Project Management and Project Performance: a Longitudinal Study

Leandro Alves Patah, PhD
Universidade Nove de Julho – São Paulo, Brasil

Abstract

The aim of this study is to investigate the relationship between the adoption of project management methodologies and project success. The methodological approach involved a longitudinal field survey conducted in three countries, Argentina, Brazil and Chile. Data were obtained for 1387 projects from different sectors. The results provide evidence that the degree of use of project management methods have statistically positive impact on operating results of the projects. The number of project managers certified as PMP in the division that conducts the project, as well as investments in training in project management has a statistically positive impact on operating results of the projects. It was also possible to observe that the complexity of the project affects the operating results of the projects. Other conclusions are that it is easier to explain project success than failure in projects, complex projects have less chance of success in relation to lower complex projects, investments in project management training increase the chances of operational project success and it is possible to measure success in project management.

Keywords

Performance, project management models, complexity.

1. Introduction

Various methods and techniques have been developed and encapsulated in bodies of knowledge institutes and professional associations of project management (PMI, 2013, IPMA, 2006). Nevertheless, the project management remains a challenge highly problematic, since a lot of projects exceed their budgets, delay or fail to meet its objectives, as evidenced by several studies (DAI; WELLS, 2004, THE STANDISH GROUP, 2009, WHITE, FORTUNE, 2002).

In recent years many companies have spent significant amounts of resources in project management. The PMI (2009) presents a number of $ 12 trillion, one-fifth of world GDP, as the amount to be invested in projects in each of the years of this decade.

Despite this, there is a lot of research about the return on investment in project management methods. Thus, despite the high degree of investment in projects and increasing numbers of skilled project managers, some questions about the results and benefits come with these investments. In general, work on the revision of the theory of present projects, among others, the following questions (IKA, 2009; SODERLUND, 2004):

- How to prove that spending money on training in methods and management projects has value and what the function or value added by the project management?
- How to make senior executives committed to the methods of project management without showing the financial results generated from the investments?
- What determines the success or failure of a project?

The few existing quantitative evidence presents a picture less than rosy. The The Standish Group (2009), based on a survey of 280,000 information technology projects conducted in 2008 shows that only 32% of the projects may be considered a success. Close to half of the projects studied, ie 44%, presents problems of timing or costs and 24% can no longer be recovered and projects were considered failures. In the same survey, projects that spend more than the predicted value, burst its budget on average by 45%. How to complete the project on time, the survey data are also not far from encouraging, on average, the schedule is increased by 63% of its original, and only 67% of the required characteristics and features are typically delivered to customers designs. Projects fail and this will not change unless companies start to measure where the projects fail and why (BUCHANAN, 2008).

Some empirical studies highlight the challenges associated with the implementation of PM methodologies (BESNER; HOBBS, 2013; HONG et al., 2011; CHOU; YANG, 2012; ALA-RISKU; KARKKAINEN, 2006).

Although the volume of literature in the area, there is scant empirical evidence that relates implementation of project management to the results obtained. On the other hand, executives are also seeking evidence that their investments are working effectively and producing the expected value of profits at the end of projects. In short the question of quantifying the value of Project Management has not yet been satisfactorily answered (IKA, 2009, THOMAS, MULLALY, 2008).

Aiming to contribute to the evaluation of the benefits of project management in organizations, this paper seeks to assess the relationship between investments and results of projects. Investments in the implementation of project management involve the development and use of tools and methods, training of project managers, and administrative and organizational support. As a proxy to the pay off it will be used the operating performance achieved by the projects. The methodological approach involves a longitudinal study with a hybrid approach, qualitative and quantitative.

This paper is divided into five sections. Section 2 presents a summary of the theoretical framework, followed by Section 3 which presents the methodological approach. The results and discussions are presented in section 4. Finally, section 5 presents the conclusions and recommendations for future work.

2. Review of Literature

2.1. Methods of Project Management

Projects can be defined as organizations "forgettable", which arise through the routine, being composed of individuals who are unlikely to work together again. A strategy to encode the organization's capabilities in project management should be defined at the enterprise level to repeat successful approaches in future projects. Using a well-structured and implemented, these capabilities can be stored and transferred over time, space and context. Additionally, through the creation of an external memory to individuals, this type of coding knowledge can make organizations less vulnerable to loss the tacit knowledge stored in people (IBERT, 2004).

A systematic project can consist of methods, toolkits and design models. Thus, project management can be viewed as the sequential application of structured processes, continuous and repeated that, when used by an organization in a gradual and safe mode for your business, lets take steps toward the institutionalization of standardized practices.

In addition, systematic team needs help in the planning and delivery of projects, considering the whole cycle of life, consistent and efficient, always business-oriented and customer satisfaction (SILVEIRA, 2008). And for that, there are some characteristics of systematic project management organizations highlighted by the author as being in line with ISO 9000 standards or other official institutes of project management. It should also have a flexible and comprehensive set of processes, tools and techniques that support the activities, audited periodically by a PMO (Project Management Office). It is worth noting the need for documentation, measuring instruments and control of projects during the life cycle and communication of results to stakeholders.

Some studies have been tried to understand the impact of these PM standards implementation (MCHUGH; HOGAN, 2011; BESNER; HOBBS, 2013; CHOU; YANG, 2012) and suggest relation between PM maturity and success.

There are currently several sets of models of project management methods available for use by professionals and organizations to better manage their projects. The most widespread methods currently are available by institutes and associations dedicated to the study as presented in Table 1.

