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Maturity and Performance in Information Technology Project Management

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Abstract

This study concerns the relationship between the information technology (IT) project performance and the project management maturity of an organization. The research was developed from a survey of 185 respondents during 2010. Project performance was evaluated using the two first dimensions proposed by Shenhar et al (2001) – project efficiency and impact on the customer. Project management maturity was evaluated using the formalization level of project management processes described in PMBoK. Data were analyzed by statistical methods (factorial analysis, Cronbach´s alpha, cluster analysis and bivariate analysis) and showed that (i) organizations with superior maturity present superior performance in their projects and (ii) different maturity dimensions have distinct impacts on IT projects performance.

Keywords: projects performance; project management maturity; projects management.

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Introduction

In the last decades, virtualization of activities and the new business models enabled by it, besides the worldwide coordination of large productive chains have been the characteristics of the so called "New Economy" (Gereffi, 2001). According to Gereffi (2001), another possible denominations for this new configuration of economic activities are "digital economy", "innovation economy", "network economy" and also "eletronic economy" (e-economy).

Information Tecnology (IT) has been the element that enables this new scenario, as the most visible factor of these great transformations, in which Castells (1999) uses the expressionas the "information society". Tapscott (2001) notes that the view of networks and knowledge forming the main source of competitive advantage in business is a distinctive aspect of the "new economy".

Therefore, the great importance that IT products and services present for economic activities of globalized markets is clear, particularly for finding innovations that allow companies to compete successfully.

The notion of maturity in project management has aroused great interest since the late 1990s (PAULK, 1994). Under the strong influence of the Capability Maturity Model (CMM) of Carnegie Mellon University, project management maturity models suggest the possibility of consistent improvement in project management within an organization (McGRATH, 1998; Goldsmith, 1997; Ibbs & Kwak, 1997 & 2000; Fincher & Levin, 1997; Remy, 1997; Hartman & Skulmoski, 1997; Kalantjakos, 2001; Schlichter, 2001; Maximiano & Rabechini, 2002). In the study of maturity models, the hypothesis that project performance improves with greater organizational maturity in project management seems reasonable.

In this context, the aim of this paper is to search for empirical evidence of this relationship (project management maturity vs. project performance) through a survey of IT projects. Data were collected between November of 2009 and July of 2010 from 185 IT professionals. This study reviewed a previous work from Moraes (2004) but with a more comprehensive conceptual basis for the maturity concept and with a greater number of respondents.

Two main issues were approached in this study: (i) project management maturity and (ii) project performance. Maturity was treated by a restrictive approach: the formalization level of project management processes described in PMBoK. Although most popular project management maturity models (such as OPM3 and PMMM) conceptualize maturity in a broader sense encompassing other organizational issues, all these models use the formalization of processes as a component of maturity. Project management processes used in this research are those described in PMBoK, with this choice being based on the widespread acceptance of the PMBoK in Brazilian organizations. Data analysis showed that the elements of the sample could be classified into three levels of maturity: inferior, medium and superior.

To evaluate project performance, a simplified version of the multidimensional model of Shenhar et al. (2001) was adopted in which only the first dimensions of this model were utilized: project efficiency and impact on the customer. Thus, project performance was treated as a concept based on the dimensions of project efficiency and impact on the customer. Here again, the elements of the search could be grouped into three categories of performance: inferior performance, medium performance and superior performance.

Section 2 presents the literature review. Section 3 describes the methodology adopted, and the collected data are presented in section 4. Analysis and discussion of the data can be found in section 5, and final considerations are presented in section 6.

Literature Review

In this section, the two main issues of this paper will be discussed: project performance and project management maturity.

Project performance

Baker, Murphy and Fisher (1983) stated that project success (or failure) corresponds to a perception of the stakeholders about the project and that the elements that affect the perception of success are not the same as those that affect the perception of failure. Pinto and Slevin (1986) identified two facets in project management. The internal facet, concerning keeping goals relative to costs, time and quality, are closely linked to project manager and project team actions. The external facet is related to the user through indicators regarding product use and satisfaction and the resolution of the problem that gave origin to the project. This vision, which suggests two dimensions of project performance, influenced many authors (e.g., LIM and MOHAMED, 1999; COOKE-DAVIES, 2000; BACCARINI, 1999; and MUNNS, 1997) to adopt similar approaches: project success and product success, micro success and macro success, project success and project management success.

