

iMPS 2011

Performance Results of Software Organizations that Adopted the MPS Model from 2008 to 2011



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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.

SOFTEX Mission

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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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. The MPS assessments in organizations have validity of three years: the 1st was accomplished in 2005; assessment number 100 happened in 2008; number 200 in 2009; and number 300 in 2011. The MPS model is adopted by small and medium sized enterprises (SME) – about 70% of the published MPS assessments as well as by large organizations of the private and public sectors – about 30%.

In 2008, SOFTEX hired the COPPE/UFRJ's Experimental Software Engineering Group to model the iMPS project – *"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 trials. The main iMPS goal was to plan a survey, following the principles of Experimental Software Engineering, and to execute it periodically to monitor and provide evidence of performance results of organizations that adopted the MPS model. More information regarding the research plan, the moments of information gathering and the treatment given to the threats of validity can be found in [Kalinowski, M., Weber, K. C., and Travassos, G. H. (2008). *"iMPS: An Experimentation Based Investigation of a Nationwide Software Development Reference Model"*. ACM/IEEE 2nd International Symposium on Empirical Software Engineering and Measurement (ESEM). October, 9-10. Kaiserslautern. Germany].

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.

The iMPS2011 research results which featured electronic questionnaires answered by 133 different companies in [Travassos, G. H. and Kalinowski, M. "iMPS 2011: Performance Results of Software Organizations that Adopted the MPS Model from 2008 to 2011"] show that in 2011 the satisfaction of the organizations with the model was again evident, with approximately 97% of them reporting to be totally or partially satisfied with the MPS model. The characterization has observed positive correlations between the maturity of organizations in the MPS model and the number of projects (both, in Brazil and abroad). In the performance variation analysis, it was possible to identify that organizations that remain persistent in the use of software engineering practices represented by the MPS maturity levels have more customers, develop more projects, have a greater number of employees, deal with larger projects and show higher estimation accuracy, despite a slight increase caused in the average time spent on their projects.

Once again, we hope that the objective evidence presented in this publication will be useful to those – in Industry, Academy and Government – interested in improving software processes and software organization competitiveness.

José Antonio Antonioni

Kival Chaves Weber

iMPS 2011: Performance Results of Software Organizations that Adopted the MPS Model from 2008 to 2011

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Abstract. *The MPS model is being increasingly used by Brazilian software organizations. To monitor the performance of these organizations due to model using, the iMPS project was initiated in 2007 with results published for the years 2008, 2009 and 2010. In this publication we present the characterization of organizations based on data provided in 2011 and also the performance variation of organizations over the years 2008, 2009, 2010 and 2011. The characterization has allowed us to observe positive correlations between more mature organizations according to MPS maturity levels and number of projects (into the country and abroad). In the performance variation analysis, we found that organizations persisting in the use of software engineering practices represented by the MPS maturity levels have more customers, develop more projects, have greater number of employees, deal with larger size projects and present higher estimate accuracy, despite present slightly increasing in the average of their projects' duration . In 2011, the organizations satisfaction with the model was again clear, with approximately 97% 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 ones, 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 2011, 317 official MPS assessments had been accomplished and published. Assessments results are available in the SOFTEX portal www.softex.br/mpsbr.

The adoption of the MPS model by Brazilian organizations reveals the interest in qualitatively understanding the performance results obtained by these organizations concerned with cost, schedule, productivity, and quality. Given this interest, the iMPS project (information to monitor and provide evidence regarding the 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 goal of the iMPS project was to plan a survey, following the principles of the Experimental Software Engineering, and execute periodically trials to monitor and provide evidence regarding the performance results in software organizations that have adopted the MPS model. More information about the research plan and mitigation of its threats to validity can be found in [Kalinowski et al., 2008]. The 2008 (baseline), 2009, 2010 and 2011 iMPS trials provided the initial evidence [Travassos e Kalinowski, 2008a] [Travassos e Kalinowski, 2009] [Travassos e Kalinowski, 2011a], to be supplemented annually by new iMPS trials, allowing comparative analyses.

This publication presents the results of the 2011 iMPS trial. This year, the questionnaires were provided in electronic form (via a Web application), which helped to increase the quality of reported data (until 2009 they were provided in free text format). Results are presented from two perspectives: (i) 2011 characterization, (ii) performance variation analysis over the years (2010/2011, 2009/2010/2011 and 2008/2009/2010/2011). In this iMPS trial an additional performance variation analysis was performed in which organizations of the different years were grouped together. The perspective of this additional grouping is to compare the possible effects in the performance indicators given the persistence of the organizations using the MPS model.

The goal of the characterization is to outline the performance of organizations that adopted the MPS in 2011. The goal of the performance variation analysis in recent years, on the other hand, is to observe the performance variation of organizations with unexpired MPS assessments between 2008 and 2011. 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 section 2 and 3 the iMPS project and how it was applied to software organizations in 2011 are presented. Section 4 contains the 2010 characterization results. In Section 5, the performance variation results of organizations with unexpired MPS assessments (2010/2011, 2009/2010/2011 and 2008/2009/2010/2011) are presented. Finally, section 6 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 of software organizations that have adopted the MPS model. This monitoring is based on a survey, which was planned following the Experimental Software Engineering principles [Wohlin et al., 2000]. This survey should allow 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 study validity 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 the understanding of 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, 2009 and 2010 allowed to evolve the questionnaires for the 2011 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 2011 trial.

3. Survey Application and Initial Data Preparation: 2011 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 Management¹. Filling out the electronic questionnaires resulted in automatic transference of data from the organizations to the iMPS repository². 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 data, since some organizations didn't have all data requested in the survey. Some additional organization characterization information, such as the MPS maturity level, was obtained directly from existing SOFTEX databases.

In total, 133 questionnaires from different organizations representing data for the year 2011 have been received (between 08/01/2010 and 07/31/2011). 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 above for characterizing the organizations.

During 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 possible to identify that the majority of outliers were found in data of organizations starting the MPS model implementation 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 and up, which leads us to believe that the measures received from these organizations (maturity level F and up) are more reliable.

The next three sections describe the results of the 2010 iMPS trial, including the 2011 characterization, the performance variation analysis (2010/2011, 2009/2010/2011 and 2008/2009/2010/2011) and the performance variation analysis with the evolution of organizations in their MPS deployment initiatives. The 2008, 2009, and 2010 trial results can be found in [Travassos and Kalinowski, 2008a], [Travassos and Kalinowski, 2009] and [Travassos and Kalinowski, 2011a].

4. iMPS 2011 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 (8 starting the MPS implementation, 32 in assessment process, 49 assessed MPS level G, 28 assessed MPS level F, and 16 assessed MPS levels E-A), they were grouped during analysis in the following five categories: organizations starting the MPS model implementation, organizations in assessment process, organizations assessed MPS level G, organizations assessed MPS level F, and organizations assessed MPS levels E-A. Furthermore, data is observed focusing on three different perspectives treated by the questionnaire and concerning with organizations, their projects and the MPS itself.

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

2) iMPS Repository: Created in the CoreKM system, where official MPS assessment data are also stored.

It is important to state that the organizations starting to implement the MPS model may already be using other maturity models and could be starting to implement any of the model's maturity levels. Therefore, this information is more useful for the performance variation analysis (next section) than for the characterization itself.

The measures considered in the survey plan [Travassos and Kalinowski, 2008b] concerning each of the perspectives (organization, project, and MPS) and their interpretation are presented in the following subsections, together with the obtained values, considering the set of organizations that participated in this study trial. For each of the measures, beyond the basic aggregated information found (median or percentage), the number of valid answers obtained is presented and, when relevant, a textual interpretation with additional information is provided.

4.1. Perspective ORGANIZATION

An organization represents the entity under study. In general, the concept concerns the entire software development organization. However, it is possible for an organization to have different organizational units dealing 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 considered in this research.

TABLE 1 - Measures used in the perspective Organization

MEASURE	INTERPRETATION
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 into the country.
Number of projects abroad	Represents the number of projects the organization has abroad.
Total number of employees	Staff involved in software development.

Tables 2 to 6 present values (medians and percentages) that could be obtained for the organization perspective measures. For some tables additional explanations are provided in order to help understanding the values extracted from the collected data.

TABLE 2 – Number of Customers inside the Country (Brazil)

Grouping	Number of Customers	Number of Answers
Organizations starting implementation	22	7
Organizations in assessment process	20	19
Level G Organizations	17	29
Level F Organizations	35	17
Level E-A Organizations	18	11
All organizations	20	83

For the measure regarding the number of customers abroad, only 24.8% of the organizations participating in the study reported to have customers abroad and, therefore, the medians (central value) for all groups of analysis were 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 3 – Percentage of Organizations that have Customers Abroad

Grouping	% that have Customers Abroad	Number of Answers
Organizations starting implementation	42.9%	7
Organizations in assessment process	9.5%	21
Level G Organizations	9.3%	43
Level F Organizations	50%	22
Level E-A Organizations	43.8%	16
All organizations	24.8%	109

TABLE 4 – Number of Projects inside the Country (Brazil)

Grouping	Number of Projects	Number of Answers
Organizations starting implementation	12	7
Organizations in assessment process	7	31
Level G Organizations	10	37
Level F Organizations	10	18
Level E-A Organizations	18	14
All organizations	10	107

For the measure regarding the number of projects abroad, only 18.1% of the organizations participating in the study reported to have projects abroad, and the medians (central value) for all groups of analysis were 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 5 – Percentage of Organizations with Projects Abroad

Grouping	% having Projects Abroad	Number of Answers
Organizations starting implementation	37.5%	8
Organizations in assessment process	3.8%	26
Level G Organizations	8.2%	49
Level F Organizations	32.1%	28
Level E-A Organizations	37.5%	16
All organizations	18.1%	127

TABLE 6 – Number of Employees

Grouping	Number of Employees	Number of Answers
Organizations starting implementation	50	7
Organizations in assessment process	32	30
Level G Organizations	39	45
Level F Organizations	51	21
Level E-A Organizations	92	12
All organizations	41	115

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 7 presents the interpretation that was given to collect the values for the measures related to this perspective.

