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RONALDO GOMES DULTRA DE LIMA

DOES ABSORPTIVE CAPACITY AFFECT PROJECT PERFORMANCE?

A study based on project management practices, organization learning, and knowledge

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Campo do conhecimento: Gestão de Operações e Competitividade

Orientador: Prof. Dr. Luiz Artur Ledur Brito
Coorientador: Prof. Dr. João Mário Csillag

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Banca Examinadora:

Prof. Dr. Luiz Artur Ledur Brito (Orientador)
FGV-EAESP

Prof. Dr. João Mário Csillag (Coorientador)
FGV-EAESP

Prof. Dr. Ely Laureano Paiva
FGV-EAESP

Prof. Dr. Orlando Cattini Junior
FGV-EAESP

Prof. Dra. Maria Thereza Pompa Antunes
Universidade Presbiteriana Mackenzie

Prof. Dr. Leandro Alves Patah
Universidade Nove de Julho

DEDICAÇÃO

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ABSTRACT

The literature has emphasized that absorptive capacity (AC) leads to performance, but in projects its influences still unclear. Additionally, the project success is not well understood by the literature, and AC can be an important mechanism to explain it. Therefore, the purpose of this study is to investigate the effect of absorptive capacity on project performance in the construction industry of São Paulo State. We study this influence through potential and realized absorptive capacity proposed by Zahra and George (2002). For achieving this goal, we use a combination of qualitative and quantitative research. The qualitative research is based on 15 interviews with project managers in different sectors to understand the main constructs and support the next quantitative phase. The content analysis was the technique used to analyze those interviews. In quantitative phase through a survey questionnaire, we collected 157 responses in the construction sector with project managers. The confirmatory factor analysis and hierarchical linear regression were the techniques used to assess the data. Our findings suggest that the realized absorptive capacity has a positive influence on performance, but potential absorptive capacity and the interactions effect have no influence on performance. Moreover, the planning and monitoring have a positive impact on budget and schedule, and customer satisfaction while risk coping capacity has a positive impact on business success. In academics terms, this research enables a better understanding of the importance of absorptive capacity in the construction industry and it confirms that knowledge application in processes and routines enhances performance. For management, the absorptive capacity enables the improvements of internal capabilities reflected in the increased project management efficiency. Indeed, when a company manages project practices efficiently it enhances business and project performance; however, it needs initially to improve its internal abilities to enrich processes and routines through relevant knowledge.

Keywords: Absorptive capacity; Potential and Realized absorptive capacity; Project management practices; Performance; Technical and Market performance.

RESUMO

A literatura tem enfatizado que a capacidade de absorção (AC) leva ao desempenho, porém, na área de projetos sua influência ainda não está claramente estabelecida. Além disso, o sucesso de projeto também não é bem entendido pela literatura, e AC pode ser um dos mecanismos para explicá-lo. Portanto, o objetivo deste estudo é investigar o efeito da capacidade de absorção no desempenho do projeto na indústria de construção civil do Estado de São Paulo. Estudamos essa influência por meio das capacidades de absorção potencial e realizada propostas por Zahra and George (2002). Para atingir esse objetivo, usamos uma combinação de pesquisa qualitativa e quantitativa. A pesquisa qualitativa está baseada em 15 entrevistas com gerentes de projeto em diferentes setores visando entender os principais construtos e apoiar a fase quantitativa. A análise de conteúdo foi a técnica utilizada para analisar essas entrevistas. Já na fase quantitativa, realizada através de questionário eletrônico, foram coletadas 157 respostas junto aos gerentes de projeto no setor de construção civil. As técnicas utilizadas para analisar os dados foram a análise fatorial confirmatória e regressão linear hierárquica. Nossos resultados sugerem que a capacidade de absorção realizada tem relacionamento positivo com desempenho, porém, a capacidade de absorção potencial e o efeito de suas interações não têm qualquer influência sobre o mesmo. Além disso, o planejamento e monitoramento têm impacto positivo no orçamento e cronograma, e satisfação do cliente, enquanto que a capacidade de ação sobre riscos tem influência positiva sobre o sucesso do negócio. Em termos acadêmicos, esta pesquisa permite melhorar a compreensão da importância da capacidade de absorção na indústria da construção civil e confirma que a aplicação de conhecimentos em rotinas e processos melhoram o desempenho. Para a gestão, a capacidade de absorção possibilita que melhorias das capacidades internas reflitam no aumento da eficiência de gerenciamento de projetos. Realmente, quando a empresa gerencia suas práticas de projeto eficientemente melhora o desempenho do negócio e dos projetos. No entanto, ela precisa inicialmente melhorar suas capacidades internas visando purificar as rotinas e processos através de conhecimentos que são relevantes.

Palavras-chave: capacidade de absorção, capacidade de absorção potencial e realizada, práticas de gerenciamento de projetos, desempenho, desempenho técnico e de mercado.

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LIST OF ABBREVIATIONS

AC	Absorptive Capacity
AMT	Advanced Manufacturing Techniques
AVE	Average Variance Extracted
BSC	Balanced Scorecard
CCMT	Completion Confidence Measurement Tractatus
CCPM	Critical Chain Project Management
CFA	Confirmatory Factor Analysis
CMV	Common Method Variance
D^2	Mahalanobis d-squared
EFA	Exploratory Factor Analysis
FMC	Flexible Manufacturing Competence
FMS	Flexible Manufacturing System
GOF	Goodness-of-Fit Statistics
HLR	Hierarchical Linear Regression
HPM	High Performance Manufacturing
IM	Integrated Manufacturing
IT	Information Technology
JIT	Just in Time
KI	knowledge Integration
MLE	Maximum Likelihood Estimation
MRP II	Manufacturing Resource Planning
OM	Operations Management
PAC	Potential Absorptive Capacity
PLS	Partial Least Squares
PM	Project Management
PMO	Project Management Office
PMP	Project Management Practices
PMBOK®	The Project Management Body of Knowledge
RAC	Realized Absorptive Capacity
RBV	Resource-Based View
R&D	Research and Development
ROA	Real Options Analysis
ROI	Return on Investment
SCM	Supply Chain Management
SEM	Structural Equation Modeling
TBM	Time-Based Manufacturing
TOC	Theory of Constraint
TPM	Total Preventive Maintenance / Total Productive Maintenance
TP-TOC	Thinking Process of Theory of Constraint
TQM	Total Quality Management
WCM	World Class Manufacturing

CONTENT

1 INTRODUCTION

The project success is not well understood by the project literature. The lack of consensus about what is project success remains an open issue in this literature. Furthermore, some scholars recognize that this occurs because of its multidimensional criterion. This means that the project success should be assessed from different perspectives (Baccarini, 1999; De Wit, 1988; Lim & Mohamed, 1999), and the absorptive capacity (AC) can be one of the important factors able to explain it. Therefore, does absorptive capacity (AC) affect project performance?

Despite the importance of AC suggested by the literature as relevant factor for performance (Cohen & Levinthal, 1990; Jansen, Van Den Bosch, & Volberda, 2005; Lane, Koka, & Pathak, 2006; Zahra & George, 2002), the influence of AC on project success is still unclear. Moreover, it has been neglected by the project scholars. Hence, in this research, we assess the effect of AC on project success through project management practices (PMP). To evaluate this influence, we work with the main project practices such as planning and monitoring and risk management.

The literature has suggested that the AC is organizational learning capabilities, but only a few areas have explored its potential (Lane et al., 2006). According to some scholars, the AC enhance the companies' ability to assimilate new knowledge and doing things in a different way (Cohen & Levinthal, 1989), which means to refine the processes and routines (Lane et al., 2006). However, in project management, there is a lack of studies that analyze the effect of AC on project practices as well.

According to Cohen and Levinthal (1989, 1990, 1994), the term AC represents the company's ability to recognize the value of new information, then assimilate it and apply it to business goals. The literature also pointed out that AC corresponds the firm's ability to generate new knowledge (Cohen & Levinthal, 1989). However, the definition of the construct in the literature is still unclear; therefore, some scholars have proposed some conceptualization. For example, Zahra and George (2002) understand AC as dynamic capabilities and suggest to split the concept into two subsets of constructs such as potential absorptive capacity (PAC) and realized absorptive capacity (RAC). In this research, we work with the last two subsets of constructs because they comprise the essential dimensions of AC such as acquisition, assimilation, transformation, and exploitation proposed by scholars.

The literature also recognizes that AC provides benefits for companies when knowledge is accumulated in its operations, which in turn enhance their efficiency (Cohen & Levinthal, 1990; Lane & Lubatkin, 1998; Zahra & George, 2002). But to achieve this process Lane, Koka, and Pathak (2006) recognize that companies must pay attention to three characteristics to enhance AC efficiently such as improve the employees' skills, recognize the cumulative aspects of knowledge, and foster the structure of knowledge sharing.

In project management, the main aspects of AC as suggested by Lane, Koka, and Pathak (2006) are also little explored by the project literature. According to this literature, project management is an established management practice that aims to generate products and services through tools, techniques and practices based on knowledge and it is increasingly present in the business environment (Jugdev et al., 2007). Some authors see it as a specific practice in the business discipline (Besner & Hobbs, 2008b; Crawford, 2006) and has been treated by leading guides of knowledge in the project (Zwikael, 2009).

Furthermore, the PMP can be defined as a set of skills, tools or techniques used in achieving the project requirements (Atkinson, 1999; Besner & Hobbs, 2008b; Crawford, 2006; PMI, 2013). Hence, project management is an important field of practice (Crawford, 2005) and it has been used by organizations to implement their strategies in order to fulfill their organizational goals and objectives (Dinsmore & Cooke-Davies, 2006; Marques Junior & Plonski, 2011; Piyush, Dangayach, & Mittal, 2011). Implicitly, there is a concern with performance.

Even though the AC has close relationship with performance (Cohen & Levinthal, 1990; Lane & Lubatkin, 1998; Zahra & George, 2002), the study of how performance can be improved is still an open issue in the literature of both operations (Swink, Narasimhan, & Kim, 2005) as project (Besner & Hobbs, 2006, 2008a) due to the complexity of the construct (Ika, 2009).

In the construction industry, for example, the definition of performance success also remains unclear (Chan, 2001; Chan & Chan, 2004; Chan, Scott, & Lam, 2002). Hence, in project performance, we analyze the project success through two subsets of performance such as technical and market dimensions. The technical performance can be translated into the most common dimensions such as cost, scope, time, and quality (Atkinson, 1999; Aubry & Lièvre, 2010; Ika, 2009; Mahaney & Lederer, 2011) and market performance, which considers the trade aspects such as return on investment (ROI), profitability, sales, market share, contribution to technological leadership, contribution to employee retention, and customer satisfaction (Tatikonda & Montoya-Weiss, 2001; Thieme, Song, & Shin, 2003). However, there is no consensus in the literature regarding dimensions that improve performance (Ika, 2009). Therefore, the AC can be the mechanism to be explored aiming their understanding in the project performance.

In the operations literature, many authors have discussed and suggested that operational practices increase the performance (Besner & Hobbs, 2006; Flynn, Sakakibara, Schroeder, 1995; Flynn, Schroeder, Sakakibara, 1995; Kaynak, 2003; Kerzner, 2006; Nair, 2006; Swink et al., 2005; Voss, 1995). However, Besner and Hobbs (2006, 2008a) argue that the literature is unclear to point out which practices, in project management, have greater relevance to performance. In this research, we chose the planning and monitoring and risk management practices to understand this influence. Moreover, we analyzed the influence of AC on the PMP and performance relationship because the lack of studies in this area. For example, in the construction industry, although some scholars have suggested that practices lead to performance (Besner & Hobbs, 2008b), it is not clear yet how it occurs. Furthermore, Bassioni, Price, and Hassan (2005) and Olawale and Sun (2010) have pointed out that it is common to find unsatisfactory performance in the construction sector.

Regarding the discussion above, in this research we propose a combination of qualitative and quantitative research to address the main open issues. In qualitative research we expect to understand the process related to those constructs; in quantitative research to evaluate whether AC and PMP affect performance directly, and whether the moderation effect of AC influences positively the relation in relation to PMP and performance.

Additionally, we developed this research into the construction sector in São Paulo State. In only one case, we conduct the interview outside Brazil (e.g. Tennessee, USA) for qualitative phase with company D. In quantitative phase, the database were collected in São Paulo State from the Regional Council of Engineering and Architecture of São Paulo State (CREA-SP) and social network. Even though we have important companies in other states in Brazil, we focus on São Paulo State because of its importance to the country and its huge amount of companies in this sector.

Our qualitative results suggest that knowledge sharing is not a common practice in the construction industry, but the most important form of knowledge acquisition is through training and labor market. Regarding some practices under study, the sector emphasizes the importance of planning; however, pointed out that Brazilian professionals put more efforts on execution than on planning. In terms of risk management, the sector does not work with a sophisticated method to run or analyze risk.

We also confirm the technical performance dimensions such as cost, time, and quality as the most relevant to evaluate project performance in this sector. Furthermore, regarding market performance, the sector uses profitability indicators wherein gross margin emerges as the most important, sales, and customer satisfaction. This is consistent with previous literature (Chan, 2001; Chan & Chan, 2004; Chan, Scott, & Lam, 2002).

Additionally, our quantitative research suggests that the most relevant mechanism to achieve superior performance is the knowledge application by the construction company, by means the RAC. But potential absorptive capacity shows no direct effects on performance. This result is consistent with the literature that suggests that PAC has an influence on performance through RAC (Jansen et al., 2005; Yeoh, 2009). However, the interaction effects (moderator effect) have proven no relevant to performance.

Furthermore, some PMP such as planning and monitoring and risk coping capacity have a positive influence on performance. Planning and monitoring have shown significant and positive impact on budget and schedule and customer satisfaction. This result is in line with Doloi (2013) that shows that planning and monitoring have a positive influence on cost performance in construction industry.

By contrast, risk coping capacity has proven only influence on business success. Surprisingly, it has neither shown influence on budget and schedule nor on customer satisfaction. These mean that the action against risk does not impact on cost, time, quality, among others. Even though these results show the lack of interest in this sector regarding risk management, these are consistent with previous research. For example, Abdou (1996) suggests that the risk management is managed in the construction industry by unskilled employees; Akintoye and MacLeod (1997) suggest that fewer techniques are used in risk analysis in this sector.

On the other hand, our findings indicate that when a company puts efforts on these practices result in leverage performance both technical and market performance.

Finally, this research aims to corroborate with the AC literature, project management, and performance by analyzing their relationship, and understanding how those constructs are affected in the construction industry.

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1.1 Research Problem

Based on the discussion above, the research problem is based on three considerations. First, in the literature is unclear the contribution of AC for project management in the construction industry. Second, the literature has emphasized that operational practice leads to performance; however, in project management is also unclear what practices have more influence and in which dimension, for example, technical or market performance. Third, the literature has emphasized that performance is a multidimensional criterion; therefore, only technical performance is not enough to assess projects (De Wit, 1988). On the other hand, when we focus on the construction industry, the market performance construct is not clearly defined to assess projects in this sector. Moreover, these constructs are still an open issue in the literature due to their complexity (Ika, 2009). In short, this research aims to contribute to the literature in clarifying such problems.

1.2 Research Question

We organized this research around three general questions:

1) Does absorptive capacity affect project performance?
2) Does the moderator effect of absorptive capacity maximize the relationship between project management practice and performance?
3) What project management practices explain the project performance?

In addressing the first research question, we intend to understand the influence of absorptive capacity (AC) on project performance. In addressing the second research question, we try to explore more specifically the influence of AC to leverage the performance of project management practices (PMP) and in what forms it occurs. We propose to use absorptive capacity as a moderating factor in relation to PMP and performance.

Thereafter, through the third question we argue that adopting the PMP and following the rules influence positively on performance. Thus, this question tries to investigate whether practices in project management really have a positive relationship with performance. In addressing this research question, the goal regarding practices is the identification of which of them contribute to leverage performance. The literature argues that the prior knowledge not only influence other skills, but leverage them.

According to Yin (2014), when there are some questions that presuppose such an understanding, the case study and survey questionnaire strategies can be used as research methods. In this work, we used a combinative of qualitative and quantitative research.

1.3 Justification of the Choice of Sector

This sector was chosen for several reasons. From the point of view of the literature, in the construction sector there is no consensus regarding what practices in project management influence on performance (Chan et al., 2002; Jin et al., 2013). Other scholars understand that one of the reasons is that the constructs of performance measures are multidimensional and there are ambiguous definitions due to different perceptions (Chan & Chan, 2004; Chan et al., 2002; Ika, 2009).

In this sector, the traditional performance assessment is related to technical measures where the most common are cost, quality, and time (Chan & Chan, 2004; Chan et al., 2002). However, these measures are not sufficient to understand the whole impact on performance because this is a too restricted list (Chan et al., 2002). Regarding that argument, scholars have discussed other forms to assess performance in the construction sector, assuming both objective and subjective measures (Chan & Chan, 2004; Chan et al., 2002; Jin et al., 2013). The objective measures are related to tangible characteristics while the subjective measures are related to intangible characteristics (Chan et al., 2002).

Other factors are related to project management complexity in the construction sector. Baccarini (1996) argues that construction projects are very complex and become the most complex to manage since the World War II. This project complexity lies in the interactions between the organizational structure and the degree of operational interdependence. According to Sommer and Loch (2004), the complexity of projects comes from two dimensions such as the increasing size (number of influence variables that must be managed) and interactions between influence variables. Cicmil and Marshall (2005) pointed out three important aspects in construction projects for assessing complexity such as complex processes of communicative and power relating to project stakeholders, ambiguity and equivocality in defining the project performance criteria, and changeability over time. For them, the firms need to deal with the complexity and understand some factors like tensions and conflicts that impact on performance.

In this research, we define the project as the unit of analysis; therefore, we work with different type of projects such as commercial, industrial, heavy, residential, among others projects. But we recognize that depending on the level of project complexity, it requires more efforts, knowledge, and abilities from companies to run the tasks. However, we would have difficulty to focus on this type of project to collect data because the construction industry in Brazil is concentrated on small and middle companies (Schwark, 2006). Thus, the decision was not to focus on a specific project in this sector.

The third reason for choosing the sector is related to absorptive capacity. Gann (2001) suggests the construction firms acquire new knowledge from different published media and through interactions in their relationship networks. On the other hand, he has pointed out there are only few firms that have competences to acquire new knowledge from academic research. According to Gann (2001), this follows from the process of collaboration between that firms and the university researchers. By contrast, Kamal and Flanagan (2012) suggest that few studies have explored absorptive capacity in the construction sector. Therefore, this work aims to contribute to the literature in exploring the importance of the absorptive capacity to the construction sector and evokes the debate of this theme.

1.4 Dissertation Structure

Next, this work is structured as follows: in part two, we make a literature review on capabilities, absorptive capacity, operations management practices and projects management practices, and technical and market performance. In part three, we present the theoretical model and hypotheses. In part four, we describe the research methodology for the qualitative and quantitative research. In part five, we offer the results and discussion them, and in part six, the dissertation is concluded.

2 LITERATURE REVIEW

In this chapter, we provide the literature review of the main constructs under studies. Initially, we start with a brief summary of capabilities, and then we discuss the three main constructs related to our research; that is, absorptive capacity, project management practices, and performance. One caveat, in the section of project management practices, we started with the literature review of operational practices and their relationship with performance.

2.1 Capabilities

The study of company's capabilities has been a recurrent theme in the literature of operations as well as the strategy. The definition of the construct is still under study in the literature due to the profusion of meanings related to the topic that generates lack of consensus (Dosi, Nelson, & Winter, 2000; Pandža et al., 2003). However, Wu, Melnyk, and Flynn (2010) reported that there is consensus about the ability of a company to recombine the resources for specific purposes.

Many scholars propose the conceptualization of capabilities with focus on resources, routines, and skills (Coates & McDermott, 2002; Felin & Foss, 2005; Hayes & Pisano, 1994; Peng, Schroeder, & Shah, 2008; Pisano, 1994; Swink, 2000). However, Pandža et al. (2003) prefer to define the construct as unique and idiosyncratic processes resulting from the interaction in the company throughout its history. In line with this view, Amit and Schoemaker (1993) also agree about the idiosyncratic processes to define capabilities. They discuss them from the perspective of tangible or intangible knowledge through the interrelationship of company's resources.

Dosi, Nelson, and Winter (2000) understand capabilities from the context of organizational consciousness, which contribute to their development and implementation. Even though the authors also recognize the distinction between the construct and organizational routines, they point out that certain routines can be understood as capabilities. Therefore, capabilities are a bundle of resources, routines, and skills that provide the interaction with each other.

On the other hand, some scholars do not include the resources as capabilities. For them, the capabilities can influence the resources regarding a specific purpose. For example, Wu, Melnyk, and Flynn (2010) propose to define the construct as a bundle of capabilities such as skills, processes, and routines, in order to align the resources in response to specific problems. According to them, in a broader view, capabilities represent the strength of a set of skills and competencies by which allow resources to perform the tasks. This definition is in line with Teece, Pisano, and Shuen (1997) when referencing the way of performing activities.

Similarly, Ray, Barney, and Muhanna (2004) prefer to discuss the resources and capabilities in an interchangeable way. Additionally, as other scholars, they refer to resources and capabilities as tangible and intangible assets that enable the development and implementation of the company's strategies. This view is corroborated by Wu, Melnyk, and Flynn (2010). Even though the controversy among researchers about capabilities definition, they also agree about their importance to company's processes improvement.

According to some scholars, when the company's capabilities are embedded in their interrelated processes, they represent a source of competitive advantage. Pandža et al. (2003) and Wu, Melnyk, and Flynn (2010) argue that capabilities are skills that are not possible to transfer easily, but it is possible to do that with the resources. For Amit & Schoemaker (1993), the resources correspond to a number of factors controlled and managed by the company. According to those scholars, this is one way to influence on competitive advantage.

At the organizational level, some scholars understand the capabilities as a bundle of organizational routines (Peng et al., 2008; Winter, 2003). For Teece and Pisano (1994) and Teece et al. (1997), the construct represents the organizational or managerial processes around which things are done. Other scholars understand the capabilities as a pattern of how activities are performed by company to help it to achieve its goals (Ray et al., 2004).

On the other hand, Dosi, Nelson, and Winter (2000, p. 4) recognize that the qualification of "how things are done" is very vague; they prefer to define routines as an organized activity of repetitiveness. These definitions of routines are closely related to managerial or organizational processes of running the business. Teece et al. (1997) also highlight that these processes have three main purposes. First, coordination and integration of internal activities. Second, learning is related to repetition and experimentation process, and leading to implementation of faster and better jobs. Third, reconfiguration and transformation of the assets structure. The definitions of routines can be seen as a recurring process. Without the perspective of repeating, the understanding of routines is unacceptable (Becker, 2001). Therefore, routines are related to repetitive process at the organizational level.

The literature addresses the measurement of capabilities in the context of multidimensional measures of operational performance that includes cost, quality, delivery, and flexibility (Ferdows & De Meyer, 1990; Flynn & Flynn, 2004; Rosenzweig & Roth, 2004; Schroeder et al., 2011; Skinner, 1969). However, Peng et al. (2008) suggest measuring the construct as a set of routines. Yet, Avella and Vázquez-Bustelo (2010) also add environmental protection as an important competence. By contrast, Wu, Melnyk, and Flynn (2010) argue the construct should be evaluated under the scope of the commonalities and some reflective indicators of the company. Thus, the measurement of capabilities is still undefined by scholars due to their multidimensional context.

For resource-based view (RBV), the capabilities correspond to specific intangible assets. According to some scholars, the capabilities are developed internally by the company better than its competitor and cannot be bought outside (Hayes & Pisano, 1994, 1996; Swink, 2000). The capabilities operationalization is done through different perspectives that must be cultivated aiming to respond to market (Hayes & Pisano, 1994). For example, these authors suggest important capabilities for companies to compete in the marketplace such as production, logistics, R&D, continuous improvement, innovation, project management, among others. Boyer and Lewis (2002) and Krüger (2012) also suggest adding other dimensions such as speed and services to complement the capabilities.

Coates and McDermott (2002) analyze the construct from the perspective of competence. According to them, the capabilities can be structured when a company emphasizes certain skills, abilities, or technologies to hinder the equalization by its main competitors. This would allow the company to acquire an advantage in its target segment.

For Pisano (1994), the skills and expertise are due to the process of learning and organizational knowledge that were embedded in the organizational routines by the company.

From the strategic perspective, some basic capabilities operationalized through cost, quality, delivery speed, and flexibility are seen as competitive priorities (Hayes & Wheelwright, 1984; Wheelwright & Hayes, 1985; Wheelwright, 1984). The literature has pointed out that these studies have focused on the best practices and operational methods.

Additionally, another important capabilities such as innovation, only appears in conceptual studies because there is a lack of operational empirical studies (Ward et al., 1998). Recently, innovation has gained importance in the literature as the fifth competitive priority (Ahmad & Schroeder, 2002; Nair & Boulton, 2008). For Nonaka (1994), innovation must be understood as a process to generate and define problems, and how companies actively create the needed knowledge to solve them. Indeed, this is explained by absorptive capacity theory.

2.1.1 Absorptive Capacity

The absorptive capacity (AC) is a theory that aims to address the benefits generated through the process of organizational learning and, in turn, its influence on competitive advantage (Brown, 1997; Cohen & Levinthal, 1990; Fosfuri & Tribo, 2008; Zahra & George, 2002).

Some scholars have studied the AC from different perspectives. For instance, innovation (Tsai, 2001), interorganizational learning (Lane & Lubatkin, 1998; Lane, Salk, & Lyles, 2001), organizational learning through construction crisis (Kim, 1998), human capital and technological transformation (Keller, 1996), the knowledge integration (Grant, 1996; Van den Bosch, Volberda, & De Boer, 1999), combinative capabilities (Kogut & Zander, 1992), organizational culture (Khoja & Maranville, 2010), innovative capabilities (Eisenhardt & Martin, 2000), among others.

The term AC seemed in the literature in the 60's from the macroeconomic perspective. Adler (1965) discussed the construct from the standpoint of efficient allocation of capital as well as its adequate expected return. However, he did not discuss the AC from the organizational perspective and the benefits that the knowledge captured by firms can provide. But he recognized that some factors limit or negatively influence on AC such as uncertainties, the lack of knowledge, the lack of labor skill or expertise, lack of management experience, institutional limitations, and cultural and social constraints. For example, Adler (1965), in his words, pointed out that limitations that affect project performance:

> The lack of skills in the preparation and execution of projects is likely to increase the cost of investment; the lack of skills to operate new enterprises is bound to affect adversely the cost of operation and thus the rate of return. To overcome this absence of skills, training facilities for foremen and workers must be provided. This is an expensive and time-consuming task in which foreign assistance may be of some help. Adler (1965, p. 33).

The literature emphasized that the knowledge creation in the process of organizational knowledge can be decomposed into two accepted dimensions such as tacit knowledge and explicit knowledge (Grant, 1996; Nonaka, 1994). For Grant (1996), the tacit knowledge is associated with know-how, skills, and practical knowledge. In terms more specific, represents production tasks.

For Nonaka (1994), the tacit knowledge is related to the individual context that includes both cognitive and technical elements. The cognitive elements include personal characteristics such as schemata, paradigms, beliefs, and viewpoints in which the individual defines his position. On the other hand, technical elements include know-how, crafts, and skills applied to a specific situation (Nonaka, 1994).

The second dimension is related to explicit knowledge that correspond the knowledge acquired through past records such as database, libraries, and archives (Nonaka, 1994). In PM, for example, the lessons learned are included in this dimension. In line with this thought, Kim (1998, p. 508) suggested that "Tacit knowledge can be acquired only through experience such as observation, imitation, and practice." In the organizational context, the tacit knowledge represents prior knowledge base (Kim, 1998).

By contrast, the "Explicit knowledge is knowledge that is codified and transmittable in formal, systematic language" (Kim, 1998, p. 508). As we interested in understanding whether PMP influence on performance, the tacit knowledge or prior knowledge may has an important role in this context.

Cohen and Levinthal (1989, 1990, 1994), in their seminal papers, propose a new theory of how companies capture external knowledge and use it to achieve organizational objectives (Lane & Lubatkin, 1998). The authors suggest that prior knowledge and skills are relevant to companies and contribute to the assimilation of new knowledge and doing things in a different way (Cohen & Levinthal, 1989). Lane et al. (2006) still suggest that AC promotes the companies' ability to refine the process of doing things. This may be critical in helping to understand the effectiveness of project management practices.

To express such competence in perceiving, understanding, and applying new knowledge, Cohen and Levinthal (1989, 1990, 1994) proposed the term "Absorptive Capacity" (AC), which is the company's ability to recognize the value of new information, then assimilate it and apply it to business goals (Figure 1). This ability is related to the process of continuous learning (Tu, Vonderembse, Ragu-Nathan, & Sharkey, 2006).

However, Zahra and George (2002) propose a redefinition of the construct from the perspective of dynamic capabilities because they understand the definition proposed was incomplete. For them, the AC corresponds to a bundle of routines and processes of the company, which allows the acquisition, assimilation, transformation, and exploitation of external knowledge in order to generate a dynamic organizational capability. They still propose a new dimension; that is, the transformation that was neglected by Cohen and Levinthal (1989, 1990, 1994).

Narasimhan, Rajiv, and Dutta (2006) also agree with the vision of dynamic capability for defining AC, but they suggest that the company to absorb external knowledge efficiently depends on the level of its resources and capabilities. In this sense, they acknowledge the influence of the resources and capabilities to enhance knowledge utilization.