Table 1 – Major associations of project management and their sets

Institute	BoK	Country of Origin	Methodology Focus	Characteristics	Other differences between the demands
Project Management Institute (PMI, 2013)	*Project Management Body of Knowledge* (PMBoK)	USA	General management of projects	Set of methods developed for various types of projects, therefore, fairly generic. Structured by areas of knowledge in a project.	It is complemented by two additional sets of methods: Program and Portfolio.
International Project Management Association (IPMA, 2006)	ICB – IPMA *Competence Baseline*	European Union	General management of projects	Structured by skills that need to be developed by the Project, divided into: contextual, behavioral and technical.	Together with the Australian standard, has a much greater degree of depth than the other methods on the human aspects of the figure of the Project manager.
Australian Institute of Project Management (AIPM, 2008)	AIPM – *Professional Competency Standards for Project Management*	Australia	General management of projects	This document, published by the Australian institute of projects, is very similar in structure to the PMBoK, divided by areas of knowledge.	It also has a deeper focus on human skills.
Association for Project Management (APM, 2006)	APM *Body of Knowledge*	UK	General management of projects	One of the most complete set of methods, this document provides project-related content, value, office projects and strategic aspects of project management.	It is the most comprehensive set of methods.
Office of Government Commerce (OGC, 1996)	*Projects In Controlled Environments* (PRINCE2)	UK	Project management information systems	Set of methods structured in stages of a project and activities to be conducted by the management team.	Set of methods aimed at information technology projects.
Japan Project Management Forum (ENAA, 1992)	ENAA *Model Form-International Contract for Process Plant Construction*	Japan	Management of construction projects	The document has a large focus on the contractual aspects of a project.	The focus of this set of methods is in engineering construction projects.

Source: elaborated by authors

2.2. Success in Projects

Several studies have been conducted over the last decade, seeking to analyze how project success can be measured (BELOUT; GAUVREAU, 2004; BESNER; HOBBS, 2006; BIZAN, 2003; DVIR; RAZ; SHENHAR, 2003; GRAY, 2001; KENDRA; TAPLIN, 2004; LIPOVETSKY et al., 2005; RAZ; SHENHAR; DVIR, 2002; REPISO; SETCHI; SALMERON, 2007).

The project success is usually defined as meeting the objectives of time, cost and quality in which meets the project's stakeholders. Nevertheless, research conducted over the past year, and since the 1980s, which have been investigating the dimensions of project success, led to re-write the above formula with the general agreement that project success is multi-dimensional and that different people measure the success of projects in different ways at different times (BARBER, 2004; BRYDE, 2003; IKA, 2009; JUGDEV; MULLER, 2005).

In order to measure the success of projects you can create criteria and metrics as proposed by Ling (2004), which is a division refining the project success in achieving success in the product of the project by meeting quality standards and achieve success in the process by meeting the goals of time and budget. For this, the author uses four metrics to evaluate the performance of projects: cost, time, quality and service customer satisfaction.

Since Larson and Gobeli (1989) present some factors that may affect the success of projects such as project structure, project manager's competence and size of the project, using the same indicators proposed by Ling (2004).

Another way to measure success is folding it in two different criteria. One, the very success, which according to Cooke-Davies (2002), cannot be measured until the project is finished, and another, the performance of projects, which can be measured at runtime. According to the author, no system of metrics in projects can be considered complete without a package of measures (performance and success) and should seek a method of connecting them, as a means of assessing the accuracy with which the performance of projects predict the success of the organization.

Thamhain (2004) in a study conducted between 2000 and 2003, with 76 project teams of 27 companies, seeking, in turn, associate with the environment of project teams with the same performance. According to the author, the main variables related to the project teams that influence success, are the environment of the team and team performance.

The benefits to the client (DVIR et al., 1998), adaptability and ability to cooperate with the project in other areas of the organization (KATZ; ALLEN, 1985) and service quality standards and safety (WHITE; FORTUNE, 2002) should also be included in systems of performance measurement projects systems.

Financial criteria are also being used to measure performance on projects for some time. The criteria may include economic return, cost / benefit analysis (ARCHER; GHASEMZADEH, 1999), contribution of improved financial measures such as profits, market share and value of new projects obtained (THOMAS, DELISLE; JUGDEV, 2002).

Another direct way of assessing the benefits of project management is to analyze the margins of a firm's current projects. You can compare the scope of a project when the company sells, with the value obtained when it is completed. The difference can be partly explained by the methodology of project management.

It may be noted that the metrics for performance measurement used in most projects are those related to obtaining, at the end of the project, initially planned values of time and cost (GRAY, 2001; KATZ; ALLEN, 1985; LARSON; GOBELI, 1989; LING, 2004; WHITE, FORTUNE, 2002), and consensus is the financial issue involved (ARCHER; GHASEMZADEH, 1999; THOMAS, DELISLE; JUGDEV, 2002), which was expected. Some of these authors, however, include other concepts such as risk (ARCHER; GHASEMZADEH, 1999), satisfaction of stakeholders, obtained new projects and team performance (THOMAS; DELISLE; JUGDEV, 2002). And others, provide a slightly different by including the value as a function of the processes that organizations generate (IBBS; REGINATO, 2002).

3. Methodology and Hypotheses

3.1. Hypotheses

Our methodological approach involved a longitudinal study with a multi-methods research approach, merging qualitative and quantitative approach. It is an increasing interesting in applying multi-methodological research (SINGHAL; SINGHAL, 2012a,b), by using different sources of data, or by using different subsets of the same data.

In this study, several data collection methods were combined in order to achieve triangulation, such as structured and unstructured interviews of key participants (PMO coordinators and project managers) and PMO projects' archival data (see Appendix). Discrepancies among these sources of evidence were noted and discussed.

To test research hypothesis and develop the research model, the logistic regression method was selected.

Several factors can lead to high-performance designs, as seen previously. This study emphasizes the use of project management methods (KESSLER; WINKELLHOFER, 2002; THE STANDISH GROUP, 2009; WHITE; FORTUNE, 2002) and training of project teams (COOKE-DAVIES, 2002; DAI; WELLS, 2004).

Several authors outline the benefits of using project management methods (IBERT, 2004; KERZNER, 2001; KESSLER; WINKELLHOFER, 2002; THE STANDISH GROUP, 2009; WHITE; FORTUNE, 2002). KERZNER (2001) presents a list of benefits, including: improving the performance of activities in relation to care plans and objectives of the project. Thus emerge the following research hypotheses:

- H01: The level of utilization methods of project management does not affect the operational results of the projects.

