

Impact of reference model for project management and project management maturity models on performance: an exploratory study in information technology projects

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Abstract

Project management maturity and project management reference models have been widely adopted on information technology (IT) companies. This article aims to analyze the impact of project management maturity level and adopt reference models on IT projects performance (success). A quantitative research approach was used, including a survey with 51 professionals from the sector. Results showed positive impact between project management maturity level and meeting of stakeholders' demands. A positive statistical correlation was also found in firms that develop information technology projects through PMBoK adoption concerning meeting requirements and meeting of stakeholders' demands.

Keywords

Project Management. Information Technology (IT). Project success. Project management maturity model. Project management reference model.

1. Introduction

Managers and experts have declared that project management is the theme of the future (GRAY; LARSON, 2006), since today's projects are considered more than just solutions to technical problems. Successful projects are also means for better businesses and changes (ANDERSEN; JESSEN, 2002). Traditionally, time, cost and quality targets – known as “the iron triangle”, are used as criteria for measuring project success (PAPKE-SHIELDS; BEISE; QUAN, 2009).

The purpose of project management is to ensure their success (JHA; IYER, 2006) promoting improvements in the professionals' skills while planning, deploying and managing activities in compliance with the objectives of the organization, by means of a number of tools. However, project management is more than a group of tools; it is a results-oriented management style that can be applied

to any sort of project in any sector of the economy (GRAY; LARSON, 2006).

Within this context, in the past decades, several authors have made use of many research lines in order to identify the variables or conditions that lead to successful projects. Among these lines, the emphasis is on publications related to method models of project management as well as to maturity models in project management.

Reference models in project management and maturity models have gained increasing importance within the organizations. Organizations sometimes develop and deploy their own reference models and maturity models, sometimes make the direct deployment of preconceived market-recognized models, which are normally published by associations and institutes, for example: *Software Engineering*

Institute (SEI), *Project Management Institute (PMI)*, *International Project Management Association (IPMA)*, and *Association for Project Management (APM)*.

Several authors have contributed with case studies that describe and illustrate the deployment of maturity models prevalent in project management, typically in small enterprises. These articles provide substantial practical value for the organizations that are or may be involved with the deployment of an improvement effort based on a maturity model in project management. Nevertheless, these studies are not normally based on experimental and structured research (GRANT; PENNYPACKER, 2006). The fact is that there is a lack of publications that approach maturity in project management with experimental support or report important problems related to the measurement or improvement of this maturity, as well as the results obtained with its deployment.

Another research line has tried to assess the relation between the adoption of reference models, which gather practices and processes of project management, with achievement of better results. Among these studies, the positive correlations between success and the adoption of reference models in project management pointed by Ling et al. (2009) are highlighted.

The purpose of this article is to contribute to the knowledge generation concerning the exposed problem, through the study of the relation between reference model adoption in project management and/or maturity models and the achievement of results, hereinafter referred to as success.

Thus, the objective of this study was to evaluate the relation between the use of reference models and project management methods (*Guide of Project Management Body of Knowledge* and/or *Capability Maturity Model Integration*) and the organizational maturity level in project management (assessed by means of level 2 of *Project Management Maturity Model*) with the success of executed projects, from the viewpoint of the iron triangle, with the vertex 'quality' unfolded into fulfillment (delivery) of product/service requirements and fulfillment of stakeholders' demands. Figure 1 illustrates the general purpose of this research. In the study, surveys were conducted with representatives from companies specific of the information technology (IT) sector and also with representatives from enterprises of other sectors that develop projects of technology and information systems in their respective organizations.

Following, the article is structured in four sections: 1) summary of the theoretical discussion on success of projects, reference models in project management and maturity; 2) methodological approach used in

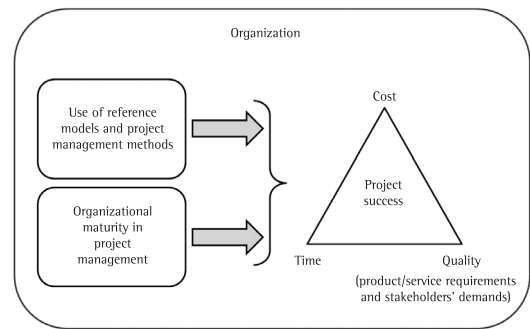


Figure 1. General purpose of the research.

the field research; 3) presentation and analysis of the obtained results; and 4) conclusions, recommendations and limitations of the study.

2. Literature review

2.1. *Project success*

The literature presents several ways and criteria to assess the development and success of projects; the most traditional is based on the so-called "iron triangle", comprising the criteria of cost, time and quality (PINTO; SLEVEN, 1987; MEREDITH; MANTEL, 2000). Thus, a project that would not overly move away from the initial budget, meet the timeline and fulfill the requirements established by stakeholders would be considered successful.

However, over the years, these criteria - often considered fundamental - have been criticized for being limited and several efforts have been made to build a more comprehensive overview. These attempts can be grouped in two different approaches: addition of more dimensions to the basic criteria, or reduction to a single evaluation criterion (YU; FLETT; BOWERS, 2005).

Chan and Chan (2004) focus on the first approach. Having revised the literature since the 1990's, they have concluded that time, cost and quality make up the basic criteria for project success in the majority of articles on this topic. They produce a consolidated scenario including extra dimensions of users' expectation, participants' satisfaction, environmental performance, health and safety, and commercial value. Given its multifunctional nature, this approach believes that project success should be seen from different perspectives, from different stakeholders, possibly leading to different verdicts in success, depending on the perspective taken. At the same approach, Shenhar and Dvir (2007) elaborated a multidimensional model called 'diamond model'.