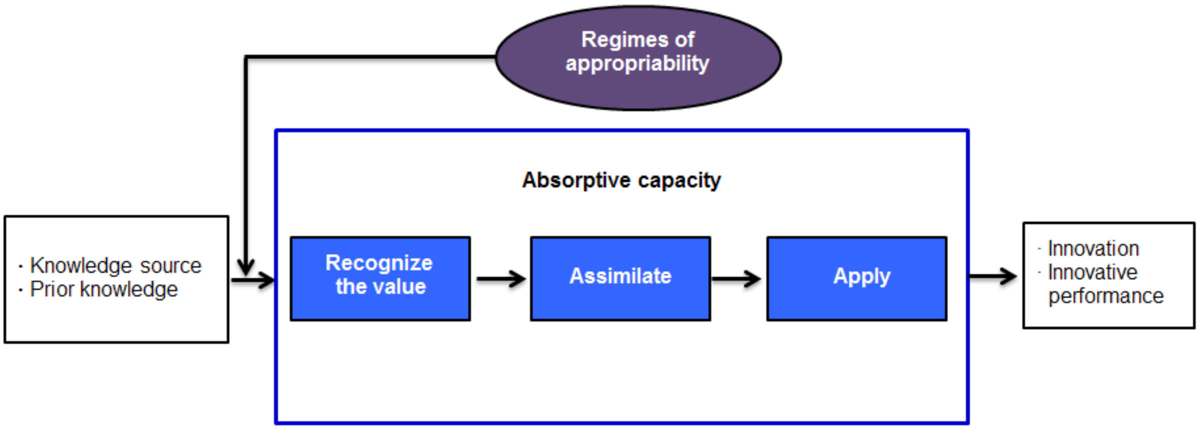

Figure 1 – A Model of absorptive capacity of Cohen and Levinthal (1990)
Source: adapted from Cohen and Levinthal (1990)

For AC theory, the prior knowledge is the determinant of AC and an important mechanism for developing new knowledge (Cohen & Levinthal, 1990; Lane et al., 2006). However, for Vega-Jurado et al. (2008), the determinants of AC were not clearly assessed by Cohen & Levinthal (1990) although they presented what factors influence on that construct. These scholars propose some factors to complement the determinants of AC such as organizational knowledge, formalization, and social integration mechanisms. The organizational knowledge comprises a bunch of knowledge, experience, and skills. Some scholars call it prior knowledge base (Cohen & Levinthal, 1990; Zahra & George, 2002). The formalization is related to rules, procedures, and instructions. The last, the social integration mechanisms are some practices responsible for increasing the interaction between members (Vega-Jurado et al., 2008).

In addition, Van den Bosch, Volberda, and De Boer (1999) still consider a new dimension neglected by Cohen and Levinthal (1989, 1990, 1994). They propose the integration dimension, and they understand that the construct complements the AC. This new dimension was based on the work of Grant (1996) that presents the concept of knowledge integration (KI) as the base of knowledge-based theory. The process of the knowledge integration corroborates to form the organizational capabilities, and he considers three characteristics in the KI process such as efficiency integration, scope integration, and flexibility integration (Grant, 1996).

Van den Bosch et al. (1999), in turn, use the KI definition as the base for defining the dimension of company's knowledge absorption. The list includes: (1) efficiency, in which comprises identification, assimilation, and exploitation knowledge, (2) scope, in which comprises the breadth of component knowledge, and (3) flexibility, in which comprises the level that a company accesses new knowledge and reconfigure its current knowledge base. For these authors, the prior knowledge, organization forms, and combinative capabilities are the determinants of AC.

However, the prior knowledge initially influences on the last two dimensions. The organization form is related to organizational structure and combinative capabilities are distinguished by three capabilities such as systems capabilities, coordination capabilities, and socialization capabilities (Van den Bosch et al., 1999). This definition extends the previous definition of AC. In other words, the integration process is responsible for leveraging AC.

The new approach of how companies acquire new knowledge and use it to their benefits has received so much attention in the two previous decades. For example, many scholars have acknowledged the importance of knowledge accumulation in operations to enhance their efficiency (Cohen & Levinthal, 1990; Lane & Lubatkin, 1998; Zahra & George, 2002). The AC corresponds the firm's ability to generate new knowledge (Cohen & Levinthal, 1989). Additionally, Lane, Koka, and Pathak (2006) emphasize three important characteristics to develop AC accordingly by companies. First, enhance the skills of their employees. Second, consider the cumulative aspects of knowledge. Third, promote the structure to share knowledge and have an efficient process of communication.

Mowery and Oxley (1995) analyzed the knowledge and technology transfer from outside and reported the importance in creating a domestic AC, R&D activities, and successful internal transfer technology. In their work, three important considerations emerged as the most important in obtaining knowledge and technology by companies. First, to exploit the knowledge and technology is more important than the channel sources used by companies to acquire technology from outside. Second, the national innovation system can influence in the early stages the process of transferring knowledge by encouraging the production and qualified workforce. In this vein, the qualified labor is important to explore new opportunities and technology externally. Third, the public policies and economy affect the technology transfer and competitiveness as a whole, which put pressure on domestic firms to improve their operations. In short, macroeconomic policies contribute to AC when affect the knowledge and technology transfer in a positive way.

Even though several studies provide interesting perspectives of how companies acquire knowledge from the environment to use it internally, Volberda, Foss, and Lyles (2010) understand that the utilization of the AC concept deserves more attention because it is not clear yet its full potential for the organization. For them, the concept has a broad perspective. In this vein, Jansen, Van Den Bosch, and Volberda (2005) also agree that AC is a multidimensional construct. In line with this thought, Zahra and George (2002) redefined the concept of AC as dynamic capabilities.

Other scholars have proposed the redefinition of AC. For example, Todorova and Durisin (2007) analyzed the model proposed by Zahra and George (2002) (Figure 2) and suggest extend it. However, they acknowledged a connection with the original model proposed by Cohen and Levinthal (1990). The assessment of Todorova and Durisin (2007) generates some important observations and contributes to enhancing the understanding of AC. First, the knowledge assimilation comes after the company recognizes the value of new information, as proposed by Cohen and Levinthal (1990). But the model proposed by Zahra and George (2002) does not recognize that. Second, the assimilation and transformation dimensions are interconnected that enable alternative processes. This observation contradicts the model proposed by Zahra and George (2002). Third, the appropriability regime moderates both knowledge source and competitive advantage. By contrast, Zahra and George (2002) only recognize the moderation effect on competitive advantage. Fourth, even though the Zahra and George (2002) model proposes AC under the context of potential AC and realized AC, it is not clear yet the definition of the potential AC (Todorova & Durisin, 2007). Fifth, Todorova and Durisin (2007) recognize that the social integration mechanisms affect the AC as a whole, but Zahra and George (2002) only understand as a moderating variable in the relation of potential AC and realized AC.

Zahra and George (2002) argue that the mechanisms of social integration may be an important variable in both knowledge assimilation and knowledge transformation by organization members. According to them, this is important from the standpoint of formal (coordination) and informal (social networks). However, the mismatch of Todorova and Durisin (2007) lie in how social integration is operationalized. They proposed AC as a set of organizational routines, like Zahra and George (2002), but suggest the contingency factor of social integration should influence not only the transformation of knowledge, but also the other components of AC (Figure 3). These scholars also recognize the power of relationships, which was neglected by Cohen and Levinthal (1990) and Zahra and George (2002) in the process of recognition and exploitation of external knowledge. Despite the conflicting ideas, the two last models offered an important contribution to AC theory.

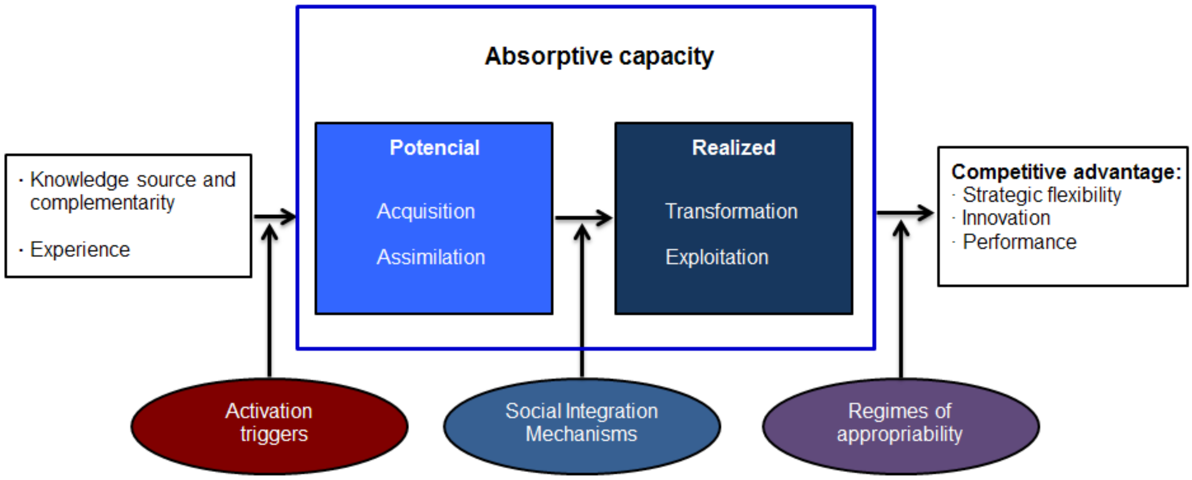

Figure 2 – A Model of absorptive capacity of Zahra and George (2002)
Source: adapted from Zahra and George (2002)

Lane and Lubatkin (1998) also propose a redefinition of AC offered by Cohen and Levinthal (1990). They suggest defining AC as a learning dyad when they study the construct in the interorganizational context; they analyze how firms interact in learning process. According to them, the learning dyad is determined by three characteristics of firms that learn from each other: (1) knowledge bases, (2) organizational structures and compensation policies, and (3) dominant logic.

By contrast, Tu et al. (2006) prefer to define the construct as a set of organizational mechanisms that enable the identification, communication, and assimilation of relevant internal and external knowledge. This definition suggests four dimensions to operationalize AC such as prior relevant knowledge, communications network, climate communications, and exploitation. However, those constructs were previously acknowledged by other scholars (Brown, 1997; Cohen & Levinthal, 1990; Van den Bosch et al., 1999; Zahra & George, 2002). Van den Bosch, Volberda, and De Boer (1999) even complement the concept of AC and suggest that the construct is not only determined by prior relevant knowledge, as some scholars pointed out, but through other two constructs such as organizational forms and combinative capabilities. The later construct was defined by Kogut and Zander (1992) as the application of current and acquired knowledge.

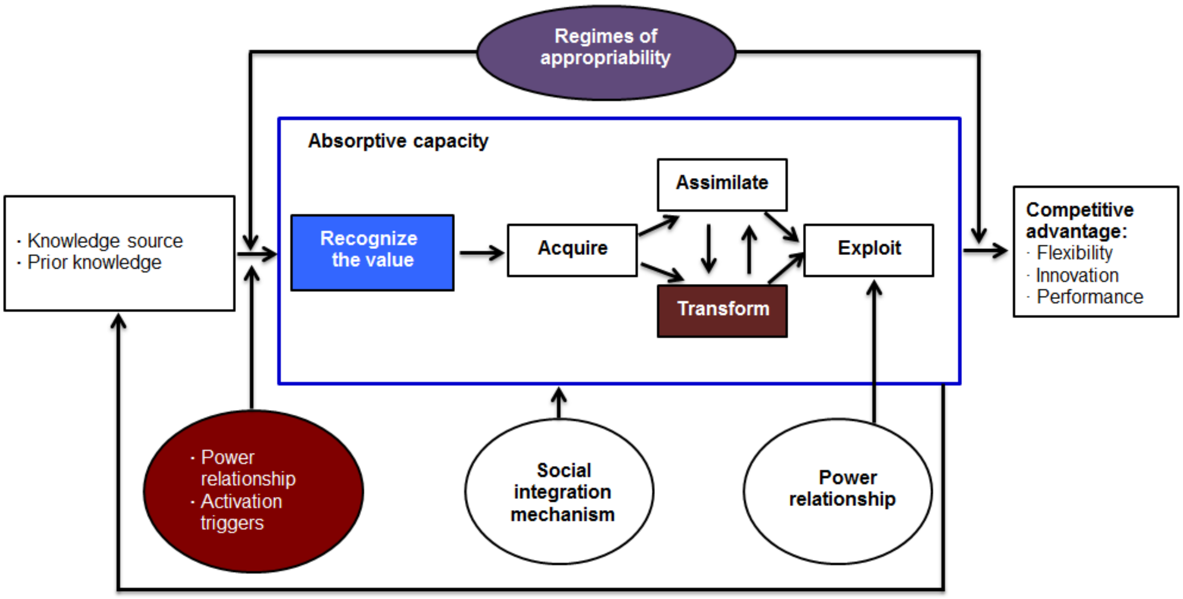

Figure 3 – A Refined model of absorptive capacity of Todorova and Durisin (2007)
Source: adapted from Todorova and Durisin (2007)

Kim (1998) recognized AC construct as an important dimension that contribute to enhancing the firm's knowledge. For him, the construct requires two important capabilities that include the learning capacity and the ability to solve problems by companies. The first capability is related to the knowledge assimilation; the second is related to the capacity to generate new knowledge. He suggested when a company proactively builds crises tend to enhance AC due to the new opportunities that it is facing. He still emphasized, "Top managers can construct a crisis internally, either in response to or in the absence of an external crisis” Kim (1998, p. 510). Thus, the internal or external crisis is a great opportunity for learning (Figure 4).

On the other hand, Tsai (2013) prefers to define AC as a result of the prolonged process of investment and knowledge accumulation. In the process, investments in R&D are prerequisite for generate AC (Cohen & Levinthal, 1990; Tsai, 2001). Thus, the generation of new information enables the company to assimilate and exploit existing information (Cohen & Levinthal, 1989). Additionally, Kogut and Zander (1992) still pointed out that the company only creates new knowledge through a recombination of its current capabilities. Cohen and Levinthal (1994) agree with this thought when they discuss that the company’s ability to explore external information is rooted in a bundle of interrelated capabilities to assess the potential knowledge. The company’s resources, in turn, are crucial for creating new expertise.

Lane et al. (2006) extend the AC concepts; however, maintain the same structure proposed by Cohen and Levinthal (1990). For them, the AC corresponds the company’s ability to apply external knowledge through recognizing and understanding their value through exploratory learning, assimilating it through transformative learning, and using the knowledge acquired to generate new knowledge through exploitative learning. They consolidate the Cohen and Levinthal’s dimensions into three perspective of learning: exploratory, transformative, and exploitative. The merit of these scholars is to formalize more clearly this complex construct.

According to Cohen and Levinthal (1994), one critical characteristic that is very important to AC is the knowledge accumulation. In this situation, two important components emerge such as the previously acquired knowledge and the cumulative of AC. The first component impacts on the current learning process; the second, enables greater efficiency in the expansion of AC in future periods. For them, companies that invest in AC adequately tend to evaluate the opportunities more quickly than other companies (Cohen & Levinthal, 1990). In other words, it enhances the proactivity of the company. Nevertheless, Lane et al. (2006) understand that AC has the cumulative and path-dependent aspects because requires the refinement of routines and processes.

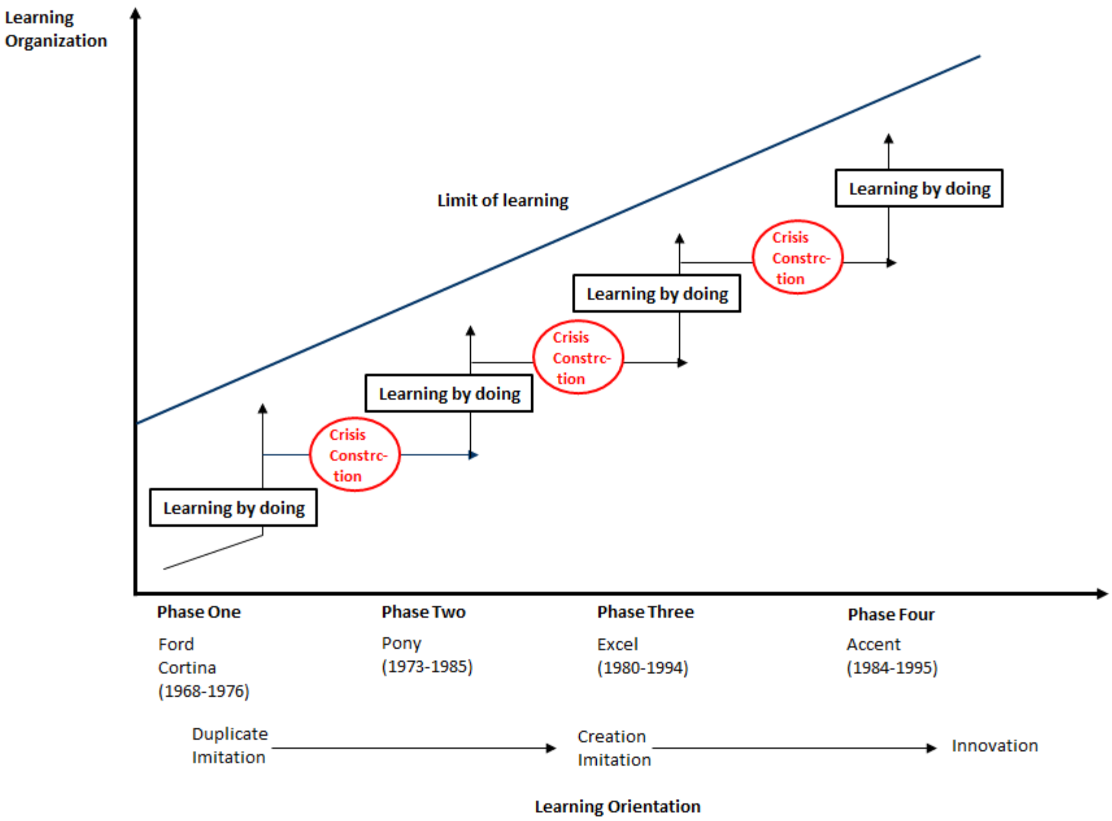

Figure 4 – Crisis construction and the shift of learning orientation
Source: adapted from Kim (1998)

The Chart 1 below presents some important definitions of AC and Figure 5 the main aspects of its evolution.

Construct	Definition	Dimension	References
Absorptive Capacity	The firms' competence to recognize new information and use it in order to their organizational goals.	Acquisition (recognizing the value, knowledge scanning), assimilation, and exploitation	Cohen and Levinthal (1989, 1990, 1994)
	Is an organization learning concept that focus on prior knowledge stock.	Prior relevant knowledge, communications network, and communications climate.	Brown (1997)
	Represents the learning capacity and the amount of energy expended by organizational members to solve problems.	Prior relevant knowledge base, Intensity of efforts.	Kim (1998)
	Comprises the process of evaluation, acquisition, integration, and the commercial utilization of new external knowledge.	Prior relevant knowledge, organizational form, and combinative capabilities.	Van den Bosch et al. (1999)
	The AC is due to the learning dyad where knowledge is transferred from company to company and vice versa.	Interorganizational learning within the alliance.	Lane and Lubatkin (1998), Lane et al. (2001)
	The AC comes from the lengthy process of investment and knowledge accumulation.	Intensity in R&D	Tsai (2001)
	Corresponds a set of routines and processes that enables a company to capture and use external knowledge in order to generate a dynamic organizational capability.	Potential AC (acquisition and assimilation), Realized AC (transformation and exploitation), and contingent factors (activation triggers, social integration mechanisms, appropriability regimes)	Zahra and George (2002)
	The organizational mechanisms enable the institutionalization of the internal and external relevant knowledge.	Prior relevant knowledge, communications network, communications climate, and exploitation.	Tu et al. (2006)
	The AC is a dynamic skill valued by the process of absorption of know-how considering the resources employed.	R&D competencies, marketing skills, and operations competencies.	Narasimhan et al. (2006)

Construct	Definition	Dimension	References
	Corresponds the ability to apply external knowledge through recognizing and understanding their value through exploratory learning, then assimilating it through transformative learning, and then using the knowledge acquired to generate new knowledge through exploitative learning.	Exploratory learning (recognize the value of new information), transformative learning (assimilate valuable external information), and exploitative learning (apply assimilate valuable external information).	Lane et al. (2006)
	Correspond a set of organizational routines, where the social integration factor affects all the components of absorptive capacity.	Acquisition (recognize the value), assimilation, transformation, exploitation, and contingent factors (activation triggers, social integration mechanisms, appropriability regimes, power relationships).	Todorova and Durisin (2007)
	Corresponds a routine-based model.	Metarotines.	Lewin, Massini, & Peeters (2011)

Chart 1 – Definition and dimensions of absorptive capacity
Source: elaborated by the author

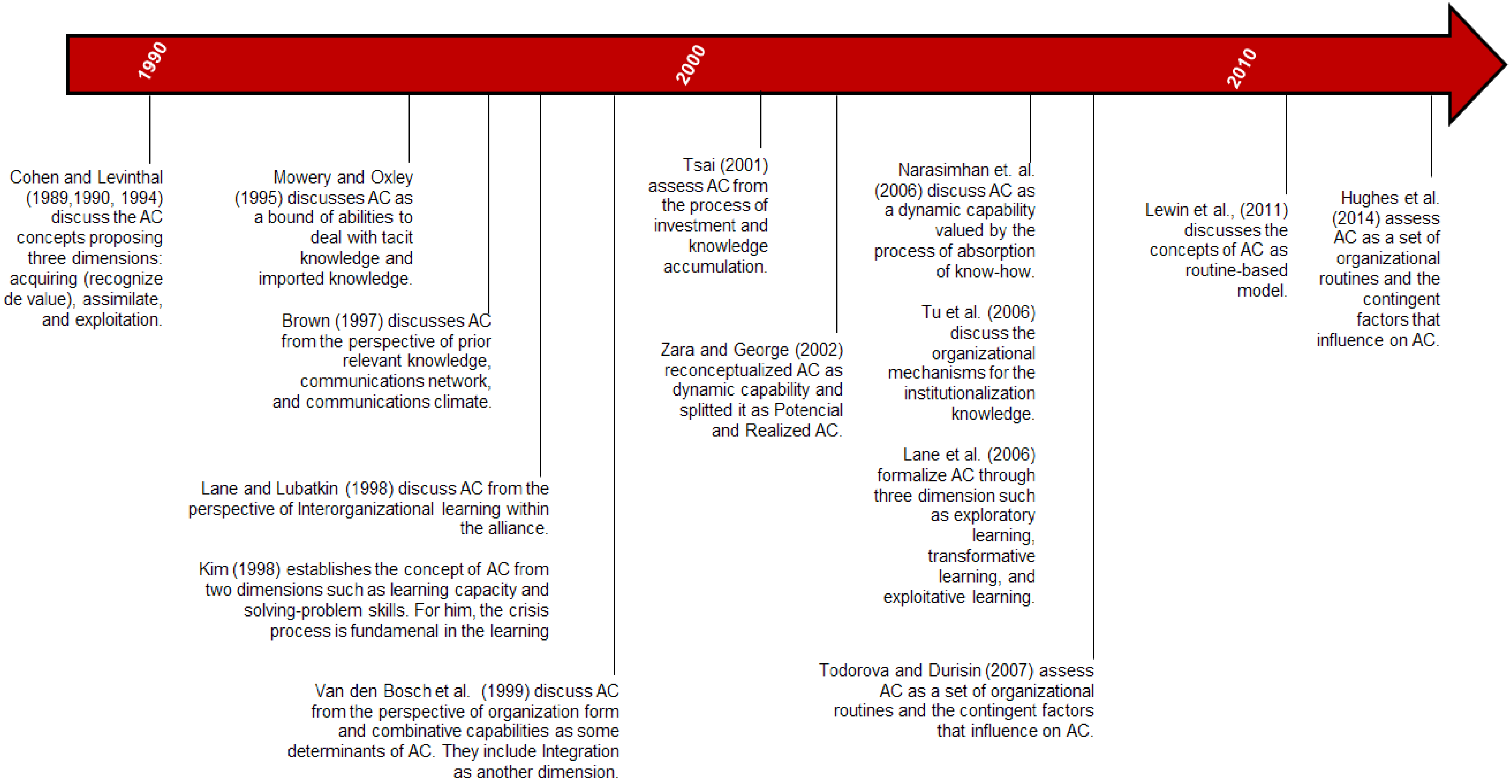

Figure 5 – The historical evolution of the absorptive capacity
Source: elaborated by the author

2.1.1.1 Potential and Realized Absorptive Capacity

Zahra and George (2002) suggested AC as dynamic capabilities and decomposed the construct into two subcategories: potential absorptive capacity (PAC) and realized absorptive capacity (RAC). These two subsets comprise four different dimensions of AC such as acquisition and assimilation for PAC and transformation and exploitation for RAC. According to them, these capabilities are complementary.

The literature suggests that proper management of AC dimensions impact on firm's performance. Zahra and George (2002) pointed out when a company closely pays attention to these dimensions, it is more likely to lead to superior performance. Additionally, Jansen, Van Den Bosch, and Volberda (2005) suggested that the knowledge stock is constantly refined when a firm focus on PAC, but increases its costs to achieve the new level of knowledge. According to Zahra and George (2002), PAC provides flexibility and freedom for firms to adapt quickly to the environment, and RAC is the main source of performance enhancements. It means when a firm focus on RAC tends to achieve a short-term profit, but neglects to respond quickly to the environment due to the lack of skills (Jansen et al., 2005).

However, Brettel, Greve, and Flatten (2011) prefer to discuss the influence of PAC on performance from the point of view of internal factors. For them, the internal factors such as the speed of decision-making, internal uncertainties, the tendency towards risk taking, and the entrepreneurial orientation are responsible for such impact from PAC on performance. By contrast, Cohen and Levinthal (1990) highlight that the relevant component to enhance AC and influence on performance is the prior knowledge. Thus, the ability to manage and apply the new knowledge from outside should be in balance with the firm's goals.

According to Leal-Rodríguez et al. (2014), the PAC captures efforts released in identifying and acquiring new knowledge from outside. This construct enhances the company's ability to explore the external relevant information (Fosfuri & Tribo, 2008). For Massini (2010), the main purpose of the construct is to capture the uncertainty related to the company's ability to explore new external information.

By contrast, the RAC comprises new insights and results from the combination of current and newly-acquired knowledge into operations (Leal-Rodríguez et al., 2014). In other terms, represents the ability to leverage acquired knowledge and transform it into innovation outcomes (Fosfuri & Tribo, 2008; Zahra & George, 2002). According to Zahra and George (2002), these two subsets (PAC and RAC) have complementary roles.

2.1.1.1.1 Acquisition

The first dimension of PAC is the acquisition and can be achieved in several ways. Cohen and Levinthal (1990, 1994) suggest that this is possible through investment in R&D, the involvement of manufacturing, or learning. However, the organization's AC depends on the AC of its individual partners (Cohen & Levinthal, 1990). According to them, the accumulation of knowledge, by the individual, depends on the prior investment by the organization. As learning occurs initially in the individual, the organization will be benefited from his knowledge transferred (Cohen & Levinthal, 1990).

Kogut and Zander (1992) corroborate with this argument expressing that, in the organization, the individual has the knowledge, but cooperates to share it among members of its social community. In line with this vision, Nonaka (1994) and Nonaka, von Krogh, and Voelpel (2006) suggested that the individual is responsible to develop its knowledge, but the organization is responsible to sediment and put the new knowledge into its processes. Kim (1998, p. 507) agrees with this thought. In his words, "Individual learning is therefore an indispensable condition for organizational learning but cannot be the sufficient condition". For him, the organizational knowledge should be incorporated into routines, processes, and practices.

Additionally, Keller (1996) reaffirms the importance of the individual when suggests that the higher level of human capital the easier will be the acquisition or assimilation the new technologies. This is in line with Narasimhan et al. (2006, p. 512) when declare that "The amount of know-how a firm can possibly absorb will depend on the level of its resources".

For Cohen and Levinthal (1990), the diversity of knowledge inside the organization is critical to learning or creating something relatively new.

2.1.1.1.2 Assimilation

The assimilation dimension corresponds to the company's process and routines that permit to recognize, analyze, process, interpret, and understand the new external information (Fosfuri & Tribo, 2008; Zahra & George, 2002). Three main abilities are emphasized by this dimension: (1) the ability to interpret, (2) the ability to comprehend, and (3) the ability to learn. Lewin et al. (2011) complement the idea by addressing that the assimilation of new knowledge occurs through transformative learning. This process provides the ability to generate new knowledge through the refinement of routines and processes, which engender desirable outcomes.

However, for being efficient in absorbing external knowledge, the company should have an organizational structure, which comprises the cognitive structures, basic skills, and shared languages (Fosfuri & Tribo, 2008). Furthermore, the cognitive structures enables to improve the knowledge absorption and assimilation (Cohen & Levinthal, 1990; Lane et al., 2006; Zahra & George, 2002), which means a linkage between organizational structures and prior knowledge.

Van den Bosch et al. (1999) pointed out that depending on the organizational structure different impacts can take place on AC. For instance, in functional form the impact expected is negative, but in divisional form the impact expected is moderate, and only in matrix form the impact expected is positive. However, they still pointed out that a specific organizational form can benefit from the knowledge absorption. For example, temporary task forces, standing committees, project teams, among others. In short, the project management structure (by project) can fit in this type of organizational form.

This process of assimilation of the new knowledge is grounded in a capability of understanding of new information and linking it to the prior knowledge base (Leal-Rodríguez et al., 2014). This process enables to purify the existing knowledge. Fosfuri and

Tribo (2008) call it the process of reinterpretation of knowledge. Furthermore, the diversity of knowledge inside the organization is crucial for learning or creating something relatively new (Cohen & Levinthal, 1990).

By contrast, the process of assimilation can occur through exchanging knowledge through members or entities. For example, some scholars understand that the knowledge assimilation occurs when the explicit knowledge from outside is translated into tacit knowledge (Kim, 1998). This occurs through knowledge sharing with experienced people and know-how from one to another company. Extending this idea, Zahra and George (2002) suggested that companies acquire knowledge from several ways, and this diversity is crucial because it impacts largely on acquisition and assimilation capabilities, the two dimensions of PAC. On the other hand, the resources and capabilities are responsible for the amount of knowledge assimilation by the company (Narasimhan et al., 2006). In short, the process of assimilation is affected by, for instance, the level of the human factor, routines, organization structure, and among others.

2.1.1.1.3 Transformation

The next dimension proposed initially by Zahra and George (2002) is transformation. This dimension corresponds the development and purification process of routines in order to conciliate the prior knowledge base with the newly knowledge acquired (Lane et al., 2006; Zahra & George, 2002). For Fosfuri and Tribo (2008) this dimension refers to the ability to change, adjust, and combine the external knowledge with existing company's knowledge. This, in turn, is responsible for generating new knowledge and outcomes.

