iMPS 2010

Performance of Software Organizations that Adopted the MPS Model from 2008 to 2010

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Translation

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SOFTEX
EXCELLENCE IN SOFTWARE

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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.

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

The SOFTEX System has national scope. Its Management Structure is formed by SOFTEX and its regional agents, to which more than 1,600 companies with activities in software and IT services are bound.

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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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Summary

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. Since then, the MPS model has been increasingly used in Brazil by both, small and medium enterprises (SMEs) and for large companies. In May 2010, among the 180 organizations in our customer database with MPS assessments: 72% were SMEs, with 6% micro (up to 10 employees), 45% small enterprises (between 11 and 50 employees) and 21% medium-sized enterprises (between 51 and 100 employees), and 28% are large organizations (over 100 employees). In November 2010 the significant milestone of 250 MPS assessments (with three year validity) since September 2005 was achieved.

In 2008, SOFTEX hired the COPPE/UFRJ's Experimental Software Engineering Group to model the iMPS (information to monitor and provide evidence regarding performance variation of software organizations that adopted the MPS model), and to support the conduct of yearly iMPS surveys. The iMPS2008 survey results, which included 123 questionnaires from different organizations, presented in [Travassos, G. H. and Kalinowski, M. "iMPS: Resultados de Desempenho de Organizações que Adotaram o Modelo MPS". SOFTEX, 2008], indicate that organizations that adopted the MPS show greater customer satisfaction, greater productivity and capacity to develop larger projects, when compared to organizations that were starting the MPS model implementation. Additionally, more than 80% of them reported to be satisfied with the MPS model.

The iMPS2009 survey results, which included 135 questionnaires from different organizations, presented in [Travassos, G. H. and Kalinowski, M. "iMPS 2009 – Characterization and Performance Variation of Software Organizations that Adopted the MPS Model" – available in English. SOFTEX, 2009], showed a notorious satisfaction of the organizations with the MPS model, with over 98% of them reporting to be partially or fully satisfied. Additionally, organizations reported that the return on investment (ROI) was obtained and, for those organizations that have evolved or internalized the MPS in their processes, it was possible to observe improvement tendency regarding cost, project duration, productivity, and quality.

The results of the 2010 iMPS trial, that featured electronic questionnaires answered by 156 different organizations, presented in this publication, show that the satisfaction of the organizations was again evident, with over 92% reporting to be partially or totally satisfied with the MPS model. The characterization allowed observing that organizations that adopted the MPS have higher customer satisfaction, handle larger projects, are more accurate in their schedule estimates, and are more productive, when compared to organizations that are starting the MPS model implementation. The performance variation analysis allowed to identify that organizations tend to obtain the expected benefits of applying software engineering principles to their development efforts, regarding cost, schedule, quality and productivity.

We hope that the objective evidence presented in this publication will be useful to those interested in improving software processes and software organization competitiveness.

José Antonio Antonioni   **Kival Chaves Weber**

iMPS 2010: Performance of Software Organizations that Adopted the MPS Model from 2008 to 2010

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Abstract. *The MPS model is being increasingly used by Brazilian organizations. To monitor the performance of these organizations facing the use of the model, the iMPS project was initiated in 2007 with results published for the years 2008 and 2009. In this publication we present the characterization of organizations from the data supplied in 2010 and also the corporate performance variation analysis over the years 2008, 2009, and 2010. The characterization has allowed us to observe that organizations that adopted the MPS have higher customer satisfaction, higher estimate accuracy, handle larger projects, and are more productive when compared to organizations that are beginning to implement the model. In the performance variation analysis, we identified that organizations tend to produce the expected benefits in terms of cost, schedule, productivity and quality of adopting software processes improvement initiatives, according to the technical literature of software engineering. In 2010, the satisfaction of the organizations with the model was again evident, with more than 92% of them partially or totally satisfied with the MPS.*

1. Introduction

The MPS.BR program represents an initiative to improve the software development capacity in Brazilian organizations. Its main objective is to develop and disseminate a Brazilian process improvement model (the MPS reference model) to establish an economically feasible way for organizations, including small and medium organizations, to achieve the benefits of process improvement and of using software engineering best practices in a reasonable time frame.

The model was developed considering international standards, internationally recognized models, software engineering best practices, and business needs of the Brazilian software industry. Regarding assessed organizations, until November 2010, 250 official MPS assessments had been accomplished and published. The results of those assessments are available in the SOFTEX portal *www.softex.br/mpsbr*.

The adoption of the MPS model by Brazilian organizations reveals the interest in understanding qualitatively the performance results obtained by these organizations, regarding cost, schedule, productivity, and quality. Given this interest, the iMPS project (information to monitor and provide evidence regarding performance variation of software organizations that adopted the MPS model)

was launched in 2007 with the Experimental Software Engineering Group of COPPE/UFRJ (*http://ese. cos.ufrj.br*).

The objective of the iMPS project was planning a survey, following the principles of the Experimental Software Engineering, and periodically execute trials of it to monitor and provide evidence regarding performance results in software organizations that have adopted the MPS model. More information about the research plan and the treatment of its threats to validity can be found in [Kalinowski et al., 2008]. The 2008 (baseline) and 2009 iMPS trials provided initial objective evidence [Kalinowski and Travassos, 2008a] [Travassos and Kalinowski, 2009], to be supplemented annually by new iMPS trials, allowing comparative analyses.

This publication presents the results of the 2010 iMPS trial. This year, the questionnaires were provided in electronic form (via a Web application), which helped increasing the quality of reported data (previously captured in free text format). Results are presented from three perspectives: (i) 2010 characterization, (ii) performance variation analysis in recent years (2009/2010 and 2008/2009/2010), and (iii) performance variation analysis with the evolution of organizations in their MPS deployment initiatives.

The goal of the characterization is to outline the performance of organizations that adopted the MPS in 2010. The goal of the performance variation analysis in recent years, on the other hand, is to observe the performance variation of organizations with with unexpired MPS assessments between 2008 and 2010. Finally, the goal of the performance variation analysis with the evolution of organizations in their MPS deployment initiatives is to observe the changes between the periods of the beginning of the MPS model implementation, during the assessment, and after evaluation. It is important to state that, for variation analyses, an organization is compared only with itself and that its individual performance data is not revealed, since data of different organizations does not belong to the same analysis context, thus losing the real sense.

The remainder of this publication is organized as follows. In sections 2 and 3 the iMPS project and how it was applied to software organizations in 2010 are presented. Section 4 contains the 2010 characterization results. In Section 5, the performance variation results of organizations with unexpired MPS assessments (2009/2010 and 2008/2009/2010) are presented. Section 6 describes the performance variation results with the evolution of organizations in their MPS deployment initiatives. Finally, section 7 contains the concluding remarks.