According to this model, the different levels of uncertainty associated to market (innovation) and to technological uncertainty affect the success expectation of projects. Shenhar and Dvir (2007) aggregate to the basic dimensions - which they name efficiency (achieve budget and time targets) - another four: impact on customer; impact for the team; business success; and preparation for the future.

In contrast, the second approach reduces the dimensions considered for project success, once it considers them related and, therefore, liable to summary. This approach understands that the traditional criteria of cost, time and quality are related, that is, to a certain quality there are relations between cost and time. As a result, time is not an independent variable and it must be used for measuring project success (KHOSROWSHAHI, 1997).

Due to these complexities, the traditional dimensions that constitute the 'iron triangle', though criticized, are still considered central for the success of a project (PAPKE-SHIELDS; BEISE; QUAN, 2009). Agarwal and Rathod (2006) state that cost, time, functionality and quality remain as important criteria for software project performance and have been used in various studies, both together with other measures and alone.

The performance assessment of development projects in technology and information systems have been the concern of several authors and organizations in the past two decades (JIANG et al., 1996; STANDISH..., 2003). However, reports by Standish Group International show that software production in the world still presents many improvement opportunities both in terms of process as well as in terms of quality, offering products at much more appealing costs than the current ones.

According to the report by Standish Group International, published in 2003, there has been an improvement compared to the ones previously published by the same organization. Indeed, the amount of IT projects rated as unsatisfactory dropped from 84% in 1994 to 66% in 2002. In that publication, which consolidated the analysis of about 50,000 IT projects, the percentage of projects with cost above the originally planned budget was 43%. In addition, there have been extension of time in 82% of the projects and quality specifications were met in only 52% them.

2.2. Reference models and project management methods

There are several sets of models of project management methods available nowadays. Also known as reference models, most of them advocate the

sequential application of a structured, replicated and continuous process that, when used by an organization in a gradual and safe way to their businesses, allow to progress toward the institutionalization of standardized practices (SILVEIRA, 2008).

But, before the implementation of a given project management method, each organization should analyze the different types of methods available in order to make use of the best concepts needed to its own strategy and project management (THOMAS; MULLALY, 2007).

The models of project management methods more disseminated nowadays are *The Guide of Project Management Body of Knowledge* (PMBok) (PROJECT..., 2008a) and *Capability Maturity Model Integration* (CMMI-DEV) (SOFTWARE..., 2006). In addition, there are other models of project management methods; among them, the following could be cited: *IPMA Competence Baseline* (ICB) (INTERNATIONAL..., 2006) and *APM Body of Knowledge* (ASSOCIATION..., 2006).

PMBok has its contents structured in five groups of processes (initiation, planning, execution, monitoring and control, and closing) and nine knowledge areas (scope, time, cost, quality, human resources, communication, risk, procurement and integration). In turn, each knowledge area consists of processes, in a total of 42, with their respective inputs, tools and techniques, and outputs (PROJECT..., 2008a).

CMMI-DEV deals with the development process of products and services through 22 process areas; each of them contains specific and generic practices, which address since the configuration management in the beginning of the process until the final validation and verification (SOFTWARE..., 2006).

2.3. Project Management Maturity Models

It is hard to imagine that organizations may have a "collective brain", but one can find organizations' knowledge and experience in operational procedures, description of labor processes, descriptions of position, paths, routines, and in knowledge databases in products and projects (GAREIS; HUEMANN, 2000).

The maturity of project management of an enterprise can be understood as a measurement of its level of excellence in the area. Organizational maturity in project activity is not necessarily related with the passage of time, but with the nature of the business and the market forces (DINSMORE, 1998).

The search for excellence in project management by organizations is measured by its maturity level in managing their projects, by measuring how much the processes of companies are dedicated to their projects. The maturity level in project management

of an organization tells how much this organization has already moved towards the search for excellence achievement in the management of its projects (PATAH, 2004).

Maturity models in project management have been influenced by the work of Humphrey (1989), who identified maturity levels in the process of IT project development, relying mainly in managerial attitudes found in enterprises (CARVALHO et al., 2003; LAURINDO et al., 2003). Paulk et al. (1995) identified the characteristics that distinguish the immature organizations, marked by *ad hoc* procedures, from the mature ones, which make disciplined use of project management methodologies.

Bouer and Carvalho (2005), based on the definition of maturity by *Project Management Institute* (PMI), report that maturity implies that management capabilities should evolve over time, with the purpose to yield consecutive results in the management of projects.

The onset of maturity models in project management is a recent phenomenon, dating from approximately a decade and a half ago. Structuring itself on the potential value of maturity models in project management, the literature has focused its attention on methods used to carry out maturity assessments (GRANT; PENNYPACKER, 2006).

Maturity models can be applied in order to describe and measure organizational capability (GAREIS; HUEMANN, 2000). The first model was developed by the *Software Engineering Institute* (SEI), it regarded the quality measuring of software development process and it is called *SEI Capability Maturity Model* (SW-CMM) (PAULK et al., 1991).

At first, CMM (*Capability Maturity Model*) was developed, beginning in 1986, to fulfill a need of the U.S. Department of Defense that sought to assess its software suppliers (PAULK et al., 1995). After that, there was an evolution from this model to a more comprehensive one called CMMI (*Capability Maturity Model Integration*), which can be applied to enterprises of any sector, not being restricted only to IT organizations. Both are based on concepts of maturity levels or stages and structural requirements of process key-areas through the compliance of a series of practices, specific and generic, inherent to each of its maturity levels: (1) Initial; (2) Repetitive; (3) Defined; (4) Managed; and (5) Optimizing. The method model of project management currently used as a reference for assessment is CMMI v1.2 (CMMI-DEV) (SOFTWARE..., 2006).