The other way to understand this dimension is from the point of view of capability. According to Zahra and George (2002), the process of recognizing two inconsistent informations and adjust or combine them to form a new way of doing things, it can be seen as capability. For Todorova and Durisin (2007), this capability clarifies how companies change their schemas in order to absorb new knowledge. On the other hand, they recognize the transformation as process of the continuance of previous dimension (assimilation).

In the transformation process, the support from top management and the competence of the resources may be critical. For example, Spender (1996) addressed that the top management must provide the support for its employees to explore new ways, new rules, new contexts in a process of continuous improvement. Nevertheless, although this process improves knowledge, some mistakes take place as a result of learning development, which are part of the transformation routines.

In short, the transformation process is characterized by the action of putting in place the assimilated knowledge in combination with existing knowledge. As a result, it is expected that the outcomes, routines, and processes are improved.

2.1.1.1.4 Exploitation

The exploitation dimension has been discussed in the literature as the transformation of knowledge into a superior performance that, in turn, lead to competitive advantage (Fosfuri & Tribo, 2008; Zahra & George, 2002). This is the knowledge application (Camisón & Forés, 2010; Cohen & Levinthal, 1990). However, Cohen and Levinthal (1994) suggested that knowledge updating and exploitation functions require investment in AC, which in turn lead to enhancing the organizational capability.

Zahra and George (2002) prefer to treat the dimension also as organizational capability, in which the routines are responsible for knowledge exploitation. They suggested that the routines permit to purify, extend, and leverage the existing expertise or develop others by means of crucial knowledge. In short, the exploitation process is grounded in critically controlled internal competence (Cohen & Levinthal, 1994).

March (1991) suggested some terms for describing the exploitation dimension such as refinement, choice, production, efficiency, selection, implementation, and execution. For other scholars, the exploitation reflects the company's capability to add new knowledge to its operations (Gluch, Gustafsson, & Thuvander, 2009; Zahra & George, 2002). This occurs through internal resources and cognitive structure (Fosfuri & Tribo, 2008; Gluch et al., 2009). For example, Spender (1996) suggested the knowledge sharing among members as the effective way to transform and exploit knowledge by the company. Additionally, McGrath (2001) suggested that the variety of knowledge structures enhances the explorative learning. As a result, they provide the enhancement of organization exploitation.

In Chart 2, we present the definition of each dimension of AC. In Appendix A (Chart 19), we present another chart depicting in more detail other dimensions and subdimensions of AC.

2.1.1.2 Absorptive Capacity and Project Management

Organizations use projects to implement their strategies to achieve their organizational goals. Consequently, they need competent project managers (Dinsmore & Cooke-Davies, 2006; Piyush et al., 2011). Marques Junior and Plonski (2011) suggest that the projects are the drivers of changing, implementation of strategies, and innovations that affect competitive advantage. As a result, projects are closely affected by the AC.

Lane et al. (2006) suggest that the AC is one of the most important organizational learning capabilities, but only a few areas in science and technology have received much attention. In PM, for instance, is not clear yet the effective influence of related practices on performance. However, in operations management, many studies have found that operational practices influence positively on performance (Flynn et al., 1995; Ketokivi & Schroeder, 2004a; Sukati et al., 2012; Swink et al., 2005). But there is no consensus regarding which practice lead to superior performance. The next section, we discussed in detail these perspectives.

According to Kogut and Zander (1992), practices consist of procedural knowledge that enable companies to do things. For example, controlling factories, planning, scheduling production, among others. By contrast, Wu, Melnyk, and Swink (2012) prefer to think in terms of capabilities. For them, operational practices are defined as the standardized procedure. In PM, practices are consolidated in PM guides.

The AC influence on the procedures and management practices that are controlled by the company. For example, when the literature discusses the AC construct from the perspective of how companies can learn, develop, assimilate, and exploit new knowledge to improve their competition through innovative process (Cohen & Levinthal, 1990; Lane et al., 2006; Zahra & George, 2002), we have in turn a possible explanation why companies have a project success or not.

Despite such interest in the literature of AC, the relationships among PMP, firm's performance, and dimensions of AC are still unclear in project management. In addition, it remains unclear the extent of AC in construction projects.

The international construction environment is highly dynamic (Unsal & Taylor, 2011); however, in Brazil the industry still suffers from the lack of innovation (Schwark, 2006). In the international construction, the rapid technological change, in which the existing technologies become obsolete as well as the processes controlled by them, it requires organizational change (Unsal & Taylor, 2011). For example, new skills, new structures to respond quickly to its environment. According to these authors, the construction business has suffered in several ways due to this turbulent environment. The ability to respond quickly to this environment depend on the degree of AC to understand and interpret the changes in order to orient the innovative processes and policies focused on productiveness and innovativeness (Unsal & Taylor, 2011). As a result, it influences performance.

In the study, Unsal and Taylor (2011) suggested that the interaction networks are relevant to absorptive capacity in interorganizational construction project networks. According to them, the AC is higher in construction innovations than in modular innovations whether the relational network is stable. Nevertheless, it is not possible to say the same when relational stability decreases; in this case, AC is higher in modular innovations. As a result, the interactions between project teams affect AC. On the other hand, the authors did not discuss, in which dimension of AC the impact is more relevant.

The results can be explained by the integration process. Grant (1996a, p. 377) suggested that the "Integration of specialist knowledge to perform a discrete productive task is the essence of organizational capability, […]". As discussed above, the organizational capability is affected by the AC.

Extending this idea, Leal-Rodríguez et al. (2014, p. 898) pointed out that "Although it seems to be logical to consider knowledge sharing and integration as something critical for the project team's success, companies do not always foster this effectively." This can be explained by the cognitive structure and the degree of AC.

For example, the AC can be affected by the way construction companies acquire knowledge. According to Gann (2001), although the sector employs skilled staff, capable to analyze and interpret new knowledge provided by the academic research, only a few companies use this way of knowledge acquisition. Nevertheless, the majority of company search new knowledge from a wide range of mechanism such as published media, consultants, interactions through networks, technical education, among others (Gann, 2001) to affect the AC.

In the next section, we discuss some practices related to operations and project management and their relations with performance.

Construct	Dimension	Definition	It is achieved from	References
Potential Absorptive Capacity (PAC)	Acquisition	This is the firms' ability to identify or maps and acquire external knowledge through experience and investment that is important for them.	Hiring personnel skilled, hiring experienced people from outside, hiring of foreign engineer, contracting for consulting services, through corporate acquisitions, research labs, universities, with other firms (e.g., equipment and material suppliers), continued training, learning by doing, learning by using, ability to learn, job rotation.	Cohen and Levinthal (1989, 1990, 1994), Kim (1998), Zahra and George (2002), Jansen et al.(2005), Narasimhan et al. (2006), Todorova and Durisin (2007)
	Assimilation	This is the firms' ability to understand what really interest to them from the knowledge captured externally.	Comprehension, analyzing, processing, understanding.	Cohen and Levinthal (1989, 1990, 1994), Zahra and George (2002), Narasimhan et al. (2006), Todorova and Durisin (2007)
Realized Absorptive Capacity (RAC)	Transformation	This is the firm's ability to improve existing routines and combine the both internally and externally knowledge.	Through development of new schema or changes to existing process, problem-solving, modified knowledge, knowledge sharing, lessons learned, recodifications, synergy, auditing, and bisociation (the combination of two sources of knowledge for generating new knowledge, for example).	Kim (1998), Zahra and George (2002), Jansen et al. (2005), Todorova and Durisin (2007), Gluch, Gustafsson, and Thuvander (2009)
	Exploitation	This is the firm's ability to apply the knowledge acquired for generating new forms of doing things.	Improving the organizational competencies and better use of knowledge into its operations.	Cohen and Levinthal (1989, 1990, 1994), Kim (1998), Zahra and George (2002), Todorova and Durisin (2007)

Chart 2 – Dimensions of potential and realized absorptive capacity
Source: elaborated by the author

2.2 Operation Management Practices

The deterioration of the competitiveness of the U.S. market from the 60s (Hayes & Abernathy, 1980) and the serious problems faced by companies in the 70s and 80s. For example, low productivity, fierce foreign competition, large sectors still unregulated, and two shocks oil, which increased inflation rates. These problems were responsible for the reassessment of the American industrial process (Appelbaum, Bailey, Berg, & Kalleberg, 2000; Hayes & Wheelwright, 1984).

According to Hayes and Wheelwright (1984), internal factors related to management policies and practices followed by U.S. companies could explain the impact on productivity over this period. Hayes and Abernathy (1980) also emphasize that those companies were focused on product orientation rather than market orientation (customer focus). Lillrank (1995) also discusses that, in this period, the Japanese production capabilities and management were transferred to the United States (after that to Europe in the 80's) challenging their mass production system. This new forms of running the production systems put aside some prevailing paradigms like defects are inevitable, the trade-off between cost and quality, and penalty costs due to increased product variety (Lillrank, 1995). This new system showed that would be possible to deal with those paradigms altogether. According to Zhang, Vonderembse, and Cao (2006), the continuous improvement was the central characteristic of this system.

Skinner (1969, 1973) facing this scenario, writes two seminal articles which emphasize the necessity of companies to consider the manufacturing as a competitive weapon and put it in the context of their corporate strategies. This view was also ratified by Hayes and Abernathy (1980) and Wheelwright (1984) who recognize the importance of operations to have a central role in business as well as the need for their strategic alignment. This last point, if neglected, would lead to a lower performance both in manufacturing and in business (Joshi, Kathuria, & Porth, 2003; Voss, 1995). Voss (1995) also emphasizes that the combination of the alignment of manufacturing capabilities and the key success factors leads to maximization of competitiveness.

The concern with developing best practices and operational methods would become evident by the end of the 70s and the early of the 80s (Laugen et al., 2005), which focuses on improving efficiency (Benner & Tushman, 2003; Lillrank, 1995) and performance (Hayes & Wheelwright, 1984; Wheelwright & Hayes, 1985; Wheelwright, 1984). However, Ketokivi and Schroeder (2004b) suggest that the adoption of manufacturing practices should be taken into account strategic goals.

Regarding the operational practices and the operational performance, four dimensions have been usually used to evaluate the economic impact such as cost, quality, flexibility, and reliability (Ferdows & De Meyer, 1990; Flynn & Flynn, 2004; Ketokivi & Schroeder, 2004a; Rosenzweig & Roth, 2004; Schroeder et al., 2011; Skinner, 1969; Vickery, 1991). Chenhall (1997) also contributes to the debate by suggesting the use of manufacturing performance measures. According to him, these measures would allow a better assessment of operational practices such as total quality management (TQM).

The operational practices have a different meaning in the operations management (OM) literature. The construct is defined as inputs used by managers and workers aiming to obtain certain levels of performance (output) (Flynn, Sakakibara, Schroeder, 1995). On the other hand, Wu, Melnyk, and Swink (2012) define practices as capabilities of doing things. These authors also argue that operational practices are well-defined as standardized methods that enable easy manipulations. Consistent with this meaning, Wu, Melnyk, and Flynn (2010) characterize the operational practices as generic instructions aiming the resources combination. In summary, the operational practices can be seen as capabilities.

Further, Ketokivi and Schroeder (2004a) pointed out the operational practices and performance are prescribed factors that contribute to high performance and competitive advantage. Under the context of best practices, Laugen et al. (2005) define them as those that have a significant effect on performance. The practices are used by companies in order to leverage performance. By contrast, Wu, Melnyk, and Flynn (2010) suggest that operational practices are not sufficient to explain performance, but operational capabilities. This view is reinforced by Schroeder, Bates, and Junttila (2002) who prefer to credit the impact on manufacturing performance as a result of increasing operational capabilities when companies incorporating both internal and external learning. Consequently, according to some scholars, the overall performance of company has to do much more with better use of resources and capabilities than the implementation of operational practices.

The study of operational practices has been a recurrent theme in the OM literature that discusses their relationship with performance. Some scholars have discussed them in terms of efficiency, effectiveness, and operational performance (Flynn, Sakakibara, Schroeder, 1995; Flynn, Schroeder, & Sakakibara, 1995; Kannan & Tan, 2005; Ketokivi & Schroeder, 2004a; Lillrank, 1995; Mackelprang & Nair, 2010; Swink, Narasimhan, & Kim, 2005). Some operational approaches have distinguished themselves and received more attention from the operations area regarding their influence on performance (Kannan & Tan, 2005), for example, total quality management (TQM), just in time (JIT), and supply chain management (SCM).

This interest could be attributed largely to the success of Japanese techniques in terms of improving the process and the product (Laugen et al., 2005). However, Yang (2013) recognizes that the implementation of best practices contributes to the achievement of manufacturing goals, but only a few companies have adopted them in their production systems. So, as we notice above, performance could be influenced by the consistent attention to operational practices.

Swink et al. (2005) have analyzed some manufacturing practices (Figure 6) and their influence on performance. The study showed that the strategic integration plays an important role in relationships between manufacturing practices, capabilities, and performance. There is evidence that the best manufacturing practices are effective when complemented by the strategic integration. They have also observed that the strategic integration improves the cost efficiency and flexibility of new products, and positively impacting on market performance.

Additionally, the role of strategic integration is also relevant when evaluating the SCM practices. For example, Sukati et al. (2012) suggested that performance is affected when strategy and supply chain management practices are integrated.

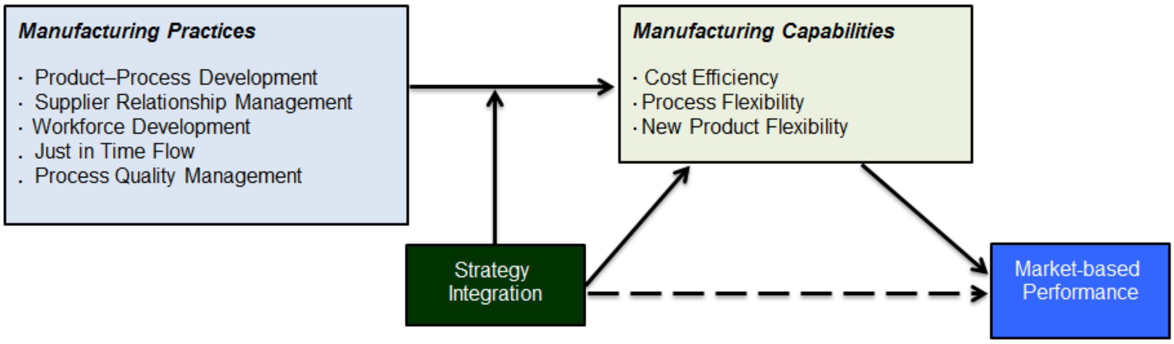

Figure 6 – Manufacturing practices and manufacturing capabilities
Source: adapted from Swink et al. (2005)

Ketokivi and Schroeder (2004b) when analyzed the influence of operational practices, pointed out that the operating performance is affected when some innovative manufacturing practices (lean manufacturing, JIT, and TQM) are implemented for the appropriate reasons. Their findings showed that operations and manufacturing practices are strategic, but only a few "best practices" contributed to manufacturing performance in several dimensions. According to them, the manufacturing structure is defined based on three proposition factors such as strategic contingencies, environment contingencies, and institutional (Figure 7).

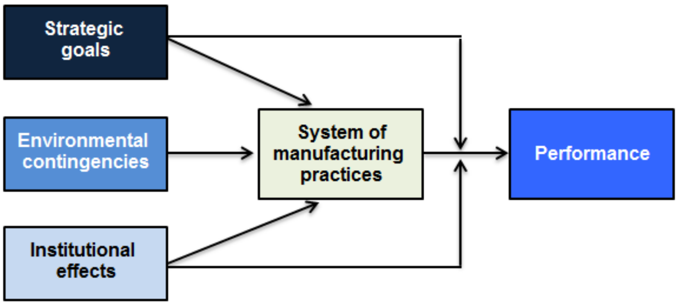

Figure 7 – Propositions that explain the implementation of manufacturing practices
Source: adapted from Ketokivi and Schroeder (2004b)

The lean production practices affect performance through reducing waste in the process. For example, this is possible by reducing process variance (Flynn, Sakakibara, & Schroeder, 1995). Lillrank (1995) pointed out that lean production practices must take into account critical success factors. The performance is affected by offering a variety of products, low cost production, high quality manufacturing, continuous improvement process, and rapid development cycle of products (Lillrank, 1995). In short, the lean production system provides effective ways of doing things.

Other studies have shown that the implementation of best practices improve performance. For example, Voss (1995) suggests that the companies that have implemented best practices tend to have superior performance in comparison to those that had not the same attention. Consistent with this view, Nahm et al., (2006) have found that companies with high level of time-based manufacturing practices (TBM) showed high level of performance when compared to companies with low attention to TBM. Thus, these scholars have shown a positive relationship between some operational practices and performance.

Simultaneously, the OM literature reports that the construct of operational practices is still in evolution regarding its definition and influence on performance. Wu, Melnyk, and Swink (2012) pointed out that the operational practices and operational capabilities are important concepts related to strategy and operational strategy, but they are not clearly defined yet, and there are ambiguities in their definitions. For example, Eisenhardt and Martin (2000) argue that best practices should be seen as dynamic capabilities. Others prefer to distinguish them in terms of achievement of superior performance (Beaumont, 2005). By contrast, Teece (2007) believes that best practices provide the implementation of activities, but do not allow companies to get results above their cost of capital or overcome their main competitors in a competitive marketplace.

Wu et al. (2010) and Flynn et al. (2010) already argue that performance variability could be explained by the operational capabilities, but not by the operational practices or resources. These authors define the construct operational capabilities as a competence that could enhance the employees' skills in order to develop products or services to fulfill consumers' needs. According to Yang (2013), the implementation of operational best practices positively impacts on the operational capabilities, which in turn enhance the manufacturing projects performance.

Swink et al. (2005) argue that there is ample space in OM literature for debating the relationship between practice and performance because of the complexity of the performance construct that requires better understanding. In short, for some scholars, the OM literature requires empirical research in order to understand some constructs due to their multidimensional view.

The OM literature has emphasized different forms of measuring performance. Ketokivi and Schroeder (2004a) also have evaluated issues related to manufacturing strategy and suggest working with three constructs in order to measure performance: goals, practices, and multidimensional performance. In line with the view, Schroeder and Flynn (2001) argue that for achieving high performance manufacturing (HPM), best practices should be chosen and adopted taking into account the company's problems. According to these authors, the integration between certain practices leads to HPM (Schroeder & Flynn, 2001, p. 5). For instance, Flynn, Sakakibara, and Schroeder (1995) pointed out that the integration of some practices can enhance the plant performance. In this study, they suggested that the combination of TQM and JIT practices generate synergies that affect positively performance.

This finding also is supported by the work of McKone, Schroeder, and Cua (2001) who observed that total preventive maintenance/total productive maintenance (TPM) influence various dimensions of performance; however, they cannot be evaluated in isolation, but in conjunction with other practices. According to these authors, the TPM practice contributes to leverage other dimensions such as cost, quality, and delivery.

Consistent with these findings, Voss (1995) agrees that quality contributes significantly to cost reduction. This can be seen by examining the quality management practices of processes that use tools associated to continuous improvement (Swink et al., 2005). The results have increased the efficiency, cost reduction, and customer satisfaction (Benner & Tushman, 2003). In line with the concept of continuous improvement, Westphal et al. (1997) define the construct from the point of view of learning. According to them, the construct is a routine that requires constant experimentation. Consistent with this view, Wu, Melnyk, and Flynn (2010) define the construct as operational processes that are refined by a distinct set of skills, processes, and routines.

Regarding the adoption of best practices by companies, Shah and Ward (2003) found a positive relationship between a set of lean practices and operational performance. This positive influence was also ratified by Wu, Melnyk, and Flynn (2010) when assessed world class manufacturing (WCM) practices by adopting some measures of operational performance (cost, quality, and flexibility). Consistent with these findings, Kannan and Tan (2005) analyzed the operational practices such as JIT, TQM, and SCM and suggest a positive relationship with performance. The finding has also support in the work of Cua, McKone, and Schroeder (2001) who consider the TQM, JIT, and TPM a bundle of operational practices that affect performance. Additionally, McKone, Schroeder, and Cua (1999) argue that the performance improvement, through a specific practice, requires great attention to the preventive maintenance system equipment.

The analysis of Mackelprang and Nair (2010) also presented positive influence on performance practices; however, it pointed out some inconsistencies. For example, some practices associated with JIT, analyzed individually, showed little influence on performance. Thus, this finding suggests new empirical studies. This finding also is supported by the previous study of Dean and Snell (1996) which showed little influence on performance for both advanced manufacturing techniques (AMT) and JIT. These researchers also suggest that companies had experienced improvement in performance after 18 months of implementation. According to them, this occurs because of companies do not take into account all aspects of integrated manufacturing (IM) practices among which include AMT, JIT, and TQM.

Ketokivi and Schroeder (2004a) also pointed out that JIT has a low impact on quality compliance when competitive aspects were considered. Pignanelli and Csillag (2008) also did not observe that the adoption of quality management practice improves corporate profitability. Kaynak (2003) suggested that lack of sponsorship from senior management contributes to quality practices failure.

According to Westphal et al. (1997), the results from the adoption of TQM practices vary as a function of time and type of implementation. Additionally, Voss (1995) discussed that the implementation of best practices does not guarantee improvements in performance.

He suggested that practices like TQM, MRP II (Manufacturing Resources Planning), JIT, flexible manufacturing system (FMS), and among others, when implemented partially, did not contribute to achieving the expected performance. Chenhall (1997) highlights that some practices have failed due to performance measures of manufacturing were not taken into account during the implementation.

The OM literature, in recent decades, has highlighted some operational practices that have contributed to improving the firms' performance. For example, quality management practices (Flynn, Sakakibara, Schroeder, 1995; Flynn, Schroeder, Sakakibara, 1995; Kaynak, 2003; Nair, 2006; Swink et al., 2005), production based on just in time philosophy (Dean & Snell, 1996; Flynn, Sakakibara, Schroeder, 1995; Ketokivi & Schroeder, 2004b; Sakakibara et al., 1997; Swink et al., 2005), functional cooperation (Ketokivi & Schroeder, 2004b), time-based manufacturing (TBM) (Koufteros et al., 1998; Nahm et al., 2003; Nahm et al., 2006), strategic integration (Swink et al., 2005), high performance manufacturing (HPM) (Schroeder & Flynn, 2001), world class manufacturing (WCM) (Flynn, Schroeder, & Flynn, 1999; Hayes & Wheelwright, 1984; Schonberger, 1986), integrated manufacturing (IM) (Dean & Snell, 1996), advanced manufacturing technology (AMT) (Dean & Snell, 1996), relationship with supply chain (Ketokivi & Schroeder, 2004b; Sukati et al., 2012), total preventive maintenance (TPM) (Cua, McKone, & Schroeder, 2001; McKone, Schroeder, & Cua, 1999, 2001), flexible manufacturing competence (FMC) (Zhang et al., 2006), among others. Thus, there are different perspectives trying to understand what kind of practices influence on performance the most.

The researches cited above provide evidence that the implementation of operational practices generates benefits to companies. This is possible by increasing efficiency, efficacy, and organization operational performance. However, it was observed the lack of consensus regarding practices affecting performance due to the inconsistencies pointed out by some scholars (Chart 3). These inconsistencies are related to the multidimensional criterion of measuring performance as pointed above.

Operational practices	Benefits generated based on literature	Constructs/Dimensions operationalized	References
Supply Chain Management (SCM)	Integration between buyers and suppliers improves material flow, reduces delivery times, allows the reduction of material costs, improves product quality, and responsiveness.	Supply chain integration, supply chain coordination, supply chain development, and information sharing.	Kannan and Tan (2005)
		Cross-functional cooperation, supply chain relationship (customer relationships), design for manufacturability, JIT (frequent delivery by suppliers, setup time reduction, pull system support), cross-training, and quality management philosophy.	Ketokivi and Schroeder (2004b)
		Lean supply chain, agile supply chain, and hybrid supply chain, strategic supplier partnership, customer relationship, information sharing, supply chain integration, supply chain flexibility, and responsiveness customer.	Sukati et al. (2012)
Total Quality Management (TQM)	Develop a corporate culture focused on customer, focus on continuous improvement, empowers employees, reduces process variation (statistical process control), focus on quality driven for the client, reduces the number of items requiring rework, reduces costs, reduces lead times, developing people; improve operational efficiency, and provides information to managers.	TQM practices: statistical process control, product design, and customer focus. Infrastructure practices: information feedback, plant environment, management support, supplier relationship, and workforce management.	Flynn, Sakakibara, and Schroeder (1995)
		TQM techniques: cross-functional product design, process management, supplier quality management, and customer involvement. Human and Strategic-oriented practices: committed leadership, strategic planning, cross-functional training, employee Involvement, and information and feedback.	Cua, McKone and Schroeder (2001)
		Management leadership, training, employee relationships, quality data and reports, supplier quality management, product/service design, process management, inventory management performance, quality performance, and financial and market performance.	Kaynak (2003)

Operational practices	Benefits generated based on literature	Constructs/Dimensions operationalized	References
		Material procurement programmes, production efficiency, improved cycle time, employee involvement in quality improvement programmes, involvement of functional personnel in strategy formulation, development of contact between manufacturing and customers, and coordination of quality improvements.	Chenhall (1997)
		Conformity, and efficiency and legitimacy.	Westphal et al. (1997)
		Product design, strategic commitment to quality, and supplier capabilities.	Kannan and Tan (2005)
Just in time	Improves quality performance, Identifies process problems, improves process feedback, reduces process variation, eliminates waste by simplifying the process, reduces setup times, controlling the flow of material, emphasizes preventive maintenance, eliminates or reduces the inventory (batch size reduction), uses resources more efficiently.	JIT practices: setup time reduction, JIT scheduling, kanban controls, and lot size reduction. Infrastructure practices: information feedback, plant environment, management support, supplier relationship, and workforce management.	Flynn, Sakakibara, and Schroeder (1995)
		JIT techniques: setup time reduction, pull system production, JIT delivery by suppliers, equipment layout, and daily schedule adherence. Human and strategic-oriented practices: committed leadership, strategic planning, cross-functional training, employee Involvement, and information and feedback.	Cua, McKone and Schroeder (2001)
		Material flow, commitment to the JIT, and supplier management.	Kannan and Tan (2005)
High Performance Manufacturing (HPM)	Positive impact on manufacturing performance (high level of production performance), improves innovative manufacturing practices, creates synergies within operations, enhances the coherence of operations, enhances supplier relations, permits to increase and	Manufacturing strategy, TQM, JIT, human resources, information systems, technology management, plant performance, plant environment.	Schroeder and Flynn (2001)

Operational practices	Benefits generated based on literature	Constructs/Dimensions operationalized	References
	emphasizes the number of initiatives, emphasizes many improvement programs simultaneously, and aligns manufacturing to business strategy.		
World Class Manufacturing (WCM)	Positive impact on manufacturing performance, pursues continuous improvement, and encompasses the concepts of TQM, JIT, and TPM.	Worker development, management technical competence, design for customer needs, employee involvement, proprietary equipment, continuous improvement, process control, information feedback, pull system, and JIT supplier practices.	Flynn, Schroeder, and Flynn (1999)
		Build the employee skills and capabilities, increase managerial skills, compete through quality, employee involvement, rebuild the production engineering, and continuous improvement approach.	Hayes and Wheelwright (1984)
		Employee involvement, continuous improvement, training (education), managerial competence, TQM, JIT, and TPM.	Schonberger (1986)
Integrated Manufacturing (IM)	Improves business performance, providing value to the customer through cost reduction, better products, and quick delivery. It increases quality and flexibility.	Advanced manufacturing technology (flexible manufacturing system and computer integrated manufacturing), total quality management, JIT, manufacturing strategy operationalized through quality, delivery flexibility, scope flexibility, and cost. Competition operationalized through munificence and complexity. Performance.	Dean and Snell (1996)
Total Preventive Maintenance / Total Productive Maintenance (TPM)	Maximizes the effective use of the equipment (improves efficiency), avoid/prevent unexpected breakages of equipment, effectives training improves the skills/abilities of operators (problem-solving), operators involvement as partners help to elevate the reliability and equipment performance, reduces costs in	TPM techniques: autonomous & planned maintenance, technology emphasis, and proprietary equipment development. Human and strategic-oriented practices: committed leadership, strategic planning, cross-functional training, employee Involvement, and information and feedback.	Cua, McKone and Schroeder (2001)

Operational practices	Benefits generated based on literature	Constructs/Dimensions operationalized	References
	the proceedings, improves the quality level and delivery process, improves the level of manufacturing performance.	Autonomous maintenance: teams, housekeeping, cross-training, and operator involvement. Planned maintenance: disciplined planning, information tracking, and schedule compliance.	McKone, Schroeder, and Cua (1999, 2001)
Time-based manufacturing (TBM)	Time process reduction, increases productivity, time response reduction to customer, possible increase in market share, risk reduction, enables charging a premium price, improves the level of customer service, increases the company's performance by reducing process time, increases the company competitiveness by increasing the speed of value delivery system.	Shop-floor employee involvement, reengineering setup, cellular manufacturing, quality improvement efforts, preventive maintenance, dependable suppliers, and pull production.	Koufteros et al. (1998); Nahm et al. (2006)
		Reengineering of set up, cellular manufacturing, quality improvement efforts, preventive maintenance, reliability of suppliers, and pull production.	Nahm et al. (2003)
Advanced Manufacturing Technology (AMT)	Provides cost reduction of manufacturing through process automation: manufacturing, assembly, and material handling. Improves process flexibility allowing products customization, and improves the quality level.	Total quality management, JIT, manufacturing strategy operationalized through quality, delivery flexibility, scope flexibility, cost, competition operationalized through munificence and complexity. Performance.	Dean and Snell (1996)

Chart 3 – Operational practices
Source: elaborated by the author

2.2.1 Project Management Practices

PMI (2013) defines project management (PM) as the use of knowledge, skills, tools, and techniques aiming to the project requirements. For Atkinson (1999), project management is the application of tools and techniques through various resources to meet a single and complex task considering constraints of time, cost, and quality. On the other hand, Williams (2008, p. 2) prefer a less technical conceptualization and more subjective. For him, the project management is the simplest way to look like a superhero, but without process contamination by the other few unreliable elements. Thus, project management is a technique to run projects.