Shenhar et al (2001) proposed a more comprehensive multidimensional vision of project management, considering aspects of very short, short, long and very long terms of performance. This model presents four dimensions, as shown in Table 1.

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The relative importance of each dimension varies over time (Figure 1). In the very short term, project efficiency is the most important dimension as well as the only dimension capable of being measured with reliable precision; although in an evaluation of a finished project after some years, its importance tends to be smaller (MORAES and Laurindo, 2010).

A significant difference among the views presented depends on the quantity of concepts related to performance. While some (like LIM and MOHAMED, 1999; COOKE-DAVIES, 2000; BACCARINI, 1999; MUNNS 1997) refer to two distinct concepts – project management success (focused on developing process) and project success (focused on the product resulting from the project) – others (such as SHENHAR et al., 2001; BAKER et al. 1983; PINTO and SLEVIN, 1988) understand that there is a single element in discussion that presents multidimensional characteristics in which the relevance of each dimension varies over time.

In this paper, the second approach – a single performance concept – will be adopted because it provides a more interesting time perspective in relation to project performance. It will specifically use the first two dimensions of the Shenhar et al. (2001) model to characterize project performance: project efficiency and impact on the customer.

Project Management Maturity

The notion of project management maturity is strongly influenced by the CMM (Capability Maturity Model) of Carnegie Mellon University (PAULK, 1994), which was developed with the support of the U.S. Department of Defense. This model defines five levels of maturity in software development processes. In general, the proposed maturity models are based on the CMM structure, but substitute software development processes for the project management process described by PMBoK (GOLDSMIRH, 1997; Ibbs And Kwak, 1997 And 2000; Remy, 1997; Schilichter, 2001).

Performance Dimension	Measures/variables used
Project efficiency	Schedule goal Budget goal
Impact on the customer	Functional performance Technical specifications Fulfilling customer needs Solving a customer's problem The customer is using the product Customer satisfaction
Business success	Commercial success Creating a large market share
Preparing for the future	Creating a new market Creating a new product line Developing a new technology

Table 1 - Project Success Dimensions (adapted from Shenhar et al., 2001)

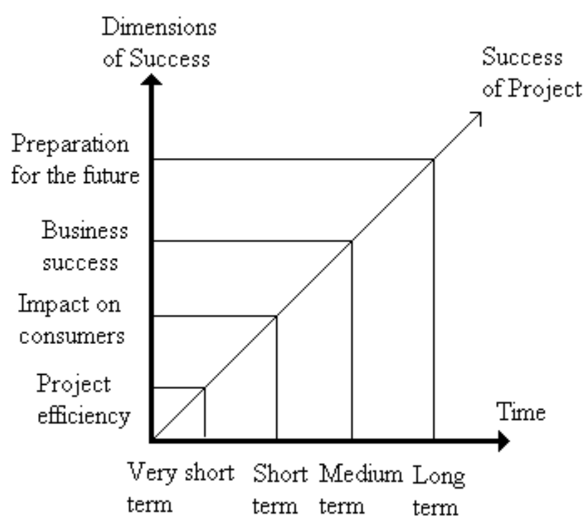

Figure 1 – Dimensions of success v. time (adapted from Shenhar et al., 2001)

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The concept of project management maturity is linked to a continuous development of specific competencies in project management (KALANTJAKOS, 2001 and SCHLICHTER, 2001), which suggests that it would be possible to establish in a broad sense that some type of directing model such as PMBok has been used.

The idea of process maturity is connected to the concept of process stability. Stable processes are those that are free from variation and are executed in a consistently homogeneous way. Formalization of the processes reflects this stability just as it reflects the motto of the ISO 9.000 model: "Do what you write and write what you do" (Antonioni & Rosa, 1995).