SEI *Capability Maturity Model* has been applied by thousands of organizations. The resources spent in improvement of software processes,

based on the model, are estimated at billions of dollars. There is a growing research basis that supports a link between high levels of maturity and optimized organizational performance. These factors have made SEI *Capability Maturity Model* an attractive starting point for the development of maturity models in project management (GRANT; PENNYPACKER, 2006).

The broad dissemination of CMM and CMMI models has motivated experimental studies on the effectiveness of their adoption. A survey carried out by Jiang et al. (2004) indicated that there is a significant relationship between project performance and maturity level of software development. In their study, the authors concluded that the adoption of CMM, specified in the key-areas for software process improvement (SPI), has a positive relation with project development.

Jiang et al. (2004) also concluded in their study that the activities of engineering processes and organizational support (CMM – level 3 recommended activities) are significantly connected to project performance in terms of predictive ability, whereas the suggested activities of product and process quality are marginally significant. Nevertheless, the authors warn that the process activities of project management (CMM – level 2 activities) have no significant relation with their regression analysis, what suggests that organizations may not experience great benefits until they reach CMM maturity Level 3. According to the authors, the process activities of project management may be the necessary basis for project success, but not for providing visible return.

In the past decades, other maturity models specific for describing and measuring competence in project management have been developed. Most of them are based on *The Guide of Project Management Body of Knowledge* (PMBok) by PMI (DUNCAN, 1996 *apud* GAREIS; HUEMANN, 2000). Among the proposed maturity models in project management the following are noteworthy: *Organizational Project Management Maturity Model* (OPM3) (PROJECT..., 2008b) and the model by Kerzner, named *Project Management Maturity Model* (PMMM) (KERZNER, 2001). Besides the ones mentioned above, other less known models have arisen, such as the maturity model proposed by Dinsmore (1998) and the one called “*PM-competence*”, proposed by Gareis and Huemann (2000).

Dinsmore (1998) proposes five stages through which an organization should go through in order to become mature and managed by projects: (1) The buying of the idea; (2) Planning; (3) Deployment; (4) Tests; and (5) Operating the management of projects. On the other hand, in the model

by Gareis and Huemann (2000), the basis for the “*PM-competence*” is project management process with sub-processes. The assessment of the “*PM-competence*” of an organization is based on an IT questionnaire containing approximately 80 questions. These questions, related, for example, to processes from the beginning of projects, are clustered in matters regarding planning methods of objectives, risks, communication, organization and culture. According to these questions, the current level of “*PM-competence*” is rated on a scale whose response possibilities are “always”, “sometimes”, “seldom” or “never” (GAREIS; HUEMANN, 2000).

In May 1998, the *Project Management Institute* (PMI) launched the *Organizational Project Management Maturity Model* (OPM3) program. This program was established to develop a maturity model certified with the standards by PMI (GRANT; PENNYPACKER, 2006). In addition, the OPM3 program tries to aid organizations to develop the capability to support the macro-business process in managing all projects, connecting them with the business strategy. The product of the OPM3 program comprises a glossary of terms, outputs that show that project management brings success, contingency variables and the descriptions of the model steps (PROJECT..., 2008b).

Originally, the OPM3 assessment questionnaire consisted of 151 questions. In 2008, the model was updated with the publishing of its second edition and the number of questions was reduced to 125. The main alteration from the first to the second edition was that the latter also assess the organizational enabling criteria (structural, cultural, technological and of human resources), as well as its suitability to the PMI portfolio standard launched in 2006.

Project Management Maturity Model (PMMM) consists of five levels that, alike the models by the *Software Engineering Institute*, each level represents a different degree of maturity in project management. Maturity assessment, for each of these five levels, is realized by means of specific questionnaires. Maturity level two of this model provides an overview of the life cycle in project management (KERZNER, 2001). It is important to emphasize that the concept of life cycle according to Kerzner (2001) differs from that presented by PMBoK (PROJECT..., 2008a), as we will see in detail in the next section.

Figure 2 shows the five maturity levels and the life cycles that characterize maturity level 2 of the PMMM model.

2.3.1. Level 2 of the PMMM model- common processes

In the second level proposed by Kerzner (2001), the organization recognizes which common processes should be defined, used and improved so that the success obtained in a project can be replicated in the other projects of the organization. The main characteristics of this level are:

- Recognition of benefits of project management;
- Organizational support at all levels;
- Recognition of needs for processes/methodologies;
- Recognition of the need for cost control;
- Development of a project management training curriculum.