The practice of PM is considered a specific area of management within the discipline of business management (Besner & Hobbs, 2008b; Crawford, 2006). These practices have been presented in the main guides of project management knowledge from institutions such as the International Project Management Association - IPMA and Project Management Institute - PMI (Zwikael, 2009). The most popular guide in project management is "A Guide to the Project Management Body of Knowledge" (PMBOK® from PMI) that consolidates project practices in ten areas of management knowledge, for example, integration, scope, time, cost, quality, human resources, communication, risk, acquisitions (Crawford, 2006; Morris et al., 2006; Zwikael, 2009), and, more recently, stakeholder management (PMI, 2013).

In the literature, we have found the different meaning of project management practices. The best practices in PM are defined as activities or replicable processes that consistently deliver value to the product project (Kerzner, 2006, p. 56). For Besner and Hobbs (2008a) and Crawford (2006), these practices are a bundle of tools or techniques used in the implementation of activities or processes. Williams (2008) notes that they bring benefits to the project when is possible to maintain: control, communication and collaboration in operation, the focus of the team members, stakeholders informed, track progress, and achieve the predefined goals. Even though the project management practices have a different meaning in the literature, it is clear that they bring benefits to the project management.

The Chart 4 highlights some project management practices identified in the literature.

The table below presents the most used tools and techniques in project management.

Activity list	*	Network diagram	**	Contract penalties
Baseline plan	*	Parametric estimating	**	Contractual commitment data
Client acceptance form	*	PM software for monitoring of cost	**	Cost-plus contract
Communication plan	*	PM software for resources leveling	**	Fast tracking / rapid implementation
Customer satisfaction surveys	*	PM software multiproject	**	Financial business benefits metrics
PM software for monitoring of schedule	*	PM software for cost estimating	**	Fixed-price contract
PM software for resources scheduling	*	Product breakdown structure	**	Gain-share contract
Project charter	*	Project communication room (war room)	**	Graphic presentation of portfolio
Quality inspection	*	Project website	**	Life Cycle Cost ("LCC")
Responsibility assignment matrix	*	Quality plan	**	Management reserve
Risk management documents	*	Ranking of risks	**	Medium-term post evaluation of success
Statement of work	*	Re-baselining	**	Monitoring critical success factors
Top-down estimating	*	scheduling/leveling	**	Multicriteria project selection
Work breakdown structure	*	Self-directed work teams	**	Needs analysis
Lesson learned/post-mortem	* #	Stakeholders analysis	**	Nonfinancial business benefits metrics
Requirements analysis	* # §	Team member performance appraisal	**	Organizational capacity analysis
Scope statement	* # §	Team building event	**	Program master plan
PM software for task scheduling	* # §	Work authorization	**	Project closure documents
Change request	* & §	Cause and effect diagram	***	Project management community of practice
Gantt chart	* & §	Control charts	***	Project mission statement
Kick-off meeting	* & §	Critical chain method and analysis	***	Project portfolio analysis
Progress report	* & §	Database of contractual commitment	***	Project priority ranking
Milestone planning	* §	Database of risks	***	Project procedures manual
Bid documents	**	Decision tree	***	Project scorecard/dashboard
Bid/seller evaluation	**	Monte-Carlo analysis	***	Project software for issue management
Bidders conferences	**	Pareto diagram	***	Project software for multiproject resource management
Bottom-up estimating	**	PM software for simulation	***	Project software for project portfolio analysis
Configuration review	**	Probabilistic duration estimate (PERT)	***	Project software for scenario analysis
Contingency plans	**	Quality function deployment	***	Project software Internet access
Cost/benefit analysis	**	Trend chart or S-curve	***	Project software linked with ERP
Critical path method and analysis	**	Life cycle cost (LCC)	***	Project war room

Database for cost estimating	**	Value analysis	***	Recovery schedule
Database of historical data	**	Assigned project sponsor	§	ROI, VAN, IRR, payback
Database of lessons learned	**	Contract documents	§	Stage gate reviews
Earned value	**	Assignment of risk ownership		Team development plan
Feasibility study	**	Business case		Timesheets linked to activities
Financial measurement tools	**	Business problem definition		Trend report
Graphic presentation of risk information	**	Change control board		Updated business case at gates
Learning curve	**	Concurrent engineering		

The * Indicates from limited to extensive use.
The ** Indicates from very limited to limited use.
The *** Indicates less than very limited use.
The # Indicates tools very valuable with potential to Increase performance.
The & Indicates tools very valuable but not used in its fullness.
The § Indicates the most used tools in project management.

Chart 4 – List of practices in project management
Source: Adapted from Besner and Hobbs (2006, 2008a, 2008b)

Projects have different features depending on the goals. For example, they are ranked according to their size, complexity, similarity, economic sector, by the type of contract, and among others (Andersen, 2006). Besner and Hobbs (2008a) also indicate that the project size is an important variable in defining the amount of project management tools to be used. For Besner and Hobbs (2006), projects are adapted to a specific situation, and research has also shown growing interest in practical projects that meet different projects and contexts (Besner & Hobbs, 2006, 2008b). Therefore, projects must be modeled to a specific situation.

The PM literature has extensively discussed the relationship between practice and performance. Companies implement best practices in project management in order to leverage the technical performance and create value to the business (Besner & Hobbs, 2006; Kerzner, 2006). The value is created when good design practice improve performance (Besner & Hobbs, 2006; Ling et al., 2009). Additionally, others suggested that the use of tools and techniques can influence on performance. For example, Besner and Hobbs (2006) also pointed out that the organizational learning and memory (requirements analysis, stakeholder analysis, scope statement, among other tools) have an influence on project performance. By contrast, Besner and Hobbs (2008b) highlight other characteristics to assess the project performance. For them, the maturity level of project management, the authority/empowerment project manager, and the availability of competent personnel are the most significant factors that enhance performance.

The project performance can be translated in terms of technical and market performance. In technical performance, the literature considers the attention to aspects such as cost, schedule, scope, and quality (Atkinson, 1999; Aubry & Lièvre, 2010; Ika, 2009; Mahaney & Lederer, 2011). Moreover, the technical performance is one of the most important goals to be achieved in the project running (Yang et al., 1997).

In market performance, some scholars understand that correspond to commercial aspects (Tatikonda & Montoya-Weiss, 2001; Thieme, Song, & Shin, 2003). These authors suggest some dimensions to evaluate market performance such as return on investment (ROI), profitability, sales, market share, contribution to technological leadership, contribution to employee retention, and degree of customer satisfaction.

In terms of technical aspects, the PM literature has defined some practices that comprise this dimension. Loo (2002) analyzed the designs of Canadian companies and identified some practices that are related to technical aspects. For example, project planning, scope management, project control, management system design and documentation, and skills (people-centered communication, and customer participation/stakeholder).

In engineering and construction, Besner and Hobbs (2008a) identified eight project management practices that contributed to the most technical performance (Chart 5). Ling et al. (2009) assessed the architecture, engineering, and construction industry in China and suggested that the managing scope practice emerged as the most important related to performance.

Zou and Lee (2009) observed that, depending on the industry, the practice of change management has a greater influence on the project running. For example, there is a greater concern to document the process of change management in the heavy industry projects; however, in the infrastructure and construction sector this is not a relevant practice to them.

Therefore, as we noticed above, the assessment of project performance has two important components such as technical and market aspects.

The chart below presents some tools and techniques used in engineering and construction.

Practices: Tools and Techniques	More Frequent	Utilization
Scope and requirements definition		
Scope statement	*	more
Requirements analysis	*	less
Project charter		less
Contract award		
Bid documents	*	more
Bidders conferences		more
Bid/seller evaluation	*	more
Organizing		
Communication plan		less
Team building event		less
Planning and control metrics		
Financial measurement tools	*	more
Estimating cost		
Database for cost estimating	*	more
Top-down estimating	*	more
Parametric estimating		more
PM software for cost estimating		more
Planning		
Quality plan	*	more
Critical path method and analysis	*	more
Control		
PM software for monitoring of cost		more
Earned value		more
Trend chart or S-Curve		more
Quality inspection	*	more
Control charts		more
Work authorization	*	more
Design		
Quality function deployment		more
Value analysis		more

The * indicates tools that are among the most frequently used on each type of project. Those without a * remain at lower use levels.

Chart 5 – List of practices used in project management in construction sector
Source: Adapted from Besner and Hobbs (2008a)

The PM literature suggests a positive relationship between PMP and project performance. However, Besner and Hobbs (2006, 2008a) pointed out that even though the implementation of best practices represents a critical factor for project success, there is still little information on what practices lead to superior technical performance. The lack of information related to this problem could be attributed to the little development of PM literature. For example, Yang (2013) argues that in manufacturing projects, the PM literature is still in its infancy in analyzing the impact on the implementation of certain key practices. Thus, there is space for analyzing the relationship between the two constructs in PM.

2.2.1.1 PMBOK® Guide and Critical Chain Project Management

The guides of knowledge in project management represent the standardized sets comprising standards, methods, processes, and practices recognized (PMI, 2013). Besner and Hobbs (2006, 2008a, 2012) also emphasize that these guides provide the key tools and techniques that constitute a bundle of best practices in PM. Moreover, Buckle and Thomas (2003) state that the PMBOK® represents project practices generally accepted, but "generally accepted" does not mean that they are appropriate.

Although the correct adoption of these practices is an important operational routine in PM, Christenson and Walker (2004) suggested that these partial influence on project performance. However, Rozenes et al. (2006) contradicted this view and pointed out that control practices enable the implementation of a pre-defined schedule. As a result, the project performance success depends on a proper planning.

In general, the PM methodologies provide a greater control of the execution activities. According to Crawford and Nahmias (2010), they are very rich in terms of theoretical foundation.

Among the main guides of knowledge in PM is "A Guide to the Project Management Body of Knowledge" (PMBOK®) (PMI, 2013), which corresponds to an alternative developed by scholars and professionals to manage projects. The PMBOK® Guide consists of knowledge of good practices in PM, which is very popular and widely accepted.

However, Bouer and Carvalho (2005) pointed out that it should not be applied uniformly to all types of projects. This is important because each project has its specificity. In line with this view, Rozenes et al. (2006) argue that project management methodology employed in the construction project should be different from those used in projects of high technology. Similarly, high complexity projects should use different methodologies when compared to simple projects. In summary, each project should have a specific PM methodology adapted to its needs.

Despite the popularity of PMBOK®, the critical chain has arisen as an alternative in PM. Eliyahu Goldratt concerned with the problems faced by the project management, developed another alternative called critical chain project management (CCPM) (Goldratt, 1997). This method is based on the concepts of thinking process (Kim, Mabin, & Davies, 2008) and the Theory of Constraints (TOC) (Goldratt & Cox, 1990; Goldratt & Fox, 1986) applied initially to mass production. This new philosophy for lean management aims to reduce delivery times for projects. In summary, the CCPM provides a new concept of running PM.

The use of TOC has a great influence on PM performance. Rahman (1998, 2002) argues that due to the existence of restrictions, there are opportunities for improvement and these restrictions under the TOC perspective are seen neither as positive nor negative. The constraints determine the performance because as the system bottleneck raises up, it influences directly on performance (Rahman, 1998, 2002). In projects, it means to protect the critical chain.

According to Stratton (2009), the adoption of CCPM became popular due to the problems faced in PM. Another reason, pointed out by this author, is related to the lack of a theory that supports the PM. Stratton still reported some examples of companies that used the CCPM with success such as a construction company Sunagogumi from Japan, Hewlett Packard, ABB, Delta, and among others. According to him, the CCPM provided clear benefits to those companies.

Some researches showed that in 95% of projects that applied the CCPM correctly, the deadlines and budgets previously defined were met (Balderstone & Mabin, 1998; Mabin &

Balderstone, 2003). Leach (1999) also states that the PM based on CCPM provides a substantial advance in continuous improvement when compared to the PMBOK®. According to him, it derives from the application of TOC and Statistics Theory to the project system. In summary, the researches provide good arguments in favor of the implementation of CCPM.

The concept of "critical path" established by the PMBOK® represents a sequence of planned activities, throughout the project, to account for the less time off. The project manager must give due attention to this sequence. According to Lechler, Ronen, and Stohr, (2005), the focus of critical path is to maximize the performance of the whole system through minimize the variance in the project. On the other hand, CCPM aims to potentialize the performance of the project as a whole. These scholars pointed out that CCPM gives much attention to running critical resources and planning them accordingly. On the other hand, the critical path neglects the importance of resources even though subordinate them into the critical path planning, and it does not consider the importance of bottleneck resource as well.

Unlike the critical path, Goldratt considered that CCPM depends on the existence of available resources and focus on to raise up the bottlenecks. Although this sequence of CCPM is similar to the sequence of the critical path, three major differences are highlighted by him: (1) the method to assess activity time, (2) the use of buffers, and (3) the concern to eliminate conflicts between resources (Watson, Blackstone, & Gardiner, 2007). Goldratt defines this method based on:

a) To reduce aggressively the tasks duration due to the estimates often hide security margin.
b) To scale holistically the safety margin for implementing the project and does not concern with individual tasks.
c) To highlight all the events that delay the project for team members.
d) To begin the task of the project when it is really time to start and not before.
e) To promote people's engagement in performing the tasks as quickly as possible.
f) To eliminate the resource conflict through the TP-TOC method.
g) To control the project buffer.
h) To consider the fundamentals of statistical fluctuation.

The bundle of principles defined by Goldratt for the CCPM is essentially normative and pragmatic such as the PMBOK®. However, what determines the success of this methodology can be assigned to a behavioral change, which justifies its adoption.

Although this methodology has its merits, Herroelen and Leus (2001) warn of the traps generated due to the problem to simplify estimates for scheduling and rescheduling. This occurs due to the estimates of buffer take into account 50% of the total estimate size, which can lead to the problem of overestimation of the buffer size of the design rule. But the methodology may be important and contribute to project performance.

2.2.1.2 Planning and Monitoring

The PMI (2013) defines planning taking into account process groups, which is the processes undertaken to establish the full scope of the effort, define and refine the objectives and develop the course of action necessary to achieve those objectives. Additionally, it defines the monitoring and controlling in the project as the process of monitoring, evaluation, and regulation of progress to meet the performance objectives defined in the project management plan.

For Williams (2008, p. 5), if a company fails in the planning phase it can be catastrophic for the project. In his words: “If you don’t plan at all, how will you know what you should be doing next? Similarly, planning once at the beginning of the project, and expecting just to be able to follow that plan, is both wonderfully naive and seriously dangerous.” Additionally, Perminova, Gustafsson, and Wikström (2008) see this practice as a key routine that supports other activities of the project such as risk identification, analysis, monitoring and control. Therefore, this is a relevant practice and whether the company does not pay much attention to it may jeopardize the project as a whole.

The PM literature has discussed the relationship between best practices and performance. Companies implement them to affect performance and create value for the business (Besner & Hobbs, 2006; Kerzner, 2006). Loo (2002) presents the top best practices in PM reported by companies and among them are effective scope management, effective project planning, and scheduling and controlling. However, Williams (2008) stated that best practices influence on project performance when is possible to maintain control the whole process in projects. Nevertheless, it is not clear yet, which practice influences on performance the most.

The CCPM has appeared as an alternative to problems faced by projects. These problems are related to delays that impact on performance. This methodology manages the critical resources very closely and planning them carefully (Goldratt, 1997). However, the critical path, by the PMBOK®, neglects the resources importance even though recognize them into the critical path planning, and it does not consider the importance of bottleneck resource as well (Lechler et al., 2005). In short, diverse methodologies treat planning differently.

In engineering and construction, Besner and Hobbs (2008a) identified eight project management practices that contributed to the most technical performance, among them, scope and requirements definition and planning and control. However, risk management does not appear as the utilization practice in this industry. Extending this idea, De Wit (1988) presented evidence that the construction industry pays close attention to some practices that enhance the probability to have a successful project. For example, planning effort (construction), planning effort (design), project manager goal commitment, project team motivation, project manager technical capabilities, scope and work definition, and control systems. As we notice, the planning and control are among the most relevant.

According to Raymond and Bergeron (2008), the better project planning, scheduling, monitoring, and control improve the efficiency and efficacy of managerial tasks. Additionally, Frimpong, Oluwoye, and Crawford (2003) argue that effective project planning, controlling and monitoring enhance project performance by minimizing or avoiding delay and cost problems in construction projects. For Baloi and Price (2003) the planning is the fundamental process in implementation the risk management that affect performance as well. However, the lack of planning and scheduling, in construction, generates the highest impact on cost performance from clients, consultants, and contractors' perspectives (Doloi, 2013). In line with this thought, Frimpong et al. (2003)

suggest that inadequate planning generates project delays and cost overruns, which in turn impacts on technical performance. In summary, the literature provides evidence that the planning and monitoring affect performance.

2.2.1.3 Risk Management

The risk management has received much attention in the literature in recent years due to the high level of uncertainties and factors that affect project and, in turn, performance (Fern & Zarei-Kesheh, 2011; Teller & Kock, 2013). According to Baloi and Price (2003), the main objectives of risk management is to mitigate uncertainties and enhance decision-making. Additionally, the risk management process is effective and cost-efficient when mitigate events caused by risk and uncertainty (van Staveren, 2014).

The risk is defined by the PMBOK® Guide as an uncertain event or condition that, if it occurs, causes a positive or negative impact on project goals (PMI, 2013). According to this guide, the project risk management includes processes related to risk management planning, risk identification, risk analysis, risk responses, risk monitoring, and risk control.

For some scholars, risk involves uncertainties and unforeseen factors. Uncertainties are unexpected events (Chapman & Ward, 2004; Fern & Zarei-Kesheh, 2011; Perminova et al., 2008) and factors are treated as opportunities or threats (Teller & Kock, 2013). In this vein, Akintoye and MacLeod (1997, p. 33) define risk as "[…] unforeseen factors that adversely affect the successful completion of the project in terms of cost, time, and quality." Other scholars understand risk and uncertainty as possible deviations from the estimated value (Creedy, Skitmore, & Wong, 2010).

Furthermore, Fern and Zarei-Kesheh (2011) stated that each project is full of uncertainties and normally the team members ignore events that effect cost estimations and their completion. Similarly, Chapman and Ward (2004) agree that uncertainty in projects implies risk. Geraldi et al. (2010) also highlight that unexpected events can negatively affect projects. Thus, the risk may cause potential problems in performance and requires a process that effectively deal with it.

Accordingly to Lee, Lee, and Li (2009), the company should develop a mechanism in order to judges the potential factors that influence on the project as well as their causal relation. The main objective of this process is to prevent potential losses by recognizing and managing threats and enhance the responsiveness to occurring risk (Teller & Kock, 2013). This process is related to risk transparency and risk coping capacity in management risk.

The risk transparency is defined as the company's ability to identify the major potential risk as well as recognize the source that can affect projects (Teller & Kock, 2013). The identification and recognition of risk in the project requires a systematic approach. For example, Akinci and Fischer (1998) suggest three features to deal with risk in project: (1) to identify the major sources of risk, (2) to evaluate the effects on projects, and (3) to find the way for controlling the risk. Additionally, Ohtaka and Fukazawa (2010) proposed a method for risk identification in order to detect symptoms of the serious problems in projects. According to them, risk problem has occurred due to multiple phenomena such as defective quality, delays, resource shortages, customer distrust, organizational issues, among others. Their method aims to analyze the cause and effect between those phenomena.

The other way to identify causes of problems in projects is through historical information. The lessons learned from previous projects are a good source of risk identification (PMI, 2013). Likewise, Holzmann (2012) point out that the lessons learned is a source of historical occurrences that provides a wide basis for analysis of potential risks. Khan (2014) agrees that lessons learned register actions that affected project performance. However, Robertson and Williams (2006) highlight that the lessons learned are rarely used by the project teams due to some reasons: (1) they do not recognize the validity of past learning, and this activity is seen as waste of time, and (2) there is no benefit in gaining from previous bad experiences. Thus, there are controversies in the literature regarding the potential benefits of lessons learned.

Lee, Lee, and Li (2009) understand the risk coping capacity as a mechanism to evaluate the potential effect and causal relations in projects due to unexpected factors. Similarly, Teller and Kock (2013) define risk coping capacity as the ability to recognize and act against occurring risks. The objective of this mechanism is to mitigate the major risk in the project through the identification and cope with potential factors (Lee et al., 2009). Crawford, Hobbs, and Turner (2005, p. 50) highlight that in contractor organization the problem to expose to high risk is critical. To deal with it, the procedures for high risk are specified and approved by a senior manager, and the company manages the potential risk by restricting the total amount of money it accepts in exposing. These procedures are related to project control.

However, in construction projects, even though the industry uses many techniques to control projects such as Microsoft Project, critical path method, program evaluation and review technique (PERT), among others, the industry still suffers with delay problems and cost overruns, which in turn impact on performance (Olawale & Sun, 2010). In line with this thoughts, Baloi and Price (2003, p. 265) argue that "Several formal techniques for managing the different types of uncertainty have been developed but there has not been any consensus on the appropriateness of such techniques so far." They still point out that, in construction, the risk management is managed based on perceptions such as experience and subjective judgement. These observations were endorsed by Akintoye and MacLeod (1997) who provide evidence that risk management is treated as amateurs by the sector. This is based on individual intuition, judgement, and experience from previous contracts.

Moreover, the industry does not recognize the risk management as valuable technique (Yoon, Tamer, & Hastak, 2014). Consistent with this thought, van Staveren (2014) argues that, in this industry, the risk management success is rarely reported.

Extending this idea, Abdou (1996) suggests that the top management, in this sector, also fails to use all tools available in order to control risk. He pointed out some reasons such as to overlook or underestimate construction risk and delegate to unskilled employees. However, when the risk is modulated by sophisticated techniques has proved successfully in assessment cost performance (Baloi & Price, 2003). In short, good tools matter.

The best practices in project risk management are important tools to deal with uncertainty in an effective and efficient manner (Chapman & Ward, 2004). For Wearne (2006), best practices mean a better allocation of resources accordingly an approved execution plan and budget. Additionally, Dikmen, Birgonul, and Han (2007) point out that the project success depend upon the company's ability to combine risks, response strategies used to reduce potential problems, and competence in managing risk. These strategies tend to manage risk properly.

The importance of the process of risk transparency and risk coping capacity is to mitigate and act against potential problems in projects that influence on performance. For example, in the construction industry, an important concern is associated with the influence of risk on common indicators of performance such as cost, time, and quality (Akintoye & MacLeod, 1997). However, van Staveren (2014) reported that is common to observe indicators applied in risk management that are neither efficient nor effective. For example, lack of clear objectives of risk management, difficult in monitoring risk, lack of risk transparency, inadequate risk reporting, among others.

In this industry, some scholars suggest that projects are economically risky due to their nature (Abdou, 1996; Creedy et al., 2010; van Staveren, 2014; Yoon et al., 2014). Thus, the potential risk is largely associated with its business environment such as business activities, rapid technological change, processes, and organization (Akintoye & MacLeod, 1997; Unsal & Taylor, 2011). But, for many companies, there are concerns about the environmental risks and their impact on projects, which require mechanisms to cope with them (Dione, Ruwanpura, & Hettiaratchi, 2005). In short, the industry needs to create adequate instruments to deal with risk in its environment.

Finally, in this research, we work with two project management practices such as planning and monitoring and risk management. The literature warns that the planning and monitoring represent the critical processes in projects, and the lack of attention to them can lead to project failure. The risk management has gained much attention in the project literature in recent years, but in construction has not received the same importance. Therefore, we evaluate risk management based on two constructs suggested by Teller and Kock (2013); that is, risk transparency and risk coping capacity.

2.3 Performance

In this section, we discuss factors that impact on project performance, and how the literature assesses performance in project management. Concerning to performance, we initially argue on factors that lead to project success as well as project failure; we contextualize them from the point of view of both strong and poor performance, respectively. Then, we discuss measuring performance in projects from the perspectives of both technical and market dimensions.

2.3.1 Factors that affect performance

The project literature has studied which factors affect performance, but there is no consensus regarding this construct. Some scholars understand it as a multidimensional dimension; it requires different views as well as the project success construct discussed below. Therefore, in this unit, we discuss the factors that compromise and leveraging projects.

The literature has pointed out that the poor performance of projects is due to a set of ineffective factors in project management. A survey by The Standish Group (data from 2008) showed that the success rate of projects (relating to time limits, budgets, and scope) had fallen to around 32%. Specifically, they had found that 24.0% of projects worldwide were canceled before completion, 79.0% did not finish on time, and 54.0% exceeded the initial budget (The Standish Group, 2009). Among the problems identified by this institute are insufficient collaborative work and technical problems. Regarding this last, they highlighted noncompliance to the initial scope, budgets, and deadlines that generate negative impacts on projects. Thus, the main problems are related to management and noncompliance to the technical aspects.

Other cases are reported in the literature regarding PM failures. For example, in the area of information technology (IT) (Keil & Mähring, 2010; Robertson & Williams, 2006).

Despite the efforts of scholars and professionals, Aubry and Lièvre (2010) discuss that there is much dissatisfaction regarding the theoretical issues related to PMP (project management practices). An important factor of this feeling stems from the success rate of projects that is very low both in public projects and in large corporation projects.

In this vein, the literature has emphasized some factors that contribute to low performance. For instance, Levasseur (2010) suggests that the main factors are the methods used by managers in change management process. He highlights that 65% of rate failure in projects are due to change management that is not well implemented, and the remaining 35% are related to technical problems (Levasseur, 2010; McManus & Wood-Harper, 2007).

Extending this idea, Savage et al. (2011) prefer to discuss poor performance in projects through technical aspects. According to them, those problems are originated in what is called the problem of averages. The estimates or reviews are defined based on averages (average cost, average maturity, average expenses, and among others), which lead to errors in estimates when compared to actual.

By contrast, one possible explanation for this high failure rate is suggested by Mahaney and Lederer (2011) who attributed to behavioral factors related to team members and factors inherent to PM. Similarly, Nokes and Kelly (2012) suggest that, in most of the time, poor performance can originate from cultural aspects and organizational factors. According to them, these aspects through the organizational structure or organizational style can influence on project performance through individual behavior. As a result, both cultural and technical aspects can generate problems in projects.

Shepherd et al. (2011) argue that the project failure is characterized by the closure of an initiative to create value to the organization, in which fell short of expectations. However, the closure of such an undertaking generates negative emotions in the members of the organization. These emotions are associated with low level of individual commitment to the organization. Shepherd et al. (2011) still suggest that the lessons learned arising from failure are neither instantaneous nor automatic, but depends on how the organization is positioned in relation to the event that occurred.

Blackstone Jr et al. (2009), Levasseur (2010), and Keil and Mähring (2010) also argue that other relevant factors corroborate with a decline in projects. For them, the non-involvement of stakeholders in the early stages of scope defining corresponds to the one of the main factors of failure. However, it is also important to understand other variables that affect these processes. For example, the lack of support from top management, the inability to obtain the commitment of users, the low commitment of the team members, and the stakeholders' disagreement with the direction of the project. In line with this view, changes that affect the scope also generate negative impacts on costs (Dinsmore & Cooke-Davies, 2006). This impact leads to noncompliance with the technical aspects. The researchers reported these factors as important contributions to low performance in projects.

Blackstone Jr et al. (2009) also emphasize that delays in traditional PM are normally related to management and skills factors. For example, lack of leadership, low user involvement, lack of competence and skill necessary for implementation, lack of communication between stakeholders and management, lack of top management support, insufficient definition of requirements (deadlines and infrastructure are incorrectly estimated), and among others. These factors are also responsible for poor performance in projects.

While such problems mentioned above are not attacked by an effective project management, these obstacles will continue and somehow affect the scaling of resources (e.g., financial, material, and human).

Even though we have good existing methodologies to run projects, for example, PMBOK®, critical chain, and among others, the lack of attention to their procedures affects performance. Aubry and Lièvre (2010) pointed out that the poor performance in projects can be explained by the lack of rigor in the application of practices and procedures suggested by these techniques. One form to minimize this problem is investing in education.

Likewise, Raz et al. (2003) suggest that the adoption of PM practice should invest massively in education at several levels of the organization to assimilate the new methodology. This is important because whether the project strategy failure can generate huge future problems, especially when they affect people's lives (Baker, 2002). The author mentions, for example, the exchange project fighter training by the North American Air Force in the 90s, which during the testing phase, generated accidents and deaths of pilots and instructors.

Finally, the problems mentioned above generate a violent rising costs for organizations, which impacts both in wasted resources and opportunities (Keil & Mähring, 2010; Mahaney & Lederer, 2011). Normally, those problems are generated due to a bad initiative in projects.

The understanding of the variables that impact on poor performance is critical because once identified they can minimize their influence on projects. As a result, scholars and professionals are seeking new practices, techniques, and new proposals for an appropriate PM (Kendra & Taplin, 2004). Practices should enable to fulfill the requirements of the project (Mahaney & Lederer, 2011) regarding both technical and benefits generated (Pinto & Slevin, 1988). Therefore, increase the rate success.

Since 2001, manufacturing companies have been evaluating new methods of PM to improve performance (Kendra & Taplin, 2004). These initiatives have focused on the growth of the PM capabilities. For example, to increase project manager skills for designing new metrics to evaluate individual performance, business processes, organization structure by the project, and management practices (Kendra & Taplin, 2004).

The communication is critical in the process of PM because it has a significant impact on team members. According to Henderson (2008), the project managers need to manage the communication, and when they encode or decode it efficiently, improves significantly the satisfaction and the productivity of team members. In line with this view, Ding and Ding (2008) also discuss ways to improve the PM focusing on the team members and communication. According to them, the collaborative process of decision-making through democratic negotiation is the key component in the process-oriented teamwork approach. They suggest starting the collaborative process at the beginning of activities when all team members work together to define the goals, scope, personnel, and logistics.

The chart below (Chart 6) shows a summary of the factors that influence on PM failure.

