

iMPS 2009

Characterization and Performance
Variation of Software Organizations
that Adopted the MPS Model



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T697i

Travassos, Guilherme Horta.
iMPS 2009 : characterization and performance variation
of software organizations that adopted the MPS model /
Guilherme Horta Travassos and Marcos Kalinowski. --
Campinas, SP : Association for Promotion of the Excellence
the Brazilian Software - SOFTEX, 2009.
27p. Translation: Marcos Kalinowski

1. Software Engineering. 2. Software - Quality Control
3. Software – Development. I. Kalinowski, Marcos.
II. Title.

CDD - 005.1

ISBN 978-85-99334-18-8

Indexes for Systematic Catalog:

| | |
|-------------------------------|-------|
| 1. Software Engineering | 005.1 |
| 2. Software - Quality Control | 005.1 |
| 3. Software – Development | 005.1 |

Summary

| | |
|--|----|
| Preface | 5 |
| Abstract | 7 |
| 1. Introduction | 7 |
| 2. iMPS: Observing the Performance Variation of Organizations that Adopted the MPS Model | 8 |
| 3. Survey Application and Initial Data Preparation: 2009 Execution | 9 |
| 4. iMPS 2009 Results: Characterization | 10 |
| 5. iMPS 2009 Results: 2008/2009 Variation Analysis | 21 |
| 6. Final Considerations | 25 |
| Acknowledgements | 25 |
| References | 26 |



SOFTEX - Association for Promoting the Brazilian Software Excellence

Created at the end of 1996, the SOFTEX Association, is a Civil Society Organization of Public Interest headquartered in Campinas, SP, Brazil.

SOFTEX is responsible for managing the Informatics Priority Program of the Federal Government for Promoting the Brazilian Software Excellence, the SOFTEX Program.

SOFTEX Mission

To expand the competitiveness of Brazilian Software and Service Companies in the domestic and overseas markets and promoting the development in Brazil.

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Among the activities of SOFTEX in the context of Quality and Competitiveness Directorate, due to results achieved since December 2003, the MPS.BR Program – Brazilian Software Process Improvement – is one of the highlights.

MPS.BR Program – Brazilian Software Process Improvement

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Preface

The MPS.BR Program - Brazilian Software Process Improvement - was created in December 2003, under the coordination of SOFTEX - Association for Promoting the Brazilian Software Excellence. In these six years of activities, the results exceeded the expected results.

When concerning quality improvement, rather than stating general assertions such as “quality and process improvement implies greater local and global competitiveness of software companies”, objective evidence should be provided.

In 2008, this was the main motivation of SOFTEX when hiring COPPE/UFRJ’s Experimental Software Engineering Group to conduct the “iMPS – Performance Results of Organizations that Adopted the MPS model” project and its subsequent yearly iMPS research studies.

The results of the first iMPS project execution, in 2008, presented in the publication “iMPS2008: Performance Results of Organizations that Adopted the MPS Model”, indicate that organizations that adopted the MPS model showed higher customer satisfaction, higher productivity, and capacity to develop bigger projects. Additionally, more than 80% of the organizations reported to be satisfied with the MPS model.

This publication, entitled “iMPS 2009: Characterization and Performance Variation of Organizations that Adopted the MPS Model”, presents the results of the 2009 iMPS project execution under two perspectives: 2009 characterization and 2008/2009 variation analysis. Overall, the satisfaction of the organizations with the model is notorious, with more than 98% of them reporting to be totally or partially satisfied. Moreover, the organizations reported return on investment and, especially for those organizations that evolved or institutionalized the MPS model in their processes, improvement trends could be observed concerning cost, quality, time, and productivity, basic assumptions when developing software according to engineering precepts.

We hope that the objective evidence presented will be useful to both, the several stakeholders of the MPS model (Implementation Institutions – II, Implementation Consultants, Assessment Institutions - AI, Provisional and Competent Assessors, Organizing Institution of Groups of Enterprises – IOGE from the acronym in Portuguese “Instituições Organizadoras de Grupos de Empresas, Organizations that adopted or want to adopt the MPS model, Acquisition Consultants - AC, and supporters and sponsors of the MPS model), and those who have interest in process improvement based on other models, such as CMMI, whether in industry, government or academia.

Campinas, Brazil, December 2009

Kival Chaves Weber

José Antonio Antonioni

iMPS 2009: Characterization and Performance Variation of Software Organizations that Adopted the MPS Model

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Abstract. *This publication presents the results of the 2009 execution of the iMPS project (information to monitor and provide evidence regarding performance variation of software organizations that adopted the MPS model). Those results are presented in two perspectives: 2009 characterization and 2008/2009 variation analysis. Overall, the satisfaction of the software organizations with the model is notorious, with more than 98% totally or partially satisfied. Moreover, the organizations reported return on investment and, especially for those organizations that evolved or institutionalized the MPS model in their processes, improvement trends could be observed concerning cost, quality, time, and productivity, basic assumptions when developing software according to engineering precepts.*

1. Introduction

The MPS.BR program was created in December 2003, representing an initiative to improve the development capacity of Brazilian software organizations. Concerning the model adoption, until September 2009, 174 assessments were published. The results of those assessments are available in the SOFTEX portal www.softex.br/mpsbr. Considering the upcoming years, around 200 assessments are expected until December 2009 and 300 until December 2010.

Given this growing adoption scenario of the MPS model by Brazilian software organizations, an interest sprouts in qualitatively understanding the performance variation of those organizations, concerning measures such as time, productivity, cost, and quality. With this purpose, the iMPS project (information to monitor and provide evidence regarding performance variation of software organizations that adopted the MPS model) was initiated with the Experimental Software Engineering Group (<http://ese.cos.ufrj.br>) of COPPE/UFRJ. The main goal of the iMPS project is to periodically monitor and provide evidence, based on surveys, regarding performance results in software organizations that adopted the MPS model.

Further details about the research plan, the moments in which information is gathered and the treatment given to validity threats can be found in [Kalinowski et al., 2008]. The 2008 execution of the iMPS project provided initial objective evidence [Travassos and Kalinowski, 2008a], to be complemented yearly by other iMPS executions, allowing to perform comparative analyses against the 2008 baseline.

In this publication we present the iMPS 2009 execution results. This year, the iMPS results will be presented under two perspectives: 2009 characterization and 2008/2009 variation analysis. The goal of the characterization is to outline the performance of organizations that adopted the MPS model in 2009. The goal of the 2008/2009 variation analysis is to observe the performance variation of organizations that adopted the MPS model. It is important to highlight that this analysis is performed comparing the company against her own data in the previous year, and that individual performance results will not be presented.

