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MPS.BR: A Successful Program for Software Process Improvement in Brazil

Research Section

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Software process improvement 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 implementing software process improvement successfully, especially for small and medium-size enterprises that operate under strict financial resources. This paper describes the MPS.BR, a nationwide program for software process improvement 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 software process improvement at reasonable costs, especially small and medium-size enterprises. This paper presents the main components of the MPS Model and discusses the strategy executed to establish and maintain a community of MPS Model practitioners. The results of MPS Model adoption and dissemination in Brazilian software industry are also presented in this paper. Copyright © 2009 John Wiley & Sons, Ltd.

KEY WORDS: software process reference model; software process assessment model; ISO/IEC 15504; CMMI

1. INTRODUCTION

Software process improvement implementation based on software process reference models and standards is a complex and long-term endeavor that requires investment of large sums of money (Goldenson and Gibson 2003). These obstacles usually hinder organizations from improving software processes, especially for small and medium-size enterprises that operate under strict financial constraints. For instance, software process reference models have been adopted by very few Brazilian organizations. Until 2003, in India, 32 organizations were assessed as Capability Maturity Model (CMM) Level 5; while in China there was 1 organization assessed as CMM Level 5 and in Brazil none (in total, only 30 Brazilian organizations had gone through CMM based assessments until 2003) (Veloso *et al*. 2003). This scenario was considered

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critical, especially for small and medium-size enterprises that usually struggle to implement software process improvement. Considering that Brazilian small and medium-size enterprises (fewer than 50 employees in small organizations and between 51 and 100 people in medium-size enterprises) employ more than 182,000 people that corresponds to 56% of the total people employed by Brazilian software organizations (SIBSS-SOFTEX. IBGE 2009), there was an urgent need in Brazil to increase software development capabilities, especially of small and medium-size enterprises.

This paper describes an initiative to improve software processes 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 was started in 2003 under the coordination of Association for Promoting the Brazilian Software Excellence (SOFTEX), and is a joint effort of Brazilian government, 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 software process improvement, especially small and medium-size enterprises. The model was developed based on international standards and internationally recognized models and best practices for software process improvement implementation and assessment, and also on Brazilian software industry business needs.

The next section discusses some background in the software process improvement area. Section 3 presents the organizational structure of the MPS.BR Program necessary to develop the MPS Model. Section 4 presents the MPS Model main components. The main results regarding adoption and dissemination of the MPS Model in the Brazilian software industry are presented in section 5. Finally, section 6 presents the conclusions.

2. BACKGROUND

The ISO/IEC 15504 standard provides a comprehensive and generic approach for the model based assessment of process capability (Rout *et al*. 2007). The ISO/IEC 15504 defines requirements for performing process assessment that fall into two classes: requirements associated with the performance of the assessment itself and requirements concerned with the process model that forms the basis of the assessment (ISO/IEC 15504 2006). The processes that are defined as a comparison target for a particular assessment are defined in a process reference model. ISO/IEC 15504-2 specifies the contents and basic structure of process reference models. Each process in a process reference model is described in terms of its purpose which are the essential measurable objectives of a process and outcomes of its implementation (ISO/IEC 15504 2006, Rout *et al*. 2007).

In order to support process definition and process assessment and improvement, the ISO/IEC also initiated an effort to develop a process reference model within the domain of software engineering. The base standard for such initiative was the ISO/IEC 12207 : 1995 (ISO/IEC 12207 : 1995 1995). This standard provides a comprehensive group of life cycle processes, activities and tasks for software products and services. The ISO/IEC 12207 : 1995 was extensively revised and these revisions were published in the form of two amendments, the ISO/IEC 12207 : 1995/Amd 1 : 2002 (ISO/IEC 12207 : 1995/Amd 1 : 2002 2002) and the ISO/IEC 12207 : 1995/Amd 2 : 2004 (ISO/IEC 12207 : 1995/Amd 2 : 2004 2004). A recent effort of ISO/IEC aiming to integrate these amendments with ISO/IEC 12207 : 1995 resulted in the ISO/IEC 12207 : 2008 (ISO/IEC 12207 : 2008 2008). This new standard supplies a process reference model that supports process capability assessment in accordance with ISO/IEC 15504-2. The process reference model defined in ISO/IEC 12207 : 2008, associated with the process attributes defined in ISO/IEC 15504-2, establishes a process assessment model used as a common basis for performing assessments of software engineering process capability (ISO/IEC 15504 2006).