Level 2 of the model proposed by Kerzner (2001) presents a breaking down of maturity into five distinct phases, which the organization shall pursue to graduate to the third level:

- Embryonic – The first life cycle phase of Level 2 is the embryonic phase, which is where the organization recognizes that project management can be beneficial. In general, companies recognize the benefits of project management through their application, necessities and through what needs to be done;
- Executive management acceptance – This phase should be duly exploited, once there is no clear executive understanding of it. Kerzner (2001) points out at least six driving forces to promote the understanding of project management benefits by executives. The six most common driving forces for project management understanding are as follows: capital, consumer expectations, internal competitiveness, executive understanding, new product development and efficiency/effectiveness;
- Line management acceptance – From the moment the management level supports and is committed, it understands the need for training their subordinate in project management. This phase includes visible line management support in project management, line management commitment to project management, line management education and release of functional employees for project management training programs;
- Growth – This is the critical phase. It can be accomplished in parallel with the first three life cycle phases. The growth phase begins with the creation of the project management process. The completion of this phase includes development of project life cycle management, development of a methodology, commitment to planning, efforts to minimize changes in scope and selection of project management software to support the methodology;

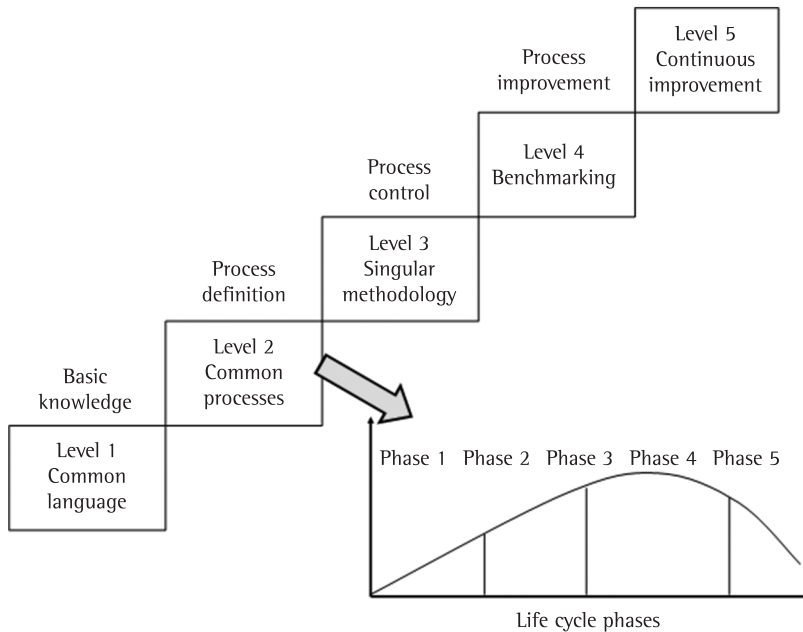


Figure 2. The five maturity levels in project management. Adapted by Kerzner (2001).

- **Maturity** – This phase is difficult to be accomplished due to various factors such as resistance of the organization in imposing a strict control of cost and time through regular reports of deviations, development of a project management capability framework and professionalization of the project management function. It includes the development of a management system for cost and time control, the integration of these controls and the development of a training curriculum in project management.

2.4. Summary of the theoretical chart

In this research, the relation between maturity and reference models with success in IT projects was considered as shown in Chart 1.

The hypotheses presented in the next section emerge from the relation between these constructs.

3. Methodological approach

Given the theoretical context presented in section 2 of this article, the authors sought to contribute to research in this area with the clarification of the following matters:

- Are there any relations between organizational maturity level in project management and IT project success?
- Is there a relation between the adoption of the reference model (CMM/CMMI; PMBoK; or others) and IT project success?

Given the nature of survey questions, the authors have chosen to adopt a quantitative survey strategy. According to Godoy (1995), in a quantitative study the author is concerned with objective measuring and quantification of results. According to Bryman (1989), assessment surveys require data collection, which, in the field of organizational survey, invariably happens by means of self-applicable questionnaires and structured or semi-structured interviews. Still according to the author, data collection is usually made in an amount of units that enables statistical generalization. However, the search for statistical generalization involves large samples. It is also worth noting that these units may be people or organizations, with people being from the same or different organizations.

Therefore, this research was characterized as a survey, carried out in the form of self-applicable questionnaires (Annex 1) comprising 4 parts:

- **Part 1** – Characterization of the interviewees containing the following questions: presence of *Professional Project Management* (PMP) certificate, participation in projects (yes or no) and project responsibility. Characterization of the enterprise with questions such as headcount, estimated company revenues, amount of ongoing projects, percentage of employees part-time or fulltime dedicated to the project, project categories, among others;
- **Part 2** – Organizational maturity assessment in project management by means of the PMMM level 2 questionnaire. This protocol consists of 20 closed questions, with Likert scale, ranging from strongly

Chart 1. Theoretical summary on maturity, reference models and success in projects.

Construct	References
Project management maturity models	Kerzner (2001), Project Management Institute (2008b), Dinsmore (1998), Gareis and Huemann (2000) and Grant and Pennypacker (2006)
Reference models for project management	Project Management Institute (2008a), International Project Management Association (2006), Association for Project Management (2006), Jiang et al. (2004), Paulk et al. (1995), Software Engineering Institute (2006), Paulk, Curtis and Chrissis (1991), Carvalho, Laurindo and Pessoa (2003) and Laurindo, Carvalho and Shimizu (2003)
Performance (success)	Yu, Flett and Bowers (2005), Shenhar and Dvir (2007), Chan and Chan (2004), Papke-Shields, Beise and Quan (2009), Agarwal and Rathod (2006), Jiang et al. (1996) and Standish Group International (2003)

disagree (negative score -3) to strongly agree (positive score +3). We have chosen this instrument already endorsed by Kerzner (2001), because, according to the author, life cycle assessment represents a transition, within an organization, from immaturity (levels 1 and 2) to maturity, (level 3). Kerzner (2001) proposes the assessment of the 20 questions in the five life cycle phases: embryonic, executive management recognition and acceptance, line management recognition and acceptance, growth and maturity. For a company to be ready for maturity level 3, a score equals or greater than 6 at all life cycle phases of level 2 is necessary. Then the company can be considered mature (KERZNER, 2001);