Archibald (2003) presents the project manager himself as one of the critical factors of project success. Additionally, Cooke-Davies (2002) includes in its list of critical success factors for a project, adequate training at all levels of the organization in project management concepts. Other authors also include issues of training and education as key success factors in project management (DAI; WELLS, 2004). To assess whether the investment in training in project management improves their performance, were established hypotheses H02a and H03b.

- H02a: The investment in training in project management does not influence the projects operational results
- H02b: The number of project managers certified as PMP in the division that conducted the project does not influence the projects operational results.

Finally, The Standish Group (2009) presents the size of a project, its duration and size of the team as metrics that can influence the success of a project. According to the institute, about the size of the project, the smaller the project, the higher the probability of project success. Regarding the duration of the project, the institute argues that smaller projects with durations are more likely to succeed. The same happens with the team size. Cooke-Davies (2002) confirms these arguments when presented as a critical success factor for the suggestion to keep the durations of the projects in three years. Crawford, Hobbs and Turner (2004); Larson and Gobeli (1989) and White and Fortune (2002) are other authors who include criteria of complexity as factors leading to an outstanding performance on projects. In turn, Shenhar, Dvir (1996) and Raz, Shenhar, Dvir (2002) classified into four levels of complexity ranging from low to super high-tech.

In order to determine whether and how the complexity of the project influences the performance of it, it was proposed to the third hypothesis of this thesis:

- H03: The complexity of the project does not affect the operational results of projects.

All null hypotheses always contain an equality on which it must obtain evidence to reject it. The significance level (α) set at 5% in this study, represents the probability (or risk) of the mistake of rejecting H0 when in fact this hypothesis is true.

3.2. Data Collection

This paper describes independent and dependent variables according to the concept of Marconi and Lakatos (2003). As the independent variable (X) is the one that influences, determines or affects another variable, according to the hypotheses, the independent variables chosen were use of project management methods and effort in training in project management.

Since the dependent variable (Y) consists of those values (phenomena or factors) to be explained or discovered, by virtue of being influenced or affected by certain independent variable, the choice of compliance costs, deadlines and financial performance of the project, were based on key indicators for measuring performance of selected theory, as discussed above.

Moderating variable (M) is one factor, phenomenon or property that also impacts the dependent variable, but to a lesser extent, influencing the relationship between the independent and dependent variables (MARCONI; LAKATIS, 2003). Thus, from the critical success factors presented above and the criteria used for selection of control, the complexity of the project was selected as the only moderating variable to assess its influence on the creation of better cost, schedule and financial performance of the project according to the use of methods and effort in training the project team. Table 2 presents the variables selected for this work and their ways of measuring and grandeur.

Table 2 - Variables and measurement forms

Variable	Shape Measurement	Greatness
X1 – Use of Project Management Methods	Degree of implementation of project management where it seeks to measure the proportion that the methods are introduced and are used.	%
X2 – Effort in Training of Project Management	Financial value of the investment in training in project management and quantity of certified project managers (PMP).	R$ and numerical value
Y1 – Budget Meeting	Relative change of the budget increase, measured by the difference in monetary value of the original budget provided for the project in relation to the real budget at the end of the project, divided by the original budget.	%
Y2 – Compliance Deadline	Variation of the relative increase of the project period, as measured by the difference between the original deadline and planned on day deadline of the project, divided by the original deadline.	%
Y3 –Financial Performance	Relative change of the margin of the project, measured by the difference between the final margin and the margin of the	%

	project originally planned, divided by the original margin.	
M1 – Project Complexity	Measured in classification of projects by type, obtained by calculating a basket of indicators.	4 Project Categories

Source: elaborated by authors

For data analysis it was used specific statistical analysis software that fully meets the needs of the work, the Statistical Package for Social Sciences (SPSS).

3.3. Selection of Sample Analysis

As suggested by Eisenhardt and Graebner (2007), theoretical sampling was used (theoretical sampling). As the focus of the research are organizations where project activity is strategic, and therefore invest in large piles methods and training in project management, this was the theoretical framework used to define the sample. In studies to investigate the performance of projects, little evidence was found in organizations with little history of project management (BRYDE, 2003; SILVEIRA, 2008).

In addition, for the longitudinal analysis, there was a requirement to access data on project performance on a temporary basis to allow data to compare the performance of projects before, during and after the implementation of methods in an approach similarly used by Hendricks and Singhal (2001). Data to address issues of values in projects are not readily available in most organizations (THOMAS; MULLALY, 2008). In choosing a single organization, with wide access to information, the authors seek to significantly reduce the risk of availability of information usually treated as confidential.

Finally, the authors needed a common basis for comparing the progress of implementation, the use of methods and maturity in projects. Given the large number of different methods available for managing projects, as presented in section 2, if the choice fell upon a number of organizations, it would be necessary to equalize these various methods adopted or adapted by companies to obtain a comparable basis of independent variables. Moreover, due to numerous possibilities for measuring project success, also discussed in section 2, would also be necessary to generate a comparable basis for the dependent variables, as shown by Pinto (2002) and quoted above.

4. Discussion and Analysis of Results

4.1. Data Obtained

The organization studied is a multinational company with several divisions operating in different markets; it was possible to obtain data from a large number of projects over a long period of analysis. This company has 60% of their gross sales from projects. The company produces and installs a wide variety of equipment, mostly delivered to customers through specific projects tailored to the needs of each. The rates of product innovation are extremely high, and the products currently sold are developed in no more than three years ago. Basically, the company sells customized solutions for its customers with low volume of units produced and a great variety.

The company has several business units, and for sizing the sample of projects examined, it was adopted the rule of thumb proposed by Hair et al. (1998), that when it comes to the analysis of dependence or interdependence among variables, one should obtain at least 20 samples for each variable, for a total of 120 samples of projects to be obtained during the stage of data collection.