Another important internationally recognized model for software process improvement is the Capability Maturity Model Integration (CMMI) (CMMI® for Development (CMMI-DEV) 2006). CMMI is a process improvement maturity model for development of software products and services developed by the Software Engineering Institute (SEI). In spite of the fact that CMMI is internationally accepted, recent studies have been executed aiming to analyze the reasons why software organizations avoid adopting CMMI. For instance, Staples *et al*.

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(2007) show 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 software process improvement services and the lack of time to dedicate on software process improvement activities. Coleman and O'Connor (2006) also present a study of how software process improvement is applied in the practice of software development. Their study results show that many software managers reject implement software process improvement models because of the associated implementation and maintenance costs.

Considering the great difficulties associated with the implementation of software process improvement initiatives, many empirical studies conducted investigations about the critical factors that influence the success of software process improvement initiatives. For instance, Wangenheim *et al*. (2006) and Cater-Steel *et al*. (2006) point out that the main issue is to convince small and medium-size enterprises on the expected business benefits, and recognize the need to minimize the costs for process assessment and to make the benefits of software process improvement initiatives visible in a short time frame.

In this context, some software process improvement initiatives worldwide are starting to be developed focusing on small and medium-size enterprises. The ISO set up a working group on Software Engineering Life-Cycle Profiles for Very Small Enterprises (companies with fewer than 25 employees) (ISO/IEC NP TR 29110). The SEI initiated a CMMI in Small Settings project to provide approaches, tools, techniques and guidance in small settings (defined in this project as organizations or companies of fewer than approximately 100 people and projects of fewer than approximately 20 people) (CMMI in Small Settings Toolkit Repository). National initiatives are also starting to flourish with the increasing need for more adequate models to deal with characteristics of specific markets. For instance, the Mexican Ministry of the Economy (Ministry of the Economy 2005) developed a standard Ministry of the Economy 2005 based on ISO/IEC 12207, including practices from ISO 9000:2000, CMMI, PMBOK, SWEBOK, and ISO/IEC 15504. Moreover, in Ireland during 2006, Enterprise Ireland (the development agency with responsibility for small companies) initiated a 3-year plan for developing and promoting software quality through improved processes (Richardson and Wangenheim 2007).

3. MPS.BR PROGRAM: DEVELOPING A BRAZILIAN MODEL FOR SOFTWARE PROCESS IMPROVEMENT

The main problems that inhibit organizations from adopting software process reference models, such as CMMI, ISO/IEC 12207 and ISO/IEC 15504, as reported in the software process improvement literature, are related to software process improvement implementation, maintenance and assessment costs, and difficulty to convince organizations of the benefits of software process improvement. 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. 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 software process improvement implementation and assessment pathway for organizations to thrive, especially small and medium-size enterprises.

A special concern during the conception of the MPS.BR Program was not only to develop a model aligned to Brazilian software industry business needs but also to establish and maintain a strategy to guarantee adequate adoption and dissemination of the model by Brazilian organizations. In order to achieve this goal, the MPS.BR Program considered the following requirements: (i) the MPS Model should incorporate internationally recognized best practices for software process implementation and assessment, and also consider Brazilian software industry business needs; (ii) the costs for implementing and assessing software process should be reasonable to small and medium-size enterprises that operate under strict resources; (iii) a community of MPS Model practitioners should be established and maintained to provide adequate MPS Model based implementation and assessment services; and (iv) the MPS Model should be adopted by a large number of Brazilian software organizations, especially small and medium-size enterprises.

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The MPS.BR Program has been operating 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, the Brazilian Research and Projects Financing Agency, the Brazilian Service of Support for Micro and Small Enterprises and the Inter-American Development Bank, but it is being increasingly sustained by revenues from MPS services.