TABLE 7 – 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 effort	Average project effort in the last 12 months, measured in hours. This measure was included in the 2011 trial, aiming at facilitating the comprehension of other indicators.
Average project duration	Duration, measured in months, considering the projects completed within the last 12 months.
Average estimated project duration	Estimated duration, measured in months, 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 8 to 13 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. Therefore, it produces relative values not comparable between different organizations. Thus, although this measure is not used for the characterization analysis, it can be perfectly used for the performance variation analysis (described in the next section).

Considering the average project size, among the various size units, the one most used by organizations is Function Points (46 organizations). Other used size units were Hours of Work (25 organizations, although this measure, according to technical literature is not appropriate to capture the size of software projects) and Use Case Points (14 organizations). Among the organizations in levels E-A (16), 10 use Function Points. The values presented in Table 8 consider only data provided by participants which use Function Points. The organizations starting to implement de MPS model were not included in this table because in this group only one organization used Function Points and provided an accurate numerical value.

TABLE 8 – Average Project Size (Function Points)

Grouping	Average Size in FP	Number of Answers
Organizations in assessment process	225	6
Level G Organizations	175	12
Level F Organizations	345.5	8
Level E-A Organizations	268.5	10
All organizations	237	37

The average project effort is a new measure, collected for the first time in 2011 to provide additional evidence for other indicators comprehension. The mean values of the average effort invested in the projects are shown in Table 9. It is important to state that this measure, in the 2011 trial, could only be used for characterization, since it was not collected in the previous years.

TABLE 9 – Average Project Effort (Hours)

Grouping	Average Effort	Number of Answers
Organizations starting implementation	724	4
Organizations in assessment process	710	12
Level G Organizations	600	44
Level F Organizations	850	19
Level E-A Organizations	1600	12
All organizations	800	91

TABLE 10 – Average Project Duration (in Months)

Grouping	Average Duration in Months	Number of Answers
Organizations starting implementation	3.7	6
Organizations in assessment process	3	28
Level G Organizations	3	44
Level F Organizations	4.1	26
Level E-A Organizations	5.5	16
All organizations	3.4	120

TABLE 11 – Average Estimated Duration of Projects (in Months)

Grouping	Average Estimated Duration	Number of Answers
Organizations starting implementation	3.5	6
Organizations in assessment process	3	26
Level G Organizations	3	44
Level F Organizations	4	26
Level E-A Organizations	5.4	16
All organizations	3	118

Considering estimation accuracy it is important to observe that many organizations informed the estimated and the actual duration of their projects with the same value (estimation accuracy 1), which according to technical literature is not the known reality of software projects. For this reason the table below, besides showing the mean value also shows the range for each of the groupings. More details concerning estimation accuracy will be discussed afterwards.

TABLE 12 - Estimation Accuracy (Relation between Estimated Duration and Real Duration)

Grouping	Estimation Accuracy	Number of Answers
Organizations starting implementation	1 (range from 0.4 to 1)	6
Organizations in assessment process	1 (range from 0.33 to 1)	22
Level G Organizations	1 (range from 0.22 to 1)	43
Level F Organizations	1 (range from 0.6 to 1)	26
Level E-A Organizations	0.94 (range from 0.67 to 1)	16
All organizations	1 (range from 0.22 to 1)	113

Regarding productivity, following the metric defined in Table 7, it was measured in Function Points/Month. Since only one of the organizations starting to implement the model provided information in Function Points with a valid value, this grouping was not included in the table.

TABLE 13 - Productivity (Function Points per Month)

Grouping	Productivity	Number of Answers
Organizations in assessment process	43.75	6
Level G Organizations	50	12
Level F Organizations	67.9	8
Level E-A Organizations	48.7	10
All organizations	50	37

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 the organization or project. Table 14 shows the interpretation of the measures that were collected for this perspective.

TABLE 14 – 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: <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 and 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 15 to 18 present values (medians and percentages) which could be obtained for the MPS model perspective measures.

TABLE 15 - MPS Implementation Time (in Months).

Grouping	Implementation Time	Number of Answers
Organizations in assessment process	12	17

TABLE 16 - MPS Implementation Investment (Percentage of Net Sales).

Grouping	Implementation Investment	Number of Answers
Organizations in assessment process	8%	21

TABLE 17 - MPS Assessment Investment (Percentage of Net Sales).

Grouping	Spent with the Assessment	Number of Answers
Organizations in assessment process	2%	19

It can be seen that, the implementation time (12 months) and the investments are suitable and consistent with the positive changes that can be triggered in the software development context.

TABLE 18 - Satisfaction with the MPS Model

Grouping	Results	
Organizations starting implementation	Fully Satisfied	50.0%
	Partially Satisfied	50.0%
	Not Satisfied	0%
	Unknown satisfaction	0%
Organizations in assessment process	Fully Satisfied	78.1%
	Partially Satisfied	19.8%
	Not Satisfied	0%
	Unknown satisfaction	3.1%
Level G Organizations	Fully Satisfied	67.3%
	Partially Satisfied	28.6%
	Not Satisfied	0%
	Unknown satisfaction	4.1%
Level F Organizations	Fully Satisfied	60.7%
	Partially Satisfied	35.7%
	Not Satisfied	0%
	Unknown satisfaction	3.6%
Level E-A Organizations	Fully Satisfied	43.8%
	Partially Satisfied	56.3%
	Not Satisfied	0%
	Unknown satisfaction	0%
All organizations (including those in assessment process)	Fully Satisfied	64.7%
	Partially Satisfied	32.3%
	Not Satisfied	0%
	Unknown satisfaction	3.0%

4.4. 2011 Characterization Analysis

The data presented in the previous section allows different interpretations, which may be related to some confounding factors and even the political and economic factors of the year 2011. 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, 2011b].

In fact, some of the organizations that participated in this study also use other reference models. This may in itself represent a confounding factor influencing 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 – In Assessment Process, 2 Level G, 3 – Level F, and 4 - Levels E-A).

Number of Projects and Employees. Considering the activity of the organizations, it is possible to observe that organizations of higher maturity levels have more projects (into the country and abroad, with correlations of +0.9 and +0.95) and more employees to handle those projects (correlation of +0.93).

Project Size. Regarding project size, of the 133 organizations considered, 46 (34.58%) reported measuring the size of their projects in Function Points. Other used measures were Hours, used by 25 organizations (although this measure is not indicated for project size given the different interpretations and measurement approaches that can be applied) and Use Case Points, used by 14 organizations.

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 in assessment process is 225 Function Points, the median for organizations in the levels E-A is 268.5. There is a positive correlation between the increase in median and the increase of MPS maturity level of +0.53. A similar behavior could be observed in the 2010 characterization [Travassos and Kalinowski, 2011a].

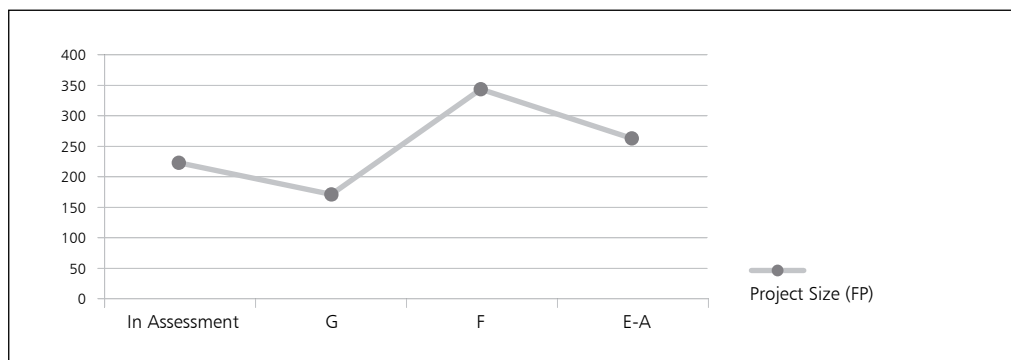


Figure 1. Median Project Size (FP).

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 estimation ranges in each of the groupings.

Figure 2 illustrates these ranges, by using a boxplot showing the maximum, minimum and median values. In this figure, it is possible to observe that organizations of maturity levels F and E-A present

lower variations and a higher minimum estimation accuracy (varying respectively between 0.6 and 1, and between 0.67 and 1) when compared to organizations in maturity level G.

Therefore, as in the 2010 characterization, according to the collected data, organizations of higher maturity level informed to achieve higher estimation accuracy.