Construct	Causes / Factors that generate failure	References
Project management failure	Methods used by managers in the change management process.	Levasseur (2010)
	Insufficient collaborative work and technical problems of noncompliance scope, budgets, and deadlines.	The Standish Group (2001, 2009)
	Behavioral factors related to project team and factors inherent to project management.	Mahaney and Lederer (2011)
	Not involvement of stakeholders, lack of support from top management, inability to obtain the commitment of users, low commitment of the members of the project team, disagreement of the stakeholders as the direction of the project.	Blackstone Jr et al. (2009), Levasseur (2010), Keil and Mähring (2010).
	Delays in PM are related to the following factors: lack of leadership, low involvement of user, lack of competence and skill necessary for the implementation, lack of communication between stakeholders and management, lack of top management support, insufficient definition of requirements (deadlines and infrastructure are incorrectly estimated).	Blackstone Jr et al. (2009)
	Cultural aspects and organizational factors.	Nokes and Kelly (2012)
	The problem of averages: costs, time, ticket, expenses, and among others.	Savage et al. (2011)
	Uncertainties.	Fern and Zarei-Kesheh (2011), Mikaelian et al. (2011), Geraldi et al. (2010)
	Environmental and behavioral problems lead to the emergence disputes in projects: unfair allocation of risk, setting unrealistic goals by client, including time, cost, quality, unrealistic expectations of information, inadequate documentation, inappropriate forms of contracts, poor communication, rework, and late approval by manager.	Love et al. (2011)
	Lack of rigor in the application of practices and procedures suggested by methodologies.	Aubry and Lièvre (2010)

Chart 6 – Factors that generate project management failure
Source: elaborated by the author

On the other hand, some scholars prefer to discuss the managerial effectiveness through competencies of the project manager. Piyush et al. (2011) argue that the leadership skills linked to the human factors (good communication, decision-making ability, and integrity) are fundamentals for project success.

However, when we consider the program success and the assessment of such portfolio, the literature highlights its complexity. Shao et al. (2012), for example, suggest that the benefits generated by such portfolio can be classified in terms of financial, non-financial, tangible, or intangible features. The results indicate the programs success is concentrated in four basic dimensions such as delivery capacity, organizational capacity, marketing capability, and innovation capacity. The delivery capacity is related to tangible benefits, and the others are related to intangible benefits.

Therefore, a possible question would be whether a project would meet certain features of both technical and benefits generated it would be considered a success? In this case there is no consensus in the literature regarding the definition of what is success or failure in project due to the subject is its infancy (Ika, 2009; Pinto & Slevin, 1988; Shao et al., 2012). Another explanation has been discussed in the literature because the constructs of "success" or "failure" are multidimensional and have been analyzed from different perspectives. Therefore, it is possible to have other dimensions that can be added to analyze those constructs. To understand clearly this point, in the next section we discuss project success and project performance from the perspective of both technical and market performance.

In the Chart 7 below, we present some causes and factors that could impact on the project and lead it to success.

Construct	Causes / Factors that generate success	References
Project management success	Encoding or decoding efficient communication.	Henderson (2008)
	Leadership and competent project managers.	Dinsmore and Cooke-Davies (2006), Piyush et al. (2011)
	Successful programs are concentrated in four basic dimensions such as delivery capability, organizational capability, marketing capability, and innovation capability.	Shao et al. (2012)
	As for management, success lies in the idea that the most common dimensions such as cost, time, and quality must be achieved.	Aubry and Lièvre (2010), Ika (2009), Mahaney and Lederer (2011)
	Meet expectations of the key people in the organization such as project team, users, and customers.	Baccarini (1999), Baker, Murphy, and Fisher (2008), De Wit (1988), Rozenes, Vitner, and Spraggett (2006)
	Should be analyzed from two perspectives; that is, project management success and product success.	Baccarini (1999)
	Meet or bring to the planned estimates.	Martin, Pearson, and Furumo (2007)
	More effective participation of stakeholders in the project development and constant feedback from customers.	Eisenhardt and Martin, (2000)
	Achieve organizational objectives.	Belout (1998)
	Focus on the project team and in the communication.	Ding and Ding (2008)

Chart 7 – Factors that generate project management success
Source: elaborated by the author

2.3.2 Project Performance

In project literature, the success and failure of projects are still under debate. Indeed, it is not clear yet what dimensions lead to project success. This construct is multidimensional and analyzed from different perspectives. Conversely, the literature agrees that when the technical and market performance were met can indicate a project success. Then, in this section, we discuss this issue from these two performance perspectives.

According to Ika (2009), there is a fertile field of research aiming to the definition of the constructs above. Thus, there are enormous challenges to researchers. The author also points out that there is an ambiguity in the definition of project success. For example, the concept is multidimensional and applied in a specific environment, in which the project can be successful from the management perspective or of the result generated.

Extending this idea, Baccarini (1999) also believes that the construct "project success" should be analyzed from two perspectives such as project management success and product success (Figure 8). The first refers to the assessment of the process where cost, time, and quality must be met. The second is related to the results or benefits generated. Lim and Mohamed (1999) cite examples of projects in this category (e.g., the Concorde, the Sydney Opera House, and the first generation Ford Taurus car) that had unsatisfactory technical performance, but the results were generated above expectations. Therefore, project success is a construct that has a multidimensional perspective for assessment.

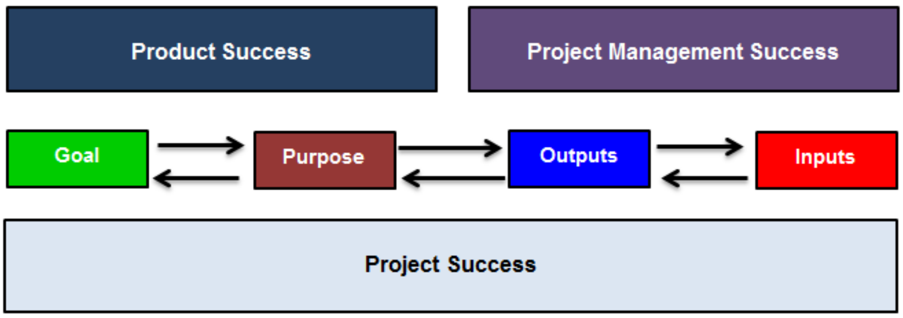

Figure 8 – Link between LFM (Logical Framework Method) and the project success
Source: adapted from Baccarini (1999)

Martin, Pearson, and Furumo (2007) argue that the projects should be taxed as success whether meet the planned estimates. For them, it would meet the budget and still have an acceptable level of performance. Contrasting this view, Lim and Mohamed (1999) argue the project success should be viewed from different perspectives because the expectations of stakeholders (e.g., project manager, stakeholders, and general public) diverge. What is good for one, is not good for the other (Lim & Mohamed, 1999). Perhaps a way to minimize these expectations would be the more effective participation of stakeholder in project development. This is suggested by Eisenhardt and Martin (2000) in product development process when they highlight that the key are constant feedbacks and visits from customers.

The analogy considering these two aspects of the construct evaluation is related to the concept of efficiency and effectiveness. The efficiency is related to the use of resources appropriately and without waste. In projects would mean attention to technical dimensions such as cost, time, quality, and scope (Aubry & Lièvre, 2010; Ika, 2009; Mahaney & Lederer, 2011). On the other hand, the concept of efficacy is associated with the achievement of organizational goals. For example, it means income earned (Belout, 1998). However, Ika (2009) comments there is no consensus in the literature regarding the concepts of efficiency and effectiveness linked to the constructs under analysis.

Shao et al. (2012) pointed out that the construct of “success” should be assessed under the approach of factors or criteria that take into account the performance. However, Mahaney and Lederer (2011) prefer to analyze the constructs project success and project failure based on agency theory. They assume that the project monitoring, by the agent, would increase the success rate as the identification of problems would occur in the early stages of its implementation. For this reason, it would be possible to implement some corrections what would minimize the aggravation of the problem.

Lenfle and Loch (2010) argue the project is the vehicle for the organization learning. According to them, the improvements in manufacturing projects come from employees in frontline. In those projects, the challenge is to separate what is desired from what is feasible. Consequently, this is also an essential source of insight for the organization strategic challenges and their solutions.

In the construction sector, the concept of project success requires more studies. According to Chan and Chan (2004) and Chan, Scott, and Lam (2002) project success is defined when a set of expectations meets the specifications and needs. However, the definition of construction project success is still unclear (Chan, 2001; Chan & Chan, 2004; Chan, Scott, & Lam, 2002). In this sector, Chan, Scott, and Lam (2002) and Chan and Chan (2004) pointed out that although some technical performance measures such as cost, time, and quality are still very important, other measures have gained attention in the field (Figure 9). For instance, security, stakeholder satisfaction, and functionality.

Extending this idea, Chan (2001) suggested a performance framework for assessing the construction sector by adding other measures. For example, product profitability/value, environmental performance, satisfaction and user expectation, and satisfaction of the participants. In the construction sector, in turn, the project success measures are multidimensional.

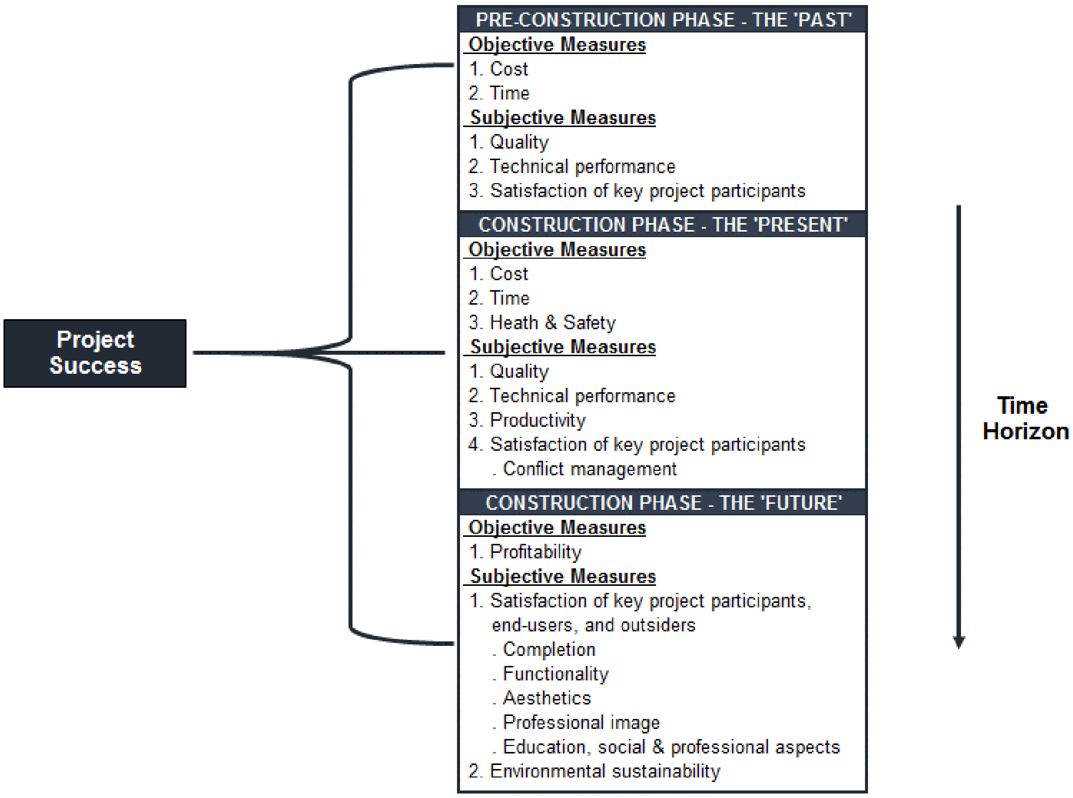

Figure 9 – Assessment framework for project success of design/build projects
Source: Adapted from Chan, Scott, and Lam (2002)

However, the construction sector has faced problems in performance. Bassioni, Price, and Hassan (2005) and Olawale and Sun (2010) argue that it is common to obtain poor performance due to non-fulfillment of technical criteria in the sector. This view is reinforced by Meng (2012) when considering the impact of the supply chain in project performance. He highlights the problems related to technical performance (time, budget, and quality). Furthermore, their study showed that the good relationship in supply chain positively influences on project performance; however, the deterioration of this relationship leads to poor performance.

In order to objectively and rationally measure both internal and external performance, Shenhar, Levy, and Dvir (1997) mapped the dimensions of project performance that impact on organizational performance. According to them, these indicators are concentrated in four dimensions. First, project efficiency (e.g., technical performance) that is linked to meet the technical aspects such as cost, time, scope, and among others. Second, the impact on customers. This dimension is linked to meet the requirements or the level of happiness of the customers. Third, direct and business success (e.g., sales and business performance). This dimension reflects the impact on organizational performance such as increasing in sales, profitability, market share, and among others. These latter indicators are more appropriate to measure the market performance. Fourth, preparing for the future. This dimension corresponds to the preparation of technological and organizational infrastructure in order to capture opportunities, develop new technologies and skills, improve the ability to move quickly, and among others (Chart 8).

Sadeh, Dvir, and Shenhar (2000) also proposed similar measures, but add measures of overall performance constituting a combination of several measures of success (Chart 9). Therefore, as also proposed by other scholars, we have a combination of technical and market performance to measure project success.

Success dimension	Success measures
Customer satisfaction	Meeting operational specifications Meeting technical specifications Fulfilling customer needs Solving a major operational problem Actually used by the customer Customer satisfaction
Budget and Schedule	Meeting time goals Meeting budget goals
Business success	Level of commercial success Generated a large market share
Future potential	Opened a new market Opened a new line of products Developed a new technology

Chart 8 – Mapping dimensions and measures of project success
Source: Adapted from Shenhar, Levy, and Dvir (1997)

Success dimension	Success measures
Meeting design goals	Functional specifications Technical specifications Schedule goals Budget goals
Benefit to end-user	Meeting acquisition goals Aswering the operational need Product entered Service Reached the end user on time Product had a substantial time for use Meaningful improvement of user operational level User is satisfied with product
Benefit to the development organization	Had relatively high profit Opened a new market Created a new product line Develop a new technological capability Increase positive reputation
Benefit to the defense and national infrastructure	Contributed to critical subjects Maintained a flow of updated generations Decreased dependence on outside source Contributed to others project
Overall success	A combined measures for project success

Chart 9 – Success dimensions and measures
Source: Adapted from Sadeh, Dvir, and Shenhar (2000)

2.3.2.1 Technical performance

The literature has treated technical performance as the most common dimensions such as cost, time, and quality must be achieved (Ika, 2009; Mahaney & Lederer, 2011; Shao et al., 2012). However, there is no guarantee that the product or service resulting from the project will be a sales success and will achieve the expected results. On the other hand, there are situations where the technical dimensions were not met, but the results obtained were above expectations (De Wit, 1988; Pinto & Slevin, 1988).

De Wit (1988) also believes that evaluating project success based only on technical criteria is inappropriate. The project can be considered a success whether it meets certain level of satisfaction of key people in the organization such as project team, users, and customers (Baccarini, 1999; Baker, Murphy, & Fisher, 2008; De Wit, 1988; Rozenes, Vitner, & Spraggett, 2006). In short, other dimensions must be considered to evaluate projects.

In Chart 10, we present definitions and dimensions of technical performance.

2.3.2.2 Market performance

Market performance represents a bundle of indicators that complement the traditional technical performance in analyzing project management. For example, in analyzing how project management practices may contribute to the survival of new products on the market. Thieme, Song, and Shin (2003) suggest that the concept of market performance is linked to the commercial aspects. These authors propose some dimensions to assess the construct such as return on investment (ROI), profitability, sales, market share, contribution to the technological leadership, contribution to employee retention, and degree of customer satisfaction.

Construct	Dimension	Type of indicator	Definition	Measurement	References
Technical performance	Cost	Financial perspective	Corresponds to managing the process cost to deliver the project on budget.	Cost overrun, unit cost.	Pinto and Slevin (1988), Shenhar et al. (1997), Baccarini (1999), Chan et al. (2002), Chan and Chan (2004), Martin et al. (2007), Ika (2009), Aubry and Lièvre (2010), Mahaney and Lederer (2011), Shao et al., (2012), PMI (2013)
	Functionality	Adequacy perspective	This dimension is correlated with the meeting of stakeholders' satisfactions. Represents the degree of adequacy achieved to all technical performance specifications.	The degree of conformance to technical specification.	Chan (2000), Chan et al. (2002), Chan and Chan (2004)
	Health and Safety	Security perspective	Represents the condition under which the project has been completed without some major problems (accidents).	Injury/accident rate per 1000 worker, number of injuries, or accidents/employment size x100.	Bubshait and Almohawis (1994), Chan (2000), Chan et al. (2002), Chan and Chan (2004)
	Quality	Control perspective	This is a subjective measure that aims to ensure that the processes and activities will be delivered as defined previously.	Defects, on-time delivery, budget compliance, the degree of conformance to predetermined standard of performance, performance of cost, schedule, and safety.	Pinto and Slevin (1988), Shenhar et al. (1997), Baccarini (1999), Chan et al. (2002), Chan and Chan (2004), Martin et al. (2007), Ika (2009), Aubry and Lièvre (2010), Mahaney and Lederer (2011), Shao et al., (2012), PMI (2013)

Construct	Dimension	Type of indicator	Definition	Measurement	References
	Scope	Control perspective	Corresponds to managing all the required process to deliver the project with success.	The quantitative engineering project scope definition (QEPSD method), Productivity = work hours per unit of design, function unit, a square meter of area, or cubic meter of volume.	Song et al. (2003), Song and Abourizk (2005), Ling et al. (2009), PMI (2013)
	Technical performance	Control perspective	Represents the degree under which the project fulfills specifications.	Technical requirements are defined and achieved.	Chan et al. (2002)
	Time	Control perspective	Corresponds to managing the process time (in days / weeks / months) needed to deliver the project on time.	Time overrun, construction time speed, speed of construction.	Pinto and Slevin (1988), Shenhar et al. (1997), Baccarini (1999), Chan et al. (2002), Chan and Chan (2004), Martin et al. (2007), Ika (2009), Aubry and Lièvre (2010), Mahaney and Lederer (2011), Shao et al., (2012), PMI (2013)

Chart 10 – Dimensions of technical performance
Source: elaborated by the author

Consistent with this view, Tatikonda and Montoya-Weiss (2001) also propose that the external performance can be measured through measures to capture the market outcome. They suggest four performance measures such as sales, customer satisfaction, profitability, and market share. According to Baccarini (1999), the market performance can be measured by the product success.

In the construction sector, Bassioni, Price, and Hassan (2005) proposed a fairly comprehensive model to benchmark the strategic performance and health of the overall business. The indicators are shown in the context of driving (e.g., leadership, stakeholder focus, strategic planning, and deployment) and performance result (e.g., project results, customers and stakeholder results, and business results). These criteria aim to focus on assessing the overall business beyond the traditional technical criteria.

In line with this perspective, Kagioglou, Cooper, and Aouad (2001) suggest that the performance in construction can be measured through three perspectives of the Balanced Scorecard (BSC). For example, financial perspective, internal process perspective, and customer perspective. According to them, the assessment of the construction project should not only consider “lagging” measures, but other indicators that look ahead in terms of future, for example, “leading” measures. The latter perspective is a complement in terms of measurement systems to provide a better understanding of the overall business results. The “leading” measures are related to non-financial measures (Kaplan & Norton, 1992, 1996) and the BSC represents a better hypotheses that better describe the business strategy (Kaplan & Norton, 2001a, 2001b). The construction sector has used a combination of financial and non-financial measures to evaluate its performance.

In Chart 11, we present definitions and dimensions of market performance.

Construct	Dimension	Type of indicator	Definition	Measurement	References
Market performance	Market share	Market perspective	Represents the percentage of a market accounted for by firm in a related period.	% Market Share (units or revenue)	Munns and Bjeirmi (1996), Shenhar et al. (1997), Tatikonda and Montoya-Weiss (2001), Thieme et al. (2003)
	Operating profit	Financial perspective	This is a financial measure that captures how much net operating profit the firm generates for each monetary unit of sales from period to period.	Operating profit in monetary value	Jin et al. (2013)
	Profitability	Financial perspective	This is a financial measure that captures how much profit the firm generates for each monetary unit of sales from period to period.	Total net revenue / Total costs (incremental measure), or Gross income / Total net revenue.	Shenhar et al. (1997), Tatikonda and Montoya-Weiss (2001), Thieme et al. (2003)
	Return on equity (ROE)	Financial perspective	This is a financial measure that captures how much profit the firm generates for each monetary unit of equity from period to period.	ROE = (Net Income / Total Equity) X 100%	Jin et al. (2013)
	Return on investment (ROI)	Financial perspective	This is a financial measure that captures how much profit the firm generates for each monetary unit invested from period to period.	ROI = (EBIT / Capital employed) X 100%; ROCE = (NOPAT / Capital employed) X 100%	Munns and Bjeirmi (1996), Shenhar et al. (1997), Thieme et al. (2003)
	Rate of sales growth	Financial perspective	Represents the sales growth from period to period.	Rate of sales growth = ($Sales_n$ / $Sales_{n-1}$) X 100%	Pinto and Slevin (1988), De Wit (1988), Munns and Bjeirmi (1996), Shenhar et al. (1997), Tatikonda and Montoya-Weiss (2001), Thieme et al. (2003)

Construct	Dimension	Type of indicator	Definition	Measurement	References
	Stakeholders Satisfaction	Satisfaction perspective	Meeting the needs and expectations of stakeholders. This the degree of happiness of people interested in the project.	Overall satisfaction with services, including technical measures performance and market performance.	De Wit (1988), Shenhar et al. (1997), Baccarini (1999), Lim and Mohamed (1999), Eisenhardt and Martin (2000), Tatikonda and Montoya-Weiss (2001), Chan et al. (2002), Thieme et al. (2003), Chan and Chan (2004), Baker et al. (2008), Jin et al. (2013)

Chart 11 – Definition of the dimensions of market performance
Source: elaborated by the author

3 CONCEPTUAL MODEL AND HYPOTHESES

The conceptual model (Figure 10) was developed based on the literature review from the absorptive capacity, operational practices, and performance in the project. In this section, we have a brief discussion of these dimensions and their relationship, in which we formalize the hypotheses.

3.1 Potential and Realized Absorptive Capacity

The AC proposed initially by Cohen & Levinthal (1989, 1990, 1994), was splitted into two subcategories by Zahra and George (2002) to express the potential absorptive capacity (PAC) and realized absorptive capacity (RAC). In this work, we used the two constructs to analyze the moderating effect of the relationship in relation to PMP and performance, and direct effect on performance.

PAC comprises two dimensions of AC such as acquisition and assimilation. This dimension aims to identify and acquire new relevant knowledge from outside (Jansen et al., 2005; Leal-Rodríguez et al., 2014; Zahra & George, 2002). RAC embraces other two dimensions such as transformation and exploitation. These later dimensions combine the new knowledge and the existing knowledge to enhance the company's ability to generate innovation outcomes (Fosfuri & Tribo, 2008; Leal-Rodríguez et al., 2014; Zahra & George, 2002).

The literature has suggested that AC dimensions lead to performance. For example, Zahra and George (2002) suggested that AC dimensions when properly managed lead to superior performance. Indeed, Jansen et al. (2005) pointed out that PAC enhances the knowledge and the company's ability to respond quickly to the environment, but RAC is more likely to enhance performance. In this vein, the transformation dimensions put in action the combined both existing knowledge and new knowledge to enhance outcomes, routines, and processes. The exploitation dimension enables the purification of the current routines through knowledge combination, which in turn creates new critical knowledge (Zahra & George, 2002).

However, other scholars understand that internal factors impact on PAC, which in turn leads to performance (Brettel et al., 2011). Conversely, Cohen and Levinthal (1990) suggested the prior knowledge as the most important to leverage performance. In short, there is no consensus in the literature regarding which dimension is the most relevant to performance.

In the construction industry, some scholars understand that due to the fierce competition and turbulent environment, companies need to increase the ability to respond quickly to them. However, it depends on the degree of AC inside the companies (Unsal & Taylor, 2011).

Based on the discussion above, we can declare the following hypotheses:

H1: Potential absorptive capacity has a positive relationship with success measure.

- **H1a:** Potential absorptive capacity has a positive relationship with budget and schedule.
- **H1b:** Potential absorptive capacity has a positive relationship with customer satisfaction.
- **H1c:** Potential absorptive capacity has a positive relationship with business success.

H2: Realized absorptive capacity has a positive relationship with success measure.

- **H2a:** Realized absorptive capacity has a positive relationship with budget and schedule.
- **H2b:** Realized absorptive capacity has a positive relationship with customer satisfaction.
- **H2c:** Realized absorptive capacity has a positive relationship with business success.

3.1.1 Moderating Factors

The moderating variables aim to affect the intensity in the relationship among the dependent and independent variables (Hair Jr. et al., 2009; Sekaran, 2000, p. 95). Baron and Kenny (1986) still suggest that it should be included when it occurs an unexpectedly weak or inconsistent relationship between both dependent and independent variables.

Regarding AC proposed by Cohen and Levinthal (1989, 1990, 1994) and redefined by Zahra and George (2002), we used the PAC and RAC as moderating factors on relationship beetween PMP and performance.

Other scholars have suggested working with AC as moderating factors. For instance, the influence of social integration mechanism on AC (Todorova & Durisin, 2007), the relational learning moderating on the relationship between PAC and RAC (Leal-Rodríguez, Roldán, et al., 2014), AC as a moderating factor for assimilating new informations (Van den Bosch et al., 1999), the moderating role of internal activation triggers (Fosfuri & Tribo, 2008), among others.

The objective of working with AC as moderating factor is to segregate the main effect (Escribano, Fosfuri, & Tribó, 2009) between PMP and success measures. In other words, we assume that PMP has a positive and direct effect on performance; however, when the relationship is moderated by the AC, we expected a potentialized effect.

In PAC, this construct can influence on PMP through acquisition and assimilation of relevant knowledge, which improves the company's ability to react quickly to external opportunities and threats (Jansen et al., 2005). Therefore, we assume that it potentializes the influence on success measures in projects. Given this, we can declare the following hypotheses:

H3: Potential absorptive capacity moderates the relationship between project management practice and success measure.

- **H3a:** Potential absorptive capacity moderates the relationship between planning and monitoring and budget and schedule.
- **H3b:** Potential absorptive capacity moderates the relationship between planning and monitoring and customer satisfaction.
- **H3c:** Potential absorptive capacity moderates the relationship between planning and monitoring and business success.

H3d: Potential absorptive capacity moderates the relationship between risk transparency and budget and schedule.

H3e: Potential absorptive capacity moderates the relationship between risk transparency and customer satisfaction.

H3f: Potential absorptive capacity moderates the relationship between risk transparency and business success.

H3g: Potential absorptive capacity moderates the relationship between risk coping capacity and budget and schedule.

H3h: Potential absorptive capacity moderates the relationship between risk coping capacity and customer satisfaction.

H3i: Potential absorptive capacity moderates the relationship between risk coping capacity and business success.

In RAC, this construct enables the company to refine its routines through knowledge combination of both existing knowledge and new knowledge. Therefore, it enhances performance (Jansen et al., 2005). Given this, we assume that RAC has a contingent effect between PMP and success measures in projects. Thus, we can declare the following hypotheses:

H4: Realized absorptive capacity moderates the relationship between project management practice and success measure.

H4a: Realized absorptive capacity moderates the relationship between planning and monitoring and budget and schedule.

H4b: Realized absorptive capacity moderates the relationship between planning and monitoring and customer satisfaction.

H4c: Realized absorptive capacity moderates the relationship between planning and monitoring and business success.

H4d: Realized absorptive capacity moderates the relationship between risk transparency and budget and schedule.

H4e: Realized absorptive capacity moderates the relationship between risk transparency and customer satisfaction.

H4f: Realized absorptive capacity moderates the relationship between risk transparency and business success.

H4g: Realized absorptive capacity moderates the relationship between risk coping capacity and budget and schedule.

H4h: Realized absorptive capacity moderates the relationship between risk coping capacity and customer satisfaction.

H4i: Realized absorptive capacity moderates the relationship between risk coping capacity and business success.

3.2 Project Management Practices and Performance

The literature has emphasized that the implementation of operational practices leads to performance. The concern with developing best practices and operational methods has become evident since 70s. These practices have focused on enhancing efficiency (Benner & Tushman, 2003; Lillrank, 1995) and performance (Hayes & Wheelwright, 1984; Wheelwright & Hayes, 1985; Wheelwright, 1984).

The operational practices have a different meaning in the OM literature. Some scholars understand as inputs used by managers and workers in order to improve performance (Flynn, Sakakibara, Schroeder, 1995). Other scholars define them as capabilities or standardized methods of doing things (Wu et al., 2012). Moreover, Wu, Melnyk, and Flynn (2010) characterize them as generic instructions in order to resources combination. In short, the operational practices can be seen as capabilities. In other words, practices are routines to do things in order to reach specific purposes.

Regarding the relationship with performance, Laugen et al. (2005) suggested that best practices have a significant effect on performance. The practices are used in order to leverage performance. Additionally, some scholars have discussed them in terms of efficiency, effectiveness, and operational performance (Flynn, Sakakibara, Schroeder, 1995; Flynn, Schroeder, & Sakakibara, 1995; Kannan & Tan, 2005; Ketokivi & Schroeder, 2004a; Lillrank, 1995; Mackelprang & Nair, 2010; Swink, Narasimhan, & Kim, 2005).

Simultaneously, the OM literature reports that the construct of operational practices is still in evolution regarding its definition and influence on performance. For example, Swink et al. (2005) argue that the relationship between practice and performance are continuously in discussion due to the complexity of the performance construct that requires better understanding.

The OM literature has emphasized different forms of measure performance. Ketokivi and Schroeder (2004a) suggest working with three constructs in order to measure performance; that is, goals, practices, and multidimensional performance.

The PM literature suggests a positive relationship between PMP and project performance. Besner and Hobbs (2006, 2008a) recognize that best practices represent a critical factor for project success, but there is no consensus on what practices lead to superior performance. A possible explanation is the lack of information in PM literature related to the effect of certain key practices on performance (Yang, 2013). Thus, there is an open issue for analyzing the relationship between the two constructs in PM.

The CCPM is the new philosophy for lean management that aims to reduce delivery times for projects (Goldratt, 1997) and in turn affects performance. This method is based on the concepts of thinking process (Kim, Mabin, & Davies, 2008) and the TOC (Goldratt & Cox, 1990; Goldratt & Fox, 1986). According to Lechler, Ronen, and Stohr, (2005), the CCPM aiming to maximize the performance of the project as a whole. The literature has emphasized that the CCPM influences on project performance.