In this view, the quality of a product is determined by the quality of the process that generated it. Hence, the quality of the development process of the software project will determine the quality of the software generated. It is the same idea that exists within quality warranty models such as ISO 9.000-3, CMM and ISO 15.504. In these models, process quality is obtained through the stability of the process. Thus, when an organization starts its certification, the auditors seek to verify whether the processes described in these models exist. In addition, they also compare the process records with their practices (Antonioni & Rosa, 1995).

In this paper, no particular maturity model is used because choosing one model would imply that it would be necessary to evaluate the maturity of the elements of the sample, and the sample would have to contain elements of different maturity levels according to the adopted model.

Therefore, the formalization of project management processes according to the PMBoK was adopted as an indicator of an organization's maturity.

Project Management Body of Knowledge - PMBoK

The PMBoK (Project Management Institute, 2004 and 2000) is the result of the efforts of the PMI (Project Management Institute) to record and document a framework for knowledge about project management. The first version was published in 1984 and successively revised (Cleland & Ireland, 2002). Despite similar efforts, such as those undertaken in Switzerland and Australia, this seems to be the main reference, with more than a half million copies published. Different project maturity models use the PMBoK to some degree as a conceptual basis.

PMBoK (2004) describes a set of processes grouped by knowledge areas that are associated with project management (Figure 2). The knowledge necessary for a project manager to perform well, as highlighted by PMBoK (2004), involves knowledge related to the following skills:

- General management
- Specific knowledge and practices related to the nature of the project (civil engineering, computing, pharmacology, etc.)
- Project management

The PMBoK is a collection of these generally accepted practices and knowledge of project management. This knowledge has been divided into 9 areas in the PMBoK as a result of

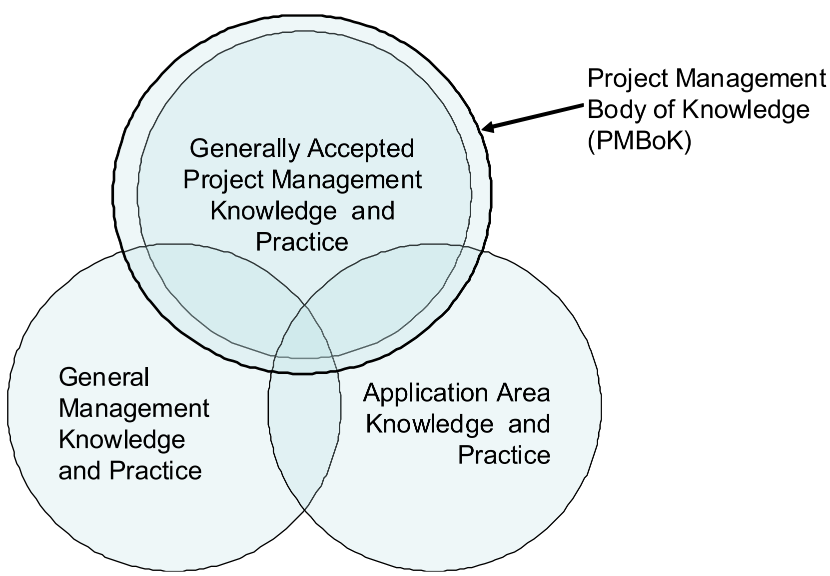

Figure 2 – Relationship of Project Management to other Management Disciplines (adapted from PMBoK, 2004)

thematic similarity: (i) Integration management, (ii) Scope management, (iii) Time management, (iv) Cost management, (v) Quality management, (vi) Managing human resources, (vii) Managing communications, (viii) Managing risks and (ix) Managing acquisitions. Table 2 presents these 9 areas and their respective processes.

Methodology

Based on the bibliographic review, a questionnaire in 3 parts was created:

- Identification of the person interviewed
- Identification and characterization of the enterprise (In this part, the level of formalization of project management processes in the organization was also determined.)
- Characterization of the elements related to project development and performance level considering project efficiency and impact on the user.

