A Nationwide Program for Software Process Improvement in Brazil

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Abstract

Continuous improvement of software development capability is fundamental for organizations to thrive in competitive markets. Nevertheless, Software Process Improvement (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. This paper describes a national program for SPI in Brazilian organizations. The main goal of this initiative is to develop and disseminate a Brazilian software process model (named MPS Model) aiming to establish a feasible pathway for organizations to achieve benefits from implementing SPI at reasonable costs, especially SMEs. This paper presents the main components of MPS Model. The results of MPS Model adoption and dissemination in Brazilian software industry are also presented in this paper. Although the main focus of the MPS Model is on SMEs, the model demonstrated to be adequate to support SPI implementation and assessment in large organizations.

1. Introduction

Continuous improvement of software development capability is fundamental for organizations to thrive in competitive markets. Nevertheless, Software Process Improvement (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 [1]. These obstacles usually hinder organizations from improving software processes, especially for Small and Medium-size Enterprises (SMEs) that operate under strict financial constraints. For instance, software process reference models have been adopted by very few Brazilian organizations [2]. Approximately 73% of the Brazilian software industry (more than 6,000 organizations) is constituted of SMEs (fewer than 50 employees in small organizations and between 51 and 100 people in medium-size enterprises). Nevertheless, few organizations have successfully implemented software process reference models - only 39 CMMI appraisals of Brazilian organizations were reported to the Software Engineering Institute so far, whereas India and China reported 177 and 158 assessments, respectively [3]. Therefore, there is an urgent need in Brazil to increase software development capabilities aiming to enhance their competitive advantages.

This paper describes an initiative to improve software process in Brazilian organizations named MPS.BR Program. MPS.BR is the acronym for the Portuguese expression *Melhoria de Processo do Software Brasileiro* (Brazilian Software Process Improvement). This initiative started in 2003 under the coordination of Association for Promoting the Brazilian Software Excellence (SOFTEX), and is a joined effort of both Brazilian software industry and research institutions. The main goal of this initiative is to develop and disseminate a Brazilian software process model (named MPS Model) aiming to establish a feasible pathway for organizations to achieve benefits from implementing SPI, especially SMEs, by reducing the SPI implementation costs and providing means for obtaining SPI benefits in a shorter time frame. The model was developed based on international standards and internationally recognized models and best practices for SPI implementation and assessment, and also on Brazilian software industry business needs.

This paper presents the structure of the MPS.BR program and the components of MPS Model. The

results of MPS Model adoption and dissemination in Brazilian industry are also presented in this paper.

The next section discusses the background in the SPI area. Section 3 presents the organizational structure of MPS.BR Program. Section 4 presents the MPS Model components. The results regarding MPS Model adoption and dissemination in Brazil are presented in section 5. Finally, section 6 presents conclusions and points out future directions of the MPS.BR Program.

2. Background

Different approaches have been developed to improve and assess software process motivated by the needs of software acquires for better techniques for the selection of contractors [11]. Concerned about the diversity of such approaches, the International Organization for Standardization and the International Electrotechnical Commission (ISO/IEC) initiated an effort to develop an internationally recognized software process assessment framework that culminated in the publication of the ISO/IEC 15504 International Standard on software process assessment [6].

The ISO/IEC 15504 standard provides a generic approach for the model-based assessment of process capability [11]. ISO/IEC 15504 defines requirements for performing process assessment aiming to achieve a greater degree of uniformity in the approach to process assessment, so as to maximize the reliability of different approaches and provide a degree of comparability between the results of different assessments [6].

The processes that are defined as a comparison target for a particular assessment are defined in a Process Reference Model (PRM). ISO/IEC 15504-2 specifies the contents and basic structure of PRMs. Basically, these are groups of defined processes for a particular domain or community of interest. Each process in a PRM is described in terms of its purpose which are the essential measurable objectives of a process, and outcomes of its implementation [6][11].

The Measurement Scale for the evaluation of process capability is described in terms of a Measurement Framework that uses descriptions of Process Attributes, applicable to any process, that represent measurable characteristics necessary to manage a process and improve its capability to perform within a scale of levels of capability [6][11].

The model that is used in the assessment is defined as a Process Assessment Model (PAM) [6]. The PAM is a two-dimensional representation of process capability: (i) the process dimension – described by a set of process entities related to PRMs; and (ii) the process capability dimension – related to the Measurement Framework constituted of capability levels and process attributes.

In order to support process definition and process assessment and improvement, the ISO/IEC also initiated an effort to develop a PRM within the domain of software engineering. The base standard for such initiative was the ISO/IEC 12207 [5]. This standard provides a comprehensive group of life cycle processes, activities and tasks for software products and services. The ISO/IEC 12207 was extensively revised and these revisions were published in the form of two amendments that provide process purpose and outcomes to establish a PRM in accordance with the requirements of ISO/IEC 15504-2.

