Implementing Software Process Improvement Initiatives in Small and Medium-Size Enterprises in Brazil

Gleison Santos, Mariano Montoni, Jucele Vasconcellos, Sávio Figueiredo, Reinaldo Cabral, Cristina Cerdeiral, Anne Elise Katsurayama, Peter Lupo, David Zanetti, Ana Regina Rocha
COPPE/UFRJ – Universidade Federal do Rio de Janeiro
{gleison, mmontoni, jucele, savio, cabral, cerdeiral, anneelisek, zanetti, darocha}@cos.ufrj.br

Abstract

Appropriate process implementation approaches are fundamental for Small and Medium-size Enterprises (SMEs) to obtain the most of Software Process Improvement (SPI) benefits. COPPE/UFRJ has been providing SPI consultancy services to the Brazilian software industry for more than two decades. In order to cope with factors that have influence on SPI success, we developed an approach to implement SPI initiatives based on the Brazilian software process model (named MPS Model) through the adoption of a SPI strategy (named SPI-KM) and the support of a Process-centered Software Engineering Environment named Taba Workstation. This paper presents the work conducted in a group of Brazilian SMEs aiming to deploy the MPS model based initiatives using the SPI-KM strategy supported by the Taba Workstation. We also discuss the lessons learned from implementing SPI in this group of SMEs and also other lessons collected throughout previous SPI experiences.

1. Introduction

In Small and Medium-size Enterprises (SMEs), Software Process Improvement (SPI) deployment approaches require special concerns due to some constraints regarding material and human resources. In order to assure their survival in the increasingly competitive market, it is necessary to overcome these difficulties and improve the productive process. For this reason, SPI deployment approaches must be developed aiming to cope with this obstacles and to provide the means for increasing SPI programs success, especially for SMEs. For instance, the Software Engineering Institute (SEI) has demonstrated interest in researches focusing SPI in small companies [1].

Since 2003, Brazilian software industry and research universities are working cooperatively in implementing a successful SPI strategy that takes into account the constraints inherent to SMEs. The main goal of this initiative is to improve the quality of Brazilian software processes and products through the development and dissemination of a Brazilian software process model, named MPS Model, based on software engineering best practices and aligned to Brazilian software industry context.

The MPS Model was developed in the context of the MPS.BR Program, a nationwide Brazilian initiative coordinated by the Association for Promoting the Brazilian Software Excellence (SOFTEX) whose main objective is to make possible the deployment of the principles of Software Engineering adapted to the reality of Brazilian companies, according to the main international approaches for software processes definition, evaluation and improvement [2]. The focus of the MPS Model is on SMEs that need to achieve significant improvements in software processes in a short time interval and with low costs. [7]. It provides mechanisms to facilitate SPI deployment of the most critical software processes. The adequate deployment of such processes promotes subsequent SPI deployment cycles and software process maturity growth.

COPPE/UFRJ has been providing SPI consultancy services to the Brazilian organizations for over two decades. Since 2003, we have been implementing software processes in SMEs groups in Rio de Janeiro. We developed and deployed a strategy to implement MPS Model-based SPI initiatives in SMEs named SPI-KM [9], which is supported by a Process-centered Software Engineering Environment (PSEE) named Taba Workstation [14]. This strategy was decisive to achieve CMMI levels 2 and 3 besides MPS Model levels F, E and D on several organizations [8].

0-7695-2948-8/07 $25.00 © 2007 IEEE
DOI 10.1109/QUATIC.2007.22

This paper presents the work carried out in a group of companies in Rio de Janeiro aiming the deployment of the MPS Model that used both SPI-KM strategy and the Taba Workstation. We also discuss the lessons learned from implementing SPI in this group of SMEs and also other lessons collected throughout previous SPI experiences. The next section presents SPI initiatives in SMEs. Section 3 describes the MPS Model and its components. Section 4 presents the SPI-KM approach main characteristics. Section 5 presents the main functionalities of Taba Workstation to support MPS Model-based deployment in SMEs. Section 6 presents the lessons learned using both SPI-KM approach and the Taba Workstation. Section 7 discusses the application of the presented approach in 5 Brazilian SMEs. Finally, section 8 presents our conclusions.

2. SPI Initiatives in SMEs

SPI implementation based on software process reference models and standards is a complex and long-term endeavor that requires investment of large sums of money. These obstacles usually hinder organizations from improving software processes, especially for SMEs that operate under strict financial constraints. Therefore, appropriate SPI implementation approaches are fundamental for SMEs to achieve benefits from implementing SPI at reasonable costs.

Many studies have been reported in the literature addressing the difficulties SMEs struggle to implement SPI initiatives. For instance, there is one study from Staples et al. [18] that present some reasons why software organizations avoid adopting CMMI. This study shows that software organizations, especially small ones, will never gain any benefit from process capability maturity improvement because they consider it infeasible to adopt CMMI mainly due to the small organization size, the high costs involved in providing SPI services, and the lack of time to dedicate on SPI activities. Staples et al. [18] also recognizes that despite the fact that models like CMMI can be tailored to be adjusted to small organizations, this tailoring involves justifying the exclusion of aspects of the model that compromises the execution of official appraisals.