The researches cited above provide evidence that the implementation of operational practices generates benefits to companies. This is possible by increasing efficiency, efficacy, and organization operational performance.

3.2.1 Planning and Monitoring

The PM literature has extensively discussed the relationship between practice and performance. Companies implement best practices in order to enhance the technical performance and create value to the business (Besner & Hobbs, 2006; Kerzner, 2006). In line with this thought, Williams (2008) points out that the best practices can influence on performance when is possible to maintain control of the processes as a whole. In short, it is expected that practices provide benefits to the project management in terms of reducing cost, delays, enhance operational efficiency, meet customer needs, and among others.

The PMI (2013) defines planning considering the process groups, which it is performed to establish the full scope, define and purify the objectives and develop the plan of execution necessary to achieve those objectives. Additionally, Zwikael and Sadeh (2007, p. 756) complement this definition, in their words: “Planning processes define and refine objectives and select the best of the alternative courses of action to attain the objectives that the project was undertaken to address.” But if a company fails in this phase, it can be disastrous for the project (Williams, 2008).

On the other hand, PMI (2013) defines the monitoring and controlling as the process of monitoring, evaluation, and regulation of progress to meet the performance objectives defined by the project management plan.

In the construction industry, some scholars have pointed out that project planning, scheduling, monitoring, and control have a significant impact on the project. For instance, Raymond and Bergeron (2008) argue that those processes improve the efficiency and efficacy of project managerial tasks. Additionally, Frimpong, Oluwoye, and Crawford (2003) argue that effective project planning, controlling and monitoring enhance project performance, reduce delays, and cost problems in construction. In short, they impact on technical performance.

Other scholars report the importance of planning and monitoring to support other activities. For example, Baloi and Price (2003) suggest that the planning supports the process of risk management, which in turn affect performance. However, Doloi (2013) discusses that the deficiency of the construct has negatively impacted on cost performance in projects. Additionally, Frimpong et al. (2003) suggest that poor planning can generate project delays and cost overruns. In summary, the literature provides evidence that the planning and monitoring affect performance.

Based on the discussion of the variables that affect performance, we can declare the following hypotheses:

H5: Planning and Monitoring have a positive relationship with success measure.

H5a: Planning and Monitoring have a positive relationship with budget and schedule.

H5b: Planning and Monitoring have a positive relationship with customer satisfaction.

H5c: Planning and Monitoring have a positive relationship with business success.

3.2.2 Risk Transparency and Risk Coping Capacity

The risk management is an operational practice that aims to deal with uncertainties. Many scholars have suggested that when a company implements a risk management process accordingly it leads to performance. This practice has received much attention in the literature because uncertainties affect project performance (Fern & Zarei-Kesheh, 2011; Teller & Kock, 2013). Therefore, one way to deal with risk and uncertainty is through effective risk management, which improves decision-making and mitigates factors that cause problems in projects (Baloi & Price, 2003; van Staveren, 2014).

The PMBOK® Guide defines risk as an uncertain event or condition that can impact positively or negatively on project goals (PMI, 2013). Other scholars define risk as unforeseen factors, or unexpected events (Chapman & Ward, 2004; Fern & Zarei-Kesheh, 2011). For Akintoye and MacLeod (1997), risk corresponds to unforeseen factors that can negatively affect the project completion in terms of cost, time, and quality. In all definitions, at least one of the components that mean uncertainty, unforeseen factors, or unexpected events, is present. Thus, the risk may cause potential problems on performance and requires a process that effectively deals with it.

Extending this idea, the company needs to create a mechanism to assess the relation between cause and effect into the project due to adverse factors (Lee et al., 2009). The objective is to avoid to potential losses and enhance the response to risk (Teller & Kock, 2013). In management risk, these processes are splitted into risk transparency and risk coping capacity.

Teller and Kock (2013) define risk transparency as the company's ability to identify the potential risk and recognize its causes through a systematic approach. For example, Akinci and Fischer (1998) suggest the following prescriptions such as to identify the major sources of risk, evaluate the effects on projects, and find the way for controlling the risk. It is expected that these actions impact on performance.

Additionally, some scholars have proposed mechanisms for risk identification in order to detect symptoms of bad omens in projects (Geraldi et al., 2010; Ohtaka & Fukazawa, 2010). The risk is a problem that can affect any phase of the project. It can be caused by multiple phenomena, for example, defective quality, delays, resource shortages, customer distrust, organizational issues, among others (Ohtaka & Fukazawa, 2010).

PMI (2013) suggests the lessons learned as a potential resource for risk identification. Likewise, Holzmann (2012) and Khan (2014) agree that the lessons learned provides a wide basis for risk analysis. By contrast, this source is rarely used by the team members; they believe it is a waste of time because it is not possible to gain from a bad situation (Robertson & Williams, 2006). The risk identification is an important practice because provides information for proper actions.

Based on the discussion above, we can declare the following hypotheses:

H6: Risk transparency has a positive relationship with success measure.

- **H6a:** Risk transparency has a positive relationship with budget and schedule.
- **H6b:** Risk transparency has a positive relationship with customer satisfaction.
- **H6c:** Risk transparency has a positive relationship with business success.

The second practice is risk coping capacity, which the main objective is to analyze the relation between cause and effect from potential risk and act on it. This practice is a mechanism used by companies to cope with unexpected factors. Some scholars suggest initially the risk identification and then act to mitigate potential factors that can cause potential losses in projects (Lee et al., 2009; Teller & Kock, 2013). This, in turn, can affect positively performance.

In the construction, many techniques are used to manage risks; however, projects continue to suffer from delay problems and cost overruns. For example, critical path technique, Microsoft Project, among others. The problems mentioned in the literature negatively affect performance (Olawale & Sun, 2010). One possible explanation can be attributed to the sector that neglects the risk management capacity to help companies to cope with such problems (Yoon et al., 2014). Baloi and Price (2003) argue that there is no consensus regarding the utilization of those techniques. They still point out that the sector manages risk management taking into account perceptions and subjective judgments. For van Staveren (2014), the risk management success is rarely reported.

Other problems are reported by Abdou (1996) who suggests that top management fails to understand the importance of such tools to control projects. For him, this occurs due to the fact that they ignore or underestimate construction risk and delegate it to unqualified employees. By contrast, Baloi and Price (2003) understand that some sophisticated techniques have proven effective to assess cost performance. In short, good tools matter.

Likewise, Geraldi et al. (2010) propose a mechanism to respond quickly to risk. For them, this mechanism recognizes the importance of responsive and functioning structure, good interpersonal relationship, and competent people. However, the success of response lies on people assets that must be engaged in the process. According to them, these pillars can help the organization to minimize or avoid negative impacts of unexpected events.

Based on the discussion above, we can declare the following hypotheses:

H7: Risk coping capacity has a positive relationship with success measure.

- **H7a:** Risk coping capacity has a positive relationship with budget and schedule.
- **H7b:** Risk coping capacity has a positive relationship with customer satisfaction.
- **H7c:** Risk coping capacity has a positive relationship with business success.

The importance of the risk management through risk transparency and risk coping capacity is to mitigate and act against potential problems in projects that affect performance. However, the lack of clear objectives of risk management difficulties monitoring risk, risk transparency, reporting risk adequate, among others.

3.2.3 Performance Indicators

The performance is a multidimensional criterion and it has been treated in the literature considering several perspectives. In OM (operations management), for example, the common indicators to assess the construct are the competitive criteria such as cost, quality, delivery, and flexibility (Ferdows & De Meyer, 1990; Flynn & Flynn, 2004; Rosenzweig & Roth, 2004; Schroeder et al., 2011). These indicators are heavily used in assessing operations manufacturing.

On the other hand, in PM (project management), other criteria are defined to evaluate performance taking into account different perspectives as well. The lack of consensus in assessing performance due to different point of views (De Wit, 1988; Shenhar et al., 1997) leads to split the attention to two perspectives such as technical performance and market performance. The common indicators of technical performance include dimensions such as cost, schedule, scope, and quality (Atkinson, 1999; Aubry & Lièvre, 2010; Ika, 2009; Mahaney & Lederer, 2011). However, in market performance, other indicators to evaluate the overall aspects of the project and the business have been defined as well.

Some scholars proposed to evaluate market performance based on commercial dimensions and in meeting stakeholders needs (Baccarini, 1999; Tatikonda & Montoya-Weiss, 2001; Thieme, Song, & Shin, 2003).

In construction industry, the combination of both technical and market performance indicators is used to measure performance (Chan & Chan, 2004; Chan, Scott, & Lam, 2002; Chan, 2001; Thieme, Song, & Shin, 2003). In technical performance, for example, the common indicators are cost, time, and quality. On the other hand, in market performance includes a bunch of indicators to assess performance such as security, stakeholder satisfaction, functionality, product profitability/value, environmental performance, satisfaction and user expectation, and satisfaction of participants (Chan & Chan, 2004; Chan et al., 2002; Chan, 2001). But the literature does not provide evidence related to market performance, which indicator is more relevant in this sector.

To evaluate performance in construction industry, we used partially the indicators proposed by Shenhar, Levy, and Dvir (1997) such as budget and schedule, customer satisfaction, business success, and preparing for the future. According to them, the indicators aim to measure both internal and external performance in an objective and rational way.

However, we discard the preparing for the future indicator because is difficult to say that companies, in this industry, are preparing for the future. Moreover, the literature does not provide evidence for that. This dimension emphasizes aspects related to the preparation of technological and organizational infrastructure in order to capture opportunities, develop new technologies and skills, improve the ability to move quickly, and prepare to make change for the future in its industry (Shenhar et al., 1997).

We propose to use the budget and schedule, customer satisfaction, and business success constructs to analyze the impact on performance from AC and PMP in projects.

The group of technical performance aims to measure the technical efficiency related to processes management of the project (Shenhar et al., 1997). Basically, in our work, the budget and schedule construct aims to measure technical aspects of the project such as cost, time, and scope.

The group of market performance aims to measure the project contribution to the overall business. In this group are included customer satisfaction and business success.

The customer satisfaction construct aims to measure the impact to customers. According to Shenhar et al. (1997), this dimension emphasizes the attention to measuring the level of customers satisfaction related to meeting technical requirements. The technical requirements are related to operational and technical specifications.

The third construct is the business success, which aims to measure the commercial and economic success. According to Shenhar et al. (1997), this dimension reflects the impact of the project on organizational performance.

In the model below, we detailed the expected relationship between the constructs and their hypotheses.

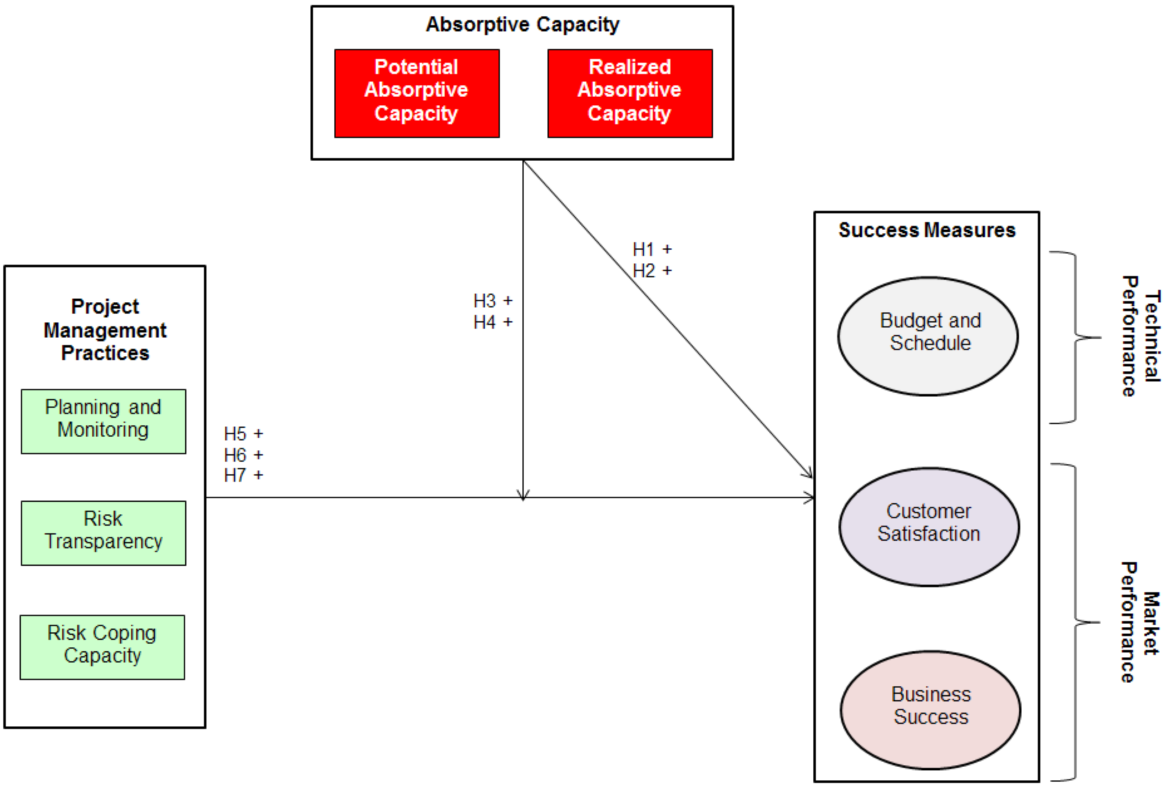

Figure 10 – Conceptual model of the research project
Source: elaborated by the author

H1: Potential absorptive capacity has a positive relationship with success measure.

H2: Realized absorptive capacity has a positive relationship with success measure.

H3: Potential absorptive capacity moderates the relationship between project management practice and success measure.

H4: Realized absorptive capacity moderates the relationship between project management practice and success measure.

H5: Planning and Monitoring have a positive relationship with success measure.

H6: Risk transparency has a positive relationship with success measure.

H7: Risk coping capacity has a positive relationship with success measure.

4 METHODOLOGY

In this chapter, we provide the methodology design that was employed in this research. In order to achieve the main objectives of the research, we proposed the adoption of a combination of qualitative and quantitative research. According to Kaplan and Duchon (1988), the combination of multiple methods provides both testability and context, and increases the robustness of the results. In line with this view, Eisenhardt (1989) understands that the combination of multiple data collection represents a synergistic process. Brown (1997) points out that a single strategy (survey questionnaire) does not permit the understanding of all the peculiarities of the results. Thus, it is important to combine both qualitative and quantitative methods.

In the next sections, we describe the detailed methodology of this research.

4.1 Research Paradigm

Despite the lack of consensus in the literature about the definition of theory, which would explain the difficulty in developing a strong theory (Sutton & Staw, 1999), Bacharach (1989) suggested a broad definition based on the literature, in his words:

> […] researchers can define a theory as a statement of relationships between units observed or approximated in the empirical world. Approximated units mean constructs, which by their very nature cannot be observed directly (e.g., centralization, satisfaction, or culture). Observed units mean variables, which are operationalized empirically by measurement. The primary goal of a theory is to answer the questions of how, when, and why, unlike the goal of description, which is to answer the question of what. Bacharach (1989, p. 498).

Based on this definition, he offered what constitutes the components of theory (Figure 11). The theoretical definitions are closely related to a set of concepts and their interrelationships to describe how the phenomenon occurs (Corley & Gioia, 2011). According to Bacharach (1989, p. 498), "[…] the constructs are related to each other by propositions and the variables are related to each other by hypotheses." This is in line with Wacker (1998) that suggested four components to describe theory such as the definitions of variables, the domain of theory application, the relationship between variables and the specific predictions. Moreover, theory shall help the researchers to respond the questions put by their research design and provides the guideline to test the relationships between constructs and variables (Wacker, 1998).

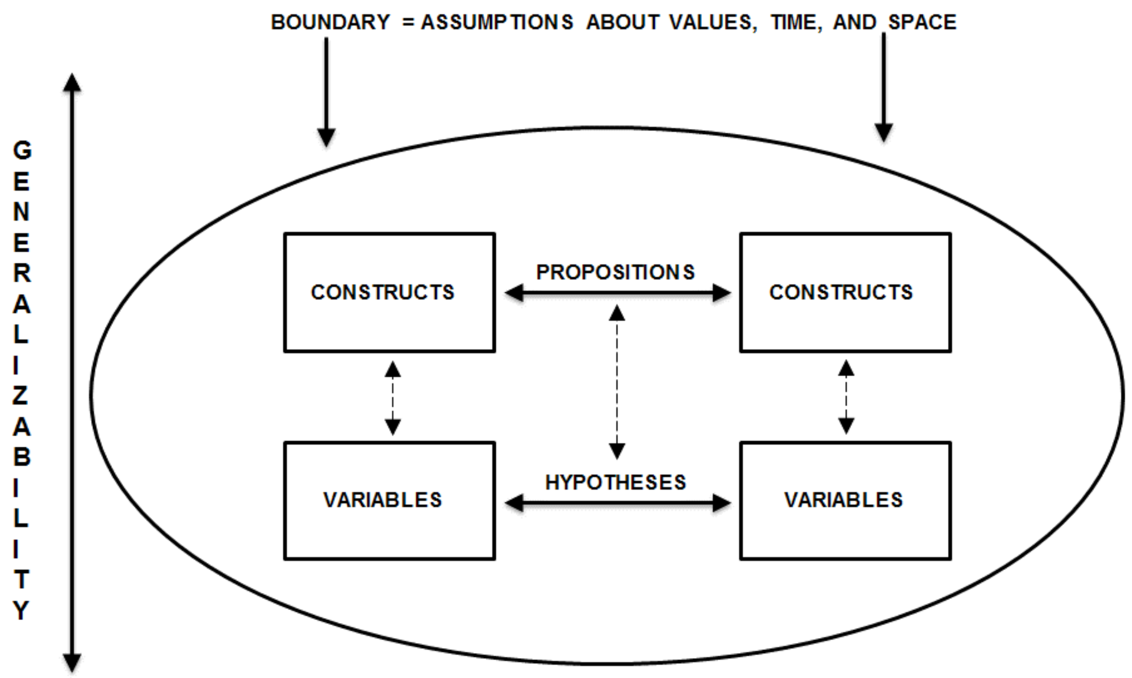

Figure 11 – Components of a theory

Source: adapted from Bacharach (1989)

Moreover, the empirical research aims to verify or refute theories as well. Miller and Tsang (2010) argue that the process of refuting theories contributes much more to expanding knowledge in some field than only verifying. Wacker (1998) prefers to think only in terms of refuting theories. This process of testing theories has been done through a diversity of methodological design (Robey, 1996).

The purpose of management research is to contribute to scientific field and provide knowledge that can be applied by the management (Van de Ven, 1989). However, Miller and Tsang (2010) addressed the concerns that theories do not provide a good guidance for research design in management. On the other hand, the management research should take into account practical problems in management (Van de Ven, 1989), which brings to overcome challenges posed by the research paradigm. For example, the complexity of organizations in terms of structure, environment, culture, among others (Miller & Tsang, 2010).

These last authors define four steps to orient the researcher for testing management research, for example: (1) identify the hypothesized constructs, (2) test for the existence of the constructs in the empirical configuration, (3) test separately causal relations using experimental or quasi-experimental designs, and (4) test the conceptual model using correlational methods. For Robey (1996), the researcher should communicate to the research community its choices about theoretical foundations, the research focus, the research design, and a rational explanation of these choices.

Currently, two common methods of research designs are used by the researchers to test theories (Miller & Tsang, 2010): (1) extensive design, and (2) intensive design. The first method is related to quantitative design, which statistical analyzes are the main method for testing the relationship between constructs and their variables. According to them, the concern here is that this method neglects explanatory mechanisms. Here, mechanisms mean constructs. The second method concerns to test assumptions exploring non-quantitative analysis. Miller and Tsang (2010) pointed out that the aim of this research design is to identify and describe the relevant constructs in action in specific cases, which it is not possible to do with quantitative design. Wacker (1998) calls them of hard and soft methods, respectively. Therefore, these concerns justify the combination of different methods and techniques (Munro & Mingers, 2002) to explain the phenomenon.

In line with these concerns, Mingers (2006) pointed out that there is a division of management research, in which one group of researchers are essentially quantitative and other groups are essentially qualitative. One form to combine different visions is through the critic realism foundations (Miller & Tsang, 2010; Mingers, 2006). According to Mingers (2006), the critic realism provides the mechanisms for the conciliations of multiple forms of research designs. In other words, it provides a rich comprehension of the phenomenon of interest (Mingers, 2001), which means explore it from several perspectives.

Robey (1996) agrees that the diversity of research methods provides substantial contributions to enrich the knowledge. From one side, the quantitative design is adequate for analyzing the structural aspects of the phenomenon; by other side, the qualitative design is adequate for analyzing the procedural aspects of the phenomenon (Miller & Tsang, 2010). But no research method is sovereign. All of them have their strengths and weaknesses; however, the research can benefit from their complementarity (Miller & Tsang, 2010; Munro & Mingers, 2002; Robey, 1996).

Regarding the research paradigms, this dissertation aims to analyze and explain the phenomenon of interest taking into account different paradigms (i.e., qualitative and quantitative). For Mingers (2001), paradigm corresponds to constructs and their assumptions. It comprises three components. First, the ontology that refers to the reality. Fleetwood (2005) prefers to define the ontology as the representation of the way we think the world. Second, the epistemology that correspond to the valid knowledge. But for Fleetwood (2005), it represents the existing knowledge. Third, the methodology, which means the process of research methodology that use different methods to understand the phenomenon. Fleetwood (2005) still includes the research techniques. For him, the methodology and research techniques correspond the way by which the phenomenon can be investigated.

According to Miller and Tsang (2010), the critical realism interrelates ontology and epistemology. By contrast, Yeung (1997) pointed out there are misunderstanding when researchers treat the critical realism as ontology, epistemology, or a method because it is not. For Mingers, Mutch, and Willcocks (2013), critical realism is a philosophy of science. As a philosophy, it accepts multimethod of research, which means the combination of both quantitative and qualitative methods. Therefore, "[…] methodological pluralism is grounded on its ontological and epistemological assumptions […]" (Mingers et al., 2013, p. 800).

Regarding ontology, it accepts its existence, efficacy, and independent of existing knowledge. It recognizes the limitations to access the field of research, and accepts the existence of multi-dimension knowledge (physical, social, and conceptual) (Mingers et al., 2013).

In the next sections, we discuss in detail the process of this research design.

4.2 Unit of Analysis

In this work, the unit of analysis is the project. We choose the construction sector to assess how the mechanisms of absorptive capacity can influence the way projects are run and the influence on performance. Moreover, we intend to assess what mechanisms the company uses to capture the external knowledge and use it internally in benefits of projects.

4.3 Qualitative Research

In the first step, we worked on an exploratory qualitative study, which aims to understand the technical and operational aspects of project, the capacity of the organization to exploit internal and external knowledge, and their relationship with performance. This phase also has the objective of understanding the relationship between absorptive capacity and project performance. Regarding this idea, this phase had three main objectives:

a) To identify the absorptive capacity dimensions (competencies), which maximize project performance and to understand the organizational learning in project management. We assessed this objective through both direct and moderator effects.
b) To identify specific practices (planning and monitoring, and risk management), which are the most relevant that influence on project performance. We assessed this objective through direct effects.
c) To confirm among specific project performance dimensions (budget and schedule, customer satisfaction, and business success) related to both technical and market performance, which are the most relevant dimensions that have a positive influence on project success. We assessed this objective through direct effects.

According to Ika (2009), there is no consensus in the literature regarding the project dimensions that influence projects success. In the construction sector, this finding still remains unclear (Chan, 2001; Chan & Chan, 2004; Chan, Scott, & Lam, 2002). Therefore, we assessed projects in this sector to investigate the phenomenon.

4.3.1 Interview Study

Although our focus is quantitative research, initially, we proposed the qualitative research based on interview study. This strategy based on verbal reports was structured on open-ended interviews (Yin, 2014, p. 122). We used this phase as exploratory stage to understand the whole process of project learning and the main dimensions of AC, PMP, and performance. The findings were used in the next phase, which is quantitative research conducted through a survey questionnaire strategy.

4.3.1.1 Sampling

In this research, the unit of analysis is project and we analyzed it through interviews in different sectors to understand the comprehension of absorptive capacity by project managers. The sampling selection is non-probabilistic based on the convenience. Hair Jr. et al. (2005, p. 240) pointed out that in this type of sampling the researcher is free to include or exclude some elements of the population. However, for the next phase (quantitative phase), we focused on the construction sector to confirm or disconfirm the relationships proposed above. It is important because, according to Karlsson (2009, p. 113), inadequate sampling selection exclude the possibility of generalizing the results.

At this time, our research strategy is not a case study, but interviews to capture the whole idea of project learning through AC (absorptive capacity) and PMP (project management practice). Thus, generalization of the findings is not our focus at this phase, but we intend to range the wide variety of projects. For generalizing the results, Yin (2014, p. 64) suggests working with two or more case studies because it provides substantial benefits instead of one case study that could lead to fragile purpose. Consistent with this view, Eisenhardt (1989) suggests that researcher should choose the range between four and ten cases, depending on the complexity of the research and its variables (Stuart, et al., 2002).

As the unit of analysis is the project and even admitting its idiosyncratic characteristic (Bresnen, Goussevskaia, & Swan, 2005), we suggest to evaluate projects that have some similarity in terms of size, complexity, and dynamism because managing projects in different environments cannot be common (Crawford & Nahmias, 2010; Gareis, 2010). Bouer and Carvalho (2005) and Rozenes et al. (2006) also understand that depending on the type of project, different methodologies can be used. Even though our key area of this research is the construction sector, it is possible to find different methodologies to run projects by the companies in this sector.

Therefore, as commented previously, we selected different areas related to projects to capture their vision about AC, PMP, and performance. The interviews were conducted in such areas as commercial, information technology (IT), product marketing, project controllership, project management office (PMO), operations, and purchasing.

4.3.1.2 Data Collection Instrument and Procedure

We used a semi-structured questionnaire for the interview in this qualitative phase. Triviños (1987) agrees that this method corresponds to one of the most crucial to study the processes of interest in qualitative research instruments. In line with this view, Alencar (2000) states that the advantage of this type of questionnaire is to allow the interviewees to express their opinions, their views, and their arguments. Sekaran (2000) also suggests asking open-ended questions at the beginning of the interview. The focus is to collect some general ideas or impressions of a situation or the phenomenon being studied. It is also an important way to minimize bias in the responses. In this process, we expected to identify the contribution of project management practices, competencies of AC, and the performance dimensions in the analysis of the phenomenon.

In both qualitative and quantitative analysis, we maintained the confidentiality of the projects, interviewees names, and company names.

In Appendix B, we present open-ended questions that were used for this qualitative phase.

4.3.1.2.1 Data Collection

We performed fifteen interviews in nine companies from seven different sectors with project managers, project director, project controller, operations manager, and other professionals in project management. In Chart 12, we present more details. We had fourteen interviews conducted in São Paulo/Brazil and one interview conducted in Tennessee/USA with a Brazilian manager who works for company D. All the interviews were done through Skype, in the period from May 01 to July 02, 2014. The average time of the interviews was 46 minutes, but in one case (company D) we had 10 minutes of interview; therefore, it was not possible to explore all the relevant questions prepared because of the bad connection. We tried various contacts with the interviewee, but she did not respond anymore.

The most of interviewees have more than 5 years of experience in project management. The aim of choosing these professionals in different sectors for discussing different aspects related to their business is to improve our understanding of the main constructs under studies in projects.

Initially, the primary criterion was that the managers must have at least three years of experience as project manager (most of them have more than that) to participate in this research. Other important point was expected that these managers were able to discuss important themes such as project management practices used in their organization, both technical and market performance indicators, the influence of project knowledge and its relationship with performance. We noted that this expectation was fulfilled because all the interviewees had a good experience in projects.

The selection of different sectors is interesting due to the contrasting information that these companies can provide (Yin, 2014). Regarding the selection sectors yet, we asked the question about polar types of projects, for example, project success and project failure. This strategy was important to capture the performance dimensions that are relevant to the project assessment. Additionally, this sampling plan was designed to contrast the findings (Eisenhardt, 1989) even though we focus on the construction sector in the quantitative phase.

Nº	Company name	Number of employees in country	Date of interview	Time of interview	Position of the interviewee	Age of interviewee (years)	Years in position	State/Country	Business sector
1	A	3,000	May 01, 2014	52 minutes	IT Project Leader	38	5	São Paulo/Brazil	Financial Market
2	B	6,000	May 06, 2014	60 minutes	Operations Manager	52	13	São Paulo/Brazil	Energy
3	C	1,000	May 08, 2014	63 minutes	Project Manager	35	5	São Paulo/Brazil	Construction
4	D	5,500	May 09, 2014	54 minutes	Project Bid Manager	29	8	São Paulo/Brazil	Power Energy
5	D	5,500	May 09, 2014	49 minutes	Project Manager	44	10	São Paulo/Brazil	Power Energy
6	D	5,500	May 12, 2014	65 minutes	Purchasing Manager of Project	50	5	São Paulo/Brazil	Power Energy
7	D	5,500	May 13, 2014	27 minutes	Project Director - PMO	56	7	São Paulo/Brazil	Power Energy
8	D	5,500	May 13, 2014	40 minutes	Project Manager	57	20	São Paulo/Brazil	Power Energy
9	D	7,000	May 14, 2014	26 minutes	Product Marketing Manager	35	1	Tennessee/USA	Power Energy
10	D	5,500	May 26, 2014	10 minutes	Project Controller Coordinator	(*)	(*)	São Paulo/Brazil	Power Energy
11	E	700	May 11, 2014	65 minutes	IT Manager	42	6	São Paulo/Brazil	Information Technology & Services
12	F	5,000	May 13, 2014	55 minutes	Business Controller of Project	55	16	São Paulo/Brazil	Energy
13	G	700	May 27, 2014	46 minutes	IT Manager	54	20	São Paulo/Brazil	Steel Production
14	H	5,000	May 30, 2014	34 minutes	Divisional Controller	35	10	São Paulo/Brazil	Electrical equipment
15	I	30	July 02, 2014	48 minutes	Commercial Director	33	0.6	São Paulo/Brazil	Construction

(*) It was not possible to collect all the data with the interviewee because we had problem with the connection.