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

The iMPS project aims at periodically monitoring the performance results in software organizations that have adopted the MPS model. This monitoring is based on a survey, which was planned following Experimental Software Engineering principles [Wohlin et al., 2000]. This survey should allow a periodic characterization of the organizations, based on which the intention is to understand the performance variation of the set of organizations that adopted the MPS model.

The choice of an experimental strategy to assess the performance variation due to MPS model adoption helps to ensure the validity of the study and allows proper data consolidation.

Following the GQM paradigm [Basili et al., 1994] and in order to avoid possible threats to validity [Kalinowski et al., 2008], sets of follow-up questionnaires were developed to be applied at the following moments: (i) when organizations are starting to implement the MPS model, (ii) when organizations are in the official assessment procedure, and (iii) periodically for organizations with unexpired MPS assessments.

These instruments were evaluated in 2008 in a pilot study and showed adequate to capture the base information contained in the survey plan to support understanding the organizations' performance variation. Additionally, for the first trial in 2008, a retroactive questionnaire was applied to organizations that had already undertaken an official assessment before the start of the survey [Travassos and Kalinowski, 2008b]. Suggestions collected in the 2008 and 2009 questionnaires allowed to evolve for the 2010 trial (in which electronic questionnaires available through a web application were used) without, however, changing the underlying information that should be collected. The following subsections describe the dynamics of applying the survey to the software organizations. Thus, the following scenarios were considered for data collection:

a) Organizations Starting to Implement the MPS Model
For organizations in this situation, once SOFTEX is notified of the beginning of an MPS implementation, it provides a link to the organization through which it can access and complete the following electronic forms: Consent Form; Characterization Form of an organization that is starting to implement the MPS model, and; Performance Questionnaire of an organization that is starting to implement the MPS model.

b) During Official MPS Assessment Procedures
This refers to organizations that were approved in an official MPS assessment. For organizations in this situation the link provided by SOFTEX during the assessment procedures (right after the final assessment) provides the following electronic forms: Consent Form, Characterization Form of an organization that is in the process of assessing the MPS model, and; Performance Questionnaire of an organization that is in the process of assessing the MPS model.

c) Periodically for Organizations with Unexpired MPS Assessments
This situation reflects the periodic (annual) survey application for organizations with unexpired MPS assessments. For organizations in this situation, SOFTEX yearly provides a link containing the following electronic forms: Consent Form; Characterization Form of an organization that was assessed according to the MPS model, and; Performance Questionnaire of an organization that was assessed according to the MPS model.

Having provided a current overview of the iMPS project, the following section describes how the survey application was carried out and the initial data preparation for the 2010 trial.

3. Survey Application and Initial Data Preparation: 2010 Trial

The sets of electronic questionnaires were distributed to participants (representatives of organizations that adopted the MPS) through the iMPS management system by the MPS.BR Operations Management[1]. Filling out the electronic questionnaires resulted in automatic transference of data from the organizations to the iMPS repository[2]. The electronic questionnaires, novelty of the 2010 trial, allowed the standardization of responses and an initial validation of the data during fill out. In the performance questionnaires it was not mandatory to fill all the data, since some organizations didn't have all the data requested in the survey. Some additional organization characterization information, such as the MPS maturity level, was obtained directly from existing databases in SOFTEX.

In total, 156 questionnaires from different organizations representing data for the year 2010 have been received (between 08/01/2009 and 07/31/2010).

As data from different organizations is involved, it is natural for the measures to show very high standard deviations. Thus, we believe that the median, representing the central value for the measure, may provide better information for the characterization of the organizations. During the data preparation, measures with values more than three standard deviations from the mean (outliers) were discarded until the final data set contained no further values in this situation. In this way, it was possible to use most responses, while not influencing the results with data which may eventually be distorted. During this filtering process it was to identify that the majority of outliers were found in data of organizations starting to implement the MPS model or at maturity level G, where the standard deviation of the measures was greater. This may be related to the fact that the measurement process is required from the MPS maturity level F up, which leads us to believe that the outcome of these organizations (maturity level F up) are more reliable.

The next three sections describe the results of the 2010 iMPS trial, including the 2010 characterization, the performance variation analysis in recent years (2009/2010 and 2008/2009/2010) and the performance variation analysis with the evolution of organizations in their MPS deployment initiatives. The 2008 and 2009 trial results can be found in [Travassos and Kalinowski, 2008a] and [Travassos and Kalinowski, 2009].

4. iMPS 2010 Results: Characterization

The characterization analysis aims to outline the performance of the organizations that adopted the MPS model in 2010. Given that most organizations are still in the initial maturity levels (23 starting the MPS implementation, 11 in assessment process, 79 assessed MPS level G, 36 assessed MPS level F, and 7 assessed MPS levels E-A), 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.

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

2) iMPS Repository: Created in the CoreKM system, where data of official MPS assessments is also stored.

The measures considered in the survey plan [Travassos and Kalinowski, 2008b], 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 trial 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 {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	Fully Satisfied: all customers show themselves satisfied with the products and/or services.
	Largely Satisfied: the majority of the customers show themselves satisfied with the products and/or services.
	Partially Satisfied: the minority of the customers show themselves satisfied with the products and/or services.
	Not Satisfied: no customer is satisfied with the products and/or services.
	Unknown satisfaction: the organization does not know the degree of customer satisfaction.

Tables 2 to 8 present values (medians and percentages) that could be obtained for the organization perspective measures. For some of the tables additional explanations are provided in order to help understanding the values extracted from the collected data.

TABLE 2 - Percentage of Organizations Assessed in the CMMI Model

Grouping	CMMI	Number of Answers
Organizations starting implementation	0%	23
Level G Organizations	2.5%	79
Level F Organizations	19.4%	36
Level E-A Organizations	71.4%	7
All the organizations (including those in assessment process)	9.0%	156

TABLE 3 - Number of Customers inside the Country (Brazil)

Grouping	Number of Customers	Number of Answers
Organizations starting implementation	22.5	16
Level G Organizations	15	50
Level F Organizations	22.5	26
Level E-A Organizations	30	7
All the organizations (including those in assessment process)	19	107

For the measure regarding the number of customers abroad, only 19.9% 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	17.4%	23
Level G Organizations	19.0%	79
Level F Organizations	19.4%	36
Level E-A Organizations	42.9%	7
All the organizations (including those in assessment process)	19.9%	156

TABLE 5 - Number of Projects inside the Country (Brazil)

Grouping	Number of Projects	Number of Answers
Organizations starting implementation	5	20
Level G Organizations	10	73
Level F Organizations	10	31
Level E-A Organizations	10.5	6
All the organizations (including those in assessment process)	10	141