The questionnaire was sent to approximately 3,500 IT professionals who then responded by email (using an attached form) or by visiting a website that hosted the questionnaire. One hundred eighty-five valid questionnaires were obtained, and the analysis process encompassed the following analyses:

- Factorial analysis to (a) reduce performance indicators to the two dimensions of project performance used in the Shenhar and Dvir (2009) model and (b) reduce the level of formalization of project management processes to the dimensions of project management maturity,
- Bivariate analysis among the factors generated by the previous step to evaluate the correlation between maturity and performance,
- Cluster analysis to group the respondents into the different project management maturity levels and
- Variance analysis to verify the existence of differences in performance (and the pattern of these differences) among the groups produced in the previous step.

Processes	Description
Initiation Processes	Acknowledge that a process or phase should begin and commit to its execution.
Planning processes	Plan and keep a viable work scheme to achieve the business objectives that led to the project's existence.
Execution processes	Coordinate people and other resources required by the plan.
Control processes	Make sure the project aims are being attained, using monitoring and progress assessment, and take corrective measures, if necessary.
Close out Processes	Formalize acceptance of the project or stage and close it out in an orderly way.

Table 3: Management Process Groups (adapted from PMBok (2004))

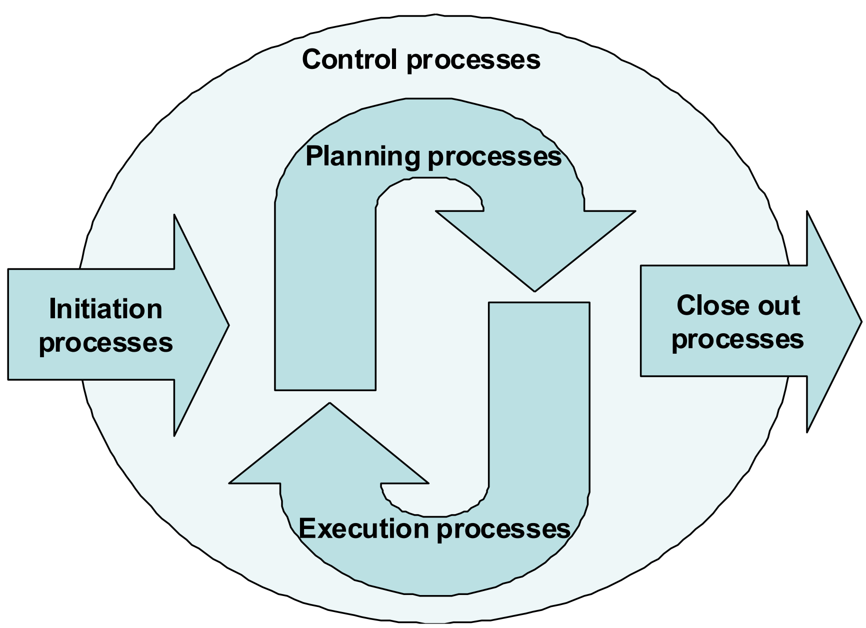

Figure 3: Connections between process groups (adapted from: PMBoK (2004))

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Knowledge areas in PM		PM process
I.	Project integration management	Developing the project charter Developing the project's preliminary scope Developing the project management plan Directing and managing project execution Monitoring and controlling project work Integrating control of changes Closing out the project
II.	Project scope management	Planning the scope
III.		Defining the scope
IV.		Creating the WBS
V.		Verifying the scope
VI.		Controlling the scope
VII.	Project time management	Defining the activities
		Sequencing the activities
		Estimating resources for the activities
		Estimating the duration of activities
		Developing the schedule
		Controlling the schedule
VIII.	Project cost management	Cost estimating
IX.		Cost budgeting
X.		Cost control
XI.	Project quality management	Quality planning
XII.		Performing quality assurance
XIII.		Performing quality control
XIV.	Project human resources management	Human resources planning
		Acquiring the project team
		Developing the project team
		Managing the project team
XV.	Project communications management	Communications planning
XVI.		Information distribution
XVII.		Performance reporting
XVIII.		Management of stakeholders
XIX.	Project risk management	Risk management planning
		Risk identification
		Qualitative risk analysis
		Quantitative risk analysis
		Risk response planning
		Risk control and monitoring
XX.	Project Procurement management	Plan purchases and acquisitions
		Plan contracting
		Request seller responses
		Select sellers
		Contract administration
		Contract close outs

Table 2: Project management processes (adapted from PMBoK (2004))

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Results

Factorial Analysis of Performance

The eight variables relating to project performance were subjected to factorial analysis, and the results were very satisfactory. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.871, which can be considered excellent according to Hair et al. (2000). Another positive aspect was that no variable had extracted a commonality of less than 0.5.