Chart 12 – Detailing of interviews in the qualitative phase
Source: elaborated by the author

Regarding to the companies in this sample, the most of them have more than 700 employees, and some are global players (company B, D, F, and H) with more than 5,000 employees in Brazil. This consideration is important because the larger the company, the greater the complexity of its operations.

It is important to comment that in company D we performed seven interviews (six in São Paulo/Brazil and one in Tennessee/USA). Even though this company is in the power energy sector, it has a very close relationship with construction sector because it provides equipment for them. Another important consideration is that the operations manager from company B and the divisional controller from company H who worked for company D, thirteen and ten years, respectively, before transfer to their current companies. During the interview, they talked much more about their prior experience in projects. The companies C and I are related to the construction sector. All the managers that participated in this phase have great experience in projects. In summary, we have eleven interviews that are very close or related to the construction sector.

All the interviews were taped and transcribed by the researcher. According to Yin (2014, p. 110) recording the interview is preferred because it provides accuracy for analyzing

4.3.1.3 Interview Transcription

The interviews were done in Portuguese and all of them were transcribed in Microsoft Word before coding. The researcher was responsible for all the transcription. In the transcription process, some important informations were provided for the identification of the companies and the interviewees. For example, name of the company (it coded to maintain confidentiality), name of the interviewee (it was preserved in this work to maintain confidentiality), age of the interviewee, position in a company, years in the company (and in the position), form of conducting interview (all of them were done through Skype), date of interview, and duration of interview. All the personal and the company data were collected at this time with the interviewee. We summarized above in Chart 12.

After that, we started the process of coding and analysis. This step is discussed in more details in the next section.

4.3.1.4 Interview Analysis

The data collected through interviews were analyzed by the content analysis techniques defined by Krippendorff (2012) and Miles, Huberman, and Saldaña (2013). The main goal of this phase is to support the development of the questionnaire for the survey in the quantitative phase (Flick, 2009). According to Eisenhardt (1989, p. 539) “Analyzing data is the heart of building theory from case studies, but it is both the most difficult and the least codified part of the process.” As we discussed previously, we are not interested in case studies, but in interviews to get an idea of our main research focus.

Even though the utilization of the software helps to analyze the huge amount of data, we did not use software for that. The content analysis was done manually after the process of taping and transcribing of the interview. Before coding, we read all the material carefully to have an idea of the main aspects of the interviews.

Miles, Huberman, and Saldaña (2013) suggest two steps for doing the content analysis. First, the researcher, with the coding table in hand (Appendix C), needs to check each sentence, full paragraphs, or some block of data and coding them. At this moment, just in case of necessity, it is possible the researcher to do some adjustments in the coding table. According to Miles, Huberman, and Saldaña (2013, p. 86) is not necessary coding all data in the interview, only the relevant part of getting the main objective of the research. So, as we have specific dimensions for our constructs, we focus on some parts of the interviews that were relevant to capture the whole idea of the constructs under study. Second, it is the process of summarizing the data. In this step, we analyzed the coding for looking for similarities. When we find some similarity in the group of coding, we consolidated them into one category of the dimension as suggested by Miles, Huberman, and Saldaña (2013). According to them, this process reduces the number of dimensions and provide a parsimonious analysis. Our focus here had two objectives: (1) to find the construct dimensions to support the survey questionnaire, and (2) to understand the relevant aspects related to our constructs by project managers.

In the definition of our codes, they were anchored by the literature review, conceptual model, hypotheses, and research questions (Miles et al., 2013, p. 81; Yin, 2014). The codes were generated to conduct the process for analyzing the interviews (deductive coding) presented in Appendix C. In this process, those tables were complemented or corrected as the coding was performed.

Although the literature suggests that more than one person participates in coding process to refine the categories and provides reliability (Krippendorff, 2012, p. 130; Miles et al., 2013, p. 84), all the processes were done by the researcher. This process is really complex (Eisenhardt, 1989) due to the amount of data to be managed (fifteen interviews) and the various dimensions to be assessed (performance, project management practices, and absorptive capacity), and training other person for coding takes so much time and energy. We decided coding by ourselves in detriment of what the literature suggests. Indeed, we need taking into account that for better results the analyst must be conversant with the objective of the research.

4.3.2 Validity and Reliability

Stuart et al. (2002) and Wacker (2004) suggest some rules for defining the conceptual construct aiming their consistent measures. These rules presuppose that the conceptual definition must use primitive and derived terms, avoid ambiguity, look for multiple sources of evidence, be parsimonious, be in line with other definitions, and enable statistical tests.

Yin (2014, p. 45) suggests four design tests in qualitative research to achieve validity and reliability. For him, the researcher should take into account the analysis of the construct validity, internal validity, external validity, and reliability when works with qualitative research. Yin (2014) still offers definitions for these concepts:

a) The construct validity refers to the identification of the correct operational measures for the concepts under study.
b) The internal validity (only for explanatory or causal studies and not for descriptive or exploratory studies) refers to the establishment of causal relation, which believes that one condition influences other conditions.
c) The external validity refers to the definition of the domain where the findings can be generalized.
d) The reliability corresponds to the procedures (for example, the data collect) that can be repeated for other studies with the same results.

For assessing the construct validity, we present in Chart 1 the definitions of AC and in Chart 2 we present a clear definition of potential absorptive capacity (PAC) and realized absorptive capacity (RAC). All these definitions were based on the literature review.

Regarding our main construct (AC), for example, the definition of absorptive capacity in the literature is quite ambiguous and based on different perceptions. For instance, the first group of authors have proposed the concepts as a capability of organizational learning (Brown, 1997; Cohen & Levinthal, 1989, 1990; Kim, 1998; Lane & Lubatkin, 1998; Tu et al., 2006). The second group has proposed it as dynamic capabilities (Narasimhan et al., 2006; Todorova & Durisin, 2007; Zahra & George, 2002). This lack of consensus leads to different forms of operationalization of AC in different contexts.

Brown (1997) analyzed AC in Information Technology (IT) from the point of view of prior relevant knowledge and communication aspects. Tu et al. (2006) discussed AC in manufacturing adding knowledge scanning and dimensions operationalized by Brown (1997). Narasimhan et al. (2006) discussed AC in the high-technology market in the context of such dimensions like marketing, R&D, and operations capabilities. In the physical engineering sector, Kamal and Flanagan (2012) have identified factors that influence AC, but it is not clear yet how AC is operationalized in this sector. Thus, depending on the sector, authors propose different forms of operationalizing AC. In Appendix A is depicted a large chart (Chart 19) with other dimensions and subdimensions of AC discussed in the literature.

For the internal validity, as we propose an exploratory study, this item does not apply as suggested by Yin (2014).

For the assessment of the external validity in this qualitative phase, we proposed to do interviews with different sectors just to have an idea of the whole understanding by project managers of the main concepts of dimensions under study. Our focus here is not to provide a study for generalizing the findings, but to use the results to support the next quantitative phase. Thus, this item does not apply as well.

To provide the reliability of this work, we clearly described the processes in previous sections (interview study, instrument procedure, data collection, and the process of the interview analysis) that permit other researchers to follow the same steps. In Appendix B, we provide the questionnaire used in the interviews and in Appendix C all the tables coding used in the analysis of interviews.

4.4 Quantitative Research

From the results that emerged from the qualitative phase, we planned quantitative research based on the survey questionnaire, which focus on construction projects. For collecting the data, a survey instrument was adapted from the literature. For assessing the data, we use a combination of statistical procedures. For instance, we use ANOVA test for analyzing the possibility of using two samples and the confirmatory factor analysis (CFA) through AMOS for validating the measurement model. For measuring the moderates and direct effects of the absorptive capacity on project management practices and performance, we used the hierarchical linear regression (HLR) through SPSS. In the next section, we discuss in more detail all these procedures.

4.4.1 Survey questionnaire

We used multi-item measurement scales with items defined from the literature. The survey questionnaire has three main blocks of items to measure the constructs under study: (1)

project management practices, (2) performance, and (3) absorptive capacity. The fourth block is related to the identification of the respondent, the company, and the specific characteristics of the projects.

In the first block, we assessed the dimensions of project management practices. We used the survey questionnaire from Doloi (2013) to measure planning and monitoring dimensions, and from Teller and Kock (2013) to measure risk management dimension. Even though the Doloi's questionnaire was defined for construction projects, for our research proposal, it required adaptation because some items were not clear. For example, as we need to evaluate a completed project, we need to adjust all the items in the correct verbal tense or rewrite the main idea. Other items that did not make sense for our purpose were removed. We proceeded in the same way for the other questionnaires.

From Teller and Kock (2013), we used two block of items for risk management: (1) risk transparency, and (2) risk coping capacity. They defined the survey questionnaire to assess project portfolio in the German industry. To validate the scales, these scholars utilized the CFA. However, Doloi's scales were not validated. He used the exploratory factor analysis (EFA) to reduce the number of factors and conducted the Kaiser-Meyer-Olkin (KMO) to validate the EFA.

Initially, we expected to find validated scales for this block in the project management literature; however, because of the difficulty to find them, some items were used without CFA validation. Therefore, this decision also affected the number of practices selected for this research.

In Chart 13, we provide the items used to assess the planning and monitoring, risk transparency, and risk coping capacity constructs.

Construct	Code	Items	Reference
Planning and Monitoring	PLAN1R*	We had planning and scheduling deficiencies.	Doloi (2013)
	PLAN2	We used good methods/techniques of construction.	
	PLAN3	We deal well with the complexity of design.	
	PLAN4R*	We early detected deficiencies in planning and scheduling of subcontractors.	
	PLAN5	We had an effective monitoring process of the project.	
Risk Transparency	TRAN1	We always identify all relevant risks of the project.	Teller and Kock (2013)
	TRAN2	We had a good understanding of the scope in which the risks could influence our goals.	
	TRAN3	Risk informations helped implement decisions.	
	TRAN4	Risk informations helped to decide better.	
Risk Coping Capacity	COPI1	We had enough freedom of action to react to risks adequately.	Teller and Kock (2013)
	COPI2	We reacted to identified risks and carry out the necessary adaptive measures quickly.	
	COPI3	We reacted to unforeseeable risks and carry out the necessary adaptive measures quickly.	
	COPI4	The recognized sources of risk could be neutralized.	

(*) Reverse scale

Chart 13 – Scales for the project management practice construct
Source: elaborated by the author

The second block was related to performance construct. We used the success measures defined by Shenhar et al. (1997) to evaluate performance. For “budget and schedule” and “business success” dimensions, only two items emerged from EFA. As these numbers of items are insufficient to measure the construct because we needed at least three items for each dimension (Hair Jr. et al., 2009), we created more two items for each dimension considering the main idea of the construct. Regarding the customer satisfaction dimension, six items emerged from EFA, but we used five items because one of them did not fit accurately for our purpose.

In Chart 14, we provide the items used to assess budget and schedule, customer satisfaction, and business success constructs.

Construct	Code	Items	Reference
Budget And Schedule	BUDG1	We met time goals	Shenhar et al. (1997)
	BUDG2	We met budget goals	
	BUDG3	We complied the project goals. **	
	BUDG4	We performed the project as planned. **	
Customer Satisfaction	SATI1	We met operational specifications.	Shenhar et al. (1997)
	SATI2	We met technical specifications.	
	SATI3	We met customer needs.	
	SATI4	The project was useful for customers.	
	SATI5	Our customer is fully satisfied.	
Business Success	BUSI1	The project was a commercial success.	Shenhar et al. (1997)
	BUSI2	The project helped the company to gain market share.	
	BUSI3	The project gave adequate return to investors. **	
	BUSI4	The project was an economic success. **	

(**) We included the item with a derivation of the two original items.

Chart 14 – Scales for the performance (success measures) construct
Source: elaborated by the author

The third block was related to absorptive capacity (AC). The scales for PAC and RAC were first defined by Jansen et al. (2005) for their research into the financial service sector in Europe. These scholars performed the CFA to validate the constructs. With the two dimensions validated, the existing scales were posteriorly adapted by Leal-Rodríguez et al. (2014) to measure the innovation outcomes in project teams belonging to the Spanish automotive components manufacturing sector. These scholars also performed the construct reliability and convergent validity of the measurement model through partial least squares (PLS). Thus, with the existing scales in hand, we adapted them for measuring construction projects.

In Chart 15, we provide the items used to assess the PAC and RAC constructs.

Regarding the control variables, we chose some of them (Chart 16) to analyze their influence on projects. The “Experience in project management” variable is related to the project manager. It was expected that the more experienced the project manager, the more efficient the management, which in turn impacts on project processes.

The “Size of investment in the completed project (in R$)”, “Number of employees allocated to the completed project”, “Duration of the completed project”, and “Classify the level of complexity of the completed project” variables are related to the project size. It was expected that the project size has a relationship with the project complexity. Therefore, the more complex is the project, the more knowledge and skilled labor are needed, which in turn impacts on project processes.

Construct	**Code**	**Items**	**Reference**
Potential Absorptive Capacity	PAC1	We had frequent meetings with senior managers to acquire new knowledge.	Jansen et al.(2005), Leal-Rodríguez et al. (2014)
	PAC2	Our team members regularly visited other project teams.	
	PAC3	We collected project informations through informal means (e.g., lunches with project colleagues, talks with senior project managers).	
	PAC4R*	Project colleagues did not visit other units or project teams.	
	PAC5	We periodically organized special meetings with clients, suppliers or third parties to acquire new knowledge.	
	PAC6	We regularly contacted external professionals such as project managers, project team or project consultants.	
	PAC7	New opportunities to serve our clients were quickly acknowledged.	
	PAC8	We quickly analyzed and interpreted changing client requirements.	
Realized Absorptive Capacity	RAC1	Our project team recorded and stored newly acquired knowledge for future reference.	Jansen et al.(2005), Leal-Rodríguez et al. (2014)
	RAC2	We quickly understood the usefulness of new external knowledge for existing knowledge in projects.	
	RAC3R*	Our project team hardly shared practical experiences.	
	RAC4R*	We laboriously grasped the opportunities for our division from new external knowledge in projects.	
	RAC5	We knew how activities within our unit should be performed.	
	RAC6R*	Clients' complaints fell on deaf ears in our project team.	
	RAC7	Our project team had a clear division of roles and responsibilities.	
	RAC8	We constantly considered how to better exploit knowledge.	
	RAC9R*	We had difficulties implementing new ideas.	
	RAC10	Our employees had a common language regarding our works.	

(*) Reverse scale

Chart 15 – Scales for the potential and realized absorptive capacity construct
Source: elaborated by the author

The last variable is the “Number of employees (last period)”. This variable is related to the company size. It was expected that the larger the company, the greater is the complexity of its operations. This, in turn, can influence on PAC and RAC in terms of generation of new critical knowledge. As we discussed above, this affects outcomes, routines, and processes.

In Chart 16, we provide the control variables used to evaluate whether specific characteristics of the project have any significant impact on performance.

Dimension	**Code**	**Variable**
Control Variables	EXP	Experience in project management.
	INV	Size of investment in the completed project (in R$).
	NEP	Number of employees allocated to the completed project.
	TDP	Duration of the completed project.
	INC	Classify the level of complexity of the completed project.
	NEE	Number of employees (last period).

Chart 16 – Control variables
Source: elaborated by the author

Our survey questionnaire was defined using a five points Likert scale with 1 representing “strongly disagree” and 5 “strongly agree”. For assessing the specific practices in project management, we proposed the semantic scale with 1 representing “not important” and 10 “critically important”. Even though the scales are in English, they were translated into Portuguese for the data collection process. In Appendix D is depicted the full questionnaire of this research.

4.4.1.1 Questionnaire Validation

The questionnaire was validated through pre-test qualitative interviews with five professionals in the construction project (e.g., project manager, project director, and engineering director) and two academic professor experts in the survey. The interviews were done by phone (two interviews) and the others personally. They noted that the scales do not have major problems in terms of distortions (problems with assertive, lack of objectivity, among others). They suggested small corrections that were done for the final questionnaire. The aim of this phase is to capture and solve possible problems that the respondent would have in the data collection process. According to Hair Jr. et al. (2009, p. 560), the pre-test is important when scales are applied in a specific context.

4.4.2 Population and Data Collection

We developed this research into the construction sector. We selected the sample in the construction sector from the database of the Regional Council of Engineering and Architecture of São Paulo State (CREA-SP). All the companies selected are located in São Paulo. For obtaining the contacts of the construction and engineering companies, we accessed the website from CREA-SP (http://www.ebge.com.br/crea/pesq_eng.aspx?uf=sp). The results from this first round were 5,109 companies. In this master list, we had many companies that were not interesting to answer our research such as reform companies, consultancy, general services in engineering, and among others. Therefore, in the second round, we discarded them and obtained 1,799 companies. From this list, we randomly selected "construction" or "engineering" company. The result was 719 companies to compound the base for our data collection.

The data collecting was done in the period from October 16 to December 03, 2014. In this period, we tried to contact all the companies in our database by phone. However, many problems occurred, for example, the phone of the company did not exist anymore, the company did not have a project manager, the project manager or the person responsible for projects rarely was in the office, the project managers refuse to answer the research, and among other problems. Therefore, from 719 companies in our database, we only obtained 356 contacts to send the e-mail with the link to our research.

The contact with those companies was by phone. Our respondent focus was the project manager with at least three years of experience. Initially, we sent the e-mails to the project managers and after one week later, we called them to know if they had received the link to the survey questionnaire. We realized that many of them had deleted the e-mails because they thought that could contain viruses, or the e-mails were in the spam box. It was another problem. Therefore, we resend the e-mails to restart the process of collecting data. During this period, various contacts were done with the respondents to get the response.

In our e-mail, we asked at least three project managers to respond the research. In this case, we would have 1,068 potential respondents, but we only had 131 responses, with 12.27% response rate.

Our second sample was built through personal contacts from the researcher, through the Linked In (social network), and through yellow pages from internet. We asked friends to indicate project managers in the construction sector. In total, we received 96 contacts in São Paulo State.

The data collecting was done in the period from October 09 to December 07, 2014. From this second master list, we received 46 responses in the period, with 47.92% response rate. However, if we consider the two samples, we had 15.21% response rate (177/1.164). In Chart 17 is depicted a summary of the data collection.

For collecting data in this quantitative phase, we used the Qualtrics Research Suite (online survey software).

	CREA-SP base	**Social network (*)**	**Total**
Initial date of data collecting	Oct. 16, 2014	Oct. 09, 2014	
Finish date of data collecting	Dec. 03, 2014	Dec. 07, 2014	
City/State	São Paulo/SP	São Paulo/SP	
Total answers (complete and incomplete)	**131**	**46**	**177**
Incomplete answers	**22**	**2**	**24**
Did not respond the identification part (**)	4	0	4
Started to respond, but stopped (***)	18	2	20
Complete answers	**109**	**44**	**153**

* Related to friend indications, social network (Linked In), and yellow pages from internet.
** Identification of the respondent, project, and company.
*** With a different degree of starting. They were excluded from de sample.
Chart 17 – Survey report
Source: elaborated by the author

4.4.2.1 Demographic Profile of Sample

This section aims to provide the whole idea of the demographic profile of the sample.

We started with respondent profile. We observed that the most of the respondents work for middle size companies (Table 1). For example, 45.2% of them work for small company and the most of them (54.8%) work for middle and large size companies. However, it is important to comment that the number of 157 does not represent the number of companies in our sample because one company could have had more than one respondent. In Table 1 is depicted some information related to our respondents.

	Frequency	Percent	Cumulative Percent
until 100	71	45.2	45.2
100 to 500	51	32.5	77.7
500 to 1,000	11	7.0	84.7
1,000 to 5,000	17	10.8	95.5
5,000 to 10,000	5	3.2	98.7
above 10,000	2	1.3	100.0
Total	157	100.0	

Table 1 – Number of employees (last period)
Source: elaborated by the author

Regarding their maturity. Approximately 87% of our respondents have more than 30 years old and 57% have more than 40 years old (Table 2). Thus, we could say that our respondent is a mature person that is interesting for the purpose of our research.

	Frequency	Percent	Cumulative Percent
20 to 25 years	7	4.5	4.5
25 to 30 years	13	8.3	12.7
30 to 35 years	29	18.5	31.2
35 to 40 years	18	11.5	42.7
40 to 45 years	27	17.2	59.9
45 to 50 years	21	13.4	73.2
50 to 55 years	18	11.5	84.7
55 to 60 years	10	6.4	91.1
60 to 65 years	8	5.1	96.2
above 65 years	6	3.8	100.0
Total	157	100.0	

Table 2 – Age of the respondent
Source: elaborated by the author

We also noticed that our sample is essentially male (Table 3). The work environment is dominated by male (69%) and only 31% are female.

	Frequency	Percent	Cumulative Percent
Male	109	69.4	69.4
Female	48	30.6	100.0
Total	157	100.0	

Table 3 – Gender of the respondent
Source: elaborated by the author

Regarding their professional position (Table 4), the most of them (approximately 80%) are working in project positions. If we exclude the project consultants and others (budget manager, executive director, chief executive officer, process coordinator, among others), we have 58.6% in management positions. In terms of experience in projects, 88.5% of them have more than three years of experience (Table 5). This was the minimum of experience in projects required from the respondent. Thereby, our sample is adequate for our research.

	Frequency	Percent	Cumulative Percent
Engineering manager	2	1.3	1.3
Leader project	27	17.2	18.5
Project consultant	33	21.0	39.5
Project controller	6	3.8	43.3
Project coordinator	6	3.8	47.1
Project director	12	7.6	54.8
Project engineering	13	8.3	63.1
Project manager	22	14.0	77.1
Project supervisor	1	0.6	77.7
Risk manager projects	3	1.9	79.6
Others	32	20.4	100.0
Total	157	100.0	

Table 4 – Position of the respondent
Source: elaborated by the author

	Frequency	Percent	Cumulative Percent
until 3 years	18	11.5	11.5
3 to 5 years	14	8.9	20.4
5 to 10 years	36	22.9	43.3
10 to 15 years	28	17.8	61.1
15 to 20 years	18	11.5	72.6
20 to 25 years	13	8.3	80.9
25 to 30 years	15	9.6	90.4
30 to 35 years	7	4.5	94.9
35 to 40 years	5	3.2	98.1
above 40 years	3	1.9	100.0
Total	157	100.0	

Table 5 – Years of experience in projects of the respondent
Source: elaborated by the author

The next tables are regarding the project identification. In terms of the type of projects (Table 6), our sample is much diversified. We noticed that 42% of the projects are related to residential construction, 20.4% related to commercial construction, and 31.2 related to industrial and heavy construction. Thus, we have approximately 93.6% of diverse projects that is good for the whole understanding in the construction sector.

In terms of investments (Table 7), 69.4% of the projects account for investments in excess of R$ 5 million, 58% in excess of R$ 10 million, and 22.9% in excess of R$ 50 million. Considering the number of people allocated to projects (Table 8), we realized that 49% of the projects have until 50 employees, 51% of the projects have more than 50 employees, and 32.5% of the projects have more than 100 employees. Thus, the most projects in our sample accounts for middle and large projects.

In terms of duration and complexity of projects (Tables 9 and 10), we observed that 86.6% of the projects required until three years to be completed, and the most of them (51%) from one year to three years, and 13.4% more than three years to be completed (Table 9). The degree of complexity (Table 10) accounts for 92.4% of the projects, which are classified from medium to extremely complex and 30.6% from high to extremely complex. Therefore, it is expected that the greater the complexity, the greater the knowledge required to run projects.

	Frequency	Percent	Cumulative Percent
Commercial construction	32	20.4	20.4
Industrial construction	30	19.1	39.5
Heavy construction	19	12.1	51.6
Residential construction	66	42.0	93.6
Land	1	0.6	94.3
Geotechnical	1	0.6	94.9
Others	8	5.1	100.0
Total	157	100.0	

Table 6 – Type of construction referred to the completed project
Source: elaborated by the author

	Frequency	Percent	Cumulative Percent
until 5 million	48	30.6	30.6
5 to 10 million	18	11.5	42.0
10 to 50 million	55	35.0	77.1
50 to 100 million	19	12.1	89.2
100 to 500 million	12	7.6	96.8
500 million to 1 billion	2	1.3	98.1
1 to 5 billion	2	1.3	99.4
above 5 billion	1,0	0.6	100.0
Total	157	100.0	

Table 7 – Size of investment in the completed project (in R$)
Source: elaborated by the author

	Frequency	Percent	Cumulative Percent
until 50	77	49.0	49.0
50 to 100	29	18.5	67.5
100 to 500	39	24.8	92.4
500 to 1,000	7	4.5	96.8
1,000 to 5,000	3	1.9	98.7
above 5,000	2	1.3	100.0
Total	157	100.0	

Table 8 – Number of employees allocated to the completed project
Source: elaborated by the author

	Frequency	Percent	Cumulative Percent
until 1 year	56	35.7	35.7
1 to 3 years	80	51.0	86.6
3 to 5 years	20	12.7	99.4
5 to 7 years	1	0.6	100.0
7 to 9 years			
9 to 10 years			
above 10 years			
Total	157	100.0	

Table 9 – Duration of the completed project
Source: elaborated by the author

	Frequency	Percent	Cumulative Percent
Low	12	7.6	7.6
Medium	97	61.8	69.4
High	43	27.4	96.8
Extremely	5	3.2	100.0
Total	157	100.0	

Table 10 – Level of complexity of the completed project
Source: elaborated by the author

4.4.3 Sample Size

The definition of sample size was based on Hair Jr. et al. (2009, p. 564) that suggest the minimum recommended size is between 100 and 150 respondents to ensure stable solutions when certain statistical techniques are used. For instance, maximum likelihood estimation (MLE) that is the common method employed by the structural equation modeling. As we have 157 respondents (153 complete answers and 4 that did not respond the identification part) in our data collection, it is in accordance with what Hair Jr. et al. (2009) suggested. In terms of the specification of the sample, Hair Jr. et al. (2005) pointed out that is important because after the data collection would be too late to change it.

4.4.4 Procedures for Data Analysis

In this section, we described the methods and procedures used for data analysis. It addresses the issue of missing value, outliers, normality test of data, working with two samples, common method variance, confirmatory factor analysis, and hierarchical linear regression.

4.4.4.1 Missing Value

The missing values are not a major problems in our data collection. We had only four missing values in the key variables and distributed in random way. Given that, we replace them by the average of their original variables (Corrar, Paulo, & Dias Filho, 2009, p. 38; Hair Jr. et al., 2009, p. 65) through SPSS. In Appendix E is depicted this analysis in more detail.

According to Arbuckle (2010, p. 269), it is common to eliminate from the analysis any response that contains missing values. However, this is not a good method because we can lose some important information. Hair Jr. et al. (2009, p. 66) pointed out that there are various strategies to replace the missing values. One common method is to replace the missing value by the average of the original variable. However, according to them, this method has some disadvantages. For example, it underestimates the value of the variance, distorts the actual distribution of values, and compresses the correlation observed. By contrast, they pointed out that it is very easy to implement and provide all the cases with complete information. Therefore, we replaced the missing values by the average of their original variables (Corrar, Paulo, & Dias Filho, 2009, p. 38; Hair Jr. et al., 2009, p. 65) through SPSS. According to Kline (2011, p. 55), a few missing values do not represent major concern, in his words: “A few missing values, such as less than 5% on a single variable, in a large sample, may be of little concern.”

4.4.4.2 Outliers

The outliers are not a major problems in our data collection as well. The maximum proportion in a sample was 1.3% in only two cases. We assessed them through univariate and multivariate analysis; we have evidence for not removing potential outliers from the sample. In Appendix F this analysis is depicted in more detail.

In univariate detection, we analyzed them through the boxplot graph (more visual) and also considering the Chebyshev's theorem (Sweeney, Williams, & Anderson, 2013, p. 114) that suggests to work with standard values for outliers detection. According to this theorem, in the case of the standard values above or below ± 3, they are considered potential outliers (Clark-Carter, 2004; Corrar, Paulo, & Dias Filho, 2009; Kline, 2011, p. 54). However, Hair Jr. et al. (2009, p. 79) suggest for sampling above 80 a standard score up to 4. The advantage of this theorem is that it allows to work with any form of data distribution (Sweeney, Williams, & Anderson, 2013, p. 113). In this sample, we have 157 respondents (more than 80 respondents); therefore, the data were analyzed considering ± 3 standard scores to be conservative.

In sequence, we performed a multivariate detection. This method was based on the Mahalanobis distance (D^2) statistic. According to this method, great values of D^2 represent very far observations from the general distribution (Hair Jr. et al., 2009, p. 78; Kline, 2011). For Kline (2011, p. 54), the D^2 represents "[…] the distance in standard deviation units between a set of scores (vector) for an individual case and the sample means for all variables (centroid), correcting for intercorrelations." Hair Jr. et al., (2009, p. 79) still suggest assessing the outliers using the measure D^2 / df. In this case, the D^2 is divided by *df* (degree of freedom) that represents all variables involved in the model. We have evidence of potential outliers when the statistic is greater than 2.5 for a small sample, or greater than 3.0 or 4.0 for a large sample. To calculate the statistic (D^2 / df), we have 56 variables in our sample, but only 44 variables were used to assess our hypotheses.

Hair Jr. et al., (2009, p. 77) and Corrar et al. (2009, p. 28) consider that the outliers are neither beneficial nor problematic; however, should be evaluated considering the type of analysis that may be required. They also are not favorable to remove outliers without previous analysis or a proof that they really are atypical observations (Corrar et al., 2009; Fávero et al., 2009; Hair Jr. et al., 2009). Hair Jr. et al., (2009, p. 79) point out that when the researcher removes them in order to improve the multivariate analysis, it can limit the generalization of research.

4.4.4.3 Normality Test of Data

The next analysis was the normality of our data. As the most part of our individual data were collected through 5-point Likert scale, the statistics tests showed that our data are not normally distributed. However, this fact is common in survey type research and many authors indicate that is not a major problem (Leech et al., 2005, p. 16). Kline suggested cutoff value of 3.0 for absolute skew and 10.0 for absolute kurtosis. In our data, all values are below these cutoff points. The absolute value of skew and kurtosis are 1.963 and 5.078 (Table 13 in descriptive statistics), respectively. As a result, there are evidence that our data are approximately normally distributed. In Appendix G is depicted this analysis in more detail.