In order to manage the MPS.BR Program, an organizational structure was defined. The MPS.BR Program Structure units are the following: (i) MPS.BR Program Team – responsible to manage the program activities; (ii) MPS Technical Model Team – responsible to develop and maintain the model, and to prepare and execute MPS Model trainings; and (iii) MPS Accreditation Forum – responsible to certify organizations to provide MPS Model based implementation and assessments services, to evaluate and control implementations and assessments results and to ensure that organizations certified on the MPS Model execute their activities within expected ethical and quality limits.

4. MPS MODEL

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. Next, we describe in details these components.

4.1. MPS Reference Model

The MPS Reference Model 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 MPS Reference Model is a 'candidate conformant' to ISO/IEC 15504 since it fulfils the requirements for a process reference model defined in ISO/IEC 15504-2. The MPS Reference Model processes are described in terms of their specific purpose and outcomes used to evaluate specific process implementation. Each process defined within the MPS Reference Model has unique process descriptions and identification and the set of process outcomes are necessary and sufficient to achieve the purpose of the process. The MPS Reference Model processes are an adaptation of the ISO/IEC 12207 : 2008 processes and the CMMI-DEV process areas. The MPS General Guide also provides a definition of scope and composition of MPS Reference Model process profiles for a declared level of organizational maturity level. A maturity level consists of process outcomes and process attributes achievement results for a predefined set of processes. Therefore, the MPS Reference Model maturity levels are defined in two dimensions: process capabilities dimension and process dimension.

The MPS Reference Model process capabilities dimension is constituted of a measurement framework for the assessment of process capability based on the processes defined in the MPS Reference Model 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 MPS Reference Model process attributes are based on the ISO/IEC 15504-2 process attributes used to define capability levels. The MPS Reference Model 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 results used to evaluate a specific PA implementation.

The MPS Reference Model process dimension is constituted of the processes to be assessed. The MPS Reference Model process dimension describes seven

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sequential and accumulative groups of processes that correspond to the MPS Reference Model maturity levels. The seven MPS Reference Model 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 the level A is the most mature one. The MPS Reference Model maturity levels processes profiles were defined accordingly to specific business needs of Brazilian software industry. The most relevant need considered while defining the MPS Reference Model maturity levels was to define processes profiles that facilitate the realization of benefits of software process improvement initiatives in a short time frame and at reasonable implementation and assessment costs.

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 the MPS Reference Model processes and the process attributes that shall be added to each maturity level.

The first MPS Reference Model maturity level 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 MPS Reference Model maturity level named F (managed). The processes of this 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. In this maturity level, the organization can also implement practices to improve the management of their project portfolio (collection of projects that addresses the strategic objectives of the organization).

The implementation of MPS Reference Model 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 software process improvement benefits are only obtained through establishment of processes institutionalization across the projects and the organization. The MPS Reference Model maturity level E (partially defined) is constituted of processes that support software processes institutionalization and improvement. These processes praise the definition of standard processes to guide execution of software

Table 1. MPS Reference Model maturity levels, processes and process attributes

Maturity Level	Processes	Process Attribute
A (Optimizing)	(No new processes)	PA 1.1, PA 2.1, PA 2.2, PA 3.1, PA 3.2, PA 4.1, PA 4.2, PA 5.1 and PA 5.2
B (Quantitatively managed)	Project Management (new outcomes)	PA 1.1, PA 2.1, PA 2.2, PA 3.1, PA 3.2, PA 4.1 and PA 4.2
C (Defined)	Risk Management, Decision Management and Development for Reuse	PA 1.1, PA 2.1, PA 2.2, PA 3.1 and PA 3.2
D (Largely defined)	Verification, Validation, Product Design and Construction, Product Integration and Requirements Development	PA 1.1, PA 2.1, PA 2.2, PA 3.1 and PA 3.2
E (Partially defined)	Project Management (new outcomes), Reuse management, Human Resources Management, Process Establishment and Process Assessment and Improvement	PA 1.1, PA 2.1, PA 2.2, PA 3.1 and PA 3.2
F (Managed)	Measurement, Quality Assurance, Project Portfolio Management, Configuration Management and Acquisition	PA 1.1, PA 2.1 and PA 2.2
G (Partially managed)	Requirements Management and Project Management	PA 1.1 and PA 2.1

The PA 4.1, PA 4.2, PA 5.1 and PA 5.2 should only be implemented for the critical processes of the organization/organizational unit, selected for performance analyses. The other process attributes should be implemented for all the processes.