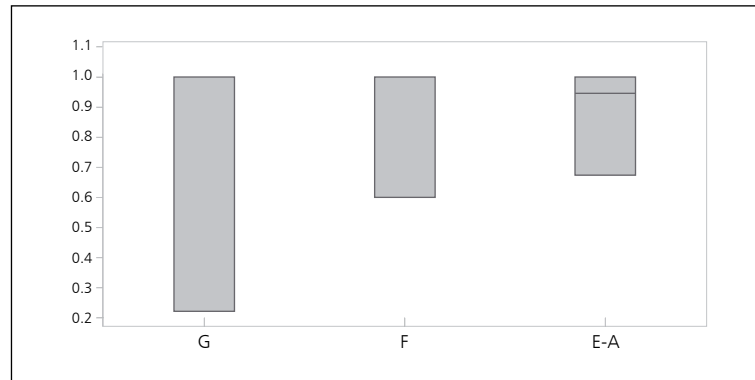


Figure 2. Estimation Accuracy Boxplot.

Productivity. Productivity is being considered in an isolated way. However, it is important to note that productivity may vary for different project types and different quality³ and cost⁴ expectations. Additionally, the productivity formula takes into account other base measures, which, as previously discussed, may be more reliable for organizations with maturity levels F or higher, where the measurement process has already been institutionalized. Given these considerations, the productivity showed a positive correlation with the increase of the MPS maturity level of +0.40. The highest median value was observed for organizations in maturity level F.

Figure 3 shows the medians representing productivity of projects of organizations that use function points, for each grouping used in the study. Again the behavior was quite similar to the one observed in the previous years of the iMPS study.

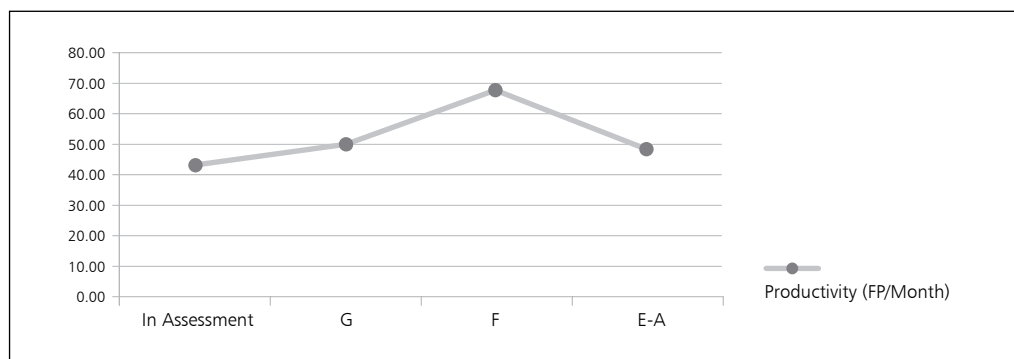


Figure 3. Median Productivity (in FP/Month).

3) Quality is captured in the questionnaire as the number of defects 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 is gathered in the questionnaires as a percentage of net sales, serving as a basis for comparing the organization with itself for the performance variation analysis.

Satisfaction with the MPS Model. Regarding satisfaction of the 133 surveyed organizations with the MPS Model, 64.66% (86 organizations) reported being completely satisfied with the model and 32.33% reported being partially satisfied. None of the organizations reported being unsatisfied and 3.01% (4 organizations) reported not know their level of satisfaction yet. This result shows an overall scenario of high satisfaction with the model.

Given these 133 organizations characterization results in 2011, the following section presents the performance variation of organizations that adopted the MPS Model between 2008 and 2011.

5. iMPS 2011 Results: Performance Variation Analysis

5.1. 2010/2011 Performance Variation Analysis

Of the 133 organizations participating in the fourth iMPS trial, 92 organizations answered the periodic questionnaire in 2011. Of these, 53 had also kindly provided information in the third trial, i.e., in the year 2010, and 27 companies of this group had already participated in previous iMPS trials. The indicators of performance variation and the calculation formulas are the same defined in the iMPS study plan.

For comparison purposes, only the indicators presenting confidence level $> 85\%$ were used to allow comparison with previous rounds of the iMPS. Therefore, not all indicators could be considered due to not presenting acceptable levels of confidence. The reasons that lead to this situation are related to organizations not providing information on the indicator or having evolved or changed their indicator treatment, e.g., using different measures in each trial.

However, in view of the importance of indicators related to productivity and quality (number of defects) and considering that the confidence level of these indicators are very close to the limit, these were also included. Table 19 presents the indicators used for this observation period.

TABLE 19 – Indicator Confidence Level

Indicator	Confidence Level (%)
Net Sales	92.17
Change in MPS Maturity Level	100.00
Average Project Cost	90.56
Average Duration Estimate	95.09
Average Project Duration	95.57
Estimation Accuracy	95.09
Average Project Size	93.38
Number of Clients (in Brazil)	96.64
Number of Employees	97.28
Number of Projects (in Brazil)	97.28
<i>Productivity</i>	<i>84.31</i>
<i>Quality</i>	<i>84.31</i>

As in previous iMPS trials, the behavior of indicators was observed from distributions organized and related to three ranges, categorizing the performance of companies for each indicator. These ranges represent the relative percentage of organizations (based on number of valid answers) who reported to have increased, decreased or not changed their measured value for a given indicator. The evaluation of the significance of the impact of an increase or decrease depends on the indicator and, in some situations, may be related to another indicator. For instance, it is expected that the average project cost reduces with the increase of productivity. So in this case, both reducing and increasing represent positive impacts for the analyzed organizations.

As can be seen in Figure 4, the organizations that adopted the model reported to have, between the years 2010 and 2011, an increase in indicators Net Sales, Number of Customers in Brazil, Number of Projects in Brazil, and Number of Employees. The behavior of these indicators is consistent, allowing to observe trends of other indicators, calling attention to the behavior exhibited by Average Project Cost, Average Duration and Average Size. When observed together, these behaviors indicate a slight positive disassociation between cost, time and size. That is, bigger projects do not necessarily lead to higher duration or cost. We consider this behavior positive and consistent with the idea associated with the organization and control of software processes.

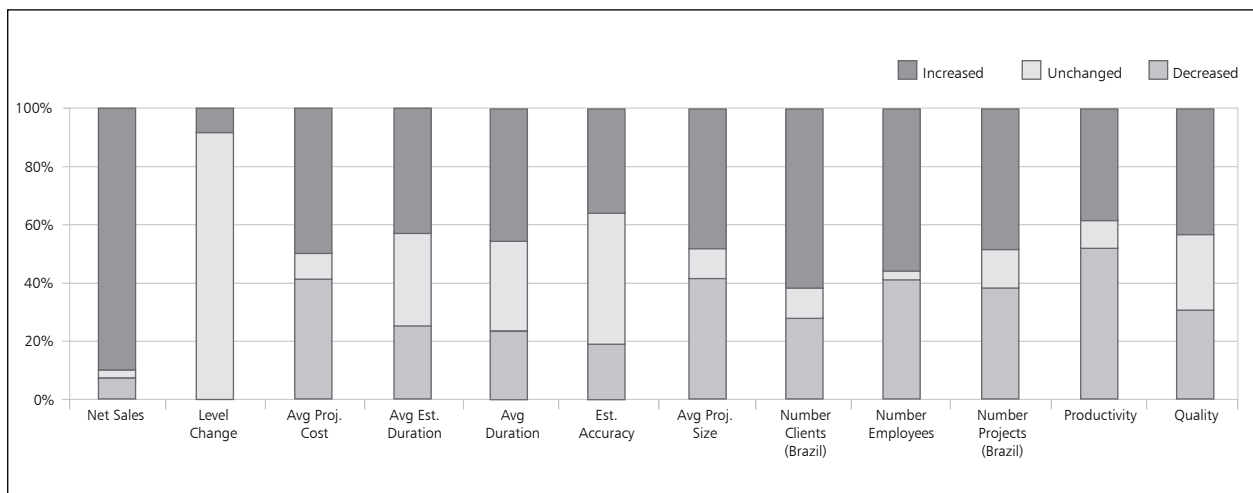


Figure 4. Performance Variation of the 53 Organizations that Adopted the MPS and Provided Periodic Information in 2010 and 2011.

Regarding the return on investment (ROI) for the MPS implementation and assessment, 26 organizations provided information that allowed the ROI calculation, representing a confidence level of 86% considering the population of 53 organizations. Among them, 50% informed to have increased their net sales in the past 12 months enough to already completely recover the investments made in MPS implementation and assessment (ROI > 100%). Other 38.46 informed to have, so far, recovered their investments partially. Figure 5 shows this distribution.

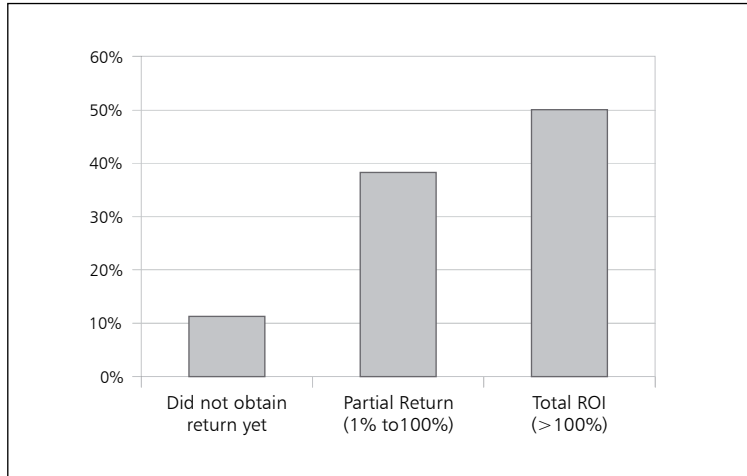


Figure 5. Return of Investment obtained by the Organizations (between 2010 and 2011).