Coleman and O'Connor [17] also present a study of how SPI is applied in the practice of software development. Their study results show that SPI programs are implementing reactively and that many software managers reject to implement SPI models such as CMMI model and ISO standards because of the associated implementation and maintenance costs. Wangenhein et al. [19] and Cater-Steel et al. [20] also point out that the main issue is to convince SMEs on the expected business benefits and recognizes the need to minimize the costs for process assessment and to make the benefits of SPI initiatives visible in a short time frame.

In order to manage the awareness of SPI benefits factor, especially in SMEs, SPI approaches, such as CMMI, must require radically less cost and time aiming to diminish the need to provide evidence about the relative costs and benefits of adopting SPI [18]. Therefore, organizations will be able to inexpensively implement SPI initiatives and observe for themselves benefits in their own context.

Staples et al. [18] suggest that recasting CMMI for the needs of small organizations may make it more widely successful in the industry, especially if there is a focus on issues of immediate concern to small organizations. For instance, the authors suggest the need to tailor the models in such way that an organization can start with minimal practices (or practices with perceived value), and add more practices according to specific needs as necessary. Wangenhein et al. [19] also points out that it is important to focus SPI on the most relevant processes, as well as to keep the assessment cost as low as possible with the maximum coverage of relevant processes. Nevertheless, there is little SPI implementation and assessment guidance specifically tailored to SMEs. This inhibits SMEs to implement SPI based on CMMI or ISO standards, and, as a consequence, limits the possibilities of SMEs to observe SPI benefits [21].

3. MPS.BR Program and SMEs

The MPS.BR Program was initiated in 2003 by the Association for Promoting the Brazilian Software Excelence (SOFTEX) aiming to increase software development capabilities of both large companies and SMEs and to enhance their competitive advantages [2]. The main goal of this program was to improve the quality of Brazilian software processes and products through the development and dissemination of a Brazilian software process model, named MPS Model, based on software engineering best practices and aligned to Brazilian software industry context. The MPS Model is constituted of three main components: the MPS Reference Model; the MPS Assessment Method; and the MPS Business Model. Figure 1 presents the MPS Model Components and the elements that constitute each component.

The MPS Reference Model (MR-MPS) is documented in the form of three guides: the MPS General Guide [2], the MPS Acquisition [3] and the MPS Implementation Guide [5].

The MPS General Guide provides a general definition of the MPS Model and common definitions to all other guides. The MR-MPS is conformant to ISO/IEC 15504 [16] since it fulfils the requirements for a Process Reference Model defined in ISO/IEC 15504-2. The MR-MPS defines seven levels of maturity and establishes expected results and attributes of processes that an organizational unit must attend when undertaking in improvement aiming to reach one of the maturity levels [2]. The MR-MPS maturity levels are: Level A (Optimization), Level B (Quantitatively Managed), Level C (Defined), Level D (Largely Defined), Level E (Partially Defined), Level F (Managed), and Level G (Partially Managed). For each of these maturity levels, processes were assigned based on the ISO/IEC 12207 [6] standard and on the process areas of levels 2, 3, 4 and 5 of CMMI staged representation. This division has a different graduation of the CMMI staged representation aiming to enable a more gradual and adequate deployment in SMEs.

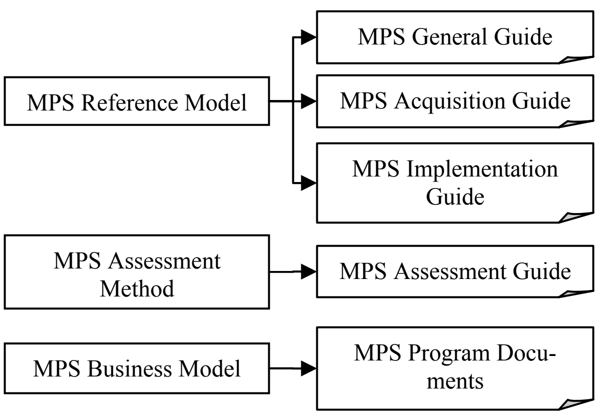

Fig. 1 MPS Model Components

The MR-MPS also defines process attributes (PA) based on the ISO/IEC 15504-2 process attributes to define capability levels. The MR-MPS defines nine PA: PA 1.1 (process performance attribute); PA 2.1 (performance management attribute); PA 2.2 (work product management attribute); PA 3.1 (process definition attribute); PA 3.2 (process deployment attribute); PA 4.1 (process measurement attribute); PA 4.2 (process control attribute); PA 5.1 (process innovation attribute); and PA 5.2 (process optimization attribute). Each PA comprises a set of Process Attribute achievement Result (PAR) used to evaluate a specific PA implementation. Table 1 presents the mapping between MR-MPS and CMMI maturity levels (ML), the MR-MPS processes and the PA that shall be added to each MR-MPS ML.

The MPS Acquisition Guide [3] describes software and service related acquisition process aiming to support organizations that desire to acquire software products or software service-related based on MR-MPS. The MPS Implementation Guide [5] provides information regarding the MR-MPS maturity levels deployment in software organizations, explaining the processes comprised by the MR-MPS and the expected results of these processes. The MPS Implementation Guide is tailored in 7 documents, one for each maturity level of MR-MPS from level G to level A.