The remainder of this publication is organized in the following way. In section 2, further details about the iMPS project and its goals are provided. In section 3, the survey application and the initial data preparation for the 2009 execution are described. In sections 4 and 5, the results of the 2009 characterization and the 2008/2009 variation analysis are presented. Section 6 contains some final considerations.

2. iMPS: Observing the Performance Variation of Organizations that Adopted the MPS Model

The iMPS main goal is to plan a survey, following Experimental Software Engineering principles [Wohlin et al., 2000], and periodically execute it to monitor and provide evidence of performance results in software organizations that adopted the MPS model. This survey should allow the characterization of those organizations to support the performance variation comprehension of organizations that adopted the MPS model.

The choice for an experimental strategy to evaluate the organizations performance variation due to MPS adoption helps to assure the research validity and to allow proper data consolidation, being an differential to other research studies with almost similar objectives, such as the study performed by the SEI (Software Engineering Institute) regarding CMMI [Gibson et al., 2006].

Following the GQM paradigm [Basili et al., 1994] and aiming to avoid possible threats to validity [Kalinowski et al., 2008], a set of questionnaires was elaborated to be applied in the following moments: (i) when organizations are starting to implement the MPS model; (ii) when organizations are being assessed; and (iii) periodically for the organizations with unexpired assessments published in the SOFTEX portal. These instruments were evaluated in 2008 in a pilot study and showed themselves adequate candidates to capture the basic information considered in the survey plan, intended to support the organizations performance variation comprehension. Additionally, for the first execution, in 2008, a retroactive application of the survey for organizations that had already been assessed was performed [Travassos e Kalinowski, 2008b]. Suggestions gathered in 2008 allowed to evolve the questionnaires for the 2009 execution, without, however, changing the information to be collected. The following subsections describe how the survey is applied in the organizations.

2.1. Application in Organizations Starting to Implement the MPS Model

For organizations in this situation the following instruments are distributed: consent form; characterization form for organizations starting to implement the MPS Model, and; performance questionnaire for organizations starting to implement the MPS Model.

2.2. Application in Organizations being Assessed According to the MPS Model

This situation refers to organizations that were approved in official MPS assessments. For these organizations the following instruments are distributed: consent form; characterization form for organizations being assessed according to the MPS Model, and; performance questionnaire for organizations being assessed according to the MPS Model.

2.3. Application in Organizations with Unexpired Assessments Published in the SOFTEX Portal

This situation reflects the survey's periodical (yearly) application in organizations with unexpired assessments published in the SOFTEX portal. For organizations in this situation the following instruments are distributed: consent form; characterization form for organizations with unexpired assessments published in the SOFTEX portal, and; performance questionnaire for organizations with unexpired assessments published in the SOFTEX portal.

3. Survey Application and Initial Data Preparation: 2009 Execution

The questionnaires were distributed to the participants (representatives of organizations that adopted MPS) by e-mail by the MPS.BR Operations Management¹, which was responsible for submitting and receiving the questionnaires. After receiving the questionnaires data was transferred manually to the iMPS repository. The fulfillment of all of the performance questionnaire fields by the organizations representative is not mandatory. Thus, some questionnaires were received with blank fields. In this case, only the data provided by the organization was transferred to the repository. Some additional characterization information, such as the MPS maturity level, was obtained directly from other already existing SOFTEX databases.

After the transference to the iMPS repository, the data quality of all the questionnaires was evaluated by the SOFTEX Observatory² team, checking the conformance of the provided information with the survey question requirements described in the research plan [Travassos e Kalinowski, 2009]. Therefore, several questionnaires with conflicting or incompatible information could be identified. In these cases, for each organization, a set of additional confirmation questions aiming the review and correction of previously provided information was sent.

1) MPS.BR Operations Management: Nelson Henrique Franco de Oliveira and André Luis Chamelet Sotovia.

2) SOFTEX Observatory: Virgínia Costa Duarte and Daniela Albini Pinheiro.

Moreover, as data of different organizations is considered, a very high standard deviation for each of the measures is naturally expected. Hence, we believe that the median, representing the central value for each of the measures, could provide more adequate information to characterize the organizations than the mean. During data preparation, for each of the measures, values more than three standard deviation from the mean were considered outliers and were discarded until the final data didn't contain any values in this situation. Thus, it was possible to consider as much as possible of the answers and at the same time without influencing the results with eventually distorted data. In this process it was possible to observe that most of the outliers were provided by organizations starting to implement the MPS model or by organizations in the first maturity level (level G), these groups also showed higher standard deviations. This could be related with the fact that the measurement process is considered by the MPS model since maturity level F. Therefore, we believe that the measure values of organizations are more confident for the higher maturity levels.

The subsequent sections describe, respectively, the results of the 2009 characterization and of the 2008/2009 performance variation analysis. The results of the 2008 baseline characterization can be found in [Travassos and Kalinowski, 2008a].

4. iMPS 2009 Results: Characterization

The characterization analysis aims to outline the performance of the organizations that adopted the MPS model in 2009. Thus, only the data of 2009 was considered in this analysis, totalizing 135 questionnaires of different organizations (20 starting the MPS implementation, 25 in assessment process, 57 assessed MPS level G, 26 assessed MPS level F, and 7 assessed MPS levels E-A). Given that most organizations are still in the initial maturity levels, they were grouped during analysis in the following 4 categories: organizations starting to implement the MPS model, organizations assessed MPS level G, organizations assessed MPS level F, and organizations assessed MPS levels E-A. Furthermore, data is observed with focus on three different perspectives treated by the questionnaire, concerning the organizations, their projects and the MPS itself.

The measures considered in the survey plan [Travassos and Kalinowski, 2009b], concerning each of the perspectives (organization, project, and MPS), and its interpretation are presented in the following subsections, together with the values that could be obtained, considering the set of organizations that participated in this execution of the study. For each of the measures, beyond the basic aggregated information found (median or percentage), the number of valid answers obtained is presented and, if relevant, a textual interpretation with additional information is provided.

4.1. Perspective ORGANIZATION

An organization represents the entity being studied. In general, the concept concerns the entire software development organization. However, it is possible for an organization to have different organizational units that deal with software development using different processes, in this case the concept could be related to an individual organizational unit that is using the MPS model in its processes. Table 1 shows the interpretation that was given to collect the values for the measures related to this perspective that were considered in this research.