Whereas the described behavior can be influenced by organizations that participated in the previous iMPS trials, Figure 6 shows the behavior of 23 organizations that participated only in the 2010 and 2011 iMPS trials. Similarly, the Productivity and Quality indicators have not reached the predetermined level of confidence (75.19% and 80.39% respectively), but are presented here for illustration and comparison.

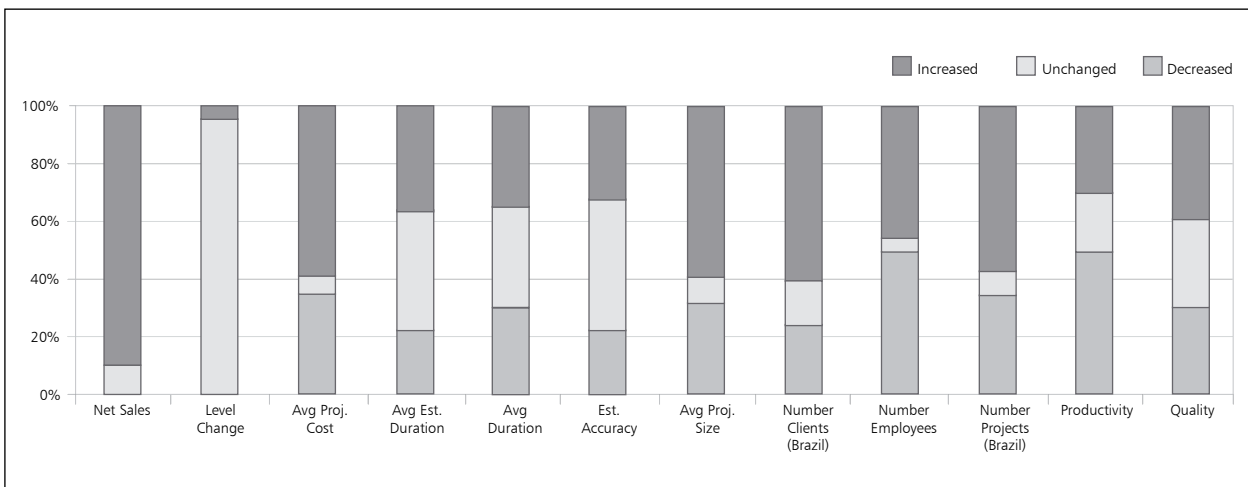


Figure 6. Performance Variation of the 23 Organizations that Adopted the MPS and Provided Periodic Information Only in 2010 and 2011.

The next section presents the variation analysis for organizations which had unexpired MPS assessments in the last three years (2009/2010/2011).

5.2. 2009/2010/2011 Performance Variation Analysis

From the set of 92 organizations which answered the periodic questionnaire in 2011, 28 of them had already provided information for past years 2009 and 2010. Seven of those organizations also participated in the first iMPS trial (2008) and will be analyzed separately (section 5.3).

As expected, not all questions could be exploited due to the evolution or change the way some indicators were treated by the companies. Even so, it was possible to evaluate this group and identify those indicators that presented acceptable confidence level ($\geq 85\%$) and compatible with the previous trials of iMPS, as shown in Table 20.

TABLE 20 – Indicator Confidence Levels

Indicator	Confidence Level (%)
Change in MPS Maturity Level	100
Average Project Cost	86.20
Average Duration Estimate	91.09
Average Project Duration	92.92
Estimation Accuracy	91.09
Average Project Size	89.41
Number of Clients (in Brazil)	91.09
Number of Employees	92.92
Number of Projects (in Brazil)	95.12

In order to provide unbiased comparisons, for each organization the slope of the line formed by all three periods (year, value) provided by each organization was calculated observing the consistency of the used measurement units. The slope of the line indicates the trend of increase (positive value), decrease (negative value) or stability (zero or very close to zero) of a given indicator. The results were then used to group organizations according to the previously defined categories, resulting in the distributions shown in Figure 7.

In this group of 21 organizations and over the 3 years, 29% changed their MPS maturity level. Among them, the lowest level is G (7 companies) and the highest is C, F being the most frequent level (9 companies). Of the considered organizations, 67% presented tendency to decrease the Average Project Cost, 77% presented stable or increasing trend in the Average Estimated Duration and 84% presented stable or increased Project Duration.

These behaviors seem to indicate better understanding and control by the organizations in their projects, allowing them to have greater awareness of the problem to be developed. The same behavior can be observed if we consider the trend displayed by the indicator Estimation Accuracy, where 89% of companies have reported stability or improvement in the estimates. Of the 21 companies, 83% reported stability or increase in the Number of Clients (in Brazil), 65% maintained or increased the Number of Employees.

By observing the indicator Number of Projects (in Brazil) it can be noticed that 53% of the organizations tended to reduce this number. However, this indicator cannot be observed in isolation. This reduction in number of projects may be compensated by increasing the number of customers. We believe that further analyses must be performed to address these results.

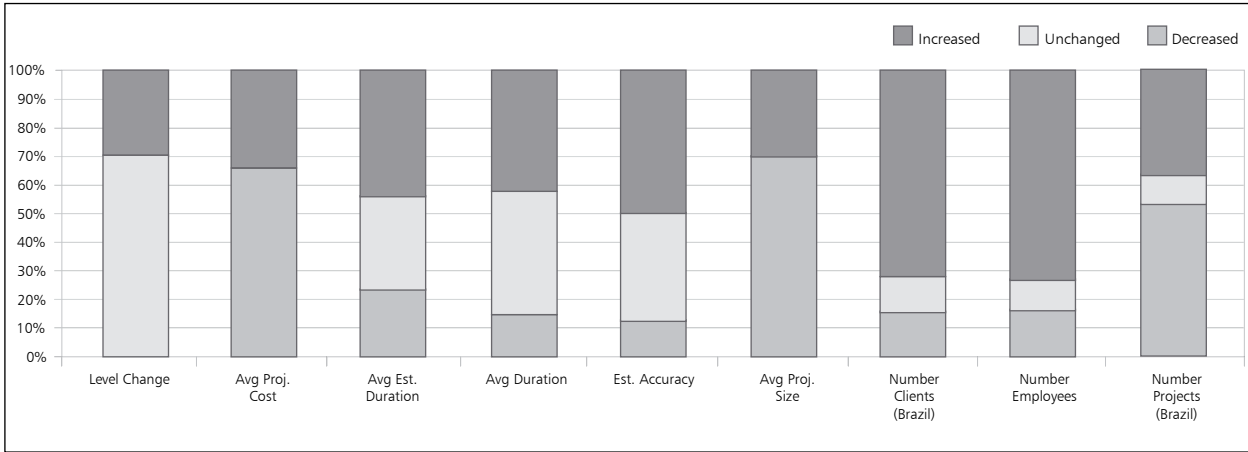


Figure 7. Performance Variation Indicators 2009-2011 for 21 Organizations.

5.3. 2008/2009/2010/2011 Performance Variation Analysis

This group is composed of 7 organizations that answered the periodic questionnaires in all years from 2008 to 2011. They were not included in the analysis of the previous group (2009-2011). Likewise, not all information could be observed and only the indicators that presented a confidence level > 85% were considered. Table 3 presents the indicators and levels of confidence for this group. Trends, as calculated for the previous group, were extracted from the slope of the line formed by the set of four points (year, value) provided by each organization, obeying the consistency of measurement units over the years.

TABLE 21 – Indicator Confidence Level

Indicator	Confidence Level (%)
Change in MPS Maturity Level	100
Average Duration Estimate	100
Average Project Duration	100
Estimation Accuracy	100
Number of Clients (in Brazil)	85
Number of Employees	100
Number of Projects (in Brazil)	100

Despite the small number of organizations who kindly completed the periodic questionnaires over the four years, some interesting behaviors can be seen in Figure 8.

It is possible to note that 86% of the organizations changed their MPS maturity level over this period, i.e., gained more maturity. In this group, the lowest level in 2011 is F (5 organizations) and the highest C. There is a tendency to increasing or stability on Average Estimated Duration (85%) and Average Project Duration (71%). Alternatively, one can observe this same behavior in the indicator Estimation Accuracy, with 72% of the organizations with a tendency to stability or improvement in their estimates.