Table 1 – Mapping Between MR-MPS and CMMI Maturity Levels, MR-MPS processes and process attributes (PA)

Maturity Levels		MR-MPS Processes	MR-MPS PA
CMMI	MR-MPS		
2	G	Project Management, Requirement Management	1.1, 2.1
	F	Measurement, Acquisition, Configuration Management, Quality Assurance	1.1, 2.1, 2.2
3	E	Human Resources Management Process Establishment Process Assessment and Improvement Project Management (new outcomes) Reuse Management	1.1, 2.1, 2.2, 3.1, 3.2
	D	Requirements Development Product Design and Construction Product Integration Verification Validation	1.1, 2.1, 2.2, 3.1, 3.2
	C	Decision Analysis and Resolution Risk Management Development for Reuse	1.1, 2.1, 2.2, 3.1, 3.2
4	B	Project Management (new outcomes)	1.1, 2.1, 2.2, 3.1, 3.2, 4.1*, 4.2*
5	A	Causal Analysis and Resolution	1.1, 2.1, 2.2, 3.1, 3.2, 4.1*, 4.2*, 5.1*, 5.2*

** These PAs are applicable only to selected processes. All others PAs must be applied to all processes.*

The MPS Assessment Guide [4] describes, among other things, the appraisal method and process. The MR Assessment Method for Process improvement was defined based on the ISO/IEC 15504 standard [16]. The level of deployment of the expected results related to a specific process is evaluated based on indicators that evidence such deployment. These indicators are defined for each company, related to the expected results of a process, and can be one of the following types: (i) Direct, (ii) Indirect, or (iii) Affirmations. Direct indicators are intermediate work products that result from an activity. Indirect indicators are generally documents that indicate that an activity was executed. Affirmations are results of interviews with the project teams of the evaluated projects.

The MPS Business Model (MN-MPS) defines business rules for: (i) training practitioners through MPS official courses, individual examinations and recycling workshops; (ii) implementing the MPS Model by organizations that provide MPS deployment services, (iii) executing process assessments by organizations that provide MPS assessment services; and (iv) organizing groups of enterprises to execute MPS deployment and assessment.

Besides, the MN-MPS comprises a Specific Business Model [2] suitable to large companies that do not want to share MPS services and costs with other companies and a Cooperative Business Model for groups of SMEs interested in implementing and assessing the MPS Model, and sharing MPS services and costs.

The possibility of rating companies' maturity considering more levels, not only decreases the cost and effort of achieving a certain maturity level, but also allows the visibility of the results of the software process improvement within the company and across the country in a short time frame.

4. SPI-KM: a Software Process Improvement Approach supported by Knowledge Management

In order to support SPI deployment initiatives, we developed a strategy, named SPI-KM [9], that has evidenced its feasibility and benefits over past well-succeeded SPI appraisals [7][10]. The strategy consists of a set of defined phases that focus on specific issues related to SPI initiatives' deployment; it has the support of Knowledge Management and takes advantage of the use of a Process-centered Software Engineering Environment (PSEE). The strategy is depicted in the Figure 2.

Diagnosis: The strategy begins when the software organization aiming to enhance its processes gets in touch with COPPE/UFRJ research group. At first, the organization business needs and goals, the organizational culture, the SPI goals, the software process reference model to be used and the level desired are identified with the high-level management. The organizational unit that is going to take part of the SPI initiative is also identified.

SPI Planning: During this phase, a plan for the SPI initiative is developed. This plan comprises, among other things: (i) the consultant team that is going to be allocated during the initiative, (ii) the organizational members to be trained, (iii) the schedule for the trainings, (iv) the processes definition prioritization regarding organizational goals and strategic needs, (v) creation of groups of work with designated responsibilities, (vi) definition of supporting tools, infrastructure and operation responsibilities, and (vi) the expected appraisal date. The SPI plan is reviewed at predefined milestones (e. g., after a review of processes improvement recommendations or after processes assessment).

Process Definition: it involves a series of meetings aiming to assess the organization processes in order to identify their current state of practice. At this moment, a process is defined trying to regard the activities that software developers in the organization already deploy and trying to be adherent to the practices of the capability maturity model level selected on the prior phase. If the company already uses a software process, a gap analysis is performed to identify practices needed to accomplish de SPI goal (e.g., required practices of maturity models). If the company does not have defined software process yet, a new one is defined based on the consultancy experience and lessons learned. Regardless the maturity model and the level selected, a standard software process is always defined and institutionalized in the organizational level. We are confident that the adoption of an institutionalized process to guide projects execution since the initial phases of SPI initiatives is essential to catalyze improvement changes and to make the SPI cycles faster. The Software Engineering Knowledge Base available in Taba Workstation through the use of Acknowledge CASE tool [11] provides valuable lessons learned and best practices to improve the efficiency and correctness of the processes to be defined.

Training: In this phase training in Software Engineering methods and techniques are provided to organization members. The training program is tailored to the characteristics and needs of the organization and its SPI initiative; for example, comprises the process areas of CMMI Level 3 or MR-MPS Level G processes (Project Management and Requirements Management). Oftentimes, it includes training in the software process defined, practices required by the capability maturity model and tools to be used. Some training activities are also carried out along with mentoring sessions during projects execution.