- Part 3 – Adoption of reference models of project management by questioning the adoption of any reference model in the area of project management (yes or no) and which models (PMBok, CMMI or others);
- Part 4 – Project or success performance analysis. Although the literature on critical factors of success in projects presents several criteria that may have an impact on their development, some factors seem to be consensual: time, cost, quality. In this study, the item quality was considered according to the fulfillment of requirements and costumers and stakeholders' satisfaction (PINTO; SLEVEN, 1987; GRANOT, 1997; DINSMORE, 1998). For the assessment of these aspects, the interviewee was asked to choose the last project he/she had concluded. For the project chosen by the interviewee, information about its characteristics (budget, number of participants, lifespan), the tools used for its management and its performance was asked. In the questionnaire regarding this part, performance was assessed after four criteria, with the option of yes/no answers, as follows: the budget planned for the project was met (yes or no); the project product/service requirements were fulfilled as planned (yes or no); the project timeline was met (yes or no); and the project has fulfilled the stakeholders' demands (yes or no). The questionnaires were distributed in person to 133 agents, consultants and analysts, formally allocated

in the IT area in the organizations where they acted. The sample has regional cutting, since it concentrates in enterprises in the State of Sao Paulo.

The questionnaires were charted and analyzed through *Minitab*-16 statistical software.

4. Field research

The sample is comprised of 113 IT professionals - "lato sensu" graduate students at a Brazilian state university. The assessment was performed in person with the surveyor available to clear any possible doubts. The respondents' selection followed the non-random sampling criterion, being considered a convenience sample. Thus, it was possible to obtain a knowledgeable sample on the studied theme that was able to answer the survey questionnaire adequately. Sixty-seven (67) out of a hundred thirteen (113) questionnaires were answered and handed in, sixteen of which were discarded for presenting incomplete information, remaining fifty-one (51) valid questionnaires. The main results of the field research will be presented in this section.

4.1. Characterization of the sample

The sample consists of professionals involved in projects of technology development and information systems, from companies belonging to the IT sector as well as to other sectors. Twenty-three (45%) out of the 51 participants in the survey work at organizations that operate in the IT sector and the 28 (55%) remaining participants are board members or work in IT departments of enterprises from other operating sectors. The participants represent 45 different companies. Thus, there are respondents from the same enterprise and the maximum number of respondents from the same company is three. Among the companies that comprise the sample, 34 (67%) are domestic and 17 (33%) are multinational. Among the interviewees, fifty-five percent (55%) perform project execution or project monitoring activities and 45% (forty-five percent) exercise project managerial

functions. Out of these respondents, 40 (78.4%) work at organizations that adopt reference models for project management. Among these enterprises, 36 (90%) utilize PMBoK, 29 (72.5%) make use of CMM/CMMI, 3 enterprises (7.5%) adopt other models (IPMA, APM and others) and 3 other companies use their own methodology for project management. It is worth noting that the interviewees could tick more than one reference model and it is also noteworthy that 26 (65%) companies adopt CMM/CMMI together with PMBoK.

4.2. Tabulation of results

In a first stage, data regarding the application of the questionnaire on maturity assessment in project management (Part 2) were determined with the intention to evaluate which organizations are classified as mature in project management. Table 1 shows, for each of the five phases of the PMMM level 2 life cycle, the number of companies with score equals or greater than six (6) in the participants' perception. In addition, the statistical patterns for standard deviation and median are presented for all phases. It is noticed that, for an enterprise be apt for maturity level 3, scores equal or greater than 6 in all life cycle phases are necessary (KERZNER, 2001). Data were also stratified by the amount of companies that were specific of the IT sector or other sectors.

Analyzing Table 1, which shows the distribution of data from the 51 survey participants per life cycle phase of projects, one can observe that the embryonic phase was the one with the greatest amount of companies that have reached or surpassed score 6 in maturity - with 21 companies (41.20%), followed by the phases of executive recognition and acceptance and growth - both with 19 companies (37.3%). In the line management recognition and acceptance phase

31.4% of the companies were classified, while in the maturity phase only eleven enterprises, corresponding to 21.6% of the total were classified.

Figure 3 depicts the profile of the general average score of companies belonging to the IT sector, the other sectors, and the general average score of the whole survey, with no stratification. The mean values calculated suggest that both groups do not present maturity in none of the five phases of the life cycle, although some enterprises, individually, have reached scores equal or greater than six in all the five phases of the life cycle, as in Table 1.

Figure 3 shows that the mean values for maturity, found for the IT companies, are greater than the values found for companies that do not belong to the IT sector, but hold projects of technology development and information systems. Therefore, the information technology sector apparently presents greater organizational maturity in project management.

Finally, concerning project development assessment, it was noticed that 86.6% of the sample responded that projects were within the planned budget (44 yes answers); 84.3% answered that projects have fulfilled stakeholders' demands (43 yes responses); 75.5% replied that projects planned timeline was met (37 yes answers); and 74% responded that projects product/service requirements were fulfilled (38 yes replies).

4.3. Results analysis

Four hypotheses were tested in order to answer the questions worded in this survey. Each one of them was unfolded into another four specific hypotheses to test the variable answers (dependents), as described below:

Table 1. Results by life cycle phase.