2851 data were obtained from projects conducted from January 2005 to June 2008. However; several of these projects did not have complete information as the final costs of implementation, the categorization assigned and others. After a detailed analysis, it was selected 1387 projects with complete data, or 48.65% of the total, able to be analyzed to try to prove the assumptions set out in section 3. These projects were conducted between July 2006 and June 2008. For all projects were obtained from the information contained in appendix.

In relation to the performance segment of the project, the area with more projects obtained is the area of energy, with 713 projects (51.41% of total), followed by the area of medicine with 218 projects. Regarding the country of realization, most of the projects was conducted in Brazil with 823 projects (59.34% of total), followed by Argentina with 294 projects (21.20%) and Chile, with 270 projects (19, 47%).

The independent variable Use of Project Management Methods (X1) is concentrated between 70.83% and 83.33% and has a low relative dispersion (coefficient of variation = 4%) and standard deviation of 3.29%. The projects have an average of 77.18% of degree of implementation of project management methodologies, with a median of 75.98% and 75.00% fashion.

The independent variable Effort in Training in Project Management (Financial Investment) (X2) has values between R$ 0.00 and R$ 615,000.00. In the business units that were developed the projects studied, the average investment is R$ 238,609.00, with a median of R$ 85,000.00, and fashion of R$ 615,000.00. The relative dispersion is 113% (coefficient of variation), with a standard deviation of R$ 270,344.00.

For the independent variable X2 - Effort in Training in Project Management (number of PMPs), the projects have, on average, seven certified employees and a median of three employees certified. The relative dispersion is 116% (CV) and standard deviation of 8.

The dependent variable Y1 – Budget Meeting distributes between a minimum of -100% (final value greater than the estimated value) and 716.6% (final value less than the estimated value). Additionally, almost half of the projects tie the final cost to plan and few projects (12.98%) have their final cost above planned levels. The projects have an annual average cost of 9.51% below the estimate, with median and mode equal to zero. The relative dispersion is high, with a coefficient of variation of 495% and standard deviation of 47.07%.

The dependent variable Y2 - Compliance Deadline distribute a range between -10% (late project) and +10% (early design). Most projects (70.23%) are completed within the planned date. The projects deadline have, on average 4.66% lower than expected, median and mode were 9.8% lower than initially estimated. The relative dispersion is high with a coefficient of variation of 159% and standard deviation of 7.42%.

The dependent variable Y3 - Financial Performance is distributed in a range between -664% (projects indicating loss) and 502% (indicating projects gain). The average is negative (-2.68%), with median and mode equal to zero. The projects have a high variability, with standard deviation of 84.40%.

4.2. Analysis of Results

As the non-parametric test of Kolmogorov-Smirnov test rejected the hypothesis of normal distribution for the three dependent variables ($p < 0.05$), the analysis was continued by logistic regression analysis, becoming the three dependent variables of follows:

- The project is considered successful if both the cost relative variation and the schedule relative variation, are positive or zero, meaning that both cost and deadline were controlled and less than or equal to the estimated a priori;
- The project is considered a failure if any of the two components (cost relative variation or schedule relative variation) is negative. This means that they were not well controlled, ie, that their final values are higher than initially planned.

As the financial performance (dependent variable Y3) is explained largely by variation in costs, this was not considered for the proposition of the new dependent variable success or failure. In fact, the margin of a project with external customer increases, as project costs are reduced. And the opposite occurs, ie, when project costs increase, the margin of the project will decrease. Another possible influence on the bank of projects with external clients is to obtain contractual amendments, discussed in this perspective does not work once it comes to a point external to the organization, more related to market and selling price of the project. So let it be a single variable related to the financial aspect to the project, along with the variable of time, to compose the new dependent variable of success.

The independent variables considered in logistic regression analysis were as follows: Use of Project Management Methods (X1); Effort in Training of Project Management (Financial Investment) (X2); Effort in Training of Project Management (Number of PMPs) (X2).

The moderating variable considered in the logistic regression analysis is the complexity of the project (M1). The new dependent variable, called result, considered in the logistic regression analysis results from the definition of the operating results of the project and was established by two response categories: Success (1) and Failure (0).

It was found that the variable X2 (Financial Investment) and X2 (Number of PMPs) are highly correlated, therefore, unnecessary and unwise, the entry of these two variables in the estimation of the model. Thus, it was kept only the variable X2 (Financial Investment) in the sequence of the analysis.

4.2.1. General Model

Table 3 presents the estimated values of the coefficients, which are used to specify the model, the standard deviations of the coefficients, the Wald statistics and p values (descriptive level of the test), and the odds ratio exp (B). The odds ratio allows a chance to know what event is going to happen under the same conditions it did not happen. The p-value denotes the probability of occurrence of events as or more extreme than observed given that H0 is true. Thus, a low p (less than or equal to the level of significance) indicates that it would be unlikely to observe a certain result if H0 were true. If $p > \alpha$ (significance level), then the decision is not to reject H0.

When testing the significance of each coefficient, they are all significantly different from zero ($p < 0.05$). Therefore, it can be said that there is evidence that these variables influence the chance of operational success of the project, or may be part of the model.

Table 3 – Variables of the model: operating results of the projects

Independent Variable	**Coefficient (B)**	**Standard Error**	**Wald Statistics**	**p**	**Exp(B)**
X1	0,094	0,018	27,604	0	1,098
X2 (Finan. Invest.)	0,084	0,023	13,863	0	1,088
M1 (If categ. = C or D)	0,576	0,12	23,113	0	1,778
Constant	-7,189	1,378	27,199	0	0,001

X2 (Finan. Invest.) = Investment in Training x R$ 100.000,00

Source: elaborated by authors

Therefore, the Equation 1 presents the coefficients necessaries to the adjusted model, as follow:

(1)

Probability (success of the project operational result) = 1 / (1 + exp(-z)), where

z = - 7,189 + 0,094 X1 + 0,084 X2 (Finan. Invest.) + 0,576 (IF the project category is less complex)

It has been established for this work that more complex projects are those of categories A and B as shown in appendix in respect of measurement criteria of the projects. Consequently, less complex projects are those in categories C and D.