TABLE 1 – Measures used in the perspective Organization

| MEASURE | INTERPRETATION |
|--------------------------------|--|
| Other process reference models | Indicates whether the organization also uses other reference models {CMM, CMMI, ISO 9001, ...}. |
| Number of customers in Brazil | Represents the number of customers the organization has in Brazil. |
| Number of customers abroad | Represents the number of customers the organization has abroad. |
| Number of projects in Brazil | Represents the number of projects the organization has in the country. |
| Number of projects abroad | Represents the number of projects the organization has abroad. |
| Total number of employees | Staff involved in software development. |
| Customer satisfaction | <p>Fully Satisfied: all customers show themselves satisfied with the products and/or services.</p> <p>Largely Satisfied: the majority of the customers show themselves satisfied with the products and/or services.</p> <p>Partially Satisfied: the minority of the customers show themselves satisfied with the products and/or services.</p> <p>Not Satisfied: no customer is satisfied with the products and/or services.</p> <p>Unknown satisfaction: the company does not know the degree of customer satisfaction.</p> |

Tables 2 to 8 present values (medians and percentages) that could be obtained for the organization perspective measures.

TABLE 2 – Other Reference Models

| Grouping | CMMI | ISO | Others | Number of Answers |
|--|-------------|------------|---------------|--------------------------|
| Organizations starting implementation | 10% | 25% | 10% | 20 |
| Level G Organizations | 10.5% | 21.1% | 17.5% | 57 |
| Level F Organizations | 11.5% | 15.4% | 3.8% | 26 |
| Level E-A Organizations | 57.1% | 85.7% | 14.3% | 7 |
| All the organizations (including those in assessment process) | 12.6% | 23% | 15.6% | 135 |

TABLE 3 – Number of customers in the country

| Grouping | Number of Customers | Number of Answers |
|--|----------------------------|--------------------------|
| Organizations starting implementation | 40 | 20 |
| Level G Organizations | 18 | 56 |
| Level F Organizations | 26 | 26 |
| Level E-A Organizations | 20 | 7 |
| All the organizations (including those in assessment process) | 20 | 134 |

For the measure regarding the number of customers abroad, only 20.3% of the organizations participating in the study reported to have customers abroad and, therefore, the medians (central value) for all groups of analysis was zero. Thus, we considered it more interesting to show, for each of the groups, the percentage of organizations that reported to have customers abroad.

TABLE 4 – Percentage of Organizations that have Customers Abroad

| Grouping | % that have Customers Abroad | Number of Answers |
|--|-------------------------------------|--------------------------|
| Organizations starting implementation | 15% | 20 |
| Level G Organizations | 21.1% | 57 |
| Level F Organizations | 26.9% | 26 |
| Level E-A Organizations | 28.6% | 7 |
| All the organizations (including those in assessment process) | 20.3% | 128 |

TABLE 5 – Number of Projects in the Country

| Grouping | Number of Projects in the Country | Number of Answers |
|--|--|--------------------------|
| Organizations starting implementation | 12 | 19 |
| Level G Organizations | 10 | 53 |
| Level F Organizations | 13 | 26 |
| Level E-A Organizations | 10 | 7 |
| All the organizations (including those in assessment process) | 12 | 130 |

For the measure regarding the number of projects abroad, only 13.3% of the organizations participating in the study reported to have projects abroad, and the median (central value) for all groups of analysis was zero. Thus, we considered it more interesting to show, for each of the groups, the percentage of organizations that reported to have projects abroad.

TABLE 6 – Percentage of Organizations with Projects Abroad

| Grouping | Number of Projects Abroad | Number of Answers |
|--|----------------------------------|--------------------------|
| Organizations starting implementation | 5% | 20 |
| Level G Organizations | 15.8% | 57 |
| Level F Organizations | 15.4% | 26 |
| Level E-A Organizations | 28.6% | 7 |
| All the organizations (including those in assessment process) | 13.3% | 135 |

TABLE 7 – Number of Employees

| Grouping | Number of Employees | Number of Answers |
|--|----------------------------|--------------------------|
| Organizations starting implementation | 32 | 20 |
| Level G Organizations | 37 | 53 |
| Level F Organizations | 75 | 23 |
| Level E-A Organizations | 30 | 5 |
| All the organizations (including those in assessment process) | 42 | 121 |

TABLE 8 – Customer Satisfaction

| Grouping | Results | |
|---------------------------------------|----------------------|-------|
| Organizations starting implementation | Fully Satisfied | 0% |
| | Largely Satisfied | 50% |
| | Partially Satisfied | 10% |
| | Not Satisfied | 0% |
| | Unknown satisfaction | 40% |
| Level G Organizations | Fully Satisfied | 19% |
| | Largely Satisfied | 53.4% |
| | Partially Satisfied | 3.4% |
| | Not Satisfied | 0% |
| | Unknown satisfaction | 24.1% |
| Level F Organizations | Fully Satisfied | 3.8% |
| | Largely Satisfied | 53.8% |
| | Partially Satisfied | 11.5% |
| | Not Satisfied | 0% |
| | Unknown satisfaction | 30.8% |

| | | |
|---|----------------------|-------|
| Level E-A Organizations | Fully Satisfied | 14.3% |
| | Largely Satisfied | 57.1% |
| | Partially Satisfied | 0% |
| | Not Satisfied | 0% |
| | Unknown satisfaction | 28.6% |
| All the organizations (including those in process of assessment) | Fully Satisfied | 14.1% |
| | Largely Satisfied | 54.1% |
| | Partially Satisfied | 6.7% |
| | Not Satisfied | 0% |
| | Unknown satisfaction | 25.2% |

4.2. Perspective PROJECTS

In the context of the MPS model a project is related to effort undertaken to create a product or to provide a service. In this perspective, only projects that were completed within the last 12 months or that are still in progress should be considered. Table 9 presents the interpretation that was given to collect the values for the measures related to this perspective.