Mentoring: it takes place during projects execution and involves direct knowledge transference to the organizational members. COPPE/UFRJ software engineering consultants are present while the software

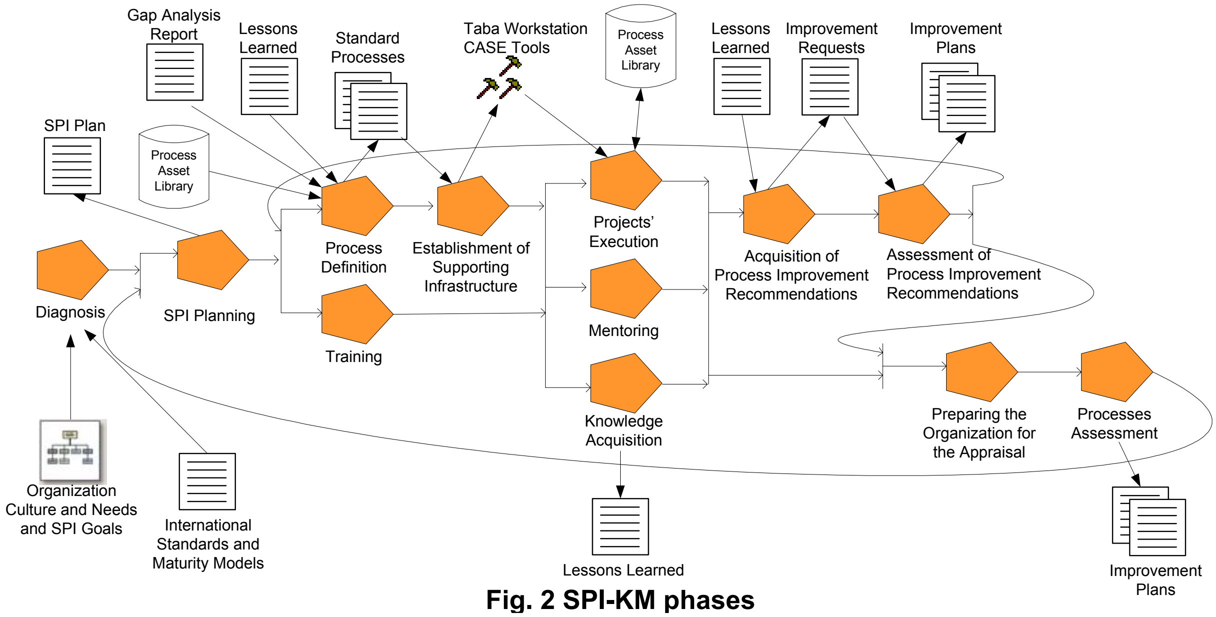

Fig. 2 SPI-KM phases

developers carry out any particular process activity for the first time, explaining how to execute that activity and the benefits expected. This close contact between the organization members and the consultants accelerates the learning process, increases the awareness of SPI benefits and minimizes resistances to changes. The knowledge items of the Software Engineering Knowledge Base help the consultant to support the activities of the organizational member during the mentoring. Nevertheless, all the knowledge is always available to any user of Taba Workstation.

Knowledge Acquisition: it involves the acquisition of knowledge, from consultants and organizational members, regarding software process activities and the SPI initiative in order to allow the organizational knowledge preservation and dissemination. After collecting the knowledge, it is filtered, packaged, stored in an Organizational Knowledge Repository and made available to guide process executions and SPI plans reviews. The support to knowledge management in Taba Workstation is provided by Acknowledge CASE tool [11] which is integrated to all others CASE tools in the environment.

Acquisition and Assessment of Process Improvement Recommendations: the acquisition of processes improvement recommendations occurs in parallel with projects execution. Process improvement ideas appear while developers get a better grasp about the process. These improvement suggestions are collected and assessed by the organizational process group and, if approved, it is incorporated into the standard software processes and can influence future reviews of the SPI plans. People affected by the changes are trained again and, new projects can use the new process.

Preparing the Organization for the Appraisal: The high management defines the expected appraisal date and commits on all necessary resources in order to achieve the SPI goals. To increase the success of the appraisal, two activities are executed during the Appraisal Preparation Phase: the fulfillment of the evidence worksheet that is going to be assessed by the appraisal team, and training the project members for the appraisal interviews that will be carried out during the appraisal. Basically, the worksheet contains the practices that an organization has to execute aiming to be adherent to the selected level of the software process reference model, and under these good practices the organization has to link artifacts that provide evidence of these practices deployment in the organization. During this phase the consultants also explain to the project members the different questions that are going to be made during the interviews and how they are going to be conducted.

Processes Assessment: the improvements deployed assessment is important to make evident the impact and benefits of the SPI initiative. Therefore, one of the characteristic of the strategy is that an official appraisal constitutes the final milestone of the SPI initiative.

5. Taba Workstation: Supporting the SPI-KM Strategy

The Taba Workstation is a Process-centered Software Engineering Environment (PSEE) that supports software processes definition, deployment and enactment. The use of this PSEE is a key factor of the SPI-KM strategy presented in the last section, mainly, because it helps to increase the processes' capability of organizations through the suitable use of Software Engineering techniques in their software processes aiming to enhance the software products quality. This PSEE has been developed by the COPPE/UFRJ software process engineering research group in the context of an academic project and it is granted to software development organizations with no costs.