It is observed that all variables positively influence the likelihood of success of the operating results of the project. That is, when the project is less complex, the chance of operational success of the project increases by almost 1.8 times (exp (B) = 1.778), indicating relatively the relevance of this factor.

The degree of implementation and investment in training also affect the chance of operational success of the project, but are less relevant due to the exp (B) or odds ratio are very close to 1 (1.098 and 1.088, respectively), and suggests that each unit increase in the variable in question on a project does not cause a large effect on operating income, making the success rate remains almost constant.

The percentage of successes of this model is 60.49%, and for the success percentage of correct prediction is 80.12% and to predict failure of 28.46%, as reported in Table 4, which presents the 1387 projects sample with its results estimated by the model and observed directly in the data table.

Table 4 – Evaluation of the effectiveness of the model: operational results of the projects

		Estimated Result		**% Correct**
		Failure	**Success**	
Observed Result	**Failure**	150	377	28,46
	Success	171	689	80,12
% Correct		46,73	64,63	60,49

Source: elaborated by authors

To better understand the results of binary logistic regression analysis, Table 5 contains some descriptive statistics.

Analytically it is noted that the mean and median of the independent variables in relation to success are higher than in projects with operating income considered failure. That is to say that the variables X1 – Use of Project Management Methods, X2 - Effort in Training of Project Management (Financial Investment) and X2 - Effort in Training of Project Management (Number of PMPs) have positive effect for at least the achievement of goals (time and cost).

Table 5 – Descriptive statistics of the model proposed by binary logistic regression analysis

		X1	**X2 (Financial Investiment)**	**X2 (Number of PMPs)**
Failure	**Avarage**	76,6%	R$ 184.278,94	4,9
	Median	75,9%	R$ 85.000,00	1,0
	Standard Deviation	3,2%	R$ 226.717,26	6,8
Success	**Avarage**	77,6%	R$ 271.901,16	8,6
	Median	76,0%	R$ 85.000,00	3,0
	Standard Deviation	3,3%	R$ 289.013,25	8,9

Source: elaborated by authors

And according to the joint distribution of operational result and the category of project complexity presented in Table 6, it is noted that 70.05% of the less complex operational projects are doomed to success, while on more complex projects, this percentage drops to 55.29%.

That is, in fact the lower complexity of the projects has a positive effect on success.

Table 6 – Distribution combined operational result and project complexity

Result		Complexity		Total
		More Complex	Less Complex	
Failure	**Frequency**	338	189	527
	% Category	44,71%	29,95%	38,00%
Success	**Frequency**	418	442	860
	% Category	55,29%	70,05%	62,00%
Total	**Frequency**	756	631	1387
	% Category	100,00%	100,00%	100,00%

Source: elaborated by authors

4.2.2. Model for More Complex Projects

The adjusted model for more complex projects is described by Equation 2:

(2)

Probability (success of the project operational result) = 1 / (1 + exp(-z)), where

z = - 7,943 + 0,107 X1 - 0,069 X2 (Finan. Invest.)

For more complex projects, investment in training, as well as the degree of implementation significantly influence the chance of operational success of the project (p <0.05).

The negative coefficient (-0.069) for investment in training, suggests that the more one invests, the lower the chance of success. However, the influence of investment is low (odds ratio = 0.933, close to 1).

The positive coefficient (0.107) indicates that the higher the degree of implementation is more likely to have the project operational success, odds ratio = 1.113 suggests that each increase of 1 percentage point in implementing the chance of success increases by 1.11 times.

Table 7 presents the estimated values of the coefficients used to specify the model, the standard deviations of the coefficients, the Wald statistics and p values (descriptive level of the test), and the odds ratio exp (B).

Table 7 – Variables of the model: operational results of more complex projects

Independent Variable	Coefficient (B)	Standard Error	Wald Statistics	p	Exp(B)
X1	0,107	0,021	25,89	0	1,113
X2 (Finan. Invest.)	-0,069	0,032	4,693	0,03	0,933
Constant	-7,943	1,618	24,089	0	0
X2 (Finan. Invest.) = Investment in Training x R$ 100.000,00					

Source: elaborated by authors

The percentage of successes of this model is 59.52%, and for the success the percentage of correct prediction is 82.30% and to predict failure is 31.36%, as seen in Table 8.

Table 8 – Evaluation of the effectiveness of the model: operational results of more complex projects

		Estimated Result		% Correct
		Failure	**Success**	
Observed Result	**Failure**	106	232	31,36
	Success	74	344	82,30
% Correct		58,89	59,72	59,52

Source: elaborated by authors

4.2.3. Model for Less Complex Projects

Table 9 presents the estimated values of the coefficients used to specify the model, the standard deviations of the coefficients, the Wald statistics and p values (descriptive level of the test), and the odds ratio exp (B).

Table 9 – Variables of the model: operational results of less complex projects

Independent Variable	Coefficient (B)	Standard Error	Wald Statistics	P	Exp(B)
X2 (Finan. Invest.)	0,243	0,034	50,336	0	1,275
X1	0,061	0,037	2,719	0,099	1,063
Constant	-4,509	2,824	2,549	0,11	0,011
X2 (Finan. Invest.) = Investment in Training x R$ 100.000,00					

Source: elaborated by authors

Differently from the model to more complex projects, for less complex projects, the degree of implementation is not relevant (coefficient not significantly different from zero for $\alpha = 5\%$), ie, increase or decrease the degree of implementation does not affect significantly in the probability of the operational result be success. For this reason this variable was removed from the model and the weights of the remaining variables were recalculated.