TABLE 9 - Measures used in the perspective Projects

| MEASURE | INTERPRETATION |
|------------------------------------|---|
| Average project cost | Measured in terms of percentage of net sales in the last 12 months. |
| Average project size | Average project size in the last 12 months, measured in the unit used by the organization. Examples: function points, use case points, lines of code, man-hours. |
| Average project duration | Duration, measured in months, considering projects completed within the last 12 months. |
| Average estimated project duration | Estimated duration, measured in month, considering projects that were completed or are in progress within the last 12 months. |
| Estimation accuracy | <p><i>Given the average estimated project duration within the last 12 months and the average project duration within the last 12 months, different than 0, calculate:</i></p> $\text{Estimation accuracy} = 1 - \left \frac{\text{average project duration within the last 12 months} - \text{average estimated project duration within the last 12 months}}{\text{average estimated project duration within the last 12 months}} \right $ |
| Productivity | <p><i>Given an average project duration within the last 12 months, different than 0, calculate:</i></p> $\text{Productivity} = \frac{\text{Average project size within the last 12 months}}{\text{average duration of projects within the last 12 months}}$ |

Tables 10 to 14 present values (medians and percentages) that could be obtained for the projects perspective measures.

Regarding the average project cost, the survey plan specifies that it should be obtained in terms of percentage of net sales, preventing the organizations to explain their financial assets. However, the question regarding project cost was mistakenly interpreted by the organizations, which provided inconsistent values with the intended interpretation. This question had already demonstrated need for improvement in the 2008 execution and was modified for 2009. However, the result is still not satisfactory and therefore the measure regarding cost had to be discarded in 2009. This question will be once again reviewed for the 2010 execution. Although this measure has been discarded from the 2009 characterization analysis, it had not to be discarded from the 2008/2009 variation analysis (described in next section), since many organizations calculated the measure the same way in 2008 and 2009 (although possibly at odds with the iMPS perspective), which allowed data comparison to verify increase or reduction.

Considering the average project size, among the various size units, the one that is used by most organizations is Function Points (44 organizations). Other size units used are Use Case Points (20 organizations) and Hours of Work (18 organizations). Among the companies in levels E-A (7) that answered the survey, all use either Function Points (5) or Points of Use Case (2). The values presented in Table 10 consider only data provided by participants which use Function Points.

TABLE 10 – Average Project Sizes (Function Points)

| Grouping | Average Size in FP | Number of Answers |
|--|---------------------------|--------------------------|
| Organizations starting implementation | 200 | 1 |
| Level G Organizations | 250 | 13 |
| Level F Organizations | 300 | 5 |
| Level E-A Organizations | 260 | 4 |
| All the organizations (including those in assessment process) | 250 | 26 |

TABLE 11 – Average Project Duration (in Month)

| Grouping | Average Duration in Month | Number of Answers |
|--|----------------------------------|--------------------------|
| Organizations starting implementation | 3.3 | 20 |
| Level G Organizations | 4 | 54 |
| Level F Organizations | 4 | 24 |
| Level E-A Organizations | 4 | 7 |
| All the organizations (including those in assessment process) | 4 | 129 |

TABLE 12 – Average Estimated Duration of Projects (in Month)

| Grouping | Average Estimated Duration | Number of Answers |
|--|-----------------------------------|--------------------------|
| Organizations starting implementation | 3.5 | 20 |
| Level G Organizations | 4 | 55 |
| Level F Organizations | 3.5 | 25 |
| Level E-A Organizations | 4 | 6 |
| All the organizations (including those in assessment process) | 4 | 130 |

TABLE 13 – Estimation Accuracy (Relation between Estimated Duration and Real Duration)

| Grouping | Estimation Accuracy | Number of Answers |
|--|----------------------------|--------------------------|
| Organizations starting implementation | 1 | 19 |
| Level G Organizations | 0.92 | 54 |
| Level F Organizations | 0.88 | 23 |
| Level E-A Organizations | 0.88 | 6 |
| All the organizations (including those in assessment process) | 0.92 | 102 |

TABLE 14 - Productivity (Function Points per Month)

| Grouping | Productivity | Number of Answers |
|--|---------------------|--------------------------|
| Organizations starting implementation | 40 | 1 |
| Level G Organizations | 75 | 13 |
| Level F Organizations | 60 | 5 |
| Level E-A Organizations | 62.3 | 4 |
| All the organizations (including those in assessment process) | 49.6 | 29 |

4.3. Perspective MPS MODEL

Represents the model itself and tries to capture the characteristics that are effectively and directly related to the MPS model, regardless of organization and project. Table 15 shows the interpretation of the measures that were collected for this perspective.

TABLE 15 – Measures used by the perspective MPS model

| MEASURE | INTERPRETATION |
|-----------------------------|--|
| Implementation Time | Average time spent by organizations to implement the MPS model. This measure takes into account only the companies that were evaluated during the current year. |
| Implementation Investment | Percentage of net sales obtained by software development invested in the implementation of the MPS model, measured by the following formula: <i>Given the organizations net sales over the past 12 months, other than 0, calculate:</i> Implementation Investment = (value invested in MPS implementation / net sales over the last 12 months) * 100. |
| Assessment Investment | Percentage of net sales obtained by software development invested in the MPS assessment, measured by the following formula: <i>Given the organizations net sales over the past 12 months, other than 0, calculate:</i> Assessment Investment = (Amount invested in evaluating MPS / value of the net sales over the last 12 months from the organization) * 100. |
| Satisfaction with the Model | Indicates the organization's satisfaction with the MPS model (Fully Satisfied, Partially Satisfied, Not Satisfied). |

Tables 16 to 19 present values (medians and percentages) which could be obtained for the MPS model perspective measures.

TABLE 16 – MPS Implementation Time (in Months)

| Grouping | Implementation Time | Number of Answers |
|---|---------------------|-------------------|
| Organizations in assessment process during 2009 | 16.5 | 18 |

TABLE 17 – MPS Implementation Investment (Percentage of Net Sales)

| Grouping | Implementation Investment | Number of Answers |
|---|---------------------------|-------------------|
| Organizations in assessment process during 2009 | 2.5% | 22 |

TABLE 18 – MPS Assessment Investment (Percentage of Net Sales)

| Grouping | Spent with the Assessment | Number of Answers |
|---|---------------------------|-------------------|
| Organizations in assessment process during 2009 | 0.3% | 22 |

TABLE 19 – Satisfaction with the MPS Model

| Grouping | Results | |
|--|----------------------|-------|
| Organizations starting implementation | Fully Satisfied | 60.0% |
| | Partially Satisfied | 40.0% |
| | Not Satisfied | 0% |
| | Unknown satisfaction | 0% |
| Level G Organizations | Fully Satisfied | 67.2% |
| | Partially Satisfied | 29.3% |
| | Not Satisfied | 1.7% |
| | Unknown satisfaction | 1.7% |
| Level F Organizations | Fully Satisfied | 80.8% |
| | Partially Satisfied | 19.2% |
| | Not Satisfied | 0% |
| | Unknown satisfaction | 0% |
| Level E-A Organizations | Fully Satisfied | 57.1% |
| | Partially Satisfied | 42.9% |
| | Not Satisfied | 0% |
| | Unknown satisfaction | 0% |
| All the organizations (including those in assessment process) | Fully Satisfied | 71.1% |
| | Partially Satisfied | 27.4% |
| | Not Satisfied | 0.7% |
| | Unknown satisfaction | 0.7% |