Another important internationally recognized model for software process improvement is the Capability Maturity Model Integration (CMMI) [7]. CMMI is a process improvement maturity model for development of software products and services developed by the Software Engineering Institute (SEI). CMMI is consistent with the international standard ISO/IEC 15504. Moreover, the official CMMI appraisal method named SCAMPI used for conducting appraisals using CMMI model can also be executed in conformance to the assessment requirements levied by ISO/IEC 15504-2 [8]. CMMI provides two representations for SPI. The continuous representation enables organizations to incrementally improve individual processes in a scale of "capability levels" ranging from 0 through 5. The staged representation enables the improvement of a set of related processes by incrementally addressing successive set of process areas aiming to improve organizational processes in a scale of "maturity levels" ranging from 1 through 5 [7].

Process reference models such as ISO/IEC 12207, ISO/IEC 15504 and CMMI do not deal with implementation details; a model based process implementation is a complex process of methodological tailoring. Moreover, SPI implementation initiatives have to deal with organizational and cultural challenges, such as resistance to change. Therefore, different organizations implement the same processes in different ways, obtain different SPI investment results and struggle to cope with different difficulties. Many studies address costs, benefits and impact of SPI initiatives based both on CMMI and ISO/IEC 15504 [1] [10]. Many other authors have also addressed the difficulties that software organizations have to cope with in order to adopt such models [12][14]. These studies justify the lack of adoption of CMMI and ISO standards in software organizations, especially in SMEs.

Considering the great difficulties associated to the implementation of SPI initiatives, many empirical studies conducted investigations about the critical factors that influence the success of SPI initiatives. For instance, the awareness of SPI benefits is recognized as a critical success factor by many empirical studies

[16][17]. Wangenhein et al. [12] and Cater-Steel et al. [9] 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.

3. MPS.BR Program: developing a Brazilian model for software process improvement, implementation and assessment

The main problems that inhibit organizations, especially SMEs, from adopting software process reference models, such as CMMI, ISO/IEC 12207 and ISO/IEC 15504, as reported in the SPI literature, are related to SPI implementation, maintenance and assessment costs, and difficulty to convince organizations of potential benefits of SPI investments. In order to cope with these problems, radically different SPI approaches are needed to drastically change the scenario of SPI in software organizations, especially in SMEs. In this context, the Association for Promoting the Brazilian Software Excellence (SOFTEX) decided to start a nationwide initiative, named MPS.BR Program, for improving software processes of Brazilian organizations and, as a consequence, making organizations more competitive both in local and global markets. In order to achieve this goal, it was important to obtain a consensus of the interests of Brazilian software industry and document it in the form of a software process model that represents the interests of the Brazilian software community [4].

Therefore, the main goal of the MPS.BR Program was to develop and disseminate a Brazilian software process model (named MPS Model) aiming to establish a feasible SPI implementation and assessment pathway for organizations to thrive, especially SMEs. Although the main focus of the initiative is on SMEs, the model is completely adequate to support SPI implementation and assessment in large organizations.

The MPS.BR Program has been executed since 2003; it is coordinated by the SOFTEX - a private not-for-profit organization created to promote Brazilian software industry competitiveness - and it is sponsored by the Brazilian Ministry of Science and Technology (MCT), the Brazilian Research and Projects Financing Agency (FINEP) and the Inter-American Development Bank (IDB), but it is being increasingly sustained by revenues from MPS services provided.

In order to manage the MPS.BR Program, an organizational structure was defined and responsibilities were assigned to SPI practitioners and researchers with practical experiences in SPI.

The MPS.BR Program Structure units are the following:

- MPS.BR Program Team: responsible to manage the program activities. This team is coordinated by SOFTEX.
- MPS Technical Model Team: responsible (i) to develop and maintain the model, and (ii) to prepare and execute MPS model trainings. This team is coordinated by COPPE/UFRJ, an institution of the Federal University of Rio de Janeiro with vast experiences in SPI research, implementation and assessment.
- MPS Accreditation Forum: responsible (i) to certify organizations to provide MPS model-based implementation and assessments services, (ii) to evaluate and control MPS model-based implementations and assessments results, and (iii) to ensure that organizations certified on the MPS model execute their activities within expected ethical and quality limits. This team is composed of Government, University and Industry representatives.

4. MPS Model

One of the requirements for developing the MPS Model is that it should incorporate internationally recognized best practices for software process implementation and assessment, and also Brazilian software industry business needs. Therefore, the ISO/IEC 12207 and ISO/IEC 15504 were used as the technical base elements for defining the MPS Model Components. Considering the importance of CMMI model for Brazilian organizations that operate in international markets, the MPS Technical Model Team also considered the CMMI as a complementary technical base element for the MPS Model processes definition. 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.