But the investment in training has revealed its importance: an increase of R$ 100,000.00 in investment, the chances of operational success increases by 1.28 times (Exp (B) = 1.275). The model adjusted for less complex projects, is described by Equation 3:

(3)

Probability (success of the project operational result) = 1 / (1 + exp(-z)), where

$$z = 0,145 + 0,255 \text{ X2 (Finan. Invest.)}$$

For less complex projects, the model can only predict success in operating profit, hitting 70.05% of cases, as shown in Table 10. It is worth noting that even in less complicated projects, not observed 100.00% of operational success (only 70.05%), as shown in Table 10.

Table 10 – Evaluation of the effectiveness of the model: operational results of less complex projects

		Estimated Result		% Correct
		Failure	**Success**	
Observed Result	**Failure**	0	189	0
	Success	0	442	100,00
% Correct		0	70,05	70,05

Source: elaborated by authors

4.2.4. Consolidated Model

Given the two models presented (for the most complex projects and for projects less complex), the model with the highest percentage of hits refers to less complex projects, but can only correctly predict all the successfully projects. It is like noted: projects less complex signal operational success.

Anyway, the statistical models relating to projects more complex and less complex when used together result in 64.31% accuracy, whatever the project, as shown in Table 11.

Table 11 – Evaluation of the effectiveness of the two models of consolidated operational results

		Estimated Result		% Correct
		Failure	**Success**	
Observed Result	**Failure**	106	421	20,11
	Success	74	786	91,40
% Correct		58,89	65,12	64,31

Source: elaborated by authors

4.2.5. Verification of Research Hypotheses

The results of the logistic regression model for the total sample are presented in Table 12.

Table 12 – Results of logistic regression for the total sample

Independent Variable	Coefficient (B)	Standard Error	Wald Statistics	p
X1	0,094	0,018	27,604	0
X2 (Finan. Invest.)	0,084	0,023	13,863	0
M1 (If categ. = C or D)	0,576	0,12	23,113	0
Constant	-7,189	1,378	27,199	0

Source: elaborated by authors

According to the results presented above it is possible to analyze the hypotheses described in Section 3.

• H01: The level of utilization methods of project management does not affect the operational results of the projects.

Reject H01 at $\alpha = 5\%$. The degree of use of project management methods have statistically positive impact operating results of the projects.

• H02a: The investment in training in project management does not influence the projects operational results

Reject H02a at α = 5%. The investment in training in project management has a statistically positive impact on operating results of the projects.

• H02b: The number of project managers certified as PMP in the division that conducted the project does not influence the projects operational results.

Reject H02b at α = 5%. The number of project managers certified as PMP in the division to conduct the project has a statistically positive impact on operating results of the projects.

• H03: The complexity of the project does not affect the operational results of projects.

Reject H03 at α = 5%. The complexity of the project has a statistically positive impact on operating results of the projects.

There is the end that all the assumptions made in this study were statistically proven by the rejection of the same throughout the analysis conducted.

Table 13 presents a summary of the results obtained from analysis of the hypotheses proposed in this paper. Due to the statistical rigor, the way they were prepared, the hypotheses based on the assumption that the various input criteria analyzed did not influence the operating results of the projects. But from the beginning, the aim of this paper is to prove that such influence exists. The results obtained with the statistical analysis, and allow rejecting the hypothesis, have demonstrated a positive influence among the criteria studied and the results of the projects.

Table 13 – Research hypotheses with the obtained analysis

Hypothesis	Expected Result	Obtained Result
H01	Influences	Positive Influence
H02a	Influences	Positive Influence
H02b	Influences	Positive Influence
H03	Influences	Positive Influence

Source: elaborated by authors

5. Conclusions

All the hypotheses established in this work were denied. The proposed objectives, the first was to measure the influence of investment in project management, through the development, implementation and use of methods of project management and training of project managers on the operational performance of the same.

The goal regarding the use of project management methods and their relation to the operational performance of the projects was achieved using the technique of multivariate data analysis type logistic regression to reject the hypothesis H01, demonstrated that the use of methods have statistically positive impact on operating results of the projects, measured through the achievement of project budget and schedule.

Another objective of this work addresses the analysis of the relationship between the effort in training of project managers and the results achieved with the project. This goal was also achieved for rejecting hypotheses H02a and H02b, respectively established to evaluate the investment in project management training by the units of analysis and the amount of project managers certified as PMPs on them. For both metrics, the statistical analysis showed that the effort in training in project management has a statistically positive impact on projects operational results.

The ultimate goal proposed for this work addresses the analysis of the influences of the complexity of projects, where lower complex projects were expected to deliver better operational results, while more complex projects should be more difficult to get your results. This was achieved with the rejection of the H03 and the results presented. Through statistical analysis conducted was found that the complexity of the project has positive statistically impact on project operational results.

Thus, as seen in the theory of critical success factors on which this discussion is more to success than the failure of projects for the consolidated model presented in this paper is easier to explain project success (effectiveness of 91.40%) than failure in projects (20.11% efficiency). It was observed that all variables positively influence the likelihood of success of the operational results of the project. Since complexity is the variable that most influenced the overall success of a project, with a weight greater than the use of methods and training. It was found that complex projects have less chance of success, around 55% in relation to projects of lower complexity that have a chance of success of 70%.

The results also showed that when the project is less complex, the chance of operational success of it nearly doubles, increasing 80%.

Given the two models presented (for the most complex projects and for projects less complex), the model with the highest percentage of hits refers to less complex projects, but can only correctly predict every project a success. It is like noted: projects less complex signal operational success.

When the analysis is make using specific models for less and more complex projects, the chance of success of the model is larger than when using a single consolidated model for the two cases. This demonstrates the increasing importance of addressing the application of management concepts in organizations in a manner customized to the needs of the company and especially the needs of projects.

The consolidated analysis developed in this work showed that for highly complex projects, success is not influenced by training in project management and, less complex projects are not influenced by use of management methods.

However, it is worth investing in training for less complex projects. As shown, each R$ 100,000.00 increase in investment in training project management, the chances of operational success increase at 28%.