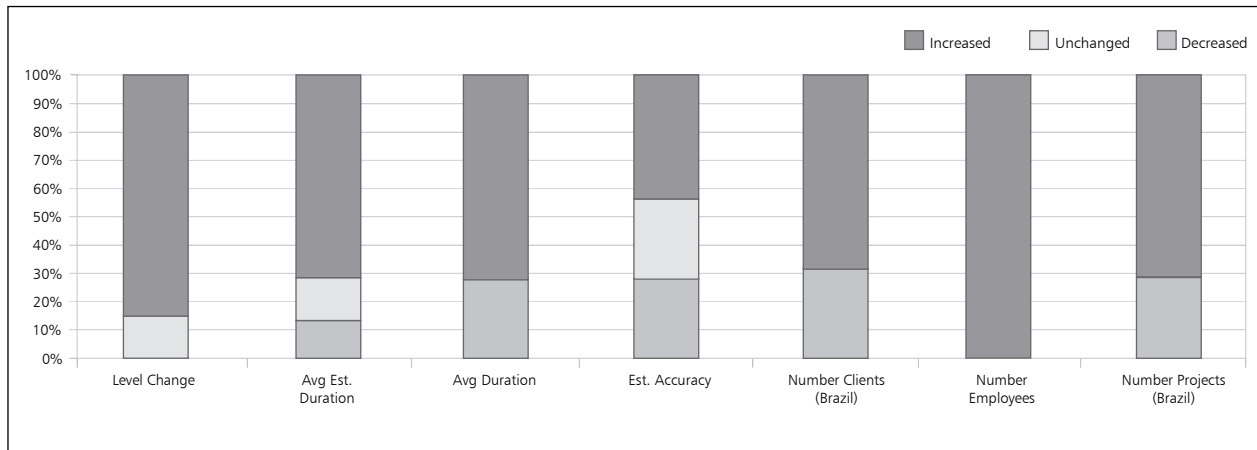


Figure 8. Performance Variation Indicators 2008-2011 for 7 Organizations.

The Average Project Size indicator, in this case, did not reach acceptable confidence level (76.1%), however it is noticed that the indicator shows a trend of increasing size of projects for four of the five companies that could have considered their historical data. Interestingly, for these companies, one can see the trend of increasing the Number of Clients (in Brazil) (67%), all presented an increase in the Number of Employees and 71% presented increasing trends regarding the number of projects into the country. Therefore, according to supplied data supplied by these organizations one could infer that they may be able to handle larger projects and in larger number.

5.4. Joint Performance Variation Analysis

To increase the capacity of observation, in this section, the organizations included in the analyses of sections 5.1 to 5.3 were grouped. The perspective about this grouping is to be able to compare the possible effects on the indicators considering the persistence of organizations in the use of MPS model. For comparison we have used only the results presented by the 81 different companies of the year 2011. Thus, the experience gained by organizations over the years is indirectly reflected off the MPS maturity level reached by 2011, as well as all the indicators would have assumed realistic and consistent values with the Brazilian economic and environmental settings. The possible differences that may exist in the business profiles of the organizations were not being taken into account. Some are more dedicated to projects, others to consultancy and some other apparently combine these perspectives in a balanced way. Thus, further investigation, separating those profiles will be needed in the next study in order to understand the intensity of the variations presented hereafter.

In this additional analysis, a set with six indicators (Number of Clients in Brazil, Number of Projects in Brazil, Number of Employees, Average Project Duration, Average Project Size and Estimation Accuracy) will be explored. The choice of these indicators is due to the quality of existing data that describe the different distributions. It is not possible to observe normality in most of these distributions. Thus, nonparametric statistical tests are applied to support the evaluation of behavior exhibited by each of the iMPS indicators. For this evaluation, we are assuming a confidence level of 95% ($\alpha \leq 0.05$), thus, more rigorous than the analysis presented in previous sections. We believe that increasing the value of the level of confidence, despite running the risk of limiting our capacity of observation and discussion, can bring a little more confidence on the observations, even considering the sample size (81) against the population comprised of organizations assessed in the MPS model (317 by November 2011).

Considering the Number of Clients in Brazil, it is perceived by the distributions shown in Figure 9 that there is an increasing trend in number of customers when the organization’s MPS maturity level increases.

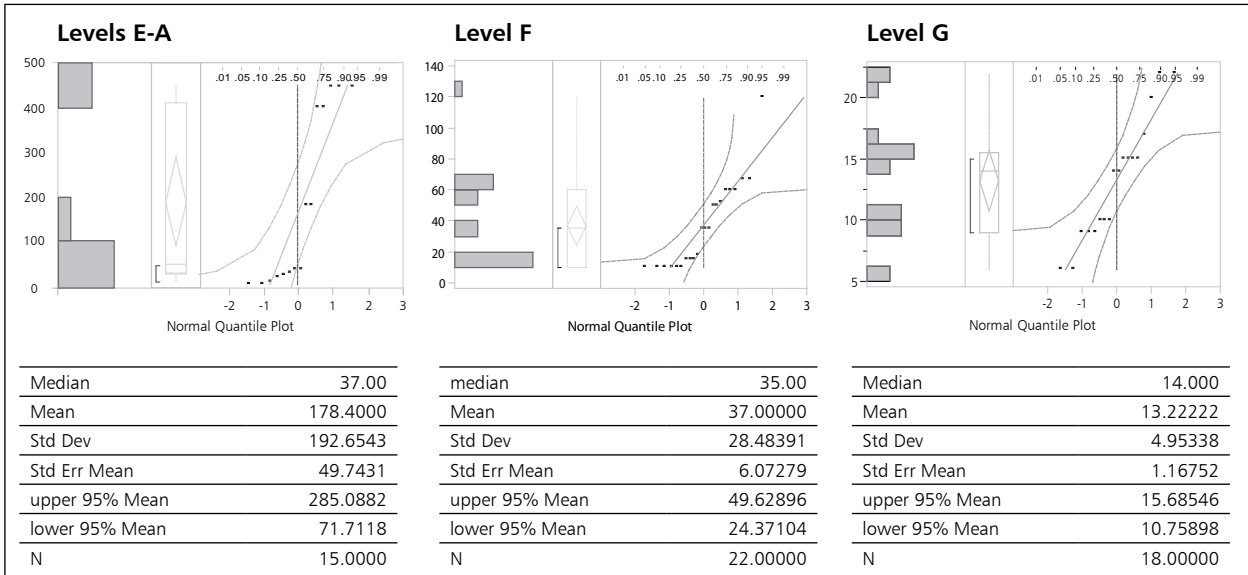
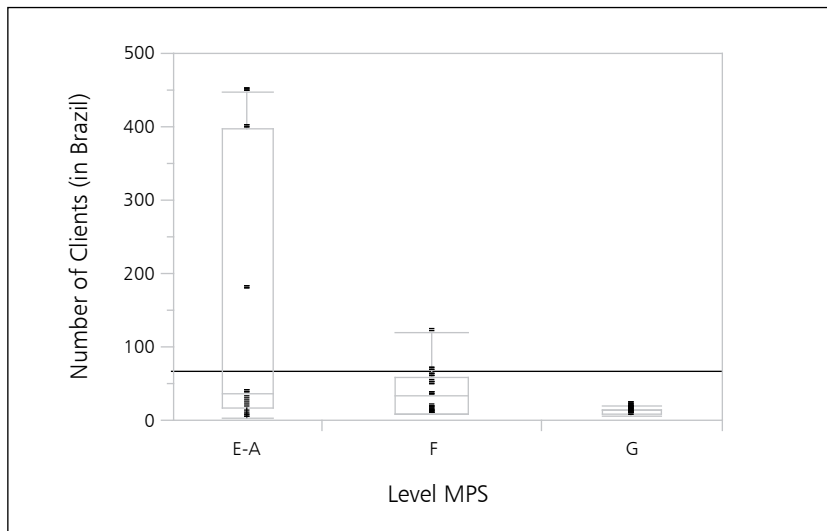


Figure 9. Distribution of the Number of Clients in Brazil by MPS Maturity Level.

This behavior is reinforced by the results presented in Figure 10, which allow us to state ($p\text{-value} = 0.0017$) that companies in higher MPS maturity levels also have a larger number of customers in Brazil.

Oneway Analysis of Number of Clients in Brazil by MPS Maturity Level



Wilcoxon / Kruskal-Wallis Tests (Rank Sums)

Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
E-A	15	546	36.4000	2.381
F	22	679.5	30.8864	1.086
G	18	314.5	17.4722	-3.403

1-way Test, ChiSquare Approximation

ChiSquare	DF	Prob>ChiSq
12.7059	2	0.0017

Figure 10. Comparison between the Number of Clients in Brazil and the MPS Maturity Level.

Considering the indicator Number of Projects in Brazil, it is expected that it shows similar behavior, i.e., increasing the number of customers should, in principle, increase the number of projects developed by the organization. As noted in the distributions shown in Figure 11, as the MPS maturity level increases the median number of projects in the country also increases ($p\text{-value} = 0.0495$), as reinforced by the results of the statistical test described in Figure 12.