4.1. MPS Reference Model

The MPS Reference Model (MR-MPS) is documented in the form of three guides: the MPS General Guide, the MPS Acquisition Guide and the MPS Implementation Guide. 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 since it fulfils the requirements for a PRM defined in ISO/IEC 15504-2. It is fundamental that the MPS Model satisfies ISO/IEC

15504-2 requirements, because the model will only get acceptance from the Brazilian market if its users have confidence that the assessment results have content validity (that is, they portray what they claim to portray) and that they are repeatable and reliable [6].

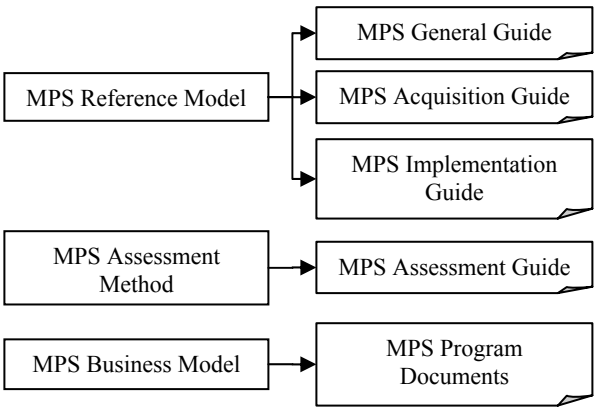

Fig. 1. MPS Model Components

The MR-MPS processes are described in terms of their specific purpose and outcomes used to evaluate specific process implementation. Each process defined within the MR-MPS has unique process descriptions and identification and the set of process outcomes are necessary and sufficient to achieve the purpose of the process. The MR-MPS processes are an adaptation of the ISO/IEC 12207 Amd 1 & Amd 2 processes and the CMMI-DEV process areas.

The MPS General Guide also provides a definition of scope and composition of MR-MPS process profiles for a declared level of organizational maturity level, even though it is not a requirement of ISO/IEC 15504-2. A maturity level consists of process outcomes and process attributes achievement results for a predefined set of processes. Therefore, the MR-MPS maturity levels are defined in two dimensions: process capabilities dimension and process dimension.

The MR-MPS process capabilities dimension is constituted of a measurement framework for the assessment of process capability based on the processes defined in the MR-MPS processes dimension. Process capability is defined on an ordinal scale that represents increasing capability of the implemented process, from not achieving the process purpose through to meeting current and projected business goals. Within this measurement framework, the measure of capability is based upon a set of process attributes (PA). Each attribute defines a particular aspect of process capability. The MR-MPS process attributes are based on the ISO/IEC 15504-2 process attributes used 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.

The MR-MPS process dimension is constituted of the processes to be assessed. The MR-MPS process dimension describes seven sequential and accumulative groups of processes that correspond to the MR-MPS maturity levels. The seven MR-MPS maturity levels are: A (Optimizing), B (Quantitatively Managed), C (Defined), D (Largely Defined), E (Partially Defined), F (Managed) and G (Partially Managed). The level G is the most immature level and level A is the most mature one. The MR-MPS maturity levels (ML) processes profiles were defined accordingly to specific business needs of Brazilian software industry.

A process shall be assessed up to and including the highest maturity level defined in the assessment scope. The combination of process outcomes and attributes achievement results and a defined grouping of processes together determine the organizational maturity level. Table 1 presents MR-MPS processes and the PA that shall be added to each maturity level.

The first MR-MPS maturity level (ML) was named level G (Partially Managed) and is constituted of the most critical project management processes. By implementing the processes of this level, the organization can focus the improvement effort on establishing better mechanisms for project planning, monitoring and control, and for managing requirements throughout the product life cycle.

In order to improve projects control, the organization must implement support processes for software development. These processes constitute the next MR-MPS ML named F (Managed). The processes of these level focus on guaranteeing product and process quality, obtaining quantitative indicators of processes performance and managing products configuration. When appropriate, the organization can decide to improve the products and services acquisition processes that are essential for projects execution.

The implementation of MR-MPS maturity levels G and F processes is a significant step in a software development organization. Nevertheless, at these levels the organization is still highly dependent on the individuals' knowledge and performance. Therefore, the greatest SPI benefits are only obtained through establishment of processes institutionalization across the projects and the organization. The MR-MPS ML E (Partially Defined) is constituted of processes that

support software processes institutionalization and improvement. These processes praise the definition of a standard processes to guide execution of software projects.