4.4. 2009 Characterization Analysis

The data presented in the previous section allows different interpretations, which may be related to various confounding factors and even the political and economic factors of the year 2009. However, some behaviors, possibly related to the adoption of the model, can be observed. An initial analysis of these behaviors was provided in [Travassos and Kalinowski, 2009a]. Some of the organizations that participated in this study also use other reference models (CMMI and ISO 9001 in most cases, see Table 2). This may in itself represent a confounding factor that influenced the results. However, most organizations focus effectively on the MPS model, which we believe to be an influent factor in the observed behaviors. Therefore, when relevant, we present the correlation coefficients between the measures and the different groups (with weights 1 - Starting Implementation to 4 - Levels E-A).

Customer Satisfaction. Customer satisfaction reported by organizations is higher for organizations that adopted the MPS Model. Considering organizations starting the implementation, 50% reported to have fully or largely satisfied customers. Among the organizations that adopted MPS this number rises to 68.13%. Considering only the organizations between levels E-A customer satisfaction reaches 71.43%.

Satisfaction with the MPS Model. Regarding satisfaction with the MPS Model, 71.11% (96 organizations) reported being completely satisfied with the model and 27.41% reported being partially met. Only 0.74% (1 organization) reported being not satisfied and 0.74% (1 organization) reported not knowing its level of satisfaction yet. All companies with maturity level F or higher declared themselves fully or partially satisfied.

Other Maturity Models. Among the other models and standards, the most used by the organizations is CMMI. This model is more present in organizations that adopted MPS. Considering the organizations starting the implementation, 10% have some CMMI maturity level. At level G the percentage of organizations with CMMI maturity levels is 10.53%. At level F, this number rises to 11.54% and between levels E-A it reaches 57.14%.

Project Size. Regarding project size, 44 (33.9%) of the 135 surveyed organizations reported measuring the size of their projects in function points, which was the most used measure of size, followed by use case points, used by 20 organizations (14.81%).

Figure 1 shows the median of the average project size of organizations that use function points, for each grouping used in the study. While the median for organizations starting the implementation is 200 function points, the median for companies in the levels of E-A is 260. There is a positive correlation between the increase in median and the increase of maturity level of +0.72.

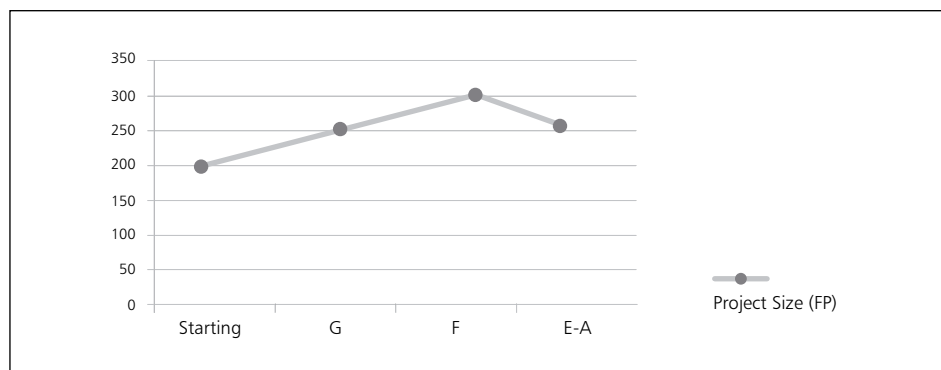


Figure 1. Median Project Size

Estimation Accuracy. For duration estimation accuracy only organizations of maturity levels G, F, and E-A were considered. This was done because organizations are not required to perform duration estimates before reaching level G and, as a result, the data for these organizations showed unlikely results (58.89% of these organizations reported to estimate project duration exactly the same as actual project duration, this number drops to 46.29% for level G organizations, 43.47% for level F and 33.3% for levels E-A).

Thus, since many organizations reported to make exact and accurate estimates, we believe that this measure is better observed by looking at the variation within each set of organizations. Figure 2 illustrates this variation, using a *boxplot*, which highlights the maximum, minimum and the median. While the median is almost the same, organizations in maturity levels E-A showed less variation and higher minimum accuracy in their estimates.

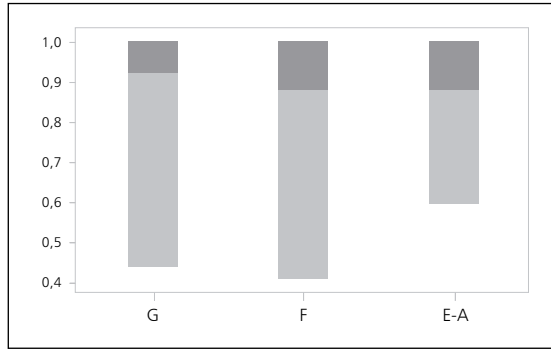


Figure 2. Boxplot of Estimation Accuracy

Productivity. Productivity appears higher for organizations that adopted the MPS model. The highest median was in the group of level G organizations. However, it is important to note that productivity should not be observed in isolation, since it may vary for different project types and different quality³ and cost⁴ expectations. Additionally, the productivity formula takes into account other base measures, which, as discussed previously, may be more reliable for organizations with maturity levels F or higher, which have an institutionalized measurement process.

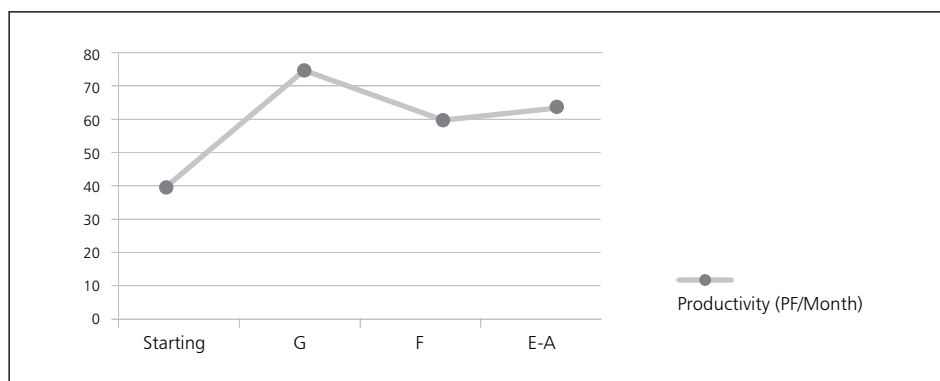


Figure 3. Median Productivity (in FP/Month)

Figure 3 shows the median representing productivity of projects of organizations that use function points for each grouping used in the study. While the median productivity for organizations starting the implementation is 40 function points per month, the median for organizations in the levels E-A is 62.32. There is a positive correlation (+0.46) between the increase of the median and the MPS maturity level.