The main objective of Taba Workstation is to provide an infra-structure to overcome inherent difficulties of SPI deployment initiatives like lack of financial resources. Moreover, the knowledge required for executing the improved processes is captured within the Taba Workstation knowledge base and disseminated throughout a set of integrated process-based tools that provides an efficient and effective mechanism to execution of complex tasks. Nevertheless, the Taba Workstation has been adopted by Brazilian SMEs in the last years aiming to overcome financial, human and infrastructure restrictions and to provide an efficient mechanism for implementing MPS Model-based initiatives. The support provided by Taba Workstation to implement MPS Model-based initiatives in SMEs is described in detail next.

Supporting MPS Model Level G in SMEs: the core activities for project planning are implemented through 3 tools that support elaboration of project schedule, cost plan and project human resources allocation plan. The tools also provide support to monitor progress against the plans and allow the evaluation of project team performance. Another tool allows the bi-directional traceability among the requirements for each level of product decomposition and the project plans.

Supporting MPS Model Level F in SMEs: measurement practices is supported by two integrated tools that provide the means for defining organizational and project specific measurement plans based on GQM method and for analyzing collected data. Configuration Management Process tasks are supported by a tool that provides mechanisms for monitoring changes in requirements during the project, for controlling change requests and for versioning documents and establishing and releasing baselines.

Supporting MPS Model Level E in SMEs: the software process definition related tasks are implemented through a CASE tool that uses the ISO/IEC 12207 standard as a basis for defining software processes and also maturity models like MPS Model. The standard processes and the specialized processes for a specific paradigm (for instance, structured and object oriented) are the organizational standard processes. In order to use the standard process in a specific project, a specialized process chosen as the most suitable to a specific project must be instantiated considering the characteristics of the project (for instance, size and complexity of the product and relevant quality and development team characteristics). This task is supported by a CASE tool that also allows the selection of the life cycle model and development methods and tools. This approach assures that the projects are executed based on a defined process tailored from the organization's set of standard processes and facilitates the institutionalization of standard processes. Another CASE tool allows the evaluation and improvement of the organizational software process and software process assets based on the evaluation of process monitoring measures, reports to high level management generated during projects, process adherence checklists and *post mortem* analyses and the review of lessons learned captured. Another CASE tool allows the identification, planning, execution and evaluation of process improvement opportunities through pilot projects.

Supporting MPS Model Level D in SMEs: the development, evaluation and selection of alternative technical solution activities are supported by a tool that captures and represents the design rationale involved in these tasks. Verification and validation activities are supported by two CASE tools that provides automatic mapping of evaluation criteria to specific work products and allow the adaptation of such knowledge to specific client needs and system and/or software requirements.

Supporting MPS Model Level C in SMEs: The formalization of decision analysis and resolution related to architectural designs is provided by the tool that supports technical solution process in MPS Model Level D. Risk management is supported by a CASE tool that allows risks identification based on the knowledge acquired during the execution of past projects. It also suggests pre-defined conditions and constraints checklist associated to each risk, supports contingency and mitigation planning and supports project monitoring against the risk management plan.

*Supporting Knowledge Management in SMEs: t*he integration of the environment and all of its CASE tools to a knowledge management tool supports the dissemination of lessons learned and also the evolution of the knowledge repository with the experiences acquired during software projects by all its participants. This approach allows the identification of weakness and strengths of processes and also facilitates the identification of process improvement opportunities. Besides that, most CASE tools provide specific and specialized knowledge about the Software Engineering sub-area related, e.g., verification support tool provides knowledge on how to perform peer-reviews, process tailoring tool provides knowledge on the differences of life cycle models etc.

Supporting MPS Model Levels A and B in SMEs: the current effort of Taba Workstation development team is related to adapt the available CASE tools, mainly the ones related to measurement and analysis activities, aiming to adhere the PSEE to MPS Model levels A and B processes requirements and outcomes.

Organizations that adopted the Taba Workstation to support SPI deployment initiatives are obtaining positive results. For instance, 4 Brazilian SMEs that adopted the Taba Workstation have gone through successful MPS Model-based assessments in the last two years. Moreover, other 5 organizations that adopted the Taba Workstation have gone through successful CMMI level 2 and level 3 official assessments also in the last two years. Both CMMI and MPS Model-based assessment teams indicated the Taba Workstation as a significant strength for the SPI deployments. Those organizations are also demonstrating excellent results of the SPI investments. For instance, one organization was able to reduce more than 36% of the amount of project rework since the adoption of Taba Workstation [10].

6. Lessons Learned During the Deployment of SPI-KM Strategy

We believe that lessons learned from previous experiences can facilitate the software process deployment and increase the chances of success of SPI initiatives. A study carried out by the COPPE/UFRJ [9] software process engineering research group identified common issues of process deployment, regardless of the organization or strategy used on the initiative. Five lessons learned could be extracted and are described in more details in the following.