For the measure regarding the number of projects abroad, only 13.5% 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	% that have Projects Abroad	Number of Answers
Organizations starting implementation	5%	23
Level G Organizations	11.4%	79
Level F Organizations	13.9%	36
Level E-A Organizations	42.9%	7
All the organizations (including those in assessment process)	13.5%	156

TABLE 7 - Number of Employees

Grouping	Number of Employees	Number of Answers
Organizations starting implementation	35	22
Level G Organizations	30	69
Level F Organizations	42	27
Level E-A Organizations	63	5
All the organizations (including those in assessment process)	34.5	132

TABLE 8 - Customer Satisfaction

Grouping	Results	
Organizations starting implementation	Fully Satisfied	8.9%
	Largely Satisfied	53.6%
	Partially Satisfied	8.9%
	Not Satisfied	0.0%
	Unknown satisfaction	28.6%
Level G Organizations	Fully Satisfied	10.0%
	Largely Satisfied	63.8%
	Partially Satisfied	8.8%
	Not Satisfied	0.0%
	Unknown satisfaction	17.5%
Level F Organizations	Fully Satisfied	11.1%
	Largely Satisfied	61.1%
	Partially Satisfied	11.1%
	Not Satisfied	0.0%
	Unknown satisfaction	16.7%
Level E-A Organizations	Fully Satisfied	14.3%
	Largely Satisfied	71.4%
	Partially Satisfied	14.3%
	Not Satisfied	0.0%
	Unknown satisfaction	0.0%
All the organizations (including those in process of assessment)	Fully Satisfied	9.6%
	Largely Satisfied	58.3%
	Partially Satisfied	10.9%
	Not Satisfied	0.0%
	Unknown satisfaction	21.2%

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	*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:* Estimation accuracy = 1 - | ((average project duration within the last 12 months - average estimated project duration within the last 12 months) / average estimated project duration within the last 12 months) |
Productivity	*Given an average project duration within the last 12 months, different than 0, calculate:* Productivity = Average project size within the last 12 months / 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 expose their financial assets. However, the question regarding project cost was interpreted differently by the organizations, resulting in values not completely compatible with the intended interpretation. This question had already demonstrated need for improvement in the 2008 and 2009 trials and was modified for the 2010 trial. However, the result is still not satisfactory and therefore in 2010 the measure regarding cost could not be used for the characterization purpose. Although this measure has been discarded from the 2010 characterization analysis, it had not to be discarded from the variation analyses (described in next sections), since many organizations calculated the measure the same way in different years (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 (50 organizations). Other size units used are Use Case Points (19 organizations) and Hours of Work (18 organizations). Among the organizations in levels E-A (7) that answered the survey, all use either Function Points (6) or Points of Use Case (1). The values presented in Table 10 consider only data provided by participants which use Function Points.

TABLE 10 - Average Project Size (Function Points)

Grouping	Average Size in FP	Number of Answers
Organizations starting implementation	45	2
Level G Organizations	250	21
Level F Organizations	300	9
Level E-A Organizations	215	6
All the organizations (including those in assessment process)	215	40

TABLE 11 - Average Project Duration (in Months)

Grouping	Average Duration in Months	Number of Answers
Organizations starting implementation	4	18
Level G Organizations	4	74
Level F Organizations	3	29
Level E-A Organizations	4	7
All the organizations (including those in assessment process)	4	139

TABLE 12 - Average Estimated Duration of Projects (in Months)

Grouping	Average Estimated Duration	Number of Answers
Organizations starting implementation	3	19
Level G Organizations	4	74
Level F Organizations	3	32
Level E-A Organizations	4	7
All the organizations (including those in assessment process)	3	143

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

Grouping	Estimation Accuracy	Number of Answers
Organizations starting implementation	0.75	18
Level G Organizations	1	73
Level F Organizations	1	28
Level E-A Organizations	1	7
All the organizations (including those in assessment process)	1	126

TABLE 14 - Productivity (Function Points per Month)

Grouping	Productivity	Number of Answers
Organizations starting implementation	45	2
Level G Organizations	47.5	22
Level F Organizations	80.4	6
Level E-A Organizations	55.3	6
All the organizations (including those in assessment process)	50	39

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 organizations 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: *Given the organizations net sales over the past 12 months, other than 0, calculate:* 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: *Given the organizations net sales over the past 12 months, other than 0, calculate:* 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 2010	12	10

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

Grouping	Implementation Investment	Number of Answers
Organizations in assessment process during 2010	2.9%	10

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

Grouping	Spent with the Assessment	Number of Answers
Organizations in assessment process during 2010	0.5%	9

It can be seen that, the implementation time (12 months) and the investments are suitable (with total investments reaching only 3.4% of the organizations' annual net sales) and consistent with the positive changes that can be triggered in the software development context.

TABLE 19 - Satisfaction with the MPS Model

Grouping	Results	
Organizations starting implementation	Fully Satisfied	43.5%
	Partially Satisfied	52.2%
	Not Satisfied	0.0%
	Unknown satisfaction	4.3%
Level G Organizations	Fully Satisfied	65.8%
	Partially Satisfied	24.1%
	Not Satisfied	1.3%
	Unknown satisfaction	8.9%
Level F Organizations	Fully Satisfied	72.2%
	Partially Satisfied	27.8%
	Not Satisfied	0.0%
	Unknown satisfaction	0.0%
Level E-A Organizations	Fully Satisfied	57.1%
	Partially Satisfied	14.3%
	Not Satisfied	0.0%
	Unknown satisfaction	28.6%
All the organizations (including those in assessment process)	Fully Satisfied	64.7%
	Partially Satisfied	28.2%
	Not Satisfied	0.6%
	Unknown satisfaction	6.4%

4.4. 2010 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 2010. However, some behaviors, possibly related to the adoption of the model, could be observed. An initial analysis of these behaviors was provided in [Travassos and Kalinowski, 2010]. In fact, some of the organizations that participated in this study also use other reference models, such as CMMI. This may in itself represent a confounding factor that influenced the results. However, most organizations (86%) 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, 2 Level G, 3 – Level F, and 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, 62.5% reported to have fully or largely satisfied customers. Among the organizations already assessed in the MPS model this number raises to 74%. Considering only the organizations between levels E-A customer satisfaction reaches 85.7%. There is a strong positive correlation between the increase of this number and the MPS maturity level of +0.92.

Satisfaction with the MPS Model. Regarding satisfaction with the MPS Model, 64.7.11% (101 organizations) reported being completely satisfied with the model and 28.2% reported being partially met. Only 0.6% (1 organization, of maturity level G) reported being not satisfied and 6.4% (10 organizations) reported not knowing their level of satisfaction yet. As in the previous year, all organizations with maturity level F or higher declared themselves fully or partially satisfied. This result shows an overall scenario of high satisfaction with the model.