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projects. The level E processes profile also addresses important issues related to management of reusable assets and intellectual capital.

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 MPS Reference Model maturity level 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 maturity level 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 have the Development for Reuse process included in the assessment scope.

The MPS Reference Model maturity levels A and B are high maturity levels focusing on continuous process improvement. In the level B, selected processes for performance analyses evolve by the implementation of specific process attributes concerned about establishing a quantitative understanding of software products and processes, and controlling causes of variations aiming to achieve process stability. The Project Management process also goes through an evolution by the addition of new outcomes focusing on quantitative management, reflecting the high maturity expected from the organization. The MPS Reference Model maturity level A focuses on continuously increasing organizational competitiveness capabilities through the implementation of process and technological innovations and on the removal of causes of problems and defects. This is achieved by the implementation of new process attributes to the processes selected for quantitative performance analyses.

A correspondence can be delineated between MPS Reference Model and CMMI maturity levels. The processes profiles of MPS Reference Model 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 MPS Reference Model maturity level G corresponds to an intermediary level between the processes profile of CMMI maturity levels 1 and 2. The processes profile of MPS Reference Model maturity levels E and D are two intermediary levels between the processes profile of CMMI maturity levels 2 and 3.

The MPS Reference Model 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 software process improvement investments results in a short time frame. These characteristics make the MPS Model more appealing to small and medium-size enterprises that operate under strict resources and need to prove by themselves the benefits from implementing software process improvement. Moreover, the MPS.BR is 'candidate conformant' with ISO/IEC 15504, since it satisfies the requirements for a software process reference and assessment model.

Besides the MPS General Guide, the MPS Reference Model contains two other guides: the MPS Acquisition Guide and the MPS Implementation Guide. The MPS Acquisition Guide describes an acquisition process for software and related services. The MPS Acquisition Guide also identifies recommended practices for software acquisition such as in IEEE STD 1062:1998 (IEEE STD 1062:1998 1998). The MPS Implementation Guide provides technical guidance for implementing the seven MPS Reference Model levels. The MPS Implementation Guide describes theoretic concepts that supports the processes defined in the MPS Reference Model maturity levels. Moreover, it contains detailed information on implementing MPS Reference Model process outcomes. This guide establishes the means to uniform Software Engineering knowledge among software process improvement practitioners and to reduce the risk of misunderstanding implementation issues essential for successfully satisfying MPS Reference Model processes outcomes.

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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 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 MPS Assessment Method. The MPS Assessment Guide also defines the requirements for accreditation of organizations to provide MPS assessments services (MPS Assessment Institutions), MPS Competent Assessors and MPS Provisional Assessors (assessors that support competent assessors during assessments).

The objective of the MPS Assessment Method 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: (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 MPS Assessment Method 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 MPS Assessment Method based assessment. An MPS Assessment Method based assessment to be valid must be conducted by an MPS Assessment Institution 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 desired MPS Reference Model maturity level. Since the level of detail provided by the MPS Reference Model 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. 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. This report is used by the assessed organization to take corrective actions aiming to guarantee that the organization is ready to perform the final assessment, which is the objective of the next subprocess.

The purpose of the 'Performing the assessment' subprocess is to train the assessment team on the 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 four steps to be described next.

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

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

Rating	Description
Fully implemented – F	- The direct indicator is present and is judged to be adequate. - There is at least one indirect indicator and/or statement confirming the implementation. - There is no sign of substantial weakness.
Largely implemented – L	- The direct indicator is present and is judged to be adequate. - There is at least one indirect indicator and/or statement confirming the implementation. - There are one or more signs of substantial weakness.
Partially implemented – P	- The direct indicator is not present or is judged to be inadequate. - Evidences/statements suggest that some aspects of the process outcomes and attributes are implemented. - Weaknesses were documented.
Not implemented – NI	Any other situation different from above.
Not assessed – NA	The project is not in the development phase that permits to satisfy the outcome or it is not in the scope of the project to satisfy the outcome.
Out of scope – OS	The process outcome is out of the assessment scope as documented in the assessment plan.