Life cycle PMMM - Level 2	Mature companies - IT*	Mature companies - other sectors	Mature companies - total	IT			Other sectors		
				Average	Standard deviation	Median	Average	Standard deviation	Median
Embryonic	12 (52.17%)	9 (32.14%)	21 (41.18%)	5.09	5.17	6.00	1.79	6.74	2.00
Executive management recognition and acceptance	11 (47.83%)	8 (28.57%)	19 (37.25%)	4.48	4.85	5.00	1.39	5.98	2.00
Line management recognition and acceptance	9 (39.13%)	7 (25.00%)	16 (31.37%)	4.70	4.54	5.00	0.86	5.47	1.50
Growth	12 (52.17%)	7 (25.00%)	19 (37.25%)	5.13	5.10	6.00	1.04	5.5	1.50
Maturity	7 (30.43%)	4 (14.29%)	11 (21.57%)	2.87	5.79	3.00	-0.86	6.13	0.50

*amount of enterprises that have reached score equal or greater than 6 in each life cycle phase.

- Hypothesis 1 – There is not a relation between the PMMM level 2 maturity phase (KERZNER, 2001) and the success of IT projects.
- Hypothesis 1a – There is not a relation between the PMMM level 2 maturity phase and the compliance with the planned budget in IT projects;
- Hypothesis 1b – There is not a relation between the PMMM level 2 maturity phase and the fulfillment (delivery) of the product/service requirements of IT projects;
- Hypothesis 1c – There is not a relation between the PMMM level 2 maturity phase and the meeting of timeline in IT projects;
- Hypothesis 1d – There is not a relation between the PMMM level 2 maturity phase and the fulfillment of stakeholders' demands in IT projects.
- Hypothesis 2 – There is not a relation between the adoption of a reference model and the success of IT projects.
 - Hypothesis 2a – There is not a relation between the adoption of a reference model and the compliance with the planned budget in IT projects;
 - Hypothesis 2b – There is not a relation between the adoption of a reference model and the fulfillment (delivery) of the product/service requirements of IT projects;
 - Hypothesis 2c – There is not a relation between the adoption of a reference model and the meeting of timeline in IT projects.
 - Hypothesis 2d – There is not a relation between the adoption of a reference model and the fulfillment of stakeholders' demands in IT projects.
- Hypothesis 3 – There is not a relation between the adoption of the CMM/CMMI model and the success of IT projects.
- Hypothesis 3a – There is not a relation between the adoption of the CMM/CMMI model and the compliance with the planned budget in IT projects;
- Hypothesis 3b – There is not a relation between the adoption of the CMM/CMMI model and the fulfillment (delivery) of the product/service requirements of IT projects;
- Hypothesis 3c – There is not a relation between the adoption of the CMM/CMMI model and the meeting of timeline in IT projects;
- Hypothesis 3d – There is not a relation between the adoption of the CMM/CMMI model and the fulfillment of stakeholders' demands in IT projects.
- Hypothesis 4 – There is not a relation between the adoption of the PMBoK model and the success of IT projects.
 - Hypothesis 4a – There is not a relation between the adoption of the PMBoK model and the compliance with the planned budget in IT projects;
 - Hypothesis 4b – There is not a relation between the adoption of the PMBoK model and the fulfillment (delivery) of the product/service requirements of IT projects;
 - Hypothesis 4c – There is not a relation between the adoption of the PMBoK model and the meeting of timeline in IT projects;
 - Hypothesis 4d – There is not a relation between the adoption of the PMBoK model and the fulfillment of stakeholders' demands in IT projects.

To prove the hypothesis test was performed chi-square test of independence of the variables of the questionnaire, using as reference for analyzing the value of $p \leq 0.05$ (descriptive level) of the likelihood ratio test of statistical software Minitab version 16 . Table 2 presents a summary of the results obtained, discriminating variables analyzed and the results of the chi-square statistic and the descriptive level (nd).

Based on the results in Table 2 it can be inferred that the hypothesis 1d is false, ie, no relationship between stage of maturity level 2 PMMM and meeting the demands of stakeholders in IT projects (nd = 0.039), as illustrated in Figure 4. This result indicates that mature organizations ensure the success of their projects partially meeting the demands of stakeholders in IT projects.

With respect to hypotheses 2 and 3, both are true, since all tests related to these hypotheses were not statistically significant. Thus, it can be stated that there is no relationship between the use of reference models and CMM/CMMI and success in IT projects in any of the four dimensions assessed. However, the hypotheses 4b and 4d are false, as can be observed

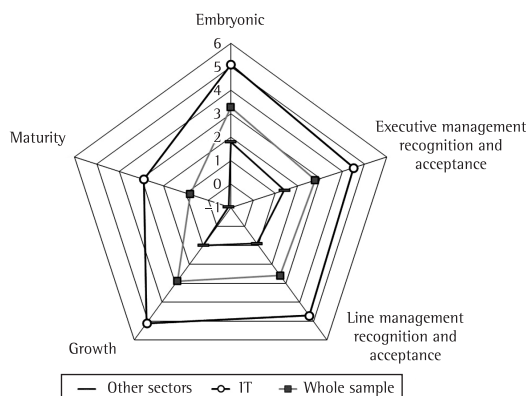


Figure 3. Profile of general average score.

Table 2. Results of the hypotheses tests.