It was also found that for projects with failure, the mean level of implementation, investment in training and number of PMPs is very close to the most complex projects and less complex. As for successful projects, investment in training and the number of PMPs are much higher than for less complex projects. That is, less complex projects require a higher operational effort to succeed.

It is possible to say that for simple projects, structural aspects of project management still have their influence felt, but for more complex projects, they no longer influence both the practice and experience applied.

Nevertheless, the results obtained together with the overall effectiveness of the model in predicting operating results of the projects, the order of 64%, suggest that there may be additional variables to those studied in this paper to explain the success or failure of a project.

Finally, as observed in this work, it is possible to measure success in project management and the values obtained may be very close to reality, as was the case of the contingency model developed here, which showed an efficiency of 91% to predict the success of a project.

References

AIPM, AUSTRALIAN INSTITUTE OF PROJECT MANAGEMENT. **AIPM Professional Competency Standards for Project Management**. Sidney: AIPM, 2008.

ALA-RISKU, T., KARKKAINEN, M. "Material delivery problems in construction projects: A possible solution.", **International Journal of Production Economics** , Vol.104, No.1, pp.19–29, 2006.

APM, ASSOCIATION FOR PROJECT MANAGEMENT. **APM Body of Knowledge**. Buckinghamshire: APM, 2006.

ARCHER, N. P.; GHASEMZADEH, F. An integrated framework for project portfolio selection. **International Journal of Project Management**, v. 17, n. 4, p. 207-216, 1999.

ARCHIBALD, R. D. **Managing High-Technology Programs and Projects**. New York: John Wiley, 2003.

BARBER, E. Benchmarking the management of projects: a review of current thinking. **International Journal of Project Management**, v. 22, p. 301-307, 2004.

BELOUT, A.; GAUVREAU, C. Factors influencing project success: The impact of human resource management. **International Journal of Project Management**, v. 22, p. 1-11, 2004.

BESNER, C.; HOBBS, B. The perceived value and potential contribution of project management practices to project success. **Project Management Journal**, v. 37, n. 3, p. 37-48, 2006.

BESNER, C., HOBBS, B., "Contextualized Project Management Practice: A Cluster Analysis of Practices and Best Practices.", **Project Management Journal**, Vol.44, No.1, pp.17-34, 2013.

BIZAN, O. The determinants of success of R&D projects: Evidence from american-israeli research alliances. **Research Policy**, v. 32, p. 1619-1640, 2003.

BRYDE, D. J. Modelling project management performance. **International Journal of Quality & Reliability Management**, v. 20, n. 2, p. 229-254, 2003.

BUCHANAN, J. Measuring up. **PM Network**. Project Management Institute, 2008.

CHOU, J.S., YANG, J.G., "Project Management Knowledge and Effects on Construction Project Outcomes: An Empirical Study." **Project Management Journal**, Vol.43, No.5, pp.47-67, 2012.

COOKE-DAVIES, T. J. The "real" success factors on projects. **International Journal of Project Management**, v.20, p. 185-190, 2002.

CRAWFORD, L.; HOBBS, B.; TURNER, R. Project categorization systems and their use in organizations: An empirical study. In: SLEVIN, D. P.; CLELAND, D. I.; PINTO, J. K. **Innovations project management research**, Pennsylvania: Newton Square, 2004.

DAI, C. X.; WELLS, W. G. An exploration of project management office features and their relationship to project performance. **International Journal of Project Management**, v. 22, p. 523-532, 2004.

DVIR, D; LIPOVETSKY, S.; SHENHAR, A.; TISHLER, A. In search of project classification: A non-universal approach to project success factors. **Research Policy**, v. 27, p. 915-935, 1998.

DVIR. D.; RAZ, T.; SHENHAR, A. An empirical analysis of the relationship between project planning and project success. **International Journal of Project Management**, v. 21, p. 89-95, 2003.

EISENHARDT, K. M.; GRAEBNER, M. E. Theory building from cases: opportunities and challenges. Academy of Management Journal, v. 50, no 1, p. 25-32, 2007.

ENAA, ENGINEERING ADVANCEMENT ASSOCIATION OF JAPAN. **Model Form-International Contract for process plant construction**. Tokyo: ENAA, 1992.

GRAY, R. Organizational climate and project success. **International Journal of Project Management**, v. 19, p. 103-109, 2001.

HAIR, J. F.; ANDERSON, R. E.; TATHAM, R. L.; BLACK, W. C. **Multivariate data analysis**. New Jersey: Prentice Hall, 1998.

HENDRICKS, K.; SINGHAL, V. R. The long-run stock price performance of firms with effective TQM programs. **Management Science**, v. 47, n. 3, p. 359-368, 2001.

HONG, P., DOLL, W.J. REVILLA, E., NAHM, A.Y., "Knowledge sharing and strategic fit in integrated product development projects: An empirical study. **", International Journal of Production Economics** , Vol.132, No.2, pp.186-196, 2011.

IBBS, W.; REGINATO, J. **Quantifying the value of project management**. Project Management Institute Inc., Pennsylvania: Newton Square, 2002.

IBERT, O. Projects and firms as discordant complements: Organisational learning in the Munich software ecology. **Research Policy**, v. 33, p. 1529-1546, 2004.

IKA, L. A. Project success as a topic in project management journals. **Project Management Journal**, Four Campus Boulevard: Project Management Institute v. 40, n. 4, p. 06-19, 2009.

IPMA, INTERNATIONAL PROJECT MANAGEMENT ASSOCIATION. **ICB – IPMA Competency Baseline**. Nijkerk: IPMA, 2006.

JUGDEV, K; MULLER, R. A retrospective look at our evolving understanding of project success. **Project Management Journal**, v. 36, n. 4, p. 19-31, 2005.

KATZ, R.; ALLEN, T. J. Project performance and the locus of influence in the R&D matrix. **Academy of Management Journal**, v. 28, 1985.