The initial characterization of the implementation degree of each process outcome and process attribute achievement result in the organization (step two) 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 three) 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.

The characterization of the implementation degree of processes in the organization (step four) 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) all process outcomes are classified as Fully implemented or Largely implemented 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.

One important aspect to the success of the MPS Model is that the assessment method should be executed aiming to minimize assessment costs without compromising the reliability and consistency of the assessment results. Therefore, the assessment method activities were defined aiming to optimize the required effort and, as consequences, making assessment costs not prohibited to software organizations, especially small and medium-size enterprises. For instance, the amount of effort necessary to completely assess an organization in the MPS Reference Model maturity level G is only 40 man-hours. The complete assessment of MPS Reference Model maturity level A processes in a specific organization would require approximately 200 man-hours. The low effort for assessing MPS Reference Model processes is obtained mainly due to the characteristics of the MPS Assessment Method. For instance, in the 'Performing the assessment' subprocess, the assessment team only revisits the processes outcomes that had problems identified in the 'Preparing to perform the assessment' subprocess. This practice helps to focus the attention on the problems in the processes implementation.

4.3. MPS Business Model

In order to guarantee the success of the MPS Model, it is essential that organizations effectively adopt it

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Table 3. Characterization scheme of process attribute to satisfy MPS Reference Model maturity levels

Maturity Level	Process Attribute	Rating
A (Optimizing)	PA 1.1 Process performance	Fully
	PA 2.1 Performance management	Fully
	PA 2.2 Work product management	Fully
	PA 3.1. Process definition	Fully
	PA 3.2 Process deployment	Fully
	PA 4.1 Process measurement	Fully
	PA 4.2 Process control	Fully
	PA 5.1 Process innovation	Largely or fully
	PA 5.2 Process optimization	Largely or fully
B (Quantitatively managed)	PA 1.1 Process performance	Fully
	PA 2.1 Performance management	Fully
	PA 2.2 Work product management	Fully
	PA 3.1. Process definition	Fully
	PA 3.2 Process deployment	Fully
	PA 4.1 Process measurement	Largely or fully
	PA 4.2 Process control	Largely or fully
C (Defined)	PA 1.1 Process performance	Fully
	PA 2.1 Performance management	Fully
	PA 2.2 Work product management	Fully
	PA 3.1. Process definition	Fully
	PA 3.2 Process deployment	Fully
D (Largely defined)	PA 1.1 Process performance	Fully
	PA 2.1 Performance management	Fully
	PA 2.2 Work product management	Fully
	PA 3.1. Process definition	Fully
	PA 3.2 Process deployment	Fully
E (Partially defined)	PA 1.1 Process performance	Fully
	PA 2.1 Performance management	Fully
	PA 2.2 Work product management	Fully
	PA 3.1. Process definition	Largely or fully
	PA 3.2 Process deployment	Largely or fully
F (Managed)	PA 1.1 Process performance	Fully
	PA 2.1 Performance management	Fully
	PA 2.2 Work product management	Largely or fully
G (Partially managed)	PA 1.1 Process performance	Largely or fully
	PA 2.1 Performance management	Largely or fully

The ratings for the process attributes Process measurement, Process control, Process innovation and Process optimization are applicable only to selected processes. All the other ratings must be applied to all processes.

and achieve benefits from implementing software process improvement. Therefore, the MPS Business Model was developed with the aim to support MPS Model adoption and dissemination.

The MPS Business Model comprises two types of software process improvement implementation models according to organizations' specific needs and availability of resources: (i) a Specific Business Model suitable to large companies which do not want to share MPS Model based software process improvement services and costs with other companies; and (ii) a Cooperative Business Model for groups of small and medium-size enterprises interested in implementing and assessing the MPS Model, and sharing MPS services and costs, for instance, training activities. The Cooperative Business Model is especially attractive to small and medium-size enterprises because the implementation based on this model is feasible to obtain external funds to support software process improvement implementation and assessment activities.

5. ADOPTION AND DISSEMINATION OF THE MPS MODEL IN THE BRAZILIAN SOFTWARE INDUSTRY

One criterion for evaluating the success of standards and models is to identify the degree of acceptance and usage by their target community (Meek 1996).