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 MPS implementation in 2010, none of them had any CMMI maturity level. At level G the percentage of organizations with CMMI maturity levels was 2.5%. At level F, this number rises to 19.4% and between levels E-A it reached 71.4%.

Number of Employees. Given the information provided by the organizations, the number of employees increases with the MPS maturity level (positive correlation of +0.85). We understand that as the number of professionals involved in projects increases, so does the need for communication between them and the therefore the need for more formal processes, an explicit characteristic of maturity levels E-A. Exception is made for organizations starting to implement the model when compared to organizations in maturity level G. In this case, the variation may represent an adjustment made by the organization, to organize its software development activities based on the processes of maturity level G, allowing a better planned use of manpower, which may shift professionals to other areas of the organization, not necessarily related to software development.

Project Size. Regarding project size, 50 (32%) of the 156 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 19 organizations (12.2%).

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 45 function points (only two organizations of this group informed their average project size in function points), the median for organizations in the levels of E-A is 215. There is a positive correlation between the increase in median and the increase of MPS maturity level of +0.8. A similar behavior could be observed in the 2009 characterization [Travassos and Kalinowski, 2009].
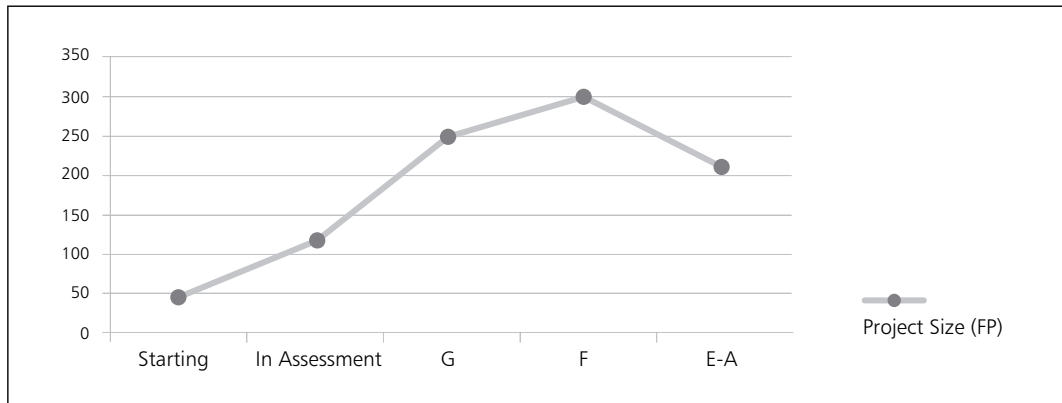

Figure 1. Median Project Size

Estimation Accuracy. Since many organizations reported to make exact and accurate project duration estimates (estimate equal to the actual duration), we believe that this measure is better observed by looking at the values of the first quartile of each group instead of the median. This criteria was necessary, having in mind that the medians, in most cases, assumed value 1, which would not allow to observe the organizations behavior properly. In Figure 2 it is possible to observe that organizations of the higher maturity level groups present higher estimation accuracy. Similar behavior was observed in the 2009 iMPS trial [Travassos and Kalinowski, 2009].
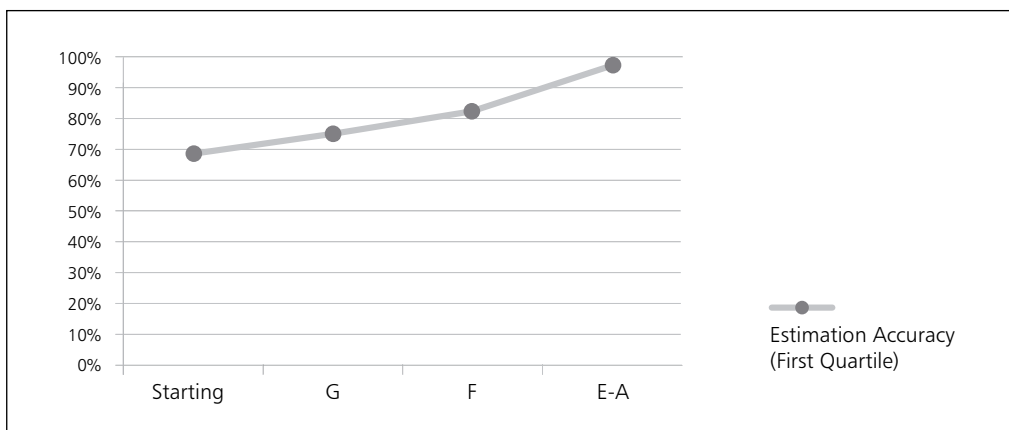

Figure 2. Organizations Estimation Accuracy (first quartile)

Productivity. In 2010, once again, productivity appeared higher for organizations that adopted the MPS model. The highest median was in the group of level F 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 quality[3] and cost[4] 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 where the measurement process should already be institutionalized.

Figure 3 shows the medians 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 45 function points per month, the median for organizations in the levels E-A is 55.33, and for level F organizations it reached 80.36 function points per month. There is a positive correlation between the increase of the median and the MPS maturity level of +0.58.

We believe that the productivity decay for maturity levels E-A (when compared to level F) cannot be seen as an isolated fact, and that it can be explained from different perspectives. The first related to the number of organizations in each group, which may be affecting the median, since there are few organizations in the higher maturity levels. Other explanations relate to the accuracy of estimates and measures or even a possible adjustment given the number of additional processes in maturity levels E-A. Even so, the values presented are higher than in the early stages and there is still a final gain.
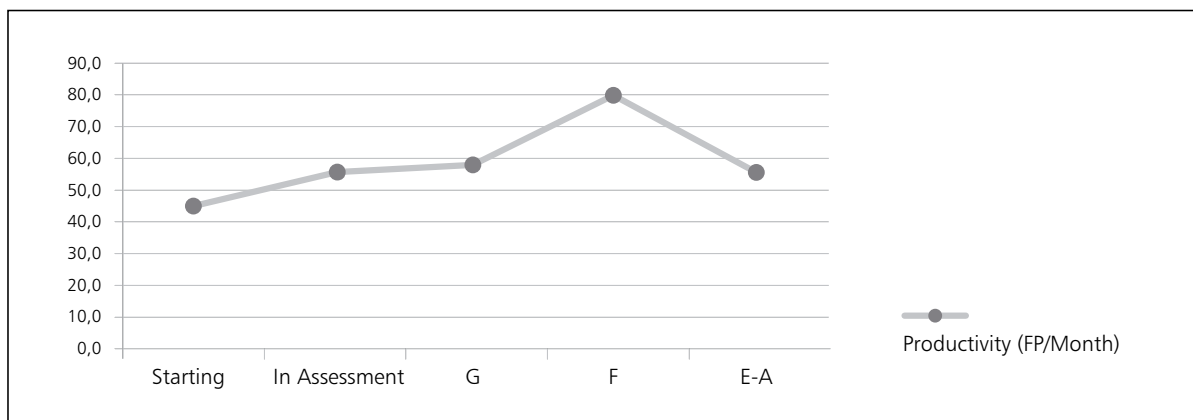

Figure 3. Productivity (in FP/Month)

Given this analysis of the 2010 characterization, the following section presents the 2009/2010 performance variation of organizations that adopted the MPS Model.