Table 1. MR-MPS maturity levels (ML), processes and process attributes (PA)

ML	Processes	PA
A	Causal Analysis and Resolution	1.1, 2.1, 2.2, 3.1, 3.2, 4.1*, 4.2*, 5.1*, 5.2*
B	Project Management (evolution)	1.1, 2.1, 2.2, 3.1, 3.2, 4.1*, 4.2*
C	Decision Analysis and Resolution Risk Management Development for Reuse Reuse Management (evolution)	1.1, 2.1, 2.2, 3.1, 3.2
D	Requirement Development Product Design and Construction Product Integration Verification Validation	1.1, 2.1, 2.2, 3.1, 3.2
E	Human Resource Management Process Establishment Process Assessment and Improvement Project Management (evolution) Reuse Management	1.1, 2.1, 2.2, 3.1, 3.2
F	Measurement Configuration Management Acquisition Quality Assurance	1.1, 2.1, 2.2
G	Requirement Management Project Management	1.1, 2.1

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

Once the infrastructure for processes execution and improvement is established within the organization, the next step is to focus on improving more specific software development processes. These processes are the engineering ones and are grouped in the maturity level named D (Largely Defined). The engineering processes are concerned on technical issues of product development, such as establishment of requirements development methodologies, definition of modular architectures and strategies for product integration, verification and validation.

The MR-MPS ML C is constituted of complementary project management processes. These processes are related to managing risks and supporting decision making situations. Moreover, the Development for Reuse process was also incorporated in the processes profile of this ML aiming to complement the Reuse Management process through the identification of systematic reuse opportunities in the organization and the establishment of a reuse program to develop assets through application domain engineering. Nevertheless, the organization can decide to include or not the Development for Reuse process in the assessment scope.

The MR-MPS maturity levels A and B are high maturity levels focusing on continuous process improvement. The MR-MPS ML B processes are concerned about establishing a quantitative understanding of software products and processes, and controlling causes of variations aiming to achieve process stability. The MR-MPS ML A processes focus on continuously increasing organizational competitiveness capabilities through the implementation of process and technological innovations and on the resolution of causes of problems and defects.

A correspondence can be delineated between MR-MPS and CMMI maturity levels. The processes profiles of MR-MPS maturity levels F, C, B and A correspond respectively to the processes profile of CMMI maturity levels 2, 3, 4 and 5. The processes profile of MR-MPS ML G corresponds to an intermediary level between the processes profile of CMMI maturity levels 1 and 2. The processes profile of MR-MPS maturity levels E and D are two intermediary levels between the processes profile of CMMI maturity levels 2 and 3. The MR-MPS organizes the processes profile differently than the CMMI for two reasons: (i) to provide a more feasible pathway for capability maturity growth by reducing the number of processes to be implemented in the first (and riskier) maturity levels, and (ii) to facilitate the visibility of SPI results in a shorter time of frame.

Besides the MPS General Guide, the MPS Model contains other 2 guides. The MPS Acquisition Guide describes an acquisition process for software and related services, and its purpose and outcomes are conformant with the ISO/IEC 12207 international standard as described in Annex F of Amendment 1. The MPS Acquisition Guide also identifies recommended practices for software acquisition such as in IEEE STD 1062 [19]. The MPS Implementation Guide provides technical guidance for implementing the seven MR-MPS levels. This guide is divided into 7 parts, one per each MR-MPS maturity level.

4.2. MPS Assessment Method

The purpose of process assessment is to determine the extent to which the software processes contribute to achievement of organizational business goals and to help it focus on the need for continuous software process improvement. According to ISO/IEC 15504-2, an assessment should be carried out against a defined assessment input utilizing conformant Process Assessment Model(s) related to one or more conformant or compliant Process Reference Model(s).

In order to satisfy ISO/IEC 15504-2 requirements for a Process Assessment Model, the MPS Technical Model Team defined the MPS Assessment Method (MA-MPS) and documented it in the form of the MPS Assessment Guide. This guide also describes the assessment process defined to support the application of the MA-MPS. Both the process and the MA-MPS were defined aiming:

- To objectively assess software processes of an organization.
- To attribute a MR-MPS maturity level based on the assessment results.
- To be applicable to different domains in the software industry.
- To be applicable to organizations of any sizes.

The MPS Assessment Guide also defines the requirements for accreditation of: Organizations to provide MPS assessments services, namely a MPS Assessment Institution (MPS AI); MPS Competent Assessors; and MPS Provisional Assessors (assessors that support competent assessors during assessments). The MPS Assessment Guide also describes the roles and responsibilities of assessment team members during assessments.

The objective of the assessment method MA-MPS described in the MPS Assessment Guide is to verify the maturity of an organization unit in the execution of its software processes. The assessment process describes the set of activities to be executed to achieve this objective. This process is implemented through three outcomes [5][6]: (i) data related to software process used in projects exist and are maintained; (ii) relative strengths and weaknesses of processes are understood; and (iii) accurate and accessible assessment records are kept and maintained.