There were two extracted factors that explained 75.5% of the variation in the original variables. The second factor, whose eigenvalue less than, but close to 1, was extracted because in this study, we adopted the two-dimension model of Shenhar et al. (2001). Therefore, the extracted factors were consistent with the performance model adopted from the literature.

An oblique rotation was adopted because these two dimensions of project performance have some degree of correlation, and the literature strongly suggests that they are not independent. The results are presented below.

Factor 2 corresponds to project efficiency (the first dimension of the Shenhar et al. (2001) model), and factor 1 corresponds to impact on the user (the second dimension).

Internal consistency, calculated by using Cronbach's alpha, also presented excellent results: 0.917 for factor 1 (project efficiency) and 0.778 for factor 2 (impact on the user).

The 44 variables relating to the level of formalization of project management processes described in the PMBoK were subjected to factorial analysis. KMO value was quite high (0.954) as well as the variables' correlations (all above 0.5), as seen in tables 6 and 7.

The analysis of factorial loads suggests the meaning of the extracted factors. Factor 1 is related to management process of different areas. Because there is no clear concentration of processes of a specific area, this factor will be labeled 'Maturity of General Project Management'. Factor 2 is clearly related to seller. Thus, it will be named 'Maturity of Seller Management'. The occurrence of negative factorial loads is not a problem. In the following analysis, the value of these negative factors is considered to represent immaturity as opposed to maturity. Factor 3 is related to maturity in risk management, and factor 4 is related to cost management. Factor 5 encompasses the maturity of integration management and scope management processes, and therefore will be called 'Maturity Integration and Scope Management', and factor 6 refers to maturity in time management (table 8).

Component	Initial Eigenvalues	Extraction Sums of Squared Loadings	Rotation Sums of Squared Loadings				
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	5.075	63.432	63.432	5.075	63.432	63.432	4.748
2	.962	12.021	75.453	.962	12.021	75.453	3.331
3	.605	7.562	83.016				
⋮	⋮	⋮	⋮				
8	.145	1.812	100.000				

Table 4- Variation extracted in the factorial analysis of the performance variables Extraction Method: Principal Component Analysis.

	Component	
	1	2
Fulfilling customer needs	.934	-.048
Solving a customer's problem	.933	-.077
The customer is using the product	.873	-.082
Technical specifications	.768	.129
Customer satisfaction	.690	.235
Functional performance	.505	.441
Schedule goal	-.076	.935
Budget goal	.123	.822

Table 5 - Factor analysis matrix for performance variables. Factorial Analysis of Maturity

Total Variance Explained							
Component	Initial Eigenvalues	Extraction Sums of Squared Loadings	Rotation Sums of Squared Loadings				
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	28.428	64.609	64.609	28.428	64.609	64.609	16.178
2	2.659	6.043	70.652	2.659	6.043	70.652	18.352
3	1.685	3.829	74.481	1.685	3.829	74.481	22.349
4	1.177	2.675	77.156	1.177	2.675	77.156	15.093
5	1.036	2.355	79.511	1.036	2.355	79.511	15.581
6	.998	2.267	81.778	.998	2.267	81.778	19.069
7	.843	1.915	83.693				
8	.759	1.726	85.419				
⋮	⋮	⋮	⋮				
44	.016	.036	100.000				

Table 6 - Variation extract from factorial analysis of the project management maturity variables.
Extraction Method: Principal Component Analysis.