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In this context, a specific goal was established in the context of the MPS.BR Program addressing MPS Model adoption and dissemination across the regions of Brazil. 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 small and medium-size enterprises.

In order to capacitate MPS Model based consultants and accredit institutions to provide MPS Model based implementation and assessment services, a strategy, constituted of official courses and exams, was defined and is being executed on a regular basis to establish and maintain a community of MPS Model practitioners. So far, more than 3,390 people attended MPS Model courses in different regions of Brazil, and more than 1,290 people were successfully approved in MPS Model exams.

Another important aspect to guarantee the adoption of the MPS Model is to accredit institutions in different parts of the country to provide MPS Model based services. A total of 20 organizations were accredited to provide MPS Model based implementation services and other 9 organizations were accredited to provide MPS Model based assessment services in different regions of Brazil. More than 130 MPS Model implementation consultants are effectively working in MPS Model based initiatives in Brazilian organizations. Moreover, in total, 55 competent and provisional assessors are associated to accredited MPS Assessment Institutions with conditions to conduct MPS Model based assessments across the country.

In order to support adoption of MPS Model by a large number of organizations, the SOFTEX (coordinator of the MPS.BR Program) organizes groups of organizations according to the MPS Cooperative Business Model for small and medium-size enterprises interested in implementing and assessing the MPS Model, and sharing MPS Model based services and costs. Sponsors usually provide 40–50% of the overall MPS Model based implementation and assessment costs of those groups. Moreover, these organizations can also share other costs, for instance, process definition and training activities. By integrating those groups, organizations can significantly reduce financial resources necessary to improve their processes. The implementation of MPS Model according to MPS Cooperative Business Model has been recognized by small and medium-size enterprises as an important pathway to achieve process improvements benefits at reasonable costs.

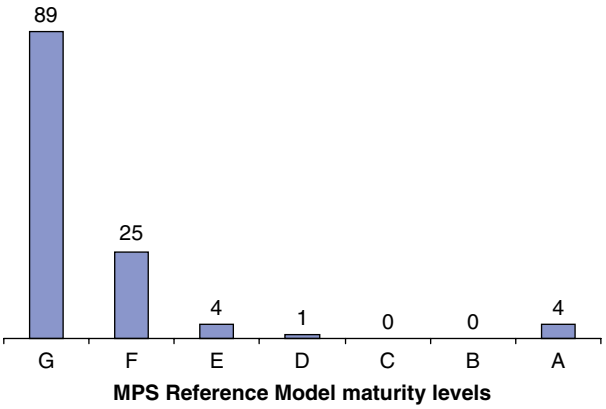

Figure 1. Number of organizations assessed in the MPS Model

Figure 1 presents the number of organizations assessed in the MPS Model. Until December 2008, 123 organizations had gone through successful MPS Model based assessments. We can observe in Figure 1 that the majority of MPS Model assessments is in the lowest MPS Reference Model maturity level G (72.4% of the total assessments). This high number shows that MPS Model is attractive to organizations seeking process improvement, but that do not have sufficient resources to commit to initiate large improvement cycles. Of the organizations that were assessed on the two bottom maturity levels (G and F), 80% are small and medium-size enterprises that implemented the MPS Model under the Cooperative Business Model. All the assessment results are published on the SOFTEX web site (www.softex.br/mpsbr).

6. CONCLUSIONS

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

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We conclude from the results of MPS Model adoption and dissemination that it facilitates software process improvement in Brazilian organizations. This conclusion is supported by two observations identified in MPS Model based software process improvement initiatives. Firstly, the seven maturity levels of the MPS Model help to diminish software process improvement complexity and to increase software process improvement initiatives control by reducing the number of processes to be implemented at each maturity level and by facilitating the achievement of software process improvement benefits visibility in a shorter term. Secondly, the MPS Business Model and the strategy to promote the community of MPS Model practitioners help to diminish inherent risks of software process improvement initiatives, such as, lack of financial and specialized human resources.

We expect that the increasing adoption and dissemination of the MPS Model by both small and medium-size enterprises 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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