The MA-MPS assessment process has four subprocesses: Contracting the assessment; Preparing to perform the assessment; Performing the assessment; and Recording assessment output.

The purpose of the "Contracting the assessment" subprocess is to establish a contract for conducting an MA-MPS based assessment. An MA-MPS based assessment to be valid must be conducted by an MPS Assessment Institution (MPS AI) accredited by the MPS Accreditation Forum.

The purpose of the "Preparing to perform the assessment" subprocess is to plan the assessment, to prepare the documentation necessary to conduct the assessment and to execute an initial assessment aiming to objectively verify whether the organizational unit is ready to be assessed at the solicited MR-MPS maturity level. Since the level of detail provided by the MR-MPS is not sufficient to be used alone as the basis for conducting assessments of organizational maturity in a reliable and consistent way, it is necessary to define a set of implementation indicators of process performance and process capability aiming to support an assessor's judgment of the performance and capability of an implemented process [6]. These indicators shall be defined in the "Preparing to perform the assessment" subprocess through the association of objective evidence to process outcomes and process attributes achievement results. The objective evidence is any qualitative or quantitative information, records or statements of fact that attest the achievement of a specific process outcome or process attribute achievement result.

After defining the implementation indicators and associating it to objective evidence produced during the projects executions, the implementation indicators are reviewed by the assessment team aiming to identify implementation problems or improvement opportunities. All these information are consolidated in an initial assessment report.

The purpose of the "Performing the assessment" subprocess is to train the assessment team on the MA-MPS assessment method, to perform the assessment and to communicate the results to the assessed organizational unit. In this subprocess the initial assessment report is used to perform a verification of implementation indicators. After that, the characterization of assessed processes is conducted through 4 steps.

The characterization of the implementation degree of each process outcome and process attribute achievement result in the projects (step 1) is conducted on a defined rating scale. Each process outcome and process attribute achievement result shall be rated using a 6-point scale. The six points are designated as F, L, P, NY, OS, NA for *Fully Achieved*, *Largely Achieved*, *Partially Achieved*, *Not Yet*, *Out of Scope* and *Not Achieved*. A summary for each of these response categories is given in Table 2.

The initial characterization of the implementation degree of each process outcome and process attribute achievement result in the organization (step 2) is conducted by applying aggregation rules of projects characterization to achieve organization

characterization. This step is executed by each mini-team responsible to assess a specific group of processes.

The characterization of the implementation degree of each process outcome and process attribute achievement result in the organization (step 3) is obtained through a consensus meeting with all the assessment team members. In this step, each mini-team presents the initial characterization results for each process outcome and process attribute achievement result in the organization and the whole team must discuss and reach a consensus about the results.

Table 2. The six-point process outcome and attribute achievement result rating scale

Rating	Description
Fully Achieved – F	All implementation indicators are adequate and there is no sign of substantial weakness.
Largely Achieved – L	All implementation indicators are adequate, but there is one or more signs of substantial weakness.
Partially Achieved – P	Some implementation indicators are not adequate and there are one or more signs of substantial weakness, but other indicators suggest that some aspects of the process outcomes and attributes are implemented.
Not Yet – NY	It is not possible to assess the process outcomes and attributes, because the project is in an early phase or the achievement of the process outcome and process achievement result is out of project scope.
Out of Scope – OS	The process outcome or process achievement result is out of the assessment scope as documented in the assessment plan.
Not Achieved – NA	Any other situation different from above.

The characterization of the implementation degree of processes in the organization (step 4) is executed by the assessment team through assignment of one of the two characterization degree values for each process: *Satisfied* or *Not satisfied*. A process is satisfied if: (i) approximately 85% of process outcomes are classified as *Fully Achieved* or *Largely Achieved*; and (ii) the processes attributes are classified according to the characterization scheme summarized in Table 3 taking in consideration the appropriate maturity level declared in the assessment scope.

After characterizing the organization processes, the assessment results are discussed with the assessment participants and the sponsor. After that, a final presentation is conducted to the whole assessed organizational unit to present the overall results and the final organizational maturity characterization.

The purpose of the "Recording assessment output" subprocess is to elaborate the final assessment report, submit it to the assessment sponsor and to SOFTEX that, in this way, inserts the assessment data in its data base and publishes the result in its web site.