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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 2010 Results: Performance Variation Analysis

5.1. 2009/2010 Performance Variation Analysis

To analyze the data sent by the organizations which responded to 2010 periodic questionnaire and had also provided information for the 2009 periodic questionnaire the same criterion was applied, with the analysis and elimination of outliers. The indicators that were considered in this analysis are defined in the iMPS study plan [Travassos and Kalinowski, 2008b]: A. Variation of Net Sales, B. Number of Customers in Brazil, C. Number of Employees, D. Average Project Cost, E. Average Project Duration, F. Average Project Size, G. Productivity, and H. Quality. Also according to the plan, beyond these indicators, the ROI for the MPS implementation and assessment is presented. In 2010 we identified a set of 65 subjects (38 assessed MPS level G, 24 assessed MPS level F, and 3 assessed MPS levels E-A) having a periodic questionnaire for the year 2009 and another for the year 2010. Additionally, a set with 11 organizations within this group could be identified and analyzed separately; containing organizations that renewed/changed their maturity level during this period.

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.

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 as 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.

The behavior observed in the collected data follows. As defined in the 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.

To support the behavior observation, visual markers will be used (↑ increase, ↓ decrease, ↔ no change). Regarding software process improvement, we believe that an expectation of behavior for organizations adopting maturity models can be represented by the observation hypotheses shown in Table 20.

TABLE 20 - Software Process Improvement Expected Behavior

Indicator	Expected Behavior
Variation in Net Sales	↑
Number of Customers in Brazil	↑
Number of Employees	↑
Average Project Cost	↓
Average Project Duration	↓
Average Project Size	↔
Productivity	↑
Quality	↑

As shown in Figure 4, the overall results show interesting trends regarding the organizations that adopted the model (and sent the questionnaires). For instance, it is possible to note that the organizations between the years of 2009 and 2010 reported increase of net sales and number of customers and a thin increase on the number of employees and quality (ability to identify defects). The calculus of the quality indicator is done by comparing the number of defects found by the organization per unit of size of the software being developed. However, the behavior of the quality indicator needs to be analyzed in further details.
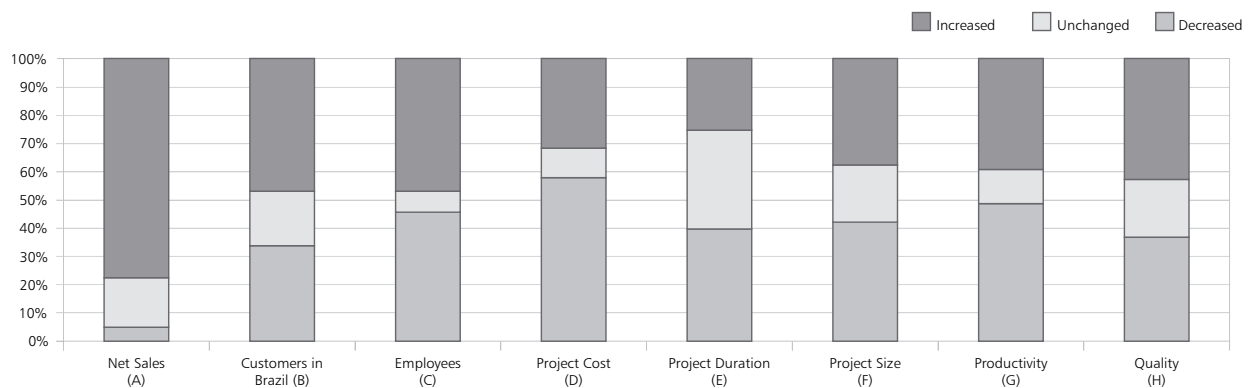
Indicator	A	B	C	D	E	F	G	H
Valid Answers	18	63	63	45	58	36	33	14
Confidence Level (%)	80.0	97.8	97.8	91.7	95.7	88.9	87.8	76.3

Figure 4. Performance Variation of the 65 Organizations that Adopted the MPS and Provided the Periodic Information in 2009 and 2010

The organizations' project size remained roughly the same, with an almost equal number of organizations experiencing increases and reductions. It is also possible to observe that most organizations reported a reduction of project cost and duration. This contrasts with the productivity, where a slightly higher number of organizations decreased. However, further analyses must be performed to identify whether the impact is positive or negative, because supposedly change occurred in the ability to identify defects and an increase the number of employees.

Table 21 presents a comparison of the observed and the expected behaviors. The gray lines highlight the indicators that showed adherence to the observation hypothesis.

TABLE 21 - Expected and Observed Behavior of the 65 Organizations that Adopted the MPS and Provided the Periodic Information in 2009 and 2010

Indicator	Expected Behavior	Observed Behavior
Variation in Net Sales	↑	↑
Number of Customers in Brazil	↑	↑
Number of Employees	↑	↔
Average Project Cost	↓	↓
Average Project Duration	↓	↓
Average Project Size	↔	↔
Productivity	↑	↓
Quality	↑	↔

Regarding the return on investment (ROI) for the MPS implementation and assessment over the past 12 months, 23 organizations provided information that allowed the ROI calculation. 14% of them reported that they did not obtain any return on investment yet. However, additional research is needed to understand whether these organizations were assessed recently, which of course would prevent to see some return on investment. Moreover, 23.8% of the organizations reported they've already gotten some return on the investment made in the MPS implementation and assessment, while the majority of the organizations (61.9%) reported that they recovered, at least, all of the investment made. Figure 5 shows this distribution. The confidence level for this sample is 84.3% considering the population of 65 organizations.
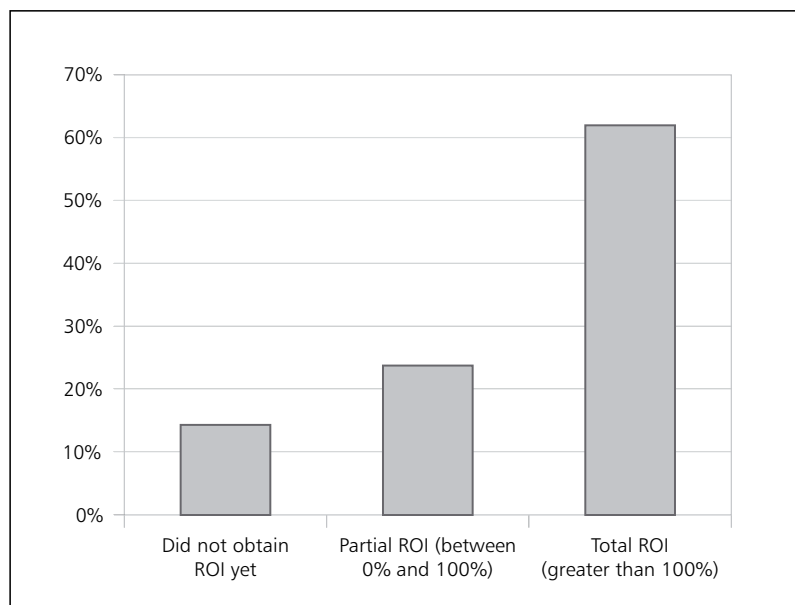