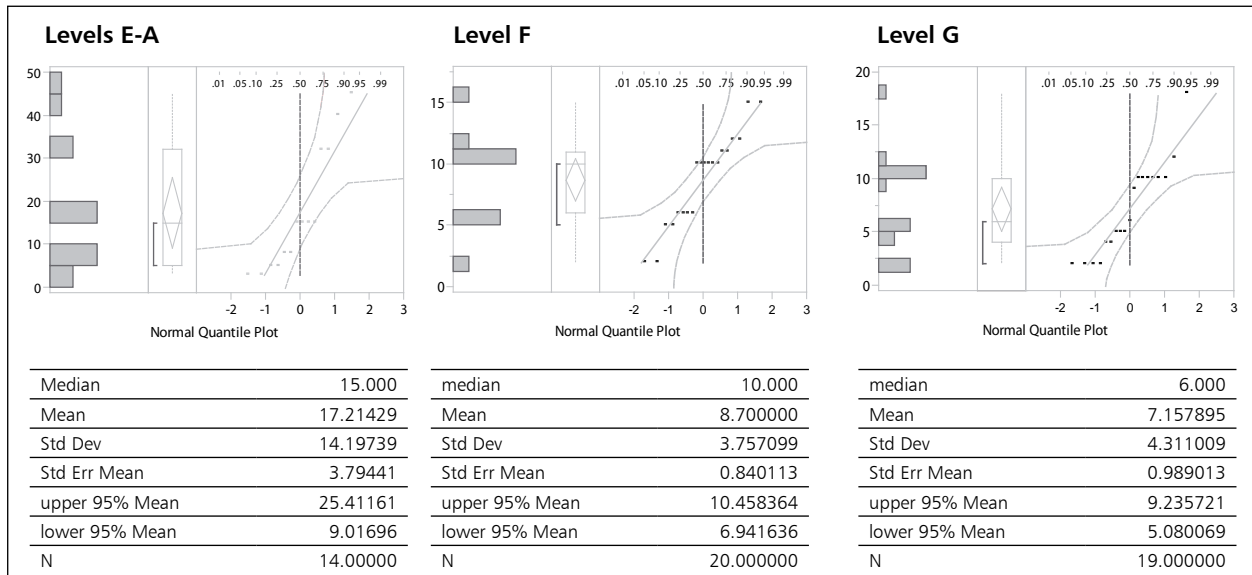
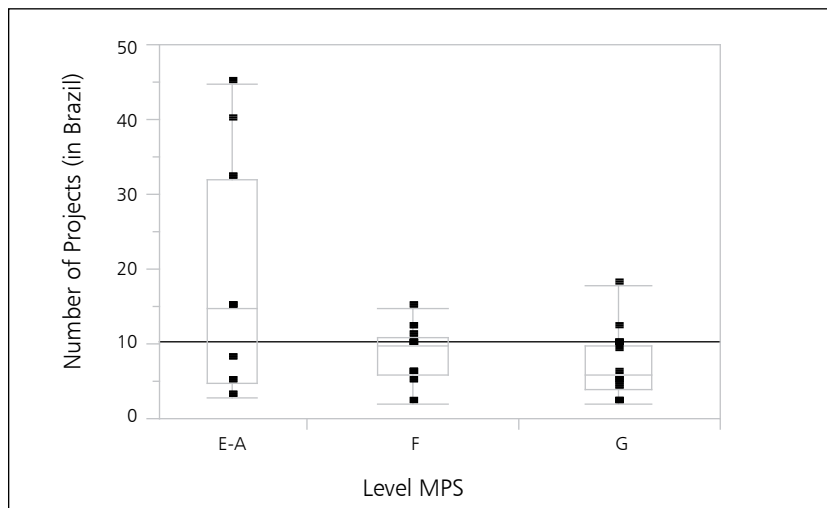


Figure 11. Distribution of the Number of Projects in Brazil by MPS Maturity Level.

Oneway Analysis of Number of Projects in Brazil by MPS Maturity Level



Wilcoxon / Kruskal-Wallis Tests (Rank Sums)					1-way Test, ChiSquare Approximation		
Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0	ChiSquare	DF	Prob>ChiSq
E-A	14	478	34.1429	2.025	6.0108	2	0.0495
F	20	554	27.7000	0.250			
G	19	399	21.0000	-2.124			

Figure 12. Comparison between the Number of Projects in Brazil and the MPS Maturity Level.

Regarding the Number of Employees indicator, the existence of a relationship between the increase of MPS maturity level and a greater number of employees can also be observed ($p\text{-value} = 0.0310$). This behavior is expected, as higher maturity levels imply additional activities that need to be performed. The distributions with respect to the indicator Number of Employees can be seen in Figure 13, the increase behavior is evidenced by the results presented in Figure 14.

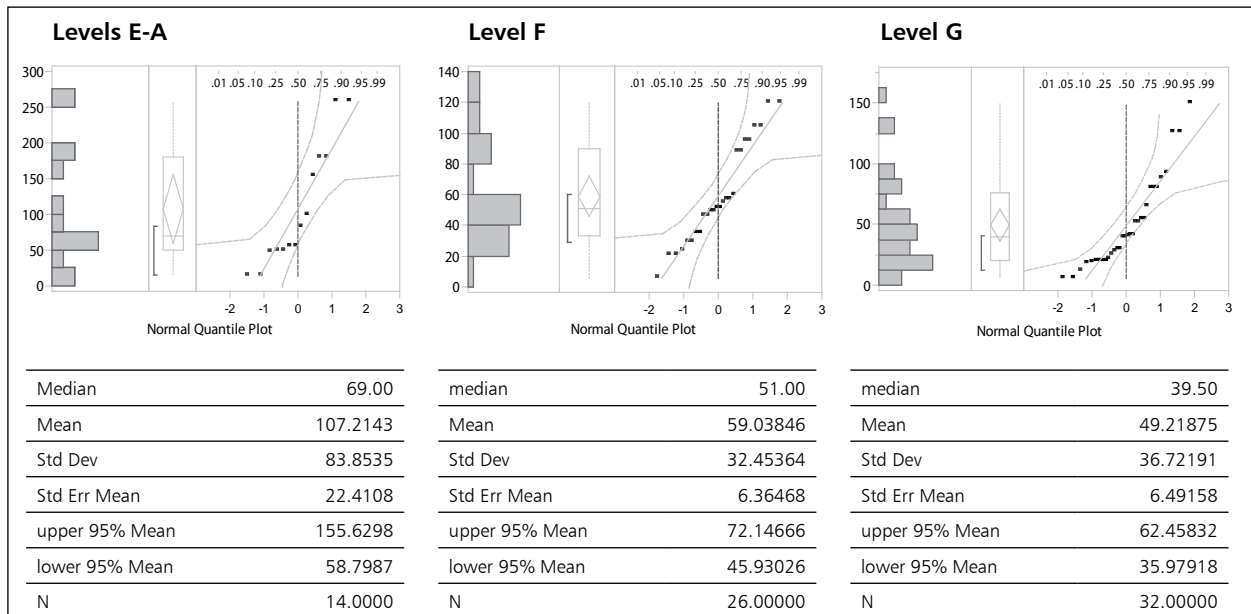
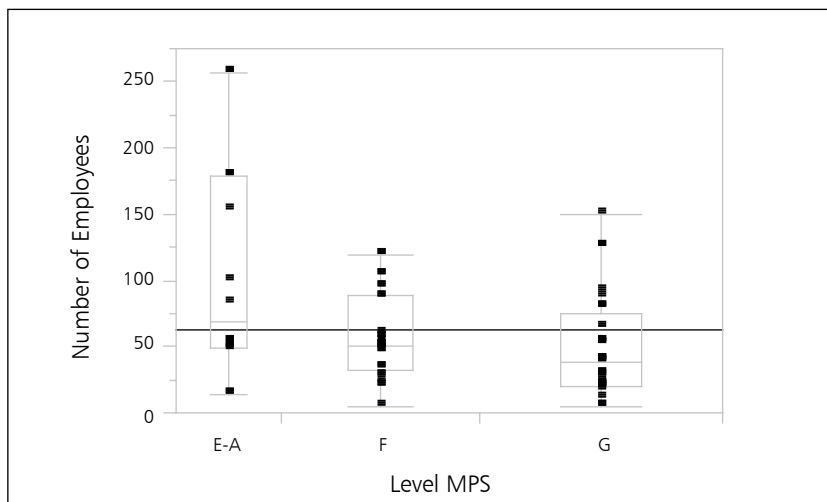


Figure 13. Distributions of the Number of Employees by MPS Maturity Level.

Oneway Analysis of Number of Employees By MPS Maturity Level



Wilcoxon / Kruskal-Wallis Tests (Rank Sums)

Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
E-A	14	665	47.5000	2.185
F	26	996	38.3077	0.545
G	32	967	30.2188	-2.273

1-way Test, ChiSquare Approximation

ChiSquare	DF	Prob>ChiSq
6.9492	2	0.0310

Figure 14. Comparison between Number of Employees by MPS Maturity Level.

In analyzing the indicator Average Project Duration (in months), we observed a slight increase in the duration as the maturity level increases, as it can be seen in the distributions shown in Figure 15. This increase is at first expected, because higher levels of maturity in software processes naturally involve more activities to be performed by development teams and management.