Table 3. Characterization scheme of process attribute (PA) to satisfy MR-MPS maturity levels (ML)

ML	PA	Rating
A	Process performance	Fully
	Performance management	Fully
	Work product management	Fully
	Process definition	Fully
	Process deployment	Fully
	Process measurement	Fully*
	Process control	Fully*
	Process innovation	Largely or fully*
	Process optimization	Largely or fully*
B	Process performance	Fully
	Performance management	Fully
	Work product management	Fully
	Process definition	Fully
	Process deployment	Fully
	Process measurement	Largely or fully*
	Process control	Largely or fully*
C	Process performance	Fully
	Performance management	Fully
	Work product management	Fully
	Process definition	Fully
	Process deployment	Fully
D	Process performance	Fully
	Performance management	Fully
	Work product management	Fully
	Process definition	Fully
	Process deployment	Fully
E	Process performance	Fully
	Performance management	Fully
	Work product management	Fully
	Process definition	Largely or fully
	Process deployment	Largely or fully
F	Process performance	Fully
	Performance management	Fully
	Work product management	Largely or fully
G	Process performance	Largely or fully
	Performance management	Largely or fully

** These ratings are applicable only to selected processes. All the other ratings must be applied to all processes.*

4.3. MPS Business Model

In order to guarantee the success of the MPS Model, it is essential that software organizations can effectively adopt it and achieve benefits from implementing SPI. Therefore a specific component, named MPS Business Model (MN-MPS), was developed and integrated to the MPS Model aiming to support its adoption and dissemination by defining business rules for:

- Training practitioners through MPS official courses, individual examinations and recycling workshops.
- Implementing the MPS Model by organizations that provide MPS Model based implementation services, namely an accredited MPS Implementation Institution (MPS II).
- Executing process assessments by organizations that provide MPS assessment services (an accredited MPS AI).
- Organizing groups of enterprises to provide MPS based implementation and assessment services.

Although the MPS Model was developed focusing on SMEs operating under strict resources, the model is also completely adequate for large organization that have sufficient resources to invest in SPI. Therefore, the MN-MPS comprises two types of SPI implementation models according to organizations specific needs and availability of resources:

- A Specific Business Model suitable to large companies which do not want to share MPS Model based SPI services and costs with other companies;
- A Cooperative Business Model for groups of SMEs interested in implementing and assessing the MPS Model, and sharing MPS services and costs.

The MN-MPS is based on the previous successful experiences of many SOFTEX agents on software process improvement initiatives such as "Towards ISO 9000" [18].

5. Adoption and dissemination of the MPS Model in the Brazilian software industry

The creation of the MPS Model is the result of a combined effort of both Brazilian software industry and research institutions. One specific goal was established in the context of the MPS.BR Program addressing MPS Model adoption and dissemination across the country. This goal is two fold: (i) to capacitate MPS Model based consultants and accredit institutions to provide MPS Model based implementation and assessment services in different cities of the country; and (ii) to support adoption of MPS Model by a large number of organizations, especially SMEs.

So far, more than 2,600 people attended MPS Model courses in different cities of Brazil. A significant number of the courses' attendants took MPS Model exams. Figure 2 presents the number of practitioners approved in MPS Model exams. The MPS Model Introductory Exam (E1) is the first requirement for people seeking to provide MPS Model based implementation and assessment services. After that, candidates must take the MPS Reference Model Implementation Exam (E2) aiming to be accredited as a MPS Reference Model Implementation Consultant. The candidate can alternatively take the MPS Assessment Method Exam (E3) if the individual interest is to be accredited as a MPS Assessment Method Provisional Assessor. The MPS Model Acquisition Exam (E4) is required for people seeking to be accredited as MPS Model Acquisition Consultant.

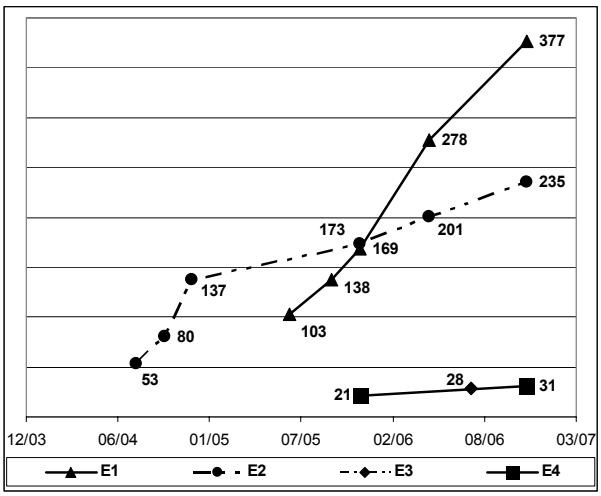

Fig. 2. SPI practitioners approved in MPS Model exams

Figure 3 presents the number of MPS Model implementation consultants and competent and provisional assessors associated to accredited MPS Model Implementation Institutions (MPS II) and MPS Model Assessment Institutions (MPS AI). 15 organizations were accredited to provide MPS Model-based implementation services and other 2 organizations were accredited to provide MPS Model-based assessment services in different regions of Brazil. The high number of consultants associated to accredited institutions is key factor to address the need of specialized people to provide MPS Model based implementation and assessment services within feasible costs.