	Component					
	1	2	3	4	5	6
Performing quality control	.594					
Information distribution	.555					
Performing quality assurance	.554					
Management of stakeholders	.546					
Communications planning	.534					
Developing the project team	.510					
Quality planning	.482					
Performance reporting	.454					
Acquiring the project team	.441					-.404
Select sellers		-.969				
Request seller responses		-.907				
Contract administration		-.895				
Contract close outs		-.853				
Plan contracting		-.808				
Plan purchases and acquisitions		-.804				
Qualitative risk analysis			-.961			
Risk response planning			-.923			
Risk identification			-.915			
Quantitative risk analysis			-.892			
Risk management planning			-.890			
Risk control and monitoring			-.870			
Cost estimating				-.811		
Cost budgeting				-.787		
Cost control				-.725		

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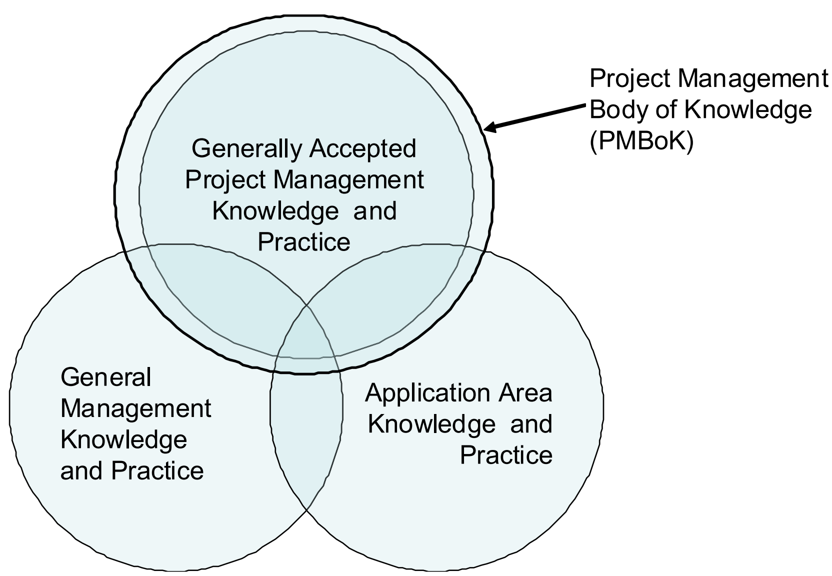

Figure 2 – Relationship of Project Management to other Management Disciplines (adapted from PMBoK, 2004)

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Bivariate Analysis – Correlation between Performance and Maturity

Table 9 shows the correlation between the dimensions of performance and the dimensions of maturity through the value and the significance of their Pearson correlation coefficient. Data analysis should consider that certain dimensions of maturity were obtained through negative factorial loads. Thus, the maturity (in this case, the inverse of immaturity) of seller management is positively correlated with project performance. In fact, there is evidence of correlation among all the dimensions of project management maturity with the analyzed dimensions of project performance. To verify the pattern of this relationship, the analyses shown in the next sections were performed.

Cluster Analysis of Maturity

Initially, we used a hierarchical cluster analysis method to determinate the number of groups to be formed. The analysis of the agglomeration schedule that led to group formation and clustering was accomplished by the K-means method. The result (shown in Table 10) is a set of groups similar to those of the project management maturity models. There are three groups of increasing maturity (whereas in general, the maturity models present five groups).

Analysis of Variance among Maturity Clusters

The comparison of average maturity among the 3 groups by variance analysis (ANOVA) shows that the performance

	Dimensions of Performance		
Dimensions of Maturity	Impact on the User	Project Efficiency	
(+)Maturity of General Project Management	Pearson Correlation	,275	,370
	Sig. (2-tailed)	,000	,000
(-)Maturity of Seller Management	Pearson Correlation	-,332	-,422
	Sig. (2-tailed)	,000	,000
(-)Maturity of Risk Management	Pearson Correlation	-,343	-,448
	Sig. (2-tailed)	,000	,000
(-)Maturity of Costs Management	Pearson Correlation	-,336	-,498
	Sig. (2-tailed)	,000	,000
(+) Maturity Integration and Scope Management	Pearson Correlation	,248	,403
	Sig. (2-tailed)	,001	,000
(-)Maturity of Time Management	Pearson Correlation	-,198	-,370
	Sig. (2-tailed)	,010	,000