Given this analysis of the 2009 characterization, the following section presents the 2008/2009 performance variation of organizations that adopted the MPS Model.

3) Quality is captured in the questionnaire as the number of defect per unit of size. Since organizations handle defects in different ways these answers are considered only in the performance variation analysis, comparing the organization with itself over time.

4) The cost could not be analyzed in the 2009 characterization because the values of the measure showed an interpretation misunderstanding of the questionnaire by several organizations.

5. iMPS 2009 Results: 2008/2009 Variation Analysis

The same data preparation criteria was used to eliminate outliers in the data sent by organizations with unexpired MPS assessments that answered the survey in 2009 and had also provided information in 2008.

The indicators were those defined in the iMPS study plan [Travassos and Kalinowski, 2009]: A. Net Sales Variation, B. Number of Customers in Brazil, C. Number of Employees, D. Average Project Cost, E. Average Project Duration, F. Average Project Size, G. Productivity, H. Quality, I. Customer Satisfaction, and J. Return on Investment (ROI).

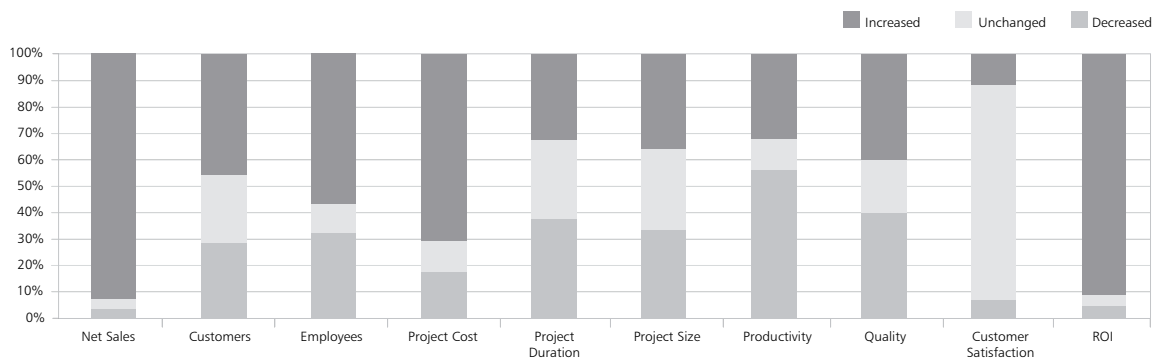
At all, 43 organizations, with a questionnaire for the year 2008 and another for the year 2009, were considered and grouped according to the same criteria used in the characterization: level G (22), level F (17), and levels E-A (4). Moreover, a new group with 9 organizations was analyzed, concerning those organizations that have increased or revalidated their maturity level in this period and answered the periodic questionnaire. The indicator calculation followed the formulas defined in the iMPS study strictly. In addition, the interpretation of results associated with the indicators was based on touted software engineering behavior assumptions for software projects, which differ naturally from traditional production processes. The concept of productivity, for instance, in the iMPS context refers to 'average project size within the last 12 months / average project duration within the last 12 months', thus relating only software project characteristics, being a simplified representation when compared to the usual concept of productivity used in other production processes.

As defined, in iMPS the data is always collected in order to avoid competitive comparison between organizations. Thus, the individual value of the indicator of each organization only makes sense for the organization itself, losing its mean when attempting to compare against other organizations. To observe the performance variation behavior for each indicator, the relative percentage of organizations (based on the number of valid answers), which had increased, decreased or not changed their performance was used. The evaluation of the meaning of the increase or reduction of an indicator depends on the indicator itself and, in some situations, may be related to other indicators. For instance, it is expected that the average project cost reduces while productivity increases. In this case, both reduction and increase represent a positive impact for the organizations. Therefore, we believe that presenting behavior trends of the organizations that adopted the MPS model may help to provide a further understanding of the benefits of the model itself, while also indicating improvement opportunities. The confidence level [Gardner and Altman, 1989] for each indicator was calculated considering the population as the total number of valid questionnaires for each group and the sample the number of valid answers for each question. The purpose of this confidence level is trying to show how much the behavior described by the indicator may represent the behavior of the specific group under study.

As shown in Figure 4, the overall results show interesting trends regarding the organizations that sent the questionnaires. For instance, it is possible to note that the organizations reported increase of net sales, number of customers, number of employees, and return on investment. On the other hand, it is possible to observe some influence related to increase of project cost and decrease of productivity. However, further analyses must be performed to identify if the impact is positive or negative, because, apparently there was variation in the ability to identify defects (observed by the quality

indicator), a slight increase in the size of projects and, as already identified, an increase of number of employees, with influence on customer satisfaction. The quality indicator behavior must be examined in more detail. The calculation of this indicator is performed by comparing the mean number of defects identified (per project per unit of size) by the organization in two consecutive years.

Thus, some organizations reported to be identifying more defects and others less. However, if compared with the results provided by the level F organizations (Figure 6) or those that increased or revalidated their maturity level (Figure 8), the quality indicator tends to present behavior of greater ability to identify defects, with tendency to decrease the average project cost. Assuming that new processes and practices, in the context of software development, are usually introduced to improve the quality of the product, this could lead us to an interpretation scenario of overall increased quality (higher ability to identify defects). However, a further analysis should be performed to verify this behavior since there is some contradiction with what can be observed for organizations in maturity levels E-A (Figure 7). These organizations, being at higher levels of maturity, should already have incorporated many of the practices and processes necessary to cover the activities of quality assurance throughout the software development process. But the lack of data points in higher maturity levels limits the ability of observation.



| Indicator | A | B | C | D | E | F | G | H | I | J |
|-----------------|------|------|------|------|------|------|------|------|-----|------|
| Valid Answers | 27 | 35 | 37 | 29 | 40 | 39 | 25 | 15 | 43 | 22 |
| Conf. Level (%) | 88.3 | 92.7 | 93.9 | 89.4 | 95.8 | 95.1 | 87.1 | 79.2 | 100 | 85.1 |

Figure 4. Performance Variation of 43 Organizations with MPS – Levels G-A

In Figure 5, the performance variation results of level G organizations indicates that these organizations appear to have an increase of net sales, number of customers, number of employees, and return on investment. On the other hand, some influence can be seen in relation to the increase of average project cost and decrease of productivity. However, further analyses must be performed to identify if the impact is positive or negative, since apparently there was an improvement of quality and an increase of project size, and, as already identified, an increase of the number of employees, with some improvement regarding customer satisfaction.