In order to support adoption of MPS Model by a large number of organizations, especially SMEs, the SOFTEX (coordinator of the MPS.BR Program) organizes every year groups of organizations according

to the MPS Cooperative Business Model for groups of SMEs interested in implementing and assessing the MPS Model, and sharing MPS services and costs. Each group is coordinated by an authorized organization, named Coordinator Institution of Groups of Enterprises (CIGE).

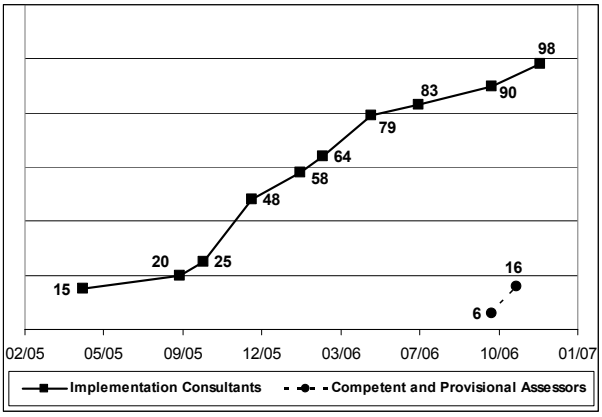

Fig. 3. MPS Implementation and Assessor Consultants associated to MPS II and MPS AI

Figure 4 presents the number of organizations implementing MPS Model based on the Cooperative Business Model. Until the present moment, 93 organizations are implementing the MPS Model according to the MPS Cooperative Business Model coordinated by 15 different CIGE in 13 cities. The Inter-American Development Bank (IDB) is providing 50% of the overall MPS Model based implementation and assessment costs of those groups under the condition that the organizations must conclude the implementation within 12 months and conduct an official MPS based assessment 3 months after concluding the implementation.

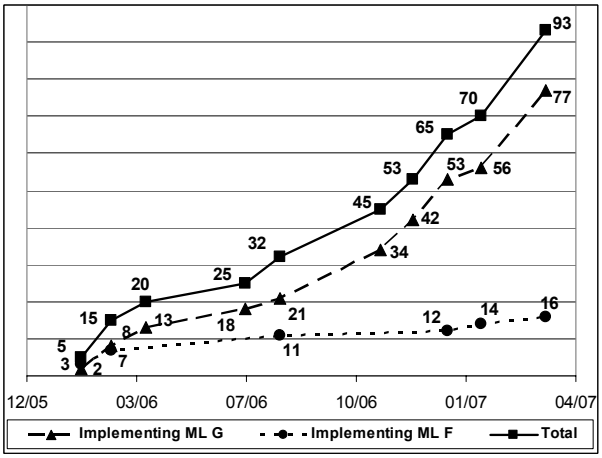

Fig. 4. Organizations implementing MPS Model based on the Cooperative Business Model

The adoption of MPS Model has been increasing significantly in Brazil. Until March 2007, 17 Brazilian organizations executed MPS Model-based assessments in 9 different cities. Figure 5 presents the number of organizations assessed in the MPS Model. We can observe in figure 10 that the majority of MPS Model assessment is in the lowest MR-MPS ML G (41%). This high number shows that MPS Model is attractive to organizations seeking process improvement, but that do not have sufficient resources to commit to initiative large improvement cycles. All the assessment results are published on the SOFTEX Web site (www.softex.br/mpsbr).

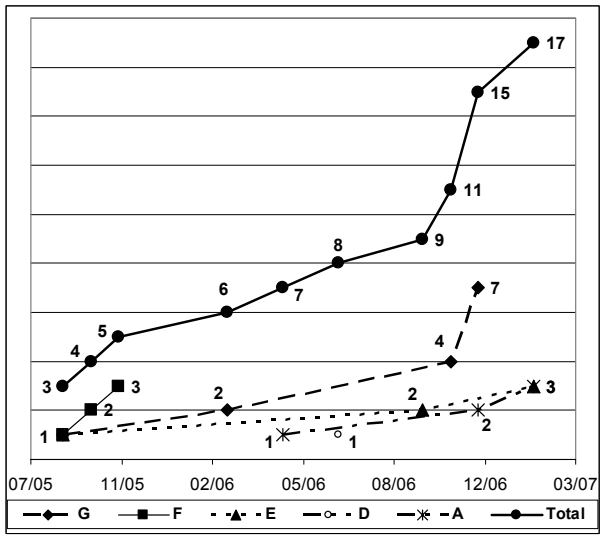

Fig. 5. Organizations assessed in the MPS Model

The future of the MPS Model is promising. It is expected to achieve 80 MPS Model based assessments until the end of 2007.

6. Conclusions

This paper presented the basic structure of the MPS.BR Program and the main components of the MPS Model, a software process model developed to address Brazilian software industry needs. This paper also presented the results of adoption and dissemination of the model by both SMEs and large organizations.