Figure 5. Return of Investment obtained by the 65 Organizations that Adopted the MPS and Provided the Periodic Information in 2009 and 2010

As in 2009, in 2010 an additional analysis was performed, considering the performance variation results of organizations that have changed or renewed their MPS maturity levels. The main characteristic of these organizations, regardless of the maturity level in which they were assessed, refers to the adoption of the MPS and continuity of development following its guidelines. As can be seen in Figure 6, among the vast majority of these organizations achieved an increase in net sales (in fact none of them reduced net sales over the last 12 months).

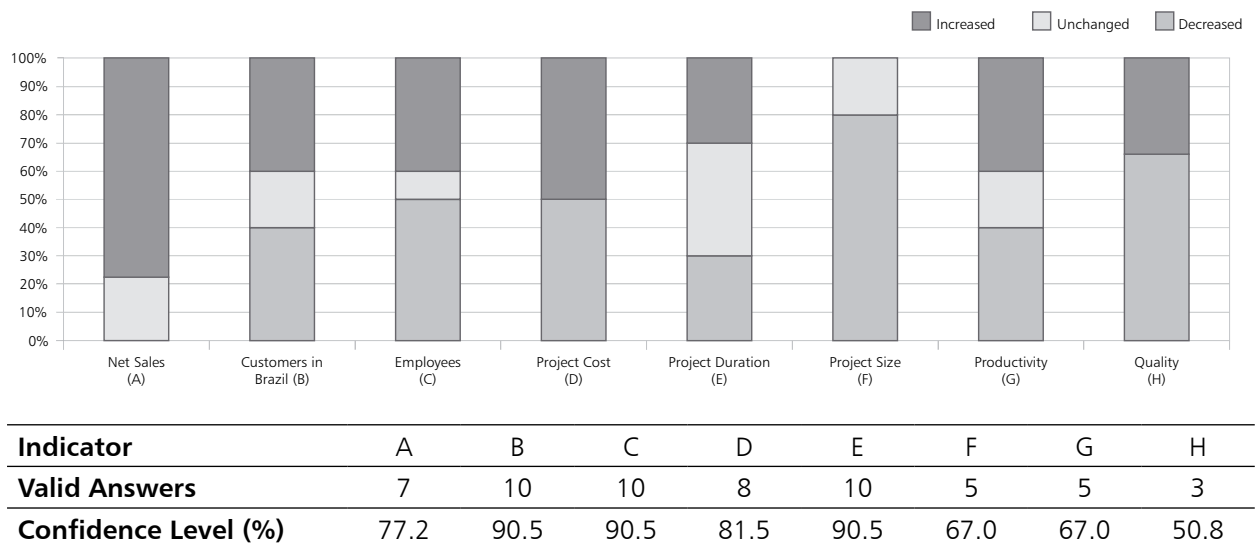| Indicator	A	B	C	D	E	F	G	H
Valid Answers	7	10	10	8	10	5	5	3
Confidence Level (%)	77.2	90.5	90.5	81.5	90.5	67.0	67.0	50.8

Figure 6. Performance Variation of the 11 Organizations that Changed or Renewed their MPS Maturity Levels between 2009 and 2010 (And Answered to Both Periodic Questionnaires)

It is also possible to observe that, according to the data provided by the organizations, the indicators show a behavior consistent with some hypotheses related to the use of software development processes combined with good software engineering practices. For example, one can observe the reduction of project cost and duration. However, it is also possible to observe that these organizations started to deal with smaller projects, which may reflect a different way to organize product and solutions development into projects, aiming at systematizing and obtaining greater control over the process. In fact, there is indication that the reduction in project size may be contributing to justify the reduction of cost and duration, which is reinforced by the fact that productivity apparently has not changed, despite the level of confidence presented for the number of answers.

The indicator related to quality (H) did not have enough information to allow a further observation of trends. Only three organizations reported results to be interpreted, resulting in a very low confidence level, increasing the risks to generalize the observed behavior for the entire population significantly. However, the results are shown in Figure 6. Further investigation needs to be done in order to try to identify the potential factors that may be influencing the low availability of information for this indicator.

The next section presents the variation analysis for organizations which had unexpired MPS assessments in the last three years (2008/2009/2010).

5.2. 2008/2009/2010 Variation Analysis

The 75 valid questionnaires (with a valid response for each survey year) include 25 organizations in two MPS maturity levels: G (11 organizations) and F (14 organizations). Organizations in other maturity levels did not show adequate responses for the iMPS indicators in one of the years during the survey period and therefore were not included in this set. Considering the questionnaires identified as valid, not all organizations responded to all questions appropriately in all of the three years. Thus, it is not possible to use the same approach to observe the results of these 25 organizations for each of the different indicators. Therefore, as done previously, for each iMPS indicator the confidence level is shown, which intends to provide a security level that allows improving the perception of the risks involved in interpreting the results and of their generalization for comparison with similar situations faced in other organizational contexts.