KENDRA, K.; TAPLIN, L. Project success: A cultural framework. **Project Management Journal**, v. 35, n. 1, p. 30-45, 2004.

KERZNER, H. **Project management** – A systems approach to planning, scheduling, and controlling. New York: John Wiley & Sons, 2001.

KESSLER, H.; WINKELLHOFER, G. **Projekt-management:** Leitfaden zur steuerung und fuhrung von projekten. Heidelberg: Springer, 2002.

LARSON, E; GOBELI, D. Significance of project management structure on development success. **IEEE Transactions on Engineering Management**, v. 36, n. 2, p. 119-125, 1989.

LING, F. Y. Y. How project managers can better control the performance of design-build projects. **International Journal of Project Management**, v. 22, p. 477-488, 2004.

LIPOVETSKY, S.; TISHLER, A.; DVIR, D.; SHENHAR, A. The relative importance of project success dimensions. **R&D Management**, v. 27, n. 2, p. 97-106, 2005.

MARCONI, M.; LAKATOS, E. **Fundamentos de metodologia científica**. São Paulo: Atlas, 2003.

MCHUGH, O., HOGAN, M., "Investigating the rationale for adopting an internationallyrecognised project management methodology in Ireland: The view of the project manager. ", **International Journal of Project Management**, Vol.29, No.5, pp.637-646, 2011.

OGC, OFFICE OF GOVERNMENT COMMERCE. **PRINCE2 – Projects in Controlled Environments**. Londres: OGC, 1996.

PINTO, S. A. O. **Gerenciamento de projetos:** Análise dos fatores de risco que influenciam o sucesso de projetos de sistemas de informação. Dissertação de Mestrado. Departamento de Administração da Faculdade de Economia, Administração e Contabilidade da Universidade de São Paulo, São Paulo, 2002.

PMI, PROJECT MANAGEMENT INSTITUTE. **A Guide to the project management body of knowledge (PMBoK Guide)**. Fifth Edition. Project Management Institute, Four Campus Boulevard, Newtown Square, 2013.

PMI, PROJECT MANAGEMENT INSTITUTE. **PMI today June 2009**. Project Management Institute, Four Campus Boulevard, Newtown Square, 2009.

RAZ, T.; SHENHAR, A. J.; DVIR, D. Risk management, project success, and techonological uncertainty. **R&D Management**, v. 32, n. 2, p. 101-109, 2002.

REPISO, L.; SETCHI, R.; SALMERON, J. **Modelling IT projects success:** Emerging methodologies reviewed. Technovation, Article in Press, 2007.

SHENHAR, A.; DVIR. D. Toward a typological theory of project management. **Research Policy**, v. 25, p.607-632, 1996.

SILVEIRA, G. A. **Fatores contribuintes para a maturidade em gerenciamento de projetos:** Um estudo em empresas brasileiras. Tese de Doutorado. Departamento de Administração da Faculdade de Economia, Administração e Contabilidade da Universidade de São Paulo, São Paulo, 2008.

SINGHAL, K, SINGHAL, J., "Imperatives of the science of operations and supply-chain management. ", **Journal of Operations Management**, Vol.30, No.3, pp. 237–244, 2012a.

SINGHAL, K, SINGHAL., J., "Opportunities for developing the science of operations and supplychain management. ", **Journal of Operations Management**, Vol.30, No.3, pp.245–252, 2012B.

SÖDERLUND, J. Building theories of project management: Past research, questions for the future. **International Journal of Project Management**, v. 22, p. 183-191, 2004.

THAMHAIN, H. J. Linkages of project environment to performance: Lessons for team leadership. **International Journal of Project Management**, v. 22, p. 533-544, 2004.

THE STANDISH GROUP INTERNATIONAL. **CHAOS Summary 2009**. Retrieved from http://www.standishgroup.com/ in Dec, 28th, 2009.

THOMAS, J., DELISLE, C. L.; JUGDEV, K. **Selling project management to senior executives**. Project Management Institute Inc., Newtown Square, 2002.

THOMAS, J.; MULLALY, M. **Researching the value of project management**. PMI. Pennsylvania: Newtown Square, 2008.

WHITE, D.; FORTUNE, J. Current practice in project management – An empirical study. **International Journal of Project Management**, v. 20, p. 1-11, 2002.

Appendix – Project Information

Type	Description
Project name	Name with which the project is known inside the organization. This information was changed by a sequential number for privacy reasons for the clients and for the organization itself
Period when the project where conducted	Measured in year and quarter of project start. The quarter information is presented as follow: ○ Q1: 1st quarter; period that comprehends the months of October, November and December of the previous year mentioned, according to the company fiscal year, that starts in October of a year and finish in September of the following year ○ Q2: 2nd quarter; period that includes the months of January, February and March ○ Q3: 3rd quarter; composed by the months of April, May and June ○ Q4: 4th quarter; comprehended by the months of July, August and September
Degree of implementation	Degree of implementation of project management where it seeks to measure the proportion that the methods are introduced and are used
Investiment in training	Financial value of the investment in training in project management by the division that conducted the project
Number of project managers certified as PMP	Number of Professional certified as PMP by the PMI in the division, not necessarily in the conduction of the specific analyzed project
Project cost variation	Relative change of the budget increase, measured by the difference in monetary value of the original budget provided for the project in relation to the real budget at the end of the project, divided by the original budget
Project schedule variation	Variation of the relative increase of the project period, as measured by the difference between the original deadline and planned on day deadline of the project, divided by the original deadline
Project margin variation	Relative change of the margin of the project, measured by the difference between the final margin and the margin of the project originally planned, divided by the original margin
Project market segment	Market segment where the project where conducted. Presented in components, energy, industry, maintenance, medicine, oil and gas, security, information technology, telecommunications and transports
Country of project conduction	Country where the project was conducted: Argentina, Brazil or Chile
Project category	Measured in classification of projects by type, obtained by calculating a basket of indicators. It is presented in 4 categories: A, B, C and D