company," *Oxford University Press*, Publisher, City, 1995

[30] P. V. Martins, A. R. Silva, "A case study applying Process and Project Alignment Methodology," *JBCS- Issue on Experimentation in Software Engineering*, Publisher, City, 2006, pp. 65-82.