Table 9 – Correlation between dimensions of performance and the dimensions of maturity. Source: The authors

Factors used in cluster analysis (K-means)	Cluster Centers		
	1 - Superior Maturity	2 - Inferior Maturity	3 - Intermediate Maturity
(+)Maturity of General Project Management	0.908532	-0.86611	-0.25138
(-)Maturity of Seller Management	-0.83742	0.912299	0.128415
(-)Maturity of Risk Management	-0.96844	1.103238	0.104822
(-)Maturity of Costs Management	-0.7403	0.876622	0.049962
(+) Maturity Integration and Scope Management	0.55288	-0.96646	0.245226
(-)Maturity of Time Management	-0.73572	1.062802	-0.12398
Number of elements of each group	73	58	64

Table 10 - Results of cluster analysis. Source: The authors

of the projects of the group with inferior maturity is worse than those of the other groups, with regard to both efficiency and impact on the user. No evidence was found regarding a difference in performance between the other two groups (intermediate maturity and superior maturity). This analysis is illustrated in Figure 4 and Table 11.

Data Analysis

In the sample, we found statistically significant correlations between maturity and performance in all dimensions of these two concepts. However, although statistically significant, the observed correlations are not high. The highest value of Pearson correlation coefficients found was 0.522 between project efficiency (performance dimension) and internal maturity (excluding procurement management processes), which means that there is just 27% of shared behavior between the constructs. This finding suggests that there are other factors besides maturity, not discussed in this paper, that also influence project performance. It is important, however, to highlight that despite presenting a low value, a correlation between maturity and performance was observed in the sample. In the analysis of groups of project management maturity, we found a statistically significant difference in performance. In the group with inferior maturity, project performance, both in efficiency and in impact on the user, was lower than the other two groups (intermediate maturity and superior maturity). This finding may suggest that the contribution of maturity to project performance is limited. Therefore, in more immature organizations, an improvement in project management maturity results in a more significant contribution to the enhancement of project performance. In more mature organizations, this relationship was not observed because in the groups with intermediate maturity and superior maturity, we found the same level of project performance.

Thus, it seems that different organizations should search for maturity levels that fit their specific situations, at least with respect to project performance level. A maturity level superior to what would be adequate would not result in a higher success rate in projects. The identification of the adequate level was not an aim of this research, and the authors did not find this question addressed in the literature. Therefore, the alternative for IT professionals is to use their experience and their organization's knowledge to identify the right level of investment for improving project management maturity.

Final Remarks

This paper presented a study about the relationship between the project management maturity and IT project performance. A survey with 185 IT professionals showed that there is statistical significance in the relationship between the dimensions of performance and the dimensions of project management maturity indentified in the data analysis. Although there was statistical evidence, the practical relevance can be considered low, as revealed by the data analysis (bivariate correlation and multiple linear regression). This finding strongly suggests that other conditioning elements affecting performance were not studied. Actually, the literature about project management discussing conditioning elements for project performance is vast. As these elements were not approached in this study, it may be concluded that not considering these elements (project performance conditioners existing in the literature) may be the cause of the low determination power found in our data analysis.

It may also be noted that there is a difference in project performance (lower) in the organizations with inferior maturity in relation to the other two groups (intermediate maturity and superior maturity). In this sense, as a consequence of this paper for IT professionals, organizations with a low level of formalization in their project management processes can achieve higher gains by increasing maturity in project management.

As a follow-up to this paper, it is our intention to evaluate how maturity affects the relationship (relative importance) of performance conditioning elements with IT project performance. A study relating to this question would help to better understand possible other benefits of project management maturity.

	Sum of Squares	df	Mean Square	F	Sig.	
Impact on the User	Between Groups	25.059	2	12.529	15.446	.000
	Within Groups	136.276	168	.811		
	Total	161.334	170			
Project Efficiency	Between Groups	38.776	2	19.388	24.863	.000
	Within Groups	131.002	168	.780		
	Total	169.778	170			

Table 11 - ANOVA. Source: The authors

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