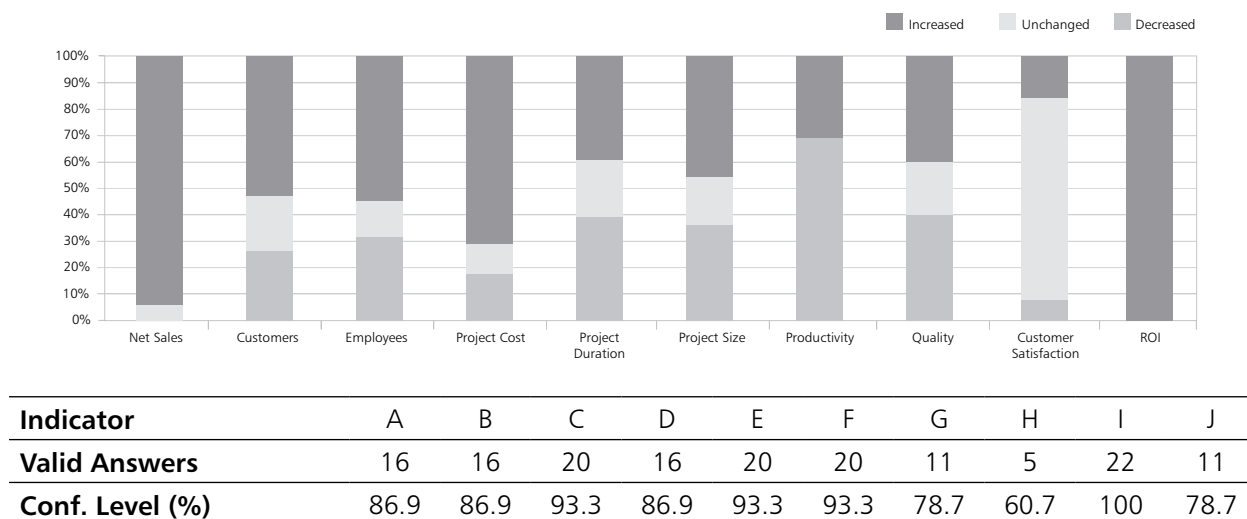


Figure 5. Performance Variation of 22 Organizations with MPS – Level G

The performance variation results of level F organizations indicate that these organizations had improvements in net sales, number of employees, average project cost (decrease), quality, and return on investment, as shown in Figure 6. On the other hand, some influence can be seen related to the decrease of project size and productivity. However, further analyses must be performed to identify if the impact is positive or negative, since, apparently, there was an improvement in quality and, as already identified, an increase of number of employees without affecting customer satisfaction (which is still high).

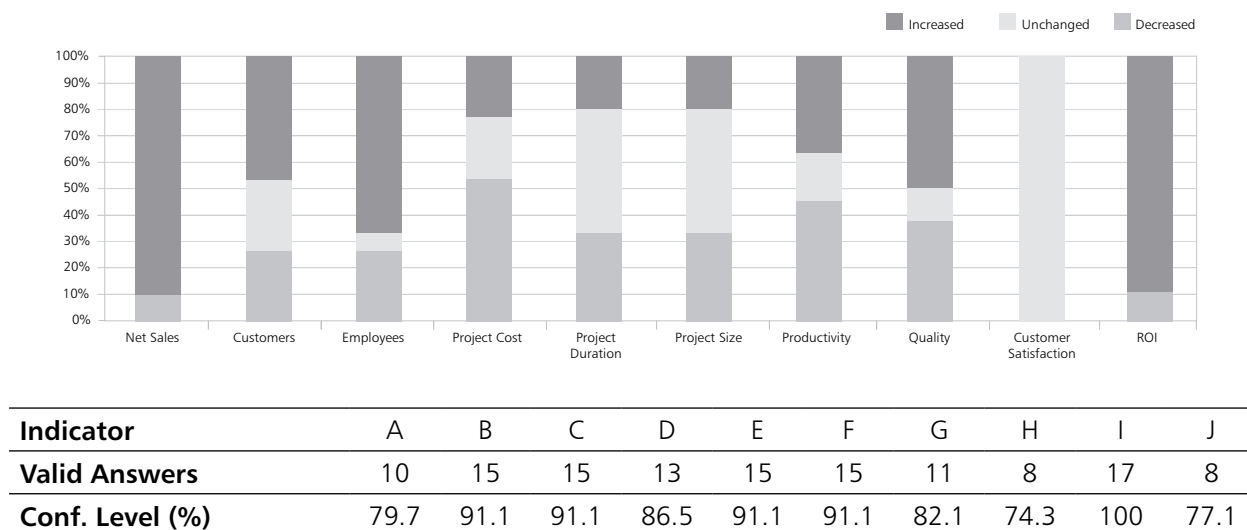
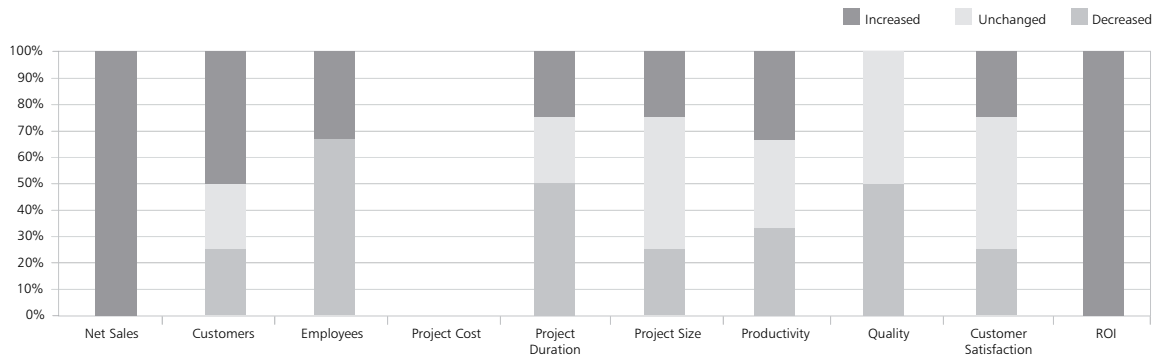