Lesson 1: **SPI initiatives should effectively improve software processes -** One important factor we have observed is the SPI results monitoring to guarantee that the initiatives are effectively improving software processes. SPI initiatives can be monitored by defining performance indicators in order to ensure that process performance is on track. Moreover, process monitoring and feedback mechanisms must be established to support the use of feedback data to evaluate the payoff for doing improvements [12][13]. If SPI costs are viewed as an investment, then the payoff is expressed in a temporally shifted, return-on-investment (ROI) model [13]. Management indicators within ROI models of SPI include, for instance, measures of: product quality, process quality, project predictability and customer satisfaction. Nonetheless, some of the biggest payoffs of SPI are expressible in human terms, not monetary units. They might involve better job satisfaction, pride in work, an increased ability to attract, retain grow experts that will innovate, company reputation for excellence, etc [13].

Lesson 2: **You will not succeed without a leader -** According to our experience in several organizations, a leading group responsible for promoting awareness of SPI and to support knowledge sharing among different practitioners is crucial to the success of SPI initiatives. This group is sometimes a full time resource with responsibility to manage the deployment and coordination of SPI activities [12] and to obtaining and sustaining high level commitment with different management levels and project members during all SPI deployments.

Lesson 3: **Commitment is crucial -** One factor that was perceived to have influenced the success of our SPI experiences regards to organization commitment (from lower level to the higher one): it is very difficult to obtain organization members commitment to SPI in some organizations. People involved with the SPI initiative must perceive the benefits deriving from its deployment, and not only its costs. Another difficulty was to maintain the organization commitment during all SPI cycles. In order to cope with this problem, SPI quantitative data related to time, cost, quality and customer satisfaction were continuously communicated to high level managers. So, managers could perceive the benefits deriving from the SPI deployment, and not only its costs.

Lesson 4: **No brain, no gain -** Once this difficulty is found in an organization, most of the methods and techniques used to support software development and management must be taught increasing the cost, difficulty and time to achieve the SPI goals. Therefore, a capacity program for enhancing members' knowledge eases the employment of new practices in both project and organizational levels. This particular type of training catalyzes knowledge transference and is considered to be one of the pillars for creating a learning software organization. The most relevant deficiency we have detected in many organizations was the lack of knowledge in Software Engineering and Project Management. Mentoring activities performed by specialists is part of our SPI strategy as consultants and are carried out constantly during the whole SPI cycle, sometimes on a daily basis. Mentoring activities, besides teaching engineering methods and techniques, how to use CASE tools and how to execute the software process, also help consultants to enforce the benefits of the SPI program and the necessity of being committed to the improvement goals.

***Lesson 5:* SPI is facilitated by software process infrastructure -** Most organizations with low maturity software processes do not have suitable infrastructure for SPI deployment. In order to provide an adequate software process infrastructure to software organizations, our SPI strategy is supported by Taba Workstation that supports individual and group activities and project management activities [14][10].

7. Implementing Software Process Improvement Initiatives in Small and Medium Sized Brazilian Organizations

Since 2006, a group of five other organizations is implementing the MPS Model supported by the Taba Workstation. This group is coordinated by an accredited organization that provides services for organizing groups of enterprises to execute MPS Model-based deployment; and the group activities are executed in conformance to the MPS Cooperative Business Model for groups of SMEs interested in implementing the MPS Model and sharing SPI services and costs. The group is divided in two sub-groups: (i) a sub-group of three SMEs implementing the MPS Model level G (Partially Managed), and (ii) a group of two SMEs implementing the MPS Model level F (Managed).

The Taba Workstation has been supporting the deployment of the MPS Model in more than 15 projects in this group of organizations. Informal process assessments have already been conducted aiming to reduce assessment risks and the results are promising. All of the projects executing the processes have provided adequate evidences based on the MPS Reference Model and the MPS Assessment Method. Therefore, the formal assessments have already been scheduled. Both sub-groups of SMEs are going to be formally assessed in June 2007. We are expecting to have positive results similarly to other assessments of SMEs that have also implemented the MPS Model supported by the Taba Workstation.

In all five organizations, the deployment approach applied was very similar using the SPI-KM approach and Taba Workstation CASE tools, but respecting characteristics, experiences and maturity of each organization.

7.1 The Organizations

Organization #1 develops systems' solutions for the financial market, on the investments area. The goal of its SPI program is to improve products' quality, enhance projects' control and diminish development and maintenance systems' costs. The organization had past experiences in SPI initiatives that improved their maturity in defining improvement objectives and process knowledge, although not being formally assessed. The support from high and medium level managers, as from members involved in the projects is visible. The project's executions are supported by a qualified process group that helped the definition of a process adapted to the reality of the organization.

Organization #2 provides IT services, developing customized systems e processes for its clients and for its own use. The goal of the SPI program is to improve products' quality and diminish production costs. The members involved in the SPI initiatives, as well as the high level managers, are fully supporting the SPI program and already observes positive results.

Organization #3 works with Business Intelligence, corporative, IT and knowledge management solutions. The organization established as the main quality goal the improvement of products quality and the diminishing of rework. The organization members involved in the SPI initiatives and the high-level managers fully support the SPI program, claiming that the program will make the organization more competitive that it represents a matter of survival for the organization. The organization is also implementing ISO 9001:2000 in parallel to the SPI improvements related here.