The calculation of the indicators used the concept of correlation. Data for a given organization were treated with one another. There is no comparison of data from a organization with another organization, as foreseen in the iMPS study plan. Thus, to observe the evolution of the indicators, the correlation between the date of questionnaire submission (time factor) and each organization's characteristics (e.g., number of employees, number of customers, among others) was used. Therefore, the mapping done is related to represent the increase (positive correlation), stabilization (zero correlation) or decrease (negative correlation) reported by organizations throughout the evaluation period. After calculating the correlation for each of the organizations' features, we identified the percentage of organizations that increased, stabilized or reduced, which was then used to generate Figure 7.
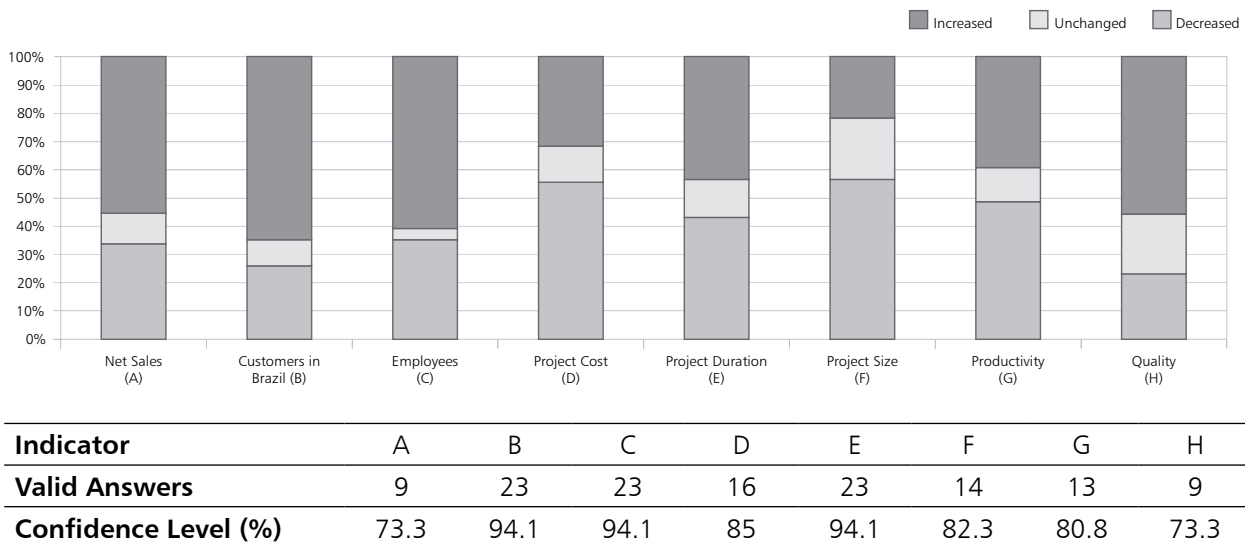

Indicator	A	B	C	D	E	F	G	H
Valid Answers	9	23	23	16	23	14	13	9
Confidence Level (%)	73.3	94.1	94.1	85	94.1	82.3	80.8	73.3

Figure 7. Performance Variation of 25 Organizations (MPS Levels G and F) in the Period 2008/2009/2010

For changes in net sales, as shown in Figure 7, the tendency of organizations throughout this period was of increase. This increase may have been supported by the increase in the number of customers in the country, which could also have influenced the increase in the number of employees. Whereas the evaluation period involved a series of global financial events that could have put several potential customers (and the organizations themselves) at risk, we identified this general behavior as extremely

positive during this period. However, the generalization ability is reduced for organizations that use the MPS with different profiles or other maturity levels. Additionally, it is necessary to make performance comparisons with organizations with similar and profiles and which are not yet using the MPS in order to identify the influence of model on this observed behavior.

Regarding software projects usually developed by these organizations, it is possible to observe that the average project cost shows a declining trend, with a trend of increasing productivity and reducing the average project size. It can also be noted that the projects had an apparent improvement in quality, with organizations tending to improve their ability to identify defects during project development. This behavior is adherent to software engineering principles and was already observed in the 2009 iMPS trial [Travassos and Kalinowski, 2009]. However, observing the behavior of the project duration indicator, no explicit trend could be identified. Some organizations reported an increase in project duration while others reported a reduction and a few remained with unchanged project durations over the survey's evaluation period.

It would be reasonable to expect a project duration decrease trend, given the improvement trends of the cost, quality and productivity indicators. One possible explanation for the unchanged behavior may be associated with, for example, increasing the number of employees, which may be affecting the indicators during their learning period, or a possible increase in the size of software projects that have not yet been possible to investigate. Regardless of the cause, we consider this scenario very positive, as there is improvement reported by the organizations to benefit the quality of software projects that have been developed for the Brazilian market, since the revenue with exports is significantly smaller and remained unchanged, according to the information provided by the organizations. Table 22 presents the observed behaviors, marking in gray the indicators that showed similar behaviors to the observation hypotheses.

TABLE 22 - Expected and Observed Behavior of 25 Organizations (MPS Levels G and F) in the Period 2008/2009/2010

Indicator	Expected Behavior	Observed Behavior
Variation in Net Sales	↑	↑
Number of Customers in Brazil	↑	↑
Number of Employees	↑	↑
Average Project Cost	↓	↓
Average Project Duration	↓	↔
Average Project Size	↔	↓
Productivity	↑	↑
Quality	↑	↑

6. Performance Variation Analysis with the Evolution of Organizations in their MPS Deployment Initiatives

In the 2010 trial, it was possible to perform an additional analysis to assess the performance variation of organizations with the evolution in their MPS deployment initiatives (since the implementation start until the established and maintained MPS maturity level). Therefore we selected only the data of organizations that started implementing the MPS between 2008 and 2010 and that had responded to the questionnaires for the three different moments of the research: staring the implementation, during the assessment process, and the periodic follow-up (with the maturity level already established). We identified 42 organizations in this situation. As there were at least three questionnaires for each of these organizations, at all data of from 137 questionnaires was analyzed.

As in the 2008/2009/2010 performance variation analysis (section 5.2), the calculation of the indicators used the concept of correlation and the data was treated without comparing different organizations. Thus, to observe the evolution of the indicators in relation to the different moments related to the MPS deployment (starting the implementation, assessment and periodic follow-up), the correlation between the questionnaire submission date and each of the indicators (e.g., number of employees, number of customers, among others) was used. Note that the questionnaire submission date has a temporal behavior similar to the moments of deployment and use of the model. Therefore, the mapping done is related to representing the increase (positive correlation), stabilization (zero correlation) or decrease (negative correlation) with the evolution in these moments. After calculating the correlation for each indicator of the organizations, it was possible to identify the percentage of companies showed increase, stabilization or reduction trends, which was then used to generate Figure 8.
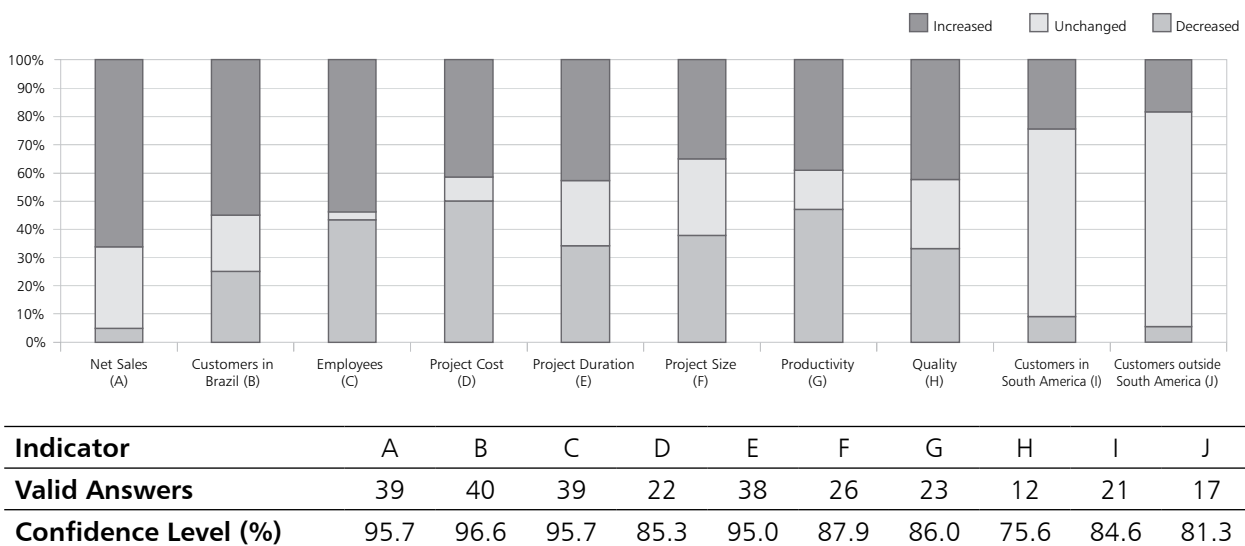