Figure 6. Performance Variation of 17 Organizations with MPS – Levels F

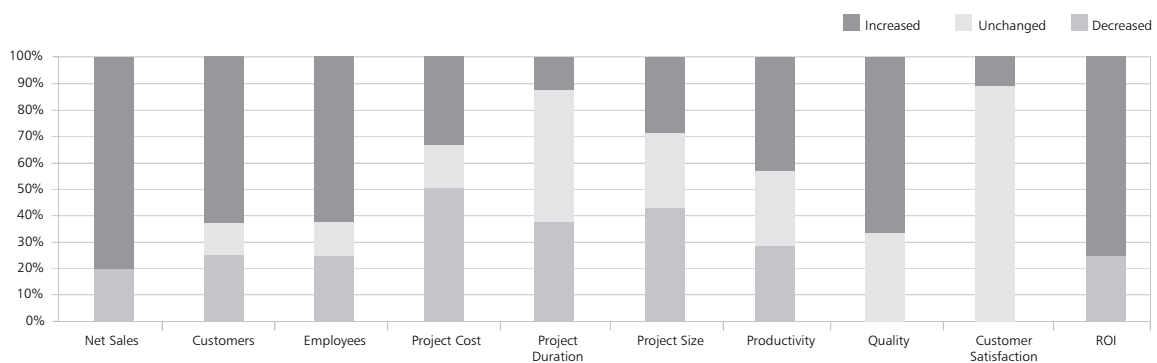
The performance variation results of organizations in maturity levels E-A can be seen in Figure 7. The low number of valid answers makes it difficult to provide a more elaborated analysis of this group of organizations. However, it is possible to observe that the number of customers increased, with an apparent reduction in the number of employees. The reduction of the number of employees may have been caused by the reduction of project duration and of average project size, requiring smaller teams. Indeed, it is necessary to increase the number of organizations and data quality of this group, so that the behavior of the indicators can be identified more clearly.



| Indicator | A | B | C | D | E | F | G | H | I | J |
|-----------------|------|-----|------|---|-----|-----|------|----|-----|------|
| Valid Answers | 1 | 4 | 3 | 0 | 4 | 4 | 3 | 2 | 4 | 1 |
| Conf. Level (%) | 13.4 | 100 | 71.1 | 0 | 100 | 100 | 71.1 | 50 | 100 | 13.4 |

Figure 7. Performance Variation of Organizations with MPS Maturity Levels E-A

Figure 8 shows the performance variation results of organizations that have increased or revalidated their MPS maturity level. The main characteristic of these organizations, regardless of the level in which they were assessed, refers to MPS adoption and continuity in developing software following the model’s guidelines. It is possible to observe that, according to the data provided by the organizations, the indicators show consistent behavior with the assumptions regarding the use of software development processes combined with good software engineering practices. For instance, cost and duration reduction tendency can be observed in combination with the increase of quality and productivity. We believe that this combination of events may be influencing positively the other indicators for these organizations, related to the increase of net sales, number of customers, employees, customer satisfaction, and ROI. Further investigation needs to be performed in order to try to identify possible confounding factors that may be influencing these results.



| Indicator | A | B | C | D | E | F | G | H | I | J |
|----------------|------|------|------|------|------|------|------|------|-----|------|
| Valid Answers | 5 | 8 | 8 | 6 | 8 | 7 | 7 | 3 | 9 | 4 |
| Conf. Level(%) | 70.2 | 88.2 | 88.2 | 76.4 | 88.2 | 82.2 | 82.2 | 52.3 | 100 | 62.7 |

Figure 8. Performance Variation of Organizations that adopted the MPS and increased/revalidated their maturity level

6. Final Considerations

In this publication we presented the 2009 execution results of the iMPS project, which aims at characterizing and understanding the performance variation of organizations due to MPS model adoption.

Regarding the 2009 characterization, it was possible to observe that organizations that adopted the MPS model reported higher customer satisfaction, handle bigger projects, present lower duration estimation errors, and show themselves more productive, when compared to organizations starting to implement the MPS model. Additionally, the CMMI model shows itself more present in organizations with higher MPS maturity levels. The satisfaction of organizations with the model is notorious, with more than 98% of the organizations reporting to be partially or fully satisfied with the model.

Regarding the 2008/2009 variation analysis, for companies that are using the MPS model, it was possible to observe that, independent of the maturity level, the MPS adoption could have contributed to increase the number of clients, the net sales and the number of employees, without affecting customer satisfaction. In general, organizations reported return on investment and, especially for those organizations that evolved or internalized the MPS model in their processes, improvement trends could be observed regarding cost, quality, time, and productivity, basic assumptions when developing software according to engineering precepts.

Concerning the research study itself, additional analyses need to be performed in order to reduce threats to conclusion validity that may still exist. Moreover, some context variables that were not identified could be influencing these results. However, we hope that these results can be used to motivate organizations that are already adopting the MPS model to continue in their process improvement initiatives and to motivate organizations that are not using the model towards adoption in a near future.

Acknowledgements

This research would not be possible without the participation of the organizations and of the following professionals Kival Chaves Weber (Executive Coordinator of the MPS.BR Program); Nelson Henrique Franco de Oliveira and André Luis Chamelet Sotovia (MPS.BR Operations Management); Virgínia Costa Duarte and Daniela Albini Pinheiro (SOFTEX Observatory); which we would like to thank for their contribution.

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iMPS 2009: Characterization and Performance Variation of Software Organizations that Adopted the MPS Model

This publication presents the results of the 2009 execution of the “iMPS – Performance Results of Organizations that Adopted the MPS Model” project. Those results are presented in two perspectives: 2009 characterization and 2008/2009 variation analysis.

In general, the satisfaction of the software organizations with the MPS model is notorious, with more than 98% reporting to be totally or partially satisfied.

Moreover, the organizations reported return of investment (ROI) and, especially for those organizations that evolved or institutionalized the MPS model in their processes, improvement trends could be observed concerning cost, quality, time, and productivity, basic assumptions when developing software according to engineering precepts.

We hope that these results can be used to motivate organizations that are already adopting the MPS model to continue in their process improvement initiatives and to motivate organizations that are not using the model towards adoption in a near future.

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ISBN 978-85-99334-18-8



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