Hypothesis	Variable 1		Variable 2			
			Budget (a)	Requirements (b)	Timeline (c)	Stakeholders (d)
1	Maturity	X ²	0.276	2.330	0.031	4.280
		Descriptive level	0.599	0.127	0.860	0.039
2	Reference model	X ²	1.897	2.711	0.167	1.279
		Descriptive level	0.168	0.100	0.683	0.258
3	CMM/CMMI	X ²	0.642	0.157	0.167	0.124
		Descriptive level	0.423	0.692	0.683	0.724
4	PMBok	X ²	2.745	4.733	0.366	4.564
		Descriptive level	0.098	0.030	0.545	0.033

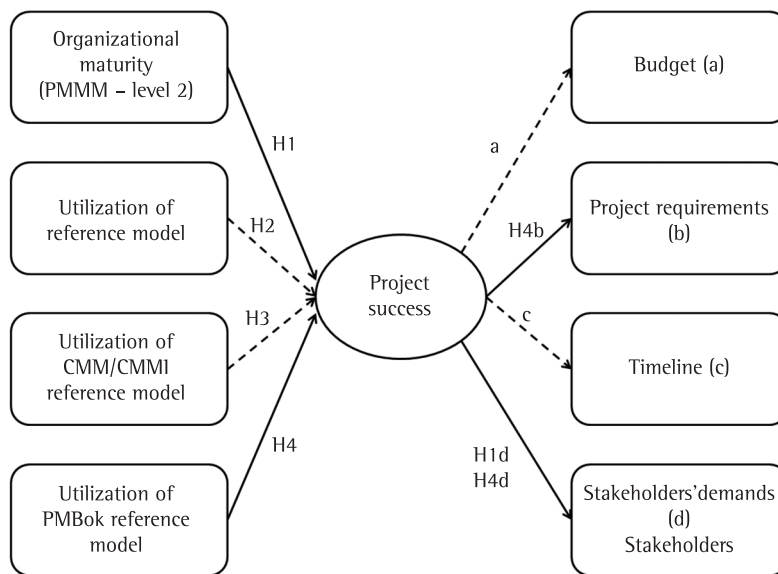


Figure 4. Confirmation of hypotheses 1d, 4b and 4d.

statistically significant differences between the adoption of the model PMBoK and service (delivery) the requirements of the product/service in IT projects ($nd = 0.030$) and meeting the demands of stakeholders IT projects ($nd = 0.033$). Therefore, the adoption of the model would add PMBoK partial success with IT projects. Figure 4 shows the confirmation of the hypothesis 4b and 4d.

5. Conclusions

One of the purposes of the present article was to assess the organizational maturity level in the management of technology development and information projects. Through the analysis of the collected data, it was possible to verify that most of the studied enterprises still have not reached the maturity score in none of the five phases of the life cycle at PMMM level 2, as presented in section 4.2. This result can be attributed to the fact that this project typology, as well as the IT sector, are relatively

new, with most companies and departments being not even two decades old, which frequently implies in little learning, lack of institutionalized processes and consolidated management models.

Even without reaching relevant maturity levels, an important finding is that the average value for maturity score, by phase of PMMM level-2 life cycle, was higher in companies that are specific of the IT sector compared to organizations belonging to other sectors. This suggests a greater development of IT enterprises compared to IT departments of other organizations, possibly due to the specialization of the former in executing this project typology.

In addition, the relation between PMMM level 2 maturity phase and project success was evaluated, testing the 1a, 1b, 1c and 1d group of hypotheses. Only with regard to fulfilling stakeholders' demands in IT projects, it was possible to verify significantly better performance of mature companies against immature ones. No significant differences were identified for the other success criteria. This is a sign that a company

with greater maturity level in project management fulfills the needs of its customers more effectively.

Studying the relation between different reference models in project management, it was possible to notice that the majority of the sample adopts PMBoK by *Project Management Institute* (2008a). It could also be noticed that the adoption for this guide had a positive impact in the performance of IT projects in the following criteria: fulfillment of products/services requirements and fulfillment of stakeholders' demands (see hypotheses 4b and 4d). Nowadays, PMBoK is probably the most well-known reference model in Brazil and, therefore, the most used. This study has demonstrated that its application has the ability to affect the performance of IT projects positively, even without the observation of complete success.

For the second reference model most adopted by companies, CMM/CMMI, it was not possible to verify any statistically significant impact in the performance of IT projects. It is worth adding that in the survey conducted by Jiang et al. (2004), the positive effect on the results of projects was more significant as from maturity level 3 of CMM/CMMI.

It is noteworthy that the performance data of IT projects from the sample differ from the survey carried out by Standish Group International (2003) in information technology projects, with relation to the following criteria: compliance with the planned budget and meeting of timeline and fulfillment of project requirements. While in the analyzed sample 75.5% of the interviewees answered that the planned timeline for projects was met, in the American survey the delay rate was 82%. Regarding the fulfillment of requirements, 74% of the sample respondents informed that products/services requirements were delivered as planned, while the survey by the Standish Group International (2003) pointed that only 52% of the required characteristics and functionalities were fulfilled. In addition, the budget criterion also presented discrepant figures, with 86% of the sample elements reporting that the project complied with the planned budget, against 57% observed in the American survey.

This discrepancy between the values observed in the sample and those published by Standish Group International (2003) may be explained by the large investment made in project management, as mentioned in section 2.3. Hence, in these six years that separate both researches, a substantial improvement may have occurred in the results of IT projects, due to increasing investments, what could be subject of future studies. Furthermore, the fact that the survey was based on respondents' perception may itself be a source of bias, therefore being one of the limitations of the used methodology. Another limitation of this study

concerns the sample. It is a reduced sample consisting of 51 respondents from 45 distinct companies. Great variability in data was observed (see Table 1). Moreover, it should be emphasized that it is not a probabilistic sample, thus it is not possible to state that it is representative of the population and, therefore, subject to generalization.