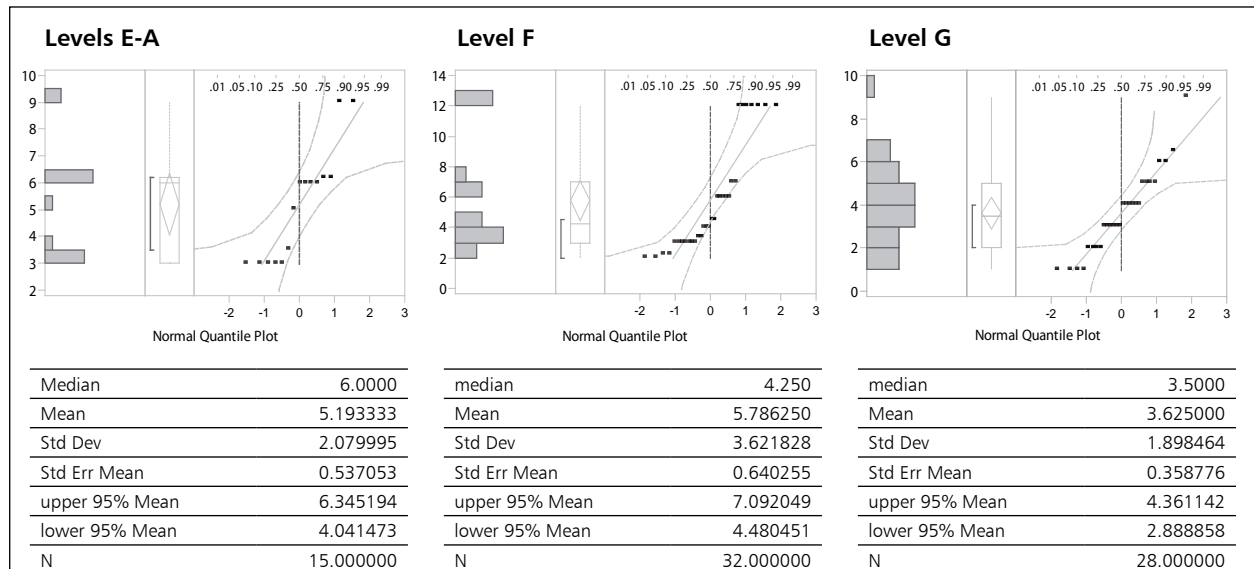
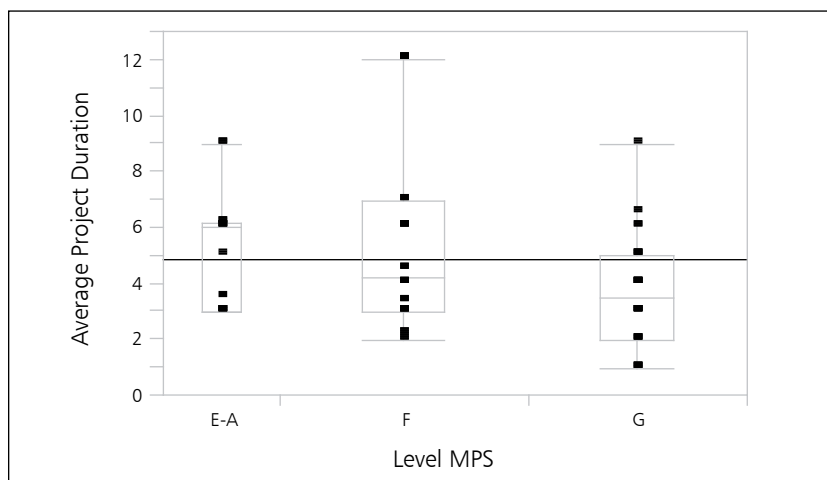


Figure 15. Distributions of Average Project Duration (in months) by MPS Maturity Level.

The results presented in Figure 16 reinforce this behavior ($p\text{-value} = 0.0292$). Moreover, as previously presented, organizations at higher maturity levels handle a larger number of projects, which means more effort into their management processes. Further analyses must be performed in conjunction with the increase of Average Project Size, considering the indication in the previous sections that organizations handle larger projects as they acquire maturity in software processes.

Oneway Analysis of Average Project Duration by MPS Maturity Model



Wilcoxon / Kruskal-Wallis Tests (Rank Sums)

Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
E-A	15	664.5	44.3000	1.258
F	32	1360.5	42.5156	1.559
G	28	825	29.4643	-2.640

1-way Test, ChiSquare Approximation

ChiSquare	DF	Prob>ChiSq
7.0665	2	0.0292

Figure 16. Comparison between Average Project Duration (in months) by MPS Maturity Level.

The measures used by these 81 organizations for Project Size are distinct, as it can be seen in the distributions shown in Figure 17. However, there seems to be some consensus among them that Function Point is a plausible indicator, particularly for the organizations at higher MPS maturity levels, where the measurement processes should already be established.

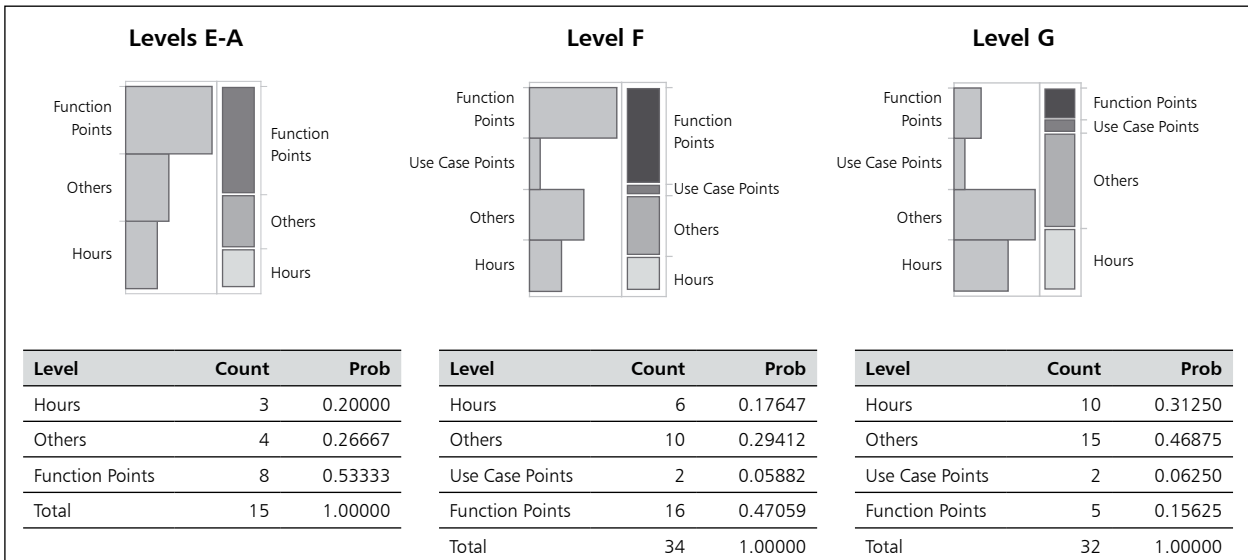


Figure 17. Measures of Project Size by MPS Maturity Level.

Considering these measures provided by organizations for project size, and without belaboring the theoretical validity of the metrics and possible approaches for the extraction of the measures [Sthatis and Jeffery, 1996] [Kitchenham, 1997] [Iokan, 1999] [Kitchenham et al., 2002] it is possible to observe different behaviors between organizations at different MPS maturity levels, depending on the type of measure used for project size. Considering the two most commonly used measures of size for these 81 companies (Hours and Function Points), one can see in Figure 18 that there is indication that the project size increases as the MPS maturity level increases, the difference being more significant for organizations in level F (in the case of measuring Function Points - $p\text{-value} = 0.0019$) or in levels E-A (in the case of measurement in hours - $p\text{-value} = 0.0304$). However, the small sample size of the measures in hours makes risky to accept this result directly.

In considering the difference in the average project size of organizations in different MPS maturity levels being valid, it allows us to observe behavior consistency with the indicator of Average Project Duration, since besides increasing the number of activities due to new software processes the Project Size also increased, which also contributes to increased effort, and often project duration. Further analysis must be performed to check the confidence in these statements. However, we believe that these statements are consistent with the behavior observed during the four iMPS trials.