Organization #4 develops and sells solutions' packages, especially in healthy, education and financial areas. The main objective of the SPI program is to enhance products' quality and diminish maintenance efforts due to the products adaptability and long market life. Since the beginning of the SPI program, all organization members involved with the SPI initiatives and the high level managers supported the initiatives and noticed some results.

Organization #5 offers software development, solutions integration, IT outsourcing and business modeling services. Their main objective for the software process improvement program is to improve projects management, enhancing development schedule, cost and effort controls and diminishing rework. The organization supports the SPI initiatives, and directors and managers are participative, demonstrating their belief in MPS Model compliance benefits.

Table 2 presents MPS Model level intended by each organization and their actual processes deployment stage. *Organization #2* had past experiences in SPI programs aiming a MR-MPS Level G appraisal and for that reason did not participate in the initial training. *Organization #4* opted for having no participation in the initial training, but the theory concepts were introduced during projects' mentoring activities. Besides *Organization #2*, no other organizations in this group had ever used a software process before. *Or-*

ganization #1 and *Organization #2* adapted the defined process to their needs, making process definition and Taba Workstation configuration time larger.

Table 2. Organizations Characteristics and Actual State

	Org. #1	*Org. #2*	*Org. #3*	*Org. #4*	*Org. #5*
MR-MPS Level	F	G	G	F	G
Project's beginning	Jul/06	Jul/06	Jul/06	Jan/07	Jul/06
Process definition and Taba Workstation configuration	Aug-Sep/06	Aug-Nov/06	Jul/06	Jan/07	Jul/06
Training of the theory	Sep/06	-	Jul/06	-	Aug/06
Deployment beginning	Sep/06	Nov/06	Aug/06	Jan/07	Aug/06
100% of the deployment	May/07	May/07	Dec/06	Jul/07	May/07
Initial assessment (MA-MPS)	Aug/07 (*)	Jun/07	Apr/07	Aug/07 (*)	Jul/07 (*)
Final assessment (MA-MPS)	Sep/07 (*)	Jun/07	May/07	Sep/07 (*)	Ago/07 (*)

(*) - Expected dates

7.2 Lessons Learned

The lessons learned during the improvement program in these 5 organizations are presented as follow:

- The internalization of the advantages and benefits of the improvement program is favored by the constant presence of consultants in the organization as long as the consultants perform their activities aiming not just the evaluation success but also the effective improvement of the processes.
- Organizations that never followed a process have difficulty to define one without help. Therefore, the definition of an initial process by the consultancy is important. During its usage in software projects, the organization acquires the necessary knowledge to define another version adapted to its specific characteristics. Moreover, the commitment to the SPI program and to the process adherence is increased.
- The first project using the defined process usually presents some difficulties to be performed. The project team members need time to adapt their practices to the new process activities and tools. In some cases, this project is performed as a pilot for the process deployment.
- A key point is the formal commitment during the project. Therefore, sometimes is observed internal and external resistance regarding the obtaining of commitment for projects' work products. Some stakeholders, mainly customers, may not be interested in the establishment of a formal commitment.
- An adequate software process infrastructure facilitates training, deployment and institutionalization of software process, since it decreases the process deployment time. If the organization has already been using support tools to software process activities, the process changes are introduced with less resistance. Moreover, the usage of Taba Workstation has been very important for the learning of new concepts and practices related to the process deployment. These concepts and practices also help the organization in defining new requirements for others support tools.
- The strategy based on a gradual deployment of software processes adherent to MR-MPS is feasible, since the software organization notices the benefits of disciplining the development based on processes.
- Small organizations intending to establish MR-MPS maturity Level G usually have limited financial resources causing problems for the improvement program. The faster the institutionalization of the processes the smaller the risks related to the SPI program.
- If the organization process group have background regarding software engineering, less consultancy effort for the program deployment is spent.
- During the SPI deployment, the organizations have a better control of the management and development activities (that begins with MR-MPS maturity Level G). Thus, they can negotiate new terms and costs with costumers after requirements changes showing the quantitative impact of these changes for the project.

8. Conclusions

This paper discussed MPS Model deployment in a SMEs group at Rio de Janeiro. The main organizations' characteristics were presented as well as their quality objectives, characterization and deployment stages in each one. Lessons learned from the SPI deployment aiming MPS Model levels G and F started in 2006 were also presented. Some organizations have already performed MPS Model's initial appraisals and the results are very promising which supports the viability and soundness of this approach. Besides that, we believe that the other organizations, for their characteristics and engagement, will achieve their SPI goals and the MPS Model appraisal.

The success cases of SMEs that adopted Taba Workstation demonstrates its feasibility to manage factors that have influence on SPI initiatives, for instance, lack of supporting tools and lack of software engineering knowledge of organization's members. Therefore, MPS Model-based deployments supported by Taba Workstation is an efficient and feasible approach for successfully implementing software engineering processes in SMEs that usually operate under financial, human and infra-structure resources constraints.

Other important characteristic of this approach is that the deployment of Taba Workstation using the MPS Cooperative Business Model helped to reduce more than 60% of SPI costs by suppressing the necessity of buying expensive supporting tools and by obtaining external financial resources from organizations like the BID (Inter-American Development Bank). After the formal assessments, this group of organizations is committed to start another SPI cycle aiming to improve their processes maturity to higher levels. The first sub-group is going to implement the MPS Model level F (Managed) processes, and the second sub-group is going to implement the MPS Model level C (Defined) processes.