However, although it is an emerging issue - still in explanatory study stage in Brazil, this research shows interesting indications. For future studies, greater data collection in a larger number of organizations/respondents is advised, what would lower data variability and enable a better statistical generalization of results. A finer detailing of companies' maturity level is recommended in order to identify the level that presents better results in projects. Performing a success assessment in the course of project execution, and not only at the end, would be another study possibility.

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Annex 1. Survey questionnaire.

Part 1 – Company and interviewee’s characterization.

Information regarding the interviewee

Name:	_____
Phone/fax:	_____
E-mail:	_____
Age:	_____
Current position/function:	_____
Educational/professional background:	_____
Time with the company:	_____
Time experience in projects:	_____
Have you got the PMP certificate ¹ ?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Have you already been trained in project management?	<input type="checkbox"/> Yes <input type="checkbox"/> No
What is your responsibility concerning the organization’s projects?	<input type="checkbox"/> Management <input type="checkbox"/> Selection <input type="checkbox"/> Prioritization <input type="checkbox"/> Allocation of resources <input type="checkbox"/> Execution <input type="checkbox"/> Monitoring Other: _____

Information regarding the company

Corporate name:	_____
Headcount:	_____
Approximate revenues:	_____
Operating sector:	_____
Number of PMP certified employees:	_____
Percentage of revenues of projects:	_____
Amount of ongoing projects:	_____
Average time length of projects:	_____
What percentage of employees is allocated fulltime in projects?	<input type="checkbox"/> 0 – 25% <input type="checkbox"/> 26 – 50% <input type="checkbox"/> 51 – 75% <input type="checkbox"/> 76 – 100%
What percentage of employees is allocated part-time in projects?	<input type="checkbox"/> 0 – 25% <input type="checkbox"/> 26 – 50% <input type="checkbox"/> 51 – 75% <input type="checkbox"/> 76 – 100%
Which project categories are carried out by the organization?	<input type="checkbox"/> Organizational change <input type="checkbox"/> Partnerships, mergers, acquisitions <input type="checkbox"/> Exploitation of new markets <input type="checkbox"/> Development of new products <input type="checkbox"/> Development of technology and information systems <input type="checkbox"/> Research & Development <input type="checkbox"/> Changes in operation/production <input type="checkbox"/> Engineering and construction Others: _____
1 Professional Project Management (PMP) offered by the Project Management Institute (PMI)	

Part 2 – Matters regarding PMMM maturity level 2 – Life cycle phases.

Please mark only one alternative while answering the following questions. Please try to be as accurate as possible in your responses. Mark the response that you consider correct and not that you would like or image to be the most adequate.

	Strongly disagree	Disagree	Partially disagree	Undecided	Partially agree	Agree	Strongly agree
My company recognizes the necessity of project management. This necessity is recognized at all management levels, including the executive management.							
My company has a system for managing both the cost and the timeline of projects. The system requires numbers of financial charges and ledger account codes. The system informs variation concerning the planned objectives.							
My company has recognized the possible advantages to be accomplished through the deployment of project management. These benefits are recognized at all management levels, including the executive management.							
My company or department has an easily detectable methodology in project management that utilizes the concept of phases or life cycle of projects.							
Our executive managers openly support project management by means of lectures, courses, articles and also through the occasional presence in meetings and reports of the project team.							
My company is committed to the advance planning aiming quality. We always try to do our best in terms of planning.							
Our area line managers completely and openly support the process of project management.							
My company does everything possible to minimize scope deviations (for example, change of scope or redefinition of scope extension) in our projects.							
Our area managers are committed to not only to project management but also to the meeting of timeline for conclusion of objectives.							
My company's executives have good knowledge on the principles of project management.							
My company has selected one or more software programs to be used as project control systems.							
Our area line managers were trained and instructed in project management.							
Our executives understand the concept of responsibility and act as sponsors in certain projects.							
Our executives recognize or identify the applications of project management throughout the several units of our business.							
My company was able to integrate cost control and timeline successfully both for project management as well as for follow-up reports.							
My company has developed a project management curriculum (for instance, more than one or two capability courses) in order to improve the capabilities of our collaborators in project management.							
Our executives recognize what needs to be done so that maturity in project management can be accomplished.							
My company considers and deals with project management as a profession, and not only as a part-time task or, when required, as a fulltime task.							
Our area line managers are willing to release their staff for project management training.							
Our executives seem to be willing to change the traditional way to run business and achieve project management maturity.							

Part 3 - Analysis of organizational variables related to the projects.**Information regarding the company.**

	(<input type="checkbox"/>) Yes
	(<input type="checkbox"/>) PMBoK (PMI)
	(<input type="checkbox"/>) CMM ou CMMI-DEV (SEI)
	(<input type="checkbox"/>) ICB (IPMA)
	(<input type="checkbox"/>) APM Body of Knowledge (APM)
	Other: _____
Does the company adopt any reference model in the project management area?	(<input type="checkbox"/>) No

Part 4 - Project development analysis.**Consider the last concluded project when answering the questions in this part.**

Has the project complied with planned budget?	(<input type="checkbox"/>) Yes
	(<input type="checkbox"/>) No
Has the project fulfilled the products/services requirements as planned?	(<input type="checkbox"/>) Yes
	(<input type="checkbox"/>) No
Has the project met the planned timeline?	(<input type="checkbox"/>) Yes
	(<input type="checkbox"/>) No
Has the project fulfilled the stakeholders' demands?	(<input type="checkbox"/>) Yes
	(<input type="checkbox"/>) No