Although the MPS Model was defined based on international standards and internationally recognized models and best practices for SPI implementation and assessment, the MPS Model is more than just a software process model; it is the principal mechanism to establish a feasible pathway for Brazilian organizations to achieve benefits from implementing SPI.

The most relevant difference of the MPS Model and other models (like CMMI) is that organizations can escalate maturity levels more easily since few processes are needed to be implemented at each MR-MPS maturity level. Moreover, organizations that implement MPS Model are eligible to obtain financial support for SPI implementation and assessment initiatives, for instance, the American Development Bank (IDB) is supporting the implementation of MPS Model in more than 90 Brazilian SMEs. Therefore, benefits of MPS Model based SPI initiatives are visible in a shorter time frame and at feasible implementation and assessment costs, especially for SMEs.

We conclude from the results of MPS Model adoption and dissemination that it effectively facilitates the promotion of changes in Brazilian organizations willing to evolve into more mature stages. One quantitative benefit observed is that the overall cost for performing MPS Model based assessment is 60% cheaper than other assessment models, such as equivalent SCAMPI Class A assessment.

We expect that the increasing adoption and dissemination of the MPS Model by both SMEs and large organizations can improve the processes of Brazilian software industry aiming to enhance organizations competitive advantages both in local and global marketplaces.

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References

[1] Goldenson, D.R., Gibson, D.L. Demonstrating the Impact and Benefits of CMMI: An Update and Preliminary Results, SEI Special Report, CMU/SEI-2003-SR-009, Oct. 2003.

[2] Brazilian Ministry of Science and Technology Web Site - www.mct.gov.br (April 2007)

[3] SEI Process Maturity Profile, http : // www. sei. cmu. edu / appraisal - program/ profile/ profile.html, Sep, 2006

[4] Softex, MPS Model – Melhoria de Processo do Software Brasileiro, MPS General Guide, MPS Acquisition Guide, MPS Implementation Guide and MPS Assessment Guide. Sociedade Softex, Brasil. Available at http://www.softex.br/mpsbr (2007)

[5] ISO/IEC 12207:1995/Amd 1:2002/Amd 2:2004. Information Technology – Software Life Cycle Processes.

[6] 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.

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

[8] Appraisal Requirements for CMMI, Version 1.2 (ARC, V1.2), TR CMU/SEI-2006-TR-011, ESC-TR-2006-011, 2006

[9] 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

[10] Tuffley, A., McNair, B.G.G.: SPICE for small organisations. Software Process: Improvement and Practice, Vol. 9 (2004) 23-31

[11] Rout, T.P., El Emam, K., Fusani, M., Goldenson, D., Jung, H.-W.: SPICE in retrospect: Developing a standard for process assessment. Journal of Systems and Software (2007), doi: 10.1016/ j.jss.2007.01.045

[12] Wangenheim, C.G.v., Varkoi, T., Salviano, C.F.: Standard based software process assessments in small companies. Software Process: Improvement and Practice, Vol. 11 (2006) 329-335

[13] Emam, K.E., Jung, H.-W.: An empirical evaluation of the ISO/IEC 15504 assessment model. Journal of Systems and Software 59 (2001) 23-41

[14] Wilkie, F.G., McFall, D., McCaffery, F.: An evaluation of CMMI process areas for small- To medium-sized software development organisations. Software Process Improvement and Practice 10 (2005) 189-201

[15] Rodriguez-Dapena, P., 2003. ECSS-Q-80-02, A standard for software process assessment and improvement for the European space domain. In: Proceedings of 3rd International SPICE Conference on Process Assessment and Improvement, Nordwijk, Netherlands, pp. 7–14.

[16] El-Emam, K., Goldenson, D., Mccurley, J., Herbsleb, J., 2001, “Modelling the Likeli-hood of Software Process Improvement: An Exploratory Study”, In: Journal of Empirical Software Engineering, Volume 6, Number 3, Sep., pp. 207-229.

[17] Niazi, M., Wilson, D., Zowghi, D., 2006, “Critical Success Factors for Software Process Improvement Implementation: An Empirical Study”, In.: Software Process Improvement and Practice, v. 11, n. 2 (Mar-Apr), pp. 193-211.

[18] Weber, K.C., Almeida, R.A.R., Amaral, H.G., Gunther, P.S., Xavier, J.H.F., Loures, R. “ISO 9001/TickIT Certification in Brazilian Software Companies”. In: Proceedings of SQM’97 (5th Int. Conf. on Software Quality Management). Bath, UK, March 1997.

[19] IEEE STD 1062:1998. IEEE Software Engineering Standards Collection. IEEE Recommended Practice for Software Acquisition, IEEE STD 1062 Edition. New York NY (1998).