Nevertheless, the lessons learned presented are important assets that act on COPPE/UFRJ's adopted strategy's feedback and refinement. Moreover, we expect that these assets can be useful to other organizations undertaking SPI initiatives in order to enhance the expected results.

9. References

[1] SEI – Software Engineering Institute "Improving Processes in Small Settings (IPSS) – A White Paper", The International Process Research Consortium (IPRC), Software Engineering Institute, Pittsburgh, 2006. (http://www.sei.cmu.edu/iprc/ipss-white-paper-v1-1.pdf).

[2] Softex, MPS.BR – Melhoria de Processo do Software Brasileiro, Guia Geral (v. 1.1). Softex, Brasil, 2006.

[3] Softex, MPS.BR – Melhoria de Processo do Software Brasileiro, Guia de Aquisição (v. 1.1), Softex, Brasil, 2006.

[4] Softex, MPS.BR – Melhoria de Processo do Software Brasileiro, Guia de Avaliação, (v. 1.0), Softex, Brasil, 2006.

[5] Softex, MPS.BR – Melhoria de Processo do Software Brasileiro, Guia Implementação,(v.1.0), Softex, Brasil, 2006.

[6] ISO/IEC 12207:2000 - Information technology –software process life cycle, 2000.

[7] Santos, G., Montoni, M., Rocha, A. R., Figueiredo, S., Mafra, S., Albuquerque, A., Paret, B. D., Amaral, M., "Using a Software Development Environment with Knowledge Management to Support Deploying Software Processes in Small and Medium Size Companies", *7th International Workshop on Learning Software Organizations* (LSO'2005), Kaiserslautern, Germany, 2005.

[8] LENS – COPPE/UFRJ Software Engineering Lab (2007) <http://lens.cos.ufrj.br/>.

[9] Santos, G., Montoni, M., Figueiredo, S., Rocha, A. R., "SPI-KM – Lessons Learned from Applying a Software Process Improvement Strategy Supported by Knowledge Management", *8th Int. Conference on Product Focused Software Process Improvement* (PROFES'2007), Latvia, 2007.

[10] Ferreira, A. I. F., Santos, G., Cerqueira, R., Montoni, M. Barreto, A., Rocha, A. R., Figueiredo, S., Barreto, A., Silva Filho, R. C., Lupo, P., Cerdeiral, C.; "Taba Workstation: Supporting Software Process Improvement Initiatives based on Software Standards and Maturity Models"; *EuroSPI 2006*; Joensuu, Finland, Oct. 2006.

[11] Montoni, M., Santos, G., Villela, K., Miranda, R., Rocha, A.R., Travassos, G.H., Fi-gueiredo, S., Mafra, S.: "Knowledge Management in an Enterprise-Oriented Software Development Environment", *5th Int. Conf of Practical Aspects of Knowledge Management*, Vienna, Austria, 2004.

[12] Zaharan, S., 1998, "Software Process Improvement – Practical Guidelines for Business Success", Addison-Wesley.

[13] Krasner, H., "Accumulating the Body of Evidence for The Payoff of Software Process Improvement", *SPI, IEEE*, pp. 519-539, 2001.

[14] Montoni, M., Santos, G., Rocha, A. R., Figueiredo, S., Cabral, R., Barcellos, R., Barreto, A., Soares, A., Cerdeiral, C., Lupo, P., "Taba Workstation: Supporting Software Process Deployment based on CMMI and MR-MPS.BR", *7th Int. Conference on Product Focused Software Process Improvement*, The Netherlands, 2006, pp. 249-262.

[15] Chrissis, M. B., Konrad, M., Shrum, S. *CMMI: Guidelines for Process Integration and Product Improvement*. 2nd Edition, Addison-Wesley, 2006.

[16] ISO/IEC 15504. Information Technology – Process Assessment. Part 1–Concepts and vocabulary; part 2–Performing an assessment; part 3–Guidance on performing an assessment; part 4–Guidance on use for process improvement and process capability de-termination; and part 5–An exemplar process assessment model, 2004.

[17] Coleman, G., O'Connor, R.: "Software process in practice: A Grounded Theory of the Irish software industry". Vol. 4257 LNCS. Springer Verlag, Heidelberg, D-69121, Germany, Joensuu, Finland, 2006, 28-39.

[18] Staples, M., Niazi, M., Jeffery, R., Abrahams, A., Byatt, P., Murphy, R.: "An exploratory study of why organizations do not adopt CMMI". *Journal of Systems and Software* 80, 2007, 883-895.

[19] Wangenheim, C.G.v., Varkoi, T., Salviano, C.F.: "Standard based software process assessments in small companies".*Soft. Proc.: Improv. and Prac.*,Vol.11,2006,329-335.

[20] Cater-Steel, A., Toleman, M., Rout, T.: "Process improvement for small firms: An evaluation of the RAPID assessment-based method". *Information and Software Technology* 48, 2006, 323-334.

[21] Wangenheim, C.G.v., Weber, S., Hauck, J.C.R., Trentin, G.: "Experiences on establishing software processes in small companies". *Information and Software Technology* 48, 2006, 890-900.