Indicator	A	B	C	D	E	F	G	H	I	J
Valid Answers	39	40	39	22	38	26	23	12	21	17
Confidence Level (%)	95.7	96.6	95.7	85.3	95.0	87.9	86.0	75.6	84.6	81.3

Figure 8. Performance Variation of 42 Organizations with the Evolution of their MPS Deployment Initiatives

In this figure it is possible to observe the performance variation with the evolution of organizations in the MPS model (i.e. with the effective implementation of process improvement in accordance with the reference model). Most of these variation results meet the expectations of investing in process

improvement and of using software engineering best practices. An increase of net sales can be noted for most organizations, as well as an increase of the number of customers and the number of employees, reducing the average cost of projects and increasing the quality assurance capacity.

As earlier discussed, variation in project size can be a simple consequence of a reorganization of the scope of projects. However, it was possible to observe behaviors that were different from the expected regarding project duration and productivity, but still within the expectations of the technological and cultural change that the MPS represents. While the productivity directly influences the project duration, the variation in productivity is directly influenced by the MPS implementation strategy and its apparent decrease may also be influenced by the impact of changes until the total institutionalization of the new processes in the organization. This interpretation may be reinforced by Figure 7 (section 5.2), which shows an increase of productivity for organizations that are already using the MPS for more than three years (with the processes that were improved for the MPS assessment already established and institutionalized). Table 23 presents the observed behaviors, marking in gray the indicators that showed similar behaviors to the observation hypotheses.

TABLE 23 - Expected and Observed Behavior of 42 Organizations with the Evolution of their MPS Deployment Initiatives

Indicator	Expected Behavior	Observed Behavior
Variation in Net Sales	↑	↑
Number of Customers in Brazil	↑	↑
Number of Employees	↑	↑
Average Project Cost	↓	↓
Average Project Duration	↓	↑
Average Project Size	↔	↓
Productivity	↑	↓
Quality	↑	↑

Additionally, as one of the goals of the MPS.BR program is to increase the software development capacity Brazilian organizations, making them more competitive in the global market, it was interesting to observe the variation in the number of customers outside Brazil during the MPS deployment period. Therefore, two additional indicators were considered, number of customers in Latin America (excluding customers in Brazil) and number of clients outside Latin America. For both indicators the trend was increasing with the MPS deployment progress.

7. Concluding Remarks

In this publication we presented the 2010 trial results of the iMPS project, which aims at characterizing and understanding the performance variation of organizations due to the MPS model adoption.

To enable us to describe the behavior of the organizations, the results were presented under three different observation scenarios: (i) 2010 characterization, (ii) performance variation analysis in recent years (2009/2010 and 2008/2009/2010), and (iii) performance variation analysis with the evolution of organizations in their MPS deployment initiatives.

Regarding the 2010 characterization, it was possible to observe that organizations that adopted the MPS model have a higher customer satisfaction, handle larger projects, have more accurate schedule estimates and are more productive when compared to organizations that are starting the MPS implementation. Additionally, despite of the low proportion of organizations using additional process improvement reference models, CMMI model proves to be more present in organizations, especially for those who have higher MPS maturity levels. The organizations' satisfaction with the MPS model is notorious, with over 92% reporting to be partially or fully satisfied.

Concerning the performance variation of organizations that have been using the MPS, it was possible to observe that, in general, the presented behaviors were very close to the expected behaviors of organizations adopting good software engineering practices, as can be seen in comparison with the observation hypotheses previously established. In particular, observing the 25 companies that have already internalized the MPS (observed over a three year period), only the project duration and the average project size behaved differently than expected. However, even with this small difference, we consider the results very positive, because the difference shown does not interfere with the gains demonstrated and, apparently, does not expose the other indicators to any risks.

Finally, the performance variation analysis with the evolution of organizations in their MPS deployment initiatives (since starting implementation until the maturity level was assessed and established) allowed us to observe that the MPS deployment investment resulted in organization growth, increasing net sales, number of employees, and number of customers (inside and outside Brazil). The growth of these organizations may be related to their project cost reduction and their greater ability to ensure product quality. After all, those who produce at lower cost and higher quality tend to obtain new customers. Another observation is that the increase in productivity may only come after the effective institutionalization of the new processes (as noted in the variation analysis - section 5.2).

It is important to state that there are some context variables that were not considered or not identified (such as economics aspects, among others) that may be influencing these results. However, given the observed behaviors, we believe that the variation analysis results for organizations that had already been assessed in the MPS model (section 5) and the results of organizations that deployed the MPS recently (section 6) can serve to motivate MPS assessed organizations to continue their process improvement activities and to support decisions of organizations wishing to move towards MPS adoption in the near future.

Acknowledgements

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iMPS 2010: Performance of Software Organizations that Adopted the MPS Model from 2008 to 2010

This publication presents the 2010 iMPS research results. This year electronic questionnaires were received from 156 different organizations that have adopted the MPS model:

- the organizations' satisfaction with the MPS model was notorious, with over 92% reporting to be partially or fully satisfied;

- the characterization allowed to observe that organizations that adopted the MPS model have higher customer satisfaction, handle larger projects, have more accurate schedule estimates and are more productive, when compared to organizations that are starting to implement the MPS model;

- the performance variation analysis allowed to identify that companies tend to obtain the expected benefits of applying software engineering principles to their development efforts, regarding cost, schedule, quality and productivity.

We hope that the objective evidence presented in this publication will be useful to those interested in improving software processes and software organization competitiveness.

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