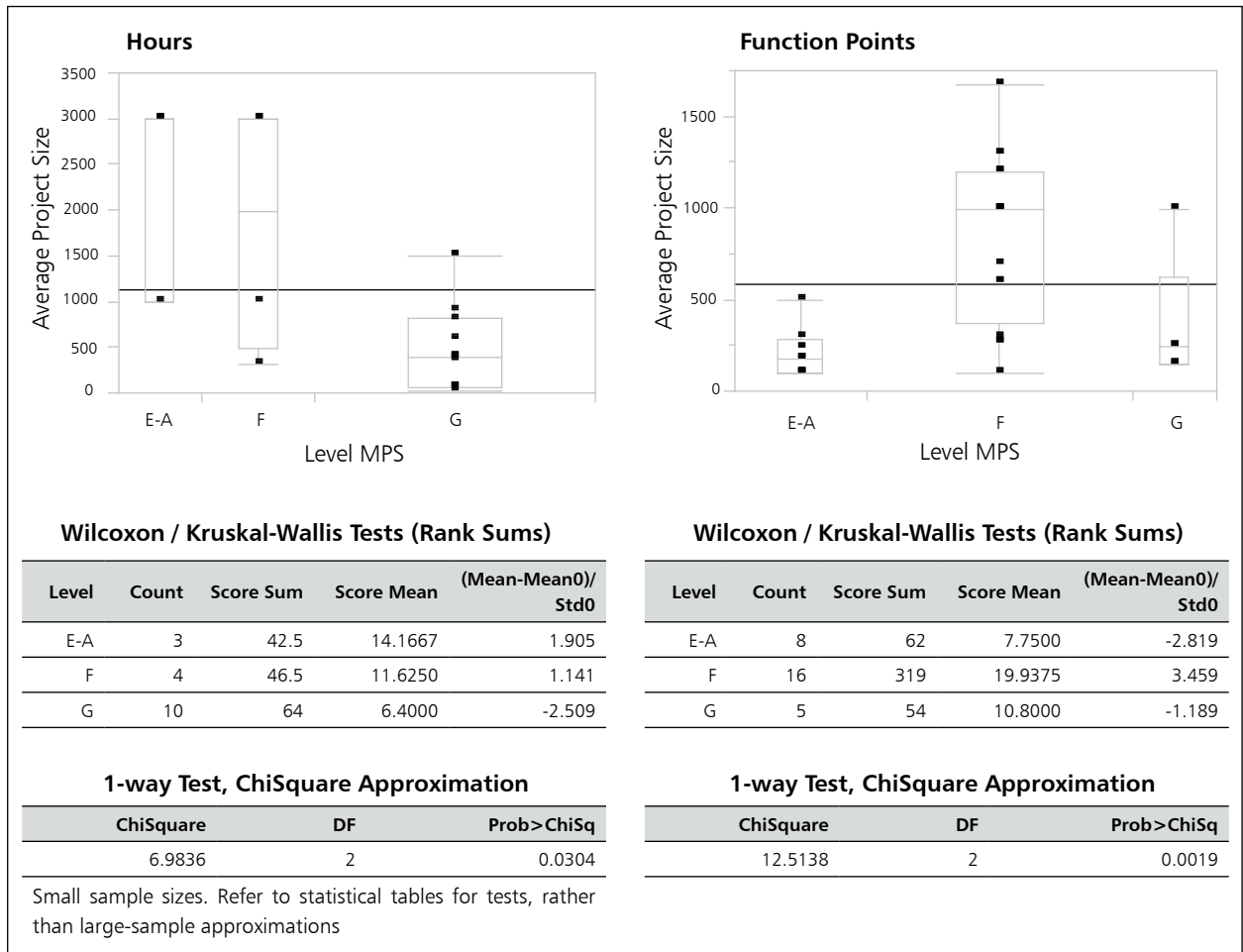


Figure 18. Average Project Size by MPS Maturity Level.

As expected for Estimation Accuracy, organizations with higher MPS maturity levels also have better estimation accuracy (p -value = 0.0019), and the F-level organizations showed the best performance for this indicator. The distributions are shown in Figure 19 and the statistical test results in Figure 20.

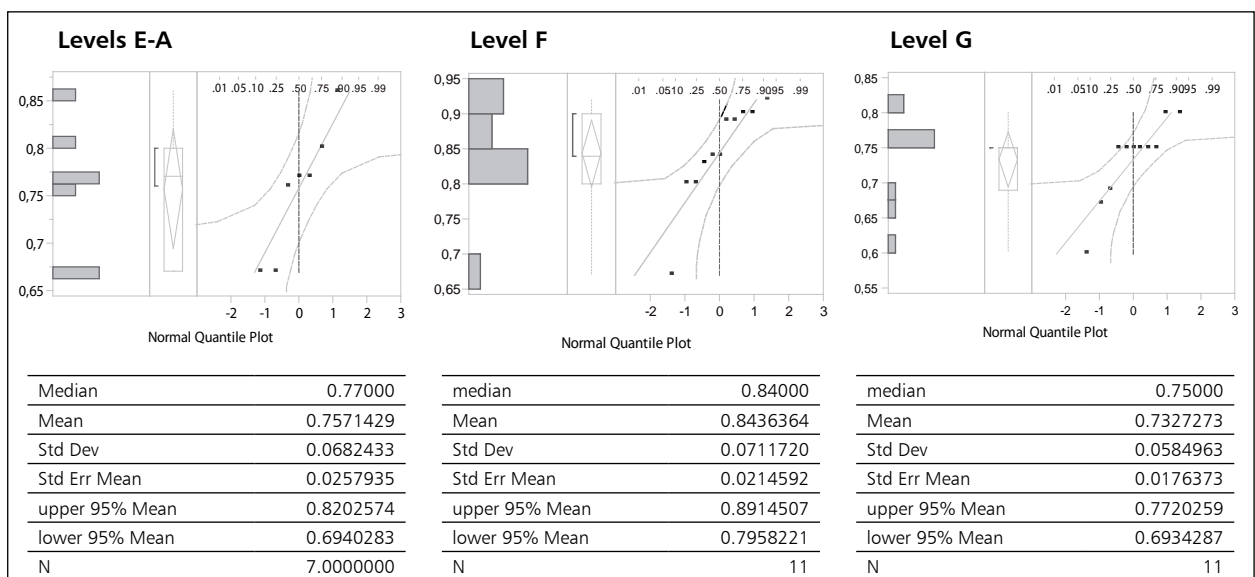
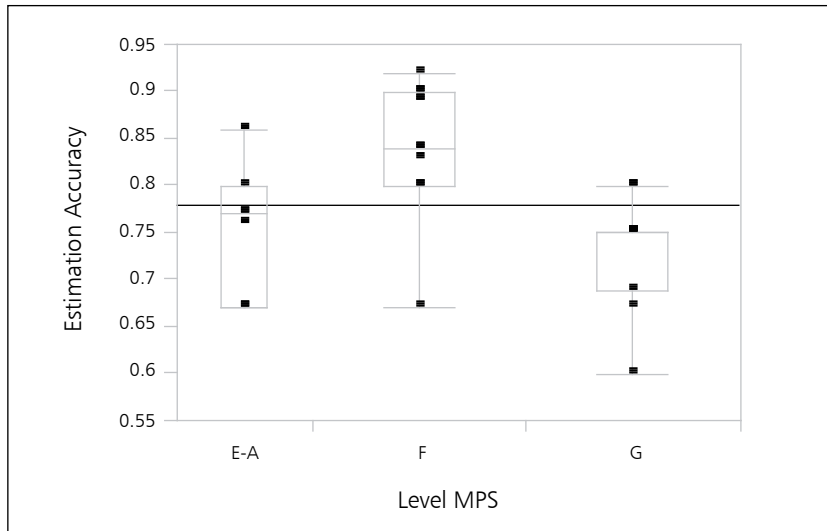


Figure 19. Distribution of Estimation Accuracy by MPS Maturity Level.

Oneway Analysis of Precisão de Estimativa By Nível MPS



Wilcoxon / Kruskal-Wallis Tests (Rank Sums)

Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
E-A	7	91	13.0000	-0.694
F	11	240.5	21.8636	3.400
G	11	103.5	9.4091	-2.765

1-way Test, ChiSquare Approximation

ChiSquare	DF	Prob>ChiSq
12.4887	2	0.0019

Figure 20. Comparison between Estimation Accuracy by MPS Maturity Level.

6. Concluding Remarks

In this publication we presented the 2011 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 two different observation scenarios: (i) 2011 characterization, (ii) performance variation analysis in recent years (2010/2011, 2009/2010/2011 and 2008/2009/2010/2011).

Regarding the 2011 characterization, positive correlations could be again observe between the maturity of organizations in the MPS model and the number of projects (both in Brazil and abroad). In fact, higher maturity organizations deal with larger projects, showed higher estimation accuracy and higher productivity. As in previous years, the satisfaction with the MPS model is almost unanimous, with approximately 97% of the organizations saying themselves totally or partially satisfied. Considering the return on investment of adopting the model, 50% of the organizations reported to have recovered, within the last 12 months, more than the total investment in the implementation and assessment of the model.

Concerning performance variation of organizations using the MPS over the years, the indicators provide evidence that organizations that remain persistent in the use of software engineering practices represented by the processes described in the MPS model are able to handle larger projects, in larger number and with more control. Organizations, in general, exhibited behaviors very close

to the expected ones when adopting good software engineering practices. Additionally, consistent behaviors could be observed among groups of organizations, which can be seen by comparing the results here presented with the results of previous iMPS trials, which can be found in the Performance Results section available at www.softex.br/mpsbr.

The iMPS project is beginning to obtain more explicit information on the effects of the MPS model in the organizations using it. At this point, it has been possible to observe that as organizations acquire maturity they also increase the number of customers, the number of projects, the number of employees, the size of projects and improve their estimation accuracy. In contrast, there was a slight increase in the average project duration that may be a consequence of additional management effort to deal with all these positive changes. However, further analyses must be performed and the collaboration of organizations on continuing to provide information that can enrich the set of iMPS historical data is of fundamental importance for the development and improvement of the MPS model.

It is important to state that there are some context variables that were not considered or not identified (such as economic aspects, among others) that may be influencing these results and representing threats to validity. All effort has been invested in order to make this analysis the most consistent, unbiased and explicit possible. However, risks of misinterpretation may naturally exist. We hope that the observed behaviors in the organizations performance variation analysis can serve to motivate the organizations that already use the MPS model to continue with their process improvement activities and to support decisions of those organizations wishing to move towards the MPS adoption in the near future.

Acknowledgements

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iMPS 2011: Performance Results of Software Organizations that Adopted the MPS Model from 2008 to 2011

This publication presents the 2011 iMPS research results. In total, questionnaires were received from 133 different organizations representing data of the year 2011:

- the satisfaction of the organizations with the model was again evident, with approximately 97% of them reporting to be totally or partially satisfied with the MPS model;
- the characterization has observed positive correlations between the maturity of organizations in the MPS model and the number of projects (both, in Brazil and abroad);
- in the performance variation analysis, it was possible to identify that organizations that remain persistent in the use of software engineering practices represented by the MPS maturity levels have more customers, develop more projects, have a greater number of employees, deal with larger projects and show higher estimation accuracy, despite a slight increase caused in the average time spent on their projects.

Once again, we hope that the objective evidence presented in this publication will be useful to those – in Industry, Academy and Government – interested in improving software processes and software organization competitiveness.

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