For analyzing the normally data, we performed various tests such as the Kolmogorov-Smirnov test, the skewness analysis suggested by Leech et al.(2005, p. 28), the skew and kurtosis analysis suggested by Kline (2011, p. 60), Mardia's (1970) normalized coefficient to analyze the multivariate distribution, and among others. In this section, we explained in detail each of them.

The assumption of normally distributed of the variables is required for parametric statistics (Corrar et al., 2009; Leech et al., 2005). Therefore, we performed the univariate analysis for each variable. The Kolmogorov-Smirnov test was performed to evaluate whether the null hypothesis that the data follows a normal distribution. If the significance level exceeds 0.05 (for 95% of confidence), we have evidence in favor of the null hypothesis that the data follows a normal distribution (Corrar et al., 2009; Hair Jr. et al., 2009).

Leech et al.(2005, p. 28) suggest another test to assess the normality. According to them, we need to divide the skewness by its standard error. If the result calculated is less than 2.5, we have evidence that the skewness is not significantly different from normal.

Regarding the 5-point Likert scale when uses perception scales such as strongly agree to strongly disagree (this is in our case), the variable could be considered normal whether the frequency distribution was approximately normal (Leech et al., 2005, p. 16). We performed the histogram for each variable to evaluate the distribution. However, this test is quite subjective because required the visual observation of each variable. At most, we could affirm that some variables are approximately normally distributed. Therefore, Hair Jr. et al. (2009, p. 83) pointed out that when we have small samples this method is quite problematic. They suggest using the normal probability plot that was performed.

Kline (2011, p. 60) suggests working with skew and kurtosis to evaluate the univariate distribution. According to him, if the absolute skew value is greater than 3.0 and the absolute kurtosis value is greater than 10.0, there are evidence in favor of the nonnormality of data. They still pointed out that these tests are more accurate for analyzing skew and kurtosis.

The prerequisite for the evaluation of multivariate normality is the need to verify the existence of univariate normality; however, this is necessary, but not sufficient condition to guarantee the multivariate normality (Byrne, 2010, p. 103; Corrar et al., 2009, p. 41). To conduct this analysis, Byrne (2010) suggests concentrating on the kurtosis and its critical value (i.e., z-value). Despite the absolute value kurtosis of 10.0 suggested by Kline (2011), Byrne (2010) prefers to be more conservative and works with absolute kurtosis value of 7.0. Our data were analyzed according to this suggestion as well.

To analyze the multivariate distribution, Bentler (2006) suggests to assess it through Mardia's (1970) normalized coefficient of multivariate kurtosis. If the multivariate critical value (i.e., z-value) that measure the Mardia's coefficient, provided by AMOS, is greater than 5.0, there is indicative of data nonnormally distributed (Byrne, 2010, p. 104).

4.4.4.4 Working with Two Samples

As we have two samples because we collected data from two sites (Chart 17) such as CREA-SP database and social network, we performed the analyzes of variance of one factor (one-way ANOVA) to validate the use of them. The result indicates evidence that the two samples come from the same population. In all cases, the significance level exceeds 0.05, which means that the null hypothesis is not rejected. Therefore, there is no major problem to work with these two samples.

Additionally, we analyzed the homogeneity of variances (homoscedasticity) through Levene Statistic. The most of results showed the significance level exceeds 0.05. In only one case, the statistic was less than the cutoff value. Therefore, there is evidence that the variances are homogeneous (Hair Jr. et al., 2009, p. 337). The discussion below details all the procedures to analyze these samples.

The total of responses into the two sites were 177, which 131 responses were related to CREA-SP database and 46 responses were related to the social network. To use them in our analysis, initially, we performed the ANOVA test. Hair Jr. et al. (2009, p. 304) pointed out that the ANOVA test is a statistical technique adequate to evaluate whether two or more independent groups come from the populations with the same averages. Therefore, we use this technique to test for equality of the averages of our two samples.

To perform the test, we calculated the average of each response for each observable variable. We used the formula 1, but at this time, we worked with variables in their raw form. The group one was defined as zero (0) and group two was defined as one (1). We configured the test with the significance level equal 0.05 and one-way ANOVA. The null hypothesis is that the averages are equal. Therefore, if the significance level exceeds 0.05, we have evidence in favor of the null hypothesis (Hair Jr. et al., 2009; Malhotra, 2012). In other words, it is expected that the null hypothesis is not rejected (significance level > 0.05) because, in this case, the independent variable would not have significant effect on the dependent variable (Malhotra, 2012, p. 402).

However, three assumptions should be attended to perform ANOVA test: (1) randomness and independence of errors, (2) normal distribution, and (3) homogeneity of variances (Levine, Berenson, & Stephan, 2000, p. 411). The first assumption was attended partially because the CREA-SP sample, discussed above in "Population and Data Collection", followed the randomness to define the company that should be contacted. However, our second sample was collected through social network and, in this case, violated the assumption of randomness. The second assumption was not fulfilled as well. However, according to Leech, Barrett, and Morgan (2005), it is possible to use parametric statistics even whether their assumptions were violated. In their words:

> […] parametric statistics have been found to be "robust" to one or more of their assumptions. Robust means that the assumption can be violated without damaging the validity of the statistic. For example, one assumption of ANOVA is that the dependent variable is normally distributed for each group. Statisticians who have studied these statistics have found that even when data are not completely normally distributed (e.g., they are somewhat skewed), they still can be used. Leech, Barrett, and Morgan (2005, p. 28).

Thus, the normality of the dependent variables is not the major problem for ANOVA test. The third assumption is the homogeneity of variances. We performed the Levene Statistic to test the homoscedasticity of variances. According to Hair Jr. et al. (2009, p. 337), the null hypothesis is that the variances are equal. In this case, if the significance level exceeds 0.05, we have evidence in favor of the null hypothesis (Hair Jr. et al., 2009, p. 337). This means that our data are homogeneous.

In Appendix H is depicted the ANOVA test and the homogeneity test.

4.4.4.5 Common Method Variance

Before proceed to the measurement model by the CFA, we examined the common method variance (CMV) (Bagozzi, Yi, & Phillips, 1991; Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). The results showed that CMV is not a problem because the variance extracted is below 50%. We discuss it in detail in this section.

What is the problem with the common method variance (CMV)? The problem would be that when we measure the dependent and independent variables with the same instrument, we can find an artificial relation between them. This only exists because the two variables were collected with the same instrument, which is a threat to the validity of the study. The literature calls this problem as a threat the common method variance.

More technically speaking, the CMV is a systematic error variance that occurs when a spurious covariance are shared among variables due to the common method used for data collection (Johnson, Rosen, & Djurdjevic, 2011; Malhotra, Kim, & Patil, 2006). According to Podsakoff et al. (2003) and Podsakoff, MacKenzie, and Podsakoff (2012), the problem of CMV occurs when the researcher utilizes a specific measurement method to evaluate different constructs. This problem causes a major problem because it treats the validity of the results (Bagozzi et al., 1991; Podsakoff et al., 2003). For example, Bagozzi et al. (1991) pointed out that the CMV can affect the results by inflating the relationship among variables measured through a specific measurement method. In line with this vision, Podsakoff et al. (2003, p. 881) complement the debate arguing that "[…] measurement error can inflate or deflate the observed correlation between the measures, depending on the correlation between the methods."

To safeguard against CMV, we followed the remedies suggested by Podsakoff et al. (2003, 2012). First, we used validated scales from the literature as much as possible and tried to adapt them to our purpose. In this process of adaptation, we tried to avoid the item ambiguity because this could affect the comprehension of the respondent. Second, during the process of data collection through Qualtrics Research Suite (online survey) we configured the software to randomize the items. This process aims to avoid that respondent gives the same answer for all items of the construct. Third, in our orientation for responding the questionnaire, we said that all the information provided by the respondent would be treated confidentially and, in no case, the data would be disclosed. This orientation aims to guarantee the anonymity of the respondents and reduce their predisposition to change the focus of their responses. Fourth, using statistical control, we assessed through Harman's single factor test whether the CMV affected our observed variables. This test was run in SPSS.

The thirteen factors emerged from exploratory factor analysis (EFA) with eigenvalues above 1.00 and with explained variance around 63.47%. The only single factor extracted was responsible for 19.11% of the total variance. According to Podsakoff et al. (2003), this findings suggest that the common method variance is not a great problem because the only single factor does not explain more than 50% the variance extracted. Therefore, no correction is needed in our model. In Appendix I is depicted the Harman's single factor test.

To measure Harman's single factor, we configured the EFA to run with principal components, unrotated solution, and we asked to extract only a single factor. All items that correspond to all constructs were selected in the study.

4.4.4.6 Confirmatory Factor Analysis

Before performing the hierarchical linear regression (HLR) to test our hypotheses, we run the first order confirmatory factor analysis (CFA) in the AMOS through MLE in order to assess the validity and reliability of the constructs and the model. According to Hair Jr. et al. (2009), the CFA aims to provide a test for our measuring theory. Thereby, the measurement model was evaluated through convergent validity, discriminant validity, and its unidimensionality.

The CFA was run partially for the group of related constructs (e.g., project management practices, performance, and absorptive capacity) due to the complexity of our model. We tested the full model, but we cannot obtain an adequate fit. The sample size did not support the number of parameters to be estimated in our full model. According to Hair Jr. et al. (2009, p. 564), the role of the sample size is to get more information and more stability of the model. But, in our case, was not possible to get the model fit because the sample size was not sufficient to estimate all parameters needed. In other words, the numbers of the degree of freedom are not enough to estimate all the parameters. Thus, the CFA was run one by one for the group of related constructs.

The refinement of the CFA model was done through the goodness-of-fit statistics (GOF). The purpose of this fit is to minimize the discrepancy between the estimated and observed covariance matrices (Byrne, 2010; Hair Jr. et al., 2009). The closer the matrices, more adequate is the model (Malhotra, 2012). Thereby, this reflects in one model more parsimonious.

Hair Jr. et al. (2009) suggest the basic rule for the refinement of the model. Multiple indices should be used in order to assess the adequacy of the model. For example, absolute fit index, relative fit index, parsimony index, fit index based on the non-central chi-square distribution, and information theoretic absolute fit index. We present below the main indices used to measure the CFA model:

a) χ^2 test. The chi-squared is a measure of overall fit of the model. Byrne (2010, p. 75) refers to this index as CMIN test (minimum discrepancy). The aim of this test is to assess the discrepancy between the estimated and observed covariance matrices. However, Hair Jr. et al. (2009) stated that the statistic is quite problematic because depends on the sample size and the difference between the estimated and observed covariance matrices. When the sample increases, the χ^2 also increases even though the difference between the matrices is the same. Despite this problem, a measure of good fit is achieved when the probability (p-value) is higher than 0.05 (95% of confidence) for the χ^2 test or CMIN test. It means we expected low value for the χ^2 statistic (Hair Jr. et al., 2009). Blunch (2010, p. 113) suggests considering the CMIN/DF statistic in CMIN test. If the value of this statistic is near 1.00, there is an indication of good fit.

b) Two other parameters are important when analyzing the CMIN test: (1) the numbers of parameters (NPAR), and (2) the degree of freedom (DF) that represents the amount of information available to estimate the parameters of the model (Hair Jr. et al., 2009).

The next three indices, Goodness-of-fit index (GFI), Adjusted goodness-of-fit index (AGFI), and Parsimony goodness-of-fit index (PGFI) are related to the category of absolute fit measures (Blunch, 2010, p. 113). In other words, these indices aim to assess how good is the quality of the model fit.

a) The GFI index measures the amount of variance and covariance in the observed covariance matrix that is explained by the estimated covariance matrix. The index takes into account the sample size. For a large sample, the value of 0.90 can be acceptable (Hair Jr. et al., 2009). A good fit is achieved when the index is 0.90 or higher (Hair Jr. et al., 2009; Malhotra, 2012).

b) The AGFI index also takes into account the sample size. This measure is quite similar to GFI, but it adjusts the degrees of freedom for a specific model (Byrne, 2010). However, this index penalizes more complex model than simpler model (Hair Jr. et al., 2009). A good fit is achieved when the index is 0.90 or higher (Hair Jr. et al., 2009; Malhotra, 2012).

c) The PGFI index focuses on the parsimony of the model. This measure also assesses the complexity of the model and provides a more realistic index (Byrne, 2010). The index compares two models and the one with the higher PGFI is preferable, but is not recommended to conduct the assessment using only this index (Hair Jr. et al., 2009). Normally, this index has low value. The fit is considered satisfactory for the value higher than 0.60 (Blunch, 2010).

The next set of indices used to assess the CFA model was the relative fit measures. These measures are in the category of incremental or comparative indices. They compare the hypothesized model with the null model (Byrne, 2010). Three indices were used to complement the analyzes of CFA model: the normed fit index (NFI), comparative fit index (CFI), and Tucker-Lewis index (TLI).

a) The NFI index corresponds the difference in proportion between the adjusted model and the null model (Hair Jr. et al., 2009). The fit is considered excellent fit for value of 0.95 or higher (Byrne, 2010). For Malhotra (2012), the value of 0.90 or higher is considered good fit.

b) The CFI index is also an incremental measure, but is more accurate than NFI. For cutoff value close to 0.90 is considered a good fit (Hair Jr. et al., 2009; Malhotra, 2012). But Byrne (2010) and Mackenzie et al. (2011) suggest a cutoff value close to 0.95 for indicative of the good fit model. Given we have a conflict in the literature, we work with cutoff value above 0.90 to assess the CFA model.

c) The TLI index is similar to the CFI, but is non-normed. Thereby, its value can be out of the range from zero to 1 (Hair Jr. et al., 2009; Malhotra, 2012). A value higher than 0.90 suggests good model fit (Malhotra, 2012) and value of 0.95 or higher suggests a well-fitting model (Byrne, 2010).

To evaluate the parsimony of the CFA model, we offered more three indices: parsimony ratio (PRATIO), parsimony normed fit index (PNFI), and parsimony comparative fit index (PCFI).

a) The PRATIO index penalizes the introduction of more complexity into the model (Blunch, 2010). The same consideration as in PGFI is done here. Normally, the parsimony index presents low value. Thereby, the fit is considered satisfactory for a value higher than 0.60 (Blunch, 2010).

b) The PNFI and PCFI indices are derived from NFI and CFI through the multiplication by PRATIO, respectively (Blunch, 2010). The PNFI has two important characteristics: (1) is more favorable to less complex model, and (2) is used to compare models and the one with the higher value is preferable (Hair Jr. et al., 2009). To assess the parsimony worth the same PRATIO rule.

The next index was the fit measures based on the non-central chi-square distribution. Two indices are offered to assess the CFA model: the root mean square error of approximation (RMSEA) and the closeness of fit (PCLOSE).

a) The most popular is RMSEA that decreases its value as more variables are added to the model (Hair Jr. et al., 2009). This index "[…] takes into account the error of approximation in the population […]" (Byrne, 2010, p. 80). There is no consensus in the literature regarding the cutoff value of this ratio. For instance, Hair Jr. et al. (2009, p. 573) suggest values with a range from 0.07 to 0.08; however, depend on the combination of sample size and CFI index. Mackenzie et al. (2011) suggest the cutoff value of 0.06 as indicative of a good fit model. Again, as we have a conflict in the literature, we work with a cutoff value of 0.08 to assess the CFA model.

b) The PCLOSE helps to evaluate the RMSEA. The index reports a confidence interval for the RMSEA value to test the hypothesis that RMSEA in the population is less than 0.05 (Blunch, 2010; Byrne, 2010). The satisfactory value for this index is higher than 0.50 (Byrne, 2010).

The last indices we offered to measure the fit of CFA model are expected cross-validation index (ECVI) and modified ECVI (MECVI).

a) The ECVI "[…] measures the discrepancy between the fitted covariance matrix in the analyzed sample, and the expected covariance matrix that would be obtained in another sample of equivalent size" (Byrne, 2010, p. 82). To assess the hypothesized model, we need to compare the ECVI value with the values of saturated and independence models. If the ECVI is the lower value, it is an indicative of the best fit to the data (Byrne, 2010).

b) The MECVI index is identical to the BCC (Browne-Cudeck (1989) criterion) that imposes a penalty for model complexity, except as the form of evaluation (Arbuckle, 2010; Byrne, 2010). If the model was estimated by MLE, the MECVI is preferable than ECVI (Blunch, 2010). To assess MECVI worth the same ECVI rule.

Additionally, we analyzed the model misfit through the standardized residual covariances and modification indices (Brown, 2006; Byrne, 2010). The tests aim to diagnose potential problems of the model's lack of fit. In other words, they correspond to useful measures for evaluating the model adequacy as a whole.

The standardized residuals refer to the difference between the estimated and observed covariance matrices (Byrne, 2010). The evidence of model misfit occurs when large standardized residuals are calculated, which means high discrepancy. In practice, large standardized value means higher than the critical value.

To analyze the model adequacy using a critical value, we refer to Byrne (2010, p. 86) and Malhotra (2012, p. 558) that suggest to work with the cutoff value of 2.58, which corresponds to the 0.01 alpha level. However, for 0.05 alpha level, the critical value is 1.96, which in practice some scholars suggest the cutoff value of 2.00 (Brown, 2006, p. 118). In short, for values below the cutoff value there is no evidence of misfit.

We also analyzed the model misfit through the degree of modification indices. The indices reflect the level of adjustment that should be done to enhance the general model. The lower the number of the modification indices, the better is the model fit.

We assessed the measurement and structural model based on the indices of CFA (Brown, 2006; Byrne, 2010; Hair, Ringle, & Sarstedt, 2011; Hair Jr. et al., 2009; Miller, Rainer Jr., & Harper, 1997). The measurement of convergent validity was analyzed through factor loadings. The variable that exhibited loading less than 0.50 were removed from the model. Therefore, to obtain the convergent validity of the measurement model, the standardized factor loadings should be at least or higher than 0.50. In other words, the factor loadings on a particular common factor show convergence to a common point (Hair Jr. et al., 2009). The t test (higher than 1.96) is indicative of the significance of the factors or by the p-value <0.05, regarding the confidence level of 95%.

Another way to assess the construct validity is through the average variance extracted (AVE) and the reliability indices. The rule is quite simple. The construct exhibits adequate convergence whether the AVE is at least or higher than 0.50 (Fornell & Larcker, 1981; Hair Jr. et al., 2009). This indicates that the AVE explains more than half of its indicator's variance (Hair et al., 2011). In line with this vision, Mackenzie, Podsakoff, and Podsakoff (2011, p. 313) understand that "[…] an AVE greater than 0.50 is desirable because it suggests that the latent construct accounts for a majority of the variance in its indicators on average."

However, the SEM programs do not calculate the AVE and the reliability of the model (Byrne, 2010; Hair Jr. et al., 2009). The coefficients were manually calculated by the definition of Fornell and Larcker (1981).

The reliability of the model was evaluated based on Cronbach's Alpha and composite reliability as well. The rule suggests adequate convergence whether the coefficients are at least or higher than 0.70 (Byrne, 2010; Hair et al., 2011; Hair Jr. et al., 2009; Henseler, Ringle, & Sinkovics, 2009). However, it is possible to have an acceptable reliability for values between 0.60 and 0.70, but the other validity coefficients should be adequate (Hair Jr. et al., 2009). If the coefficients of the composite reliability and the Cronbach's Alpha are higher than 0.70, they suggest that the convergence or internal consistency of the constructs are adequate (Hair et al., 2011; Hair Jr. et al., 2009; Henseler et al., 2009), and also indicate unidimensionality (Tenenhaus, Vinzi, Chatelin, & Lauro, 2005). The unidimensionality indicates that the observed variables measured are related to only one construct (Hair Jr. et al., 2009; Tenenhaus et al., 2005).

To assess the discriminant validity of the constructs, we report the square root of AVE on the diagonal of their correlations. If these values are higher than the intercorrelations of the constructs, it is a good indication of discriminant validity (Fornell & Larcker, 1981). This means that the constructs are correlated and distinct by themselves. Another way to examine the discriminant validity, also suggested by Fornell and Larcker (1981), is through factor loadings. Hair Jr. et al. (2009, p.120) suggest that the adequacy of factor loadings can be evaluated based on the sample size. In this case, for a sample of 150, the factor loadings of 0.45 can be acceptable. As we have 157 responses in our sample, this rule can help for low factor loadings of items that cannot be removed. Hair Jr. et al. (2009) suggest working with at least three items per construct.

Another test for assessing discriminant validity is χ^2 difference test for one pair of constructs (Anderson & Gerbing, 1988; Bagozzi & Phillips, 1982). The difference is calculated regarding the constrained model (fixed) and unconstrained model (freely estimated). The discriminant validity is achieved when the χ^2 difference between two models is above of χ^2 critical value in associated with p-value (Bagozzi & Phillips, 1982). For example, the χ^2 critical value for cutoff points of 0.01 (99% of confidence), 0.05 (95% of confidence), and 0.10 (90% of confidence) are 6.635, 3.841, and 2.706, respectively, for one degree of freedom.

4.4.4.7 Hierarchical Linear Regression

Our hypotheses were tested by the hierarchical linear regression (HLR) in the SPSS. The purpose of the multiple regression is to measure the moderate and direct effects of the absorptive capacity on project management practices and performance in cross section. According to Whisman and McClelland (2005), when the independent variables are dichotomized decrease the squared multiple correlation to about 64%. We discussed in detail the procedure for analyzing the hierarchical regression to test our hypotheses.

According to Heij et al. (2004, p. 125), for running the multiple regression model seven assumptions should be satisfied. In their words:

1) Fixed regressors: “all elements of the n x k matrix *X* containing the observations on the exploratory variables are non-stochastic. It is assumed that n ≥ k and that the matrix *X* has rank k.”

2) Random disturbances, zero mean: “the n x 1 vector ε consists of random disturbances with zero mean so that $E[\varepsilon] = 0$, that is, $E[\varepsilon_i] = 0$ (*i* = 1, …, n).” Where ε = *residuals.*

3) Homoscedasticity: “the covariance matrix of the disturbances $E[\varepsilon\varepsilon']$ exits and all its diagonal elements are equal to σ^2, that is, $E(\varepsilon_i^2) = \sigma^2$ (*i* = 1, …, n).” This means that the variance of ε is constant and do not depend on the *X* values (Malhotra, 2012). However, in the occurrence of heteroscedasticity the power and predictive capacity of the model is prejudiced (Corrar et al., 2009; Hair Jr. et al., 2009). We assessed the heteroscedasticity of the residuals through linear charts (Corrar et al., 2009).

4) No correlation: “the off-diagonal elements of the covariance matrix of the disturbances $E[\varepsilon\varepsilon']$ are all equal to zero, that is, $E[\varepsilon_i\varepsilon_j] = 0$ for all *i* ≠ *j*.” This means that the observations are taken independently of each other (Malhotra, 2012). The occurrence of this problem reduces the power and predictive capacity

of the model as well (Corrar et al., 2009; Hair Jr. et al., 2009). The correlation of residuals was assessed through linear charts (Corrar et al., 2009).

5) Constant parameters: "the elements of the *k* x 1 vector β and the scalar σ are fixed unknown numbers with $\sigma > 0$."

6) Linear model: "the data on the explained variable *y* have been generated by the data generating process (DGP), $y = X\beta + \varepsilon$." The linearity was assessed through scatterplot charts (Corrar et al., 2009).

7) Normality: "the disturbances are jointly normally distributed." The normality of residuals was assessed through Kolmogorov-Smirnov test. If the probability (p-value) is equal to 0.05 or higher is indicative that the residuals are normally distributed (Corrar et al., 2009; Hair Jr. et al., 2009).

To fulfill some of the assumptions above such as 3, 4, 6, and 7, we used scatterplot, linear charts, and Kolmogorov-Smirnov test as mention above. The multicollinearity of the variables was evaluated considering the variance inflation factor (VIF) and tolerance. For VIF less than 5.0 is indicative that multicollinearity is not a major problem (Fávero et al., 2009, p. 359). In this vein, Corrar et al. (2009, p. 188) point out that the multicollinearity is acceptable if VIF is less than the cutoff point of 10.0, and if the tolerance value is less than 1.0 is an indicative of no multicollinearity. Other indicators used to analyze the regression are discussed below.

Beta *(β)*: the beta corresponds to the difference in the predicted value of Y (dependent variable) for each one-unit difference in $X1$ (independent variable). The coefficient was analyzed as follow (Corrar et al., 2009; Hair Jr. et al., 2009): *P-value* < α (α = significance level) ➔ the beta is significant.

R Square (R^2): represents a useful measure associated with the regression line. It measures how much the variation of the dependent variable is explained by the variations of the independent variables (Corrar et al., 2009; Hair Jr. et al., 2009).

R Square Change: this index relates the changes in R^2 due to the new variables added into the model. In other words, it tests whether the increment in the squared multiple correlation (ΔR^2) is significantly greater than zero (Whisman & McClelland, 2005). This indicator was analyzed as follow (Corrar et al., 2009; Hair Jr. et al., 2009): *P-value* < α (α = significance level) ➔ the change is significant.

F-ANOVA: this index aims to test the effect of the independent variables on the dependent variable. It means to verify whether the probability of the parameters of regression as a whole is equal to zero (Corrar et al., 2009; Hair Jr. et al., 2009). In this case, the ANOVA test was analyzed as follow:

> *H0:* $\beta_1 = \beta_2 = \beta_3 = \beta_n = 0$
> *H1:* at least one of the model parameters $\beta \neq 0$
> *P-value* < α (α = significance level) ➔ rejected *H0* ➔ regression is not significant

To safeguard against the difference form of calculations of the moderation term, we centered the observed variables. According to Dawson (2014), this is critically important to maintain the same form of calculation of the interaction term when the variables entered into the regression. The mean-centered variable is zero. Moreover, even though the dependent variables were centered as well, they were used in their raw form to perform the regression (Dawson, 2014). We discuss this process in detail as follow.

To test our hypotheses by the regression analysis, first, we centered the average of the observed variables. In this process, we calculated the mean of the observed variables by the formula 1, and we calculated the mean of the construct by the formula 2 as well. The mean-centered of the observed variables was calculated by the formula 3. This procedure is required to interpret the first-order effects of interaction through the process of re-scaling (Aguinis & Gottfredson, 2010).

$$\bar{V} = \frac{1}{V_n} \sum_{i=1}^{n} V_i \qquad (1)$$

Where V is the observed variable selected in the CFA, n is the number of items, and $\bar{V}$ is the mean of the observed variables.

$$\bar{C} = \frac{1}{n}\sum_{i=1}^{n} n_i V_i \tag{2}$$

Where C is the construct, n is the number of items, and $\bar{C}$ is the mean of the construct.

$$VC = \bar{V} - \bar{C} \tag{3}$$

Where VC is the centralized mean of the observed variables.

If any interaction effect occurs, we expect that PAC or RAC potentializes the effect on the relationship in relation to PMP and performance. In other words, it is expected that the positive effect of this interaction enhances the performance. According to Whisman and McClelland (2005, p. 111), the "[…] moderator effects have also been used to study predictors of differential responses […]" To test the moderator effects of AC on the relationship in relation to PMP and performance, we created interactions variables (Table 11). To build these variables, each AC dimension was multiplied by each PMP dimension.

The test of the moderating effect is the statistical comparison of two models (model 4 and 5) (Whisman & McClelland, 2005), for example:

$$Budget\ and\ Schedule = \beta_0 + \beta_1 MplanC + \beta_2 MtranC + \beta_3 McopiC \tag{4}$$

$$Budget\ and\ Schedule = \beta_0 + \beta_1 MplanC + \beta_2 MtranC + \beta_3 McopiC + \beta_4 MpacC \tag{5}$$

The last term of model 5 is the moderating term that aims to assess the effects of AC on the relationship in relation to PMP and performance. If the coefficient β_4 differs from zero, which means the probability < 0.05 (for 95% of confidence), we have a significative effect of the PAC interaction on Budget and Schedule (performance). The other way to assess the interactions is through the increment in the squared multiple correlation (ΔR^2) as well. In this case, we are testing differences correlations in our groups (Whisman & McClelland, 2005).

To test the moderator effects, we used variables with good reliability that was selected by the CFA model. Good reliability means greater than 0.70. If variables with lower reliability are used, the regression reduces its power to predict the interaction effects (Whisman & McClelland, 2005).

We created square variables of AC dimensions as well (Table 12). As we have a quadratic element in our regression, we are testing for non-linear effects (Dawson, 2014). These variables aim to measure whether the AC squared potentialize the indirect effect on performance. Moreover, as we work with square variables, we are testing for a positive effect on performance.

$$Budget\ and\ Schedule = \beta_0 + \beta_1 MplanC + \beta_2 MtranC + \beta_3 McopiC + MpacC^2 \quad (6)$$

In the last term of model 6 tests whether the PAC exponential factor potentialize the effect on Budget and Schedule (performance).

Additionally, in Chart 18 we provide a summary of the two methodologies.

Type of variables	Dimensions	Code	Mean of the V *	Mean of the V minus mean of the C **
Independent variables	Planning and Monitoring	PLAN2 PLAN3 PLAN5	MPLAN	MplanC
	Risk Transparency	TRAN2 TRAN3 TRAN4	MTRAN	MtranC
	Risk Coping Capacity	COPI1 COPI2 COPI3	MCOPI	McopiC
Dependent variables	Budget and Schedule	BUDG1 BUDG3 BUDG4	MBUDG	MbudgC
	Customer Satisfaction	SATI1 SATI2 SATI3 SATI5	MSATI	MsatiC
	Business Success	BUSI1 BUSI3 BUSI4	MBUSI	MbusiC
Moderator factors	Potential Absorptive Capacity	PAC1 PAC2 PAC5 PAC7	MPAC	MpacC
	Realized Absorptive Capacity	RAC3R RAC5 RAC6R RAC7 RAC9R RAC10	MRAC	MracC

Type of variables	Dimensions	Code	Mean of the V *	Mean of the V minus mean of the C **
Control variables***	Experience in project management	EXP		
	Size of investment in the completed project (in R$)	INV		
	Number of employees allocated to the completed project	NEP		
	Duration of the completed project	TDP		
	Classify the level of complexity of the completed project	INC		
	Number of employees (last period)	NEE		

* This code represents the mean of observed variables of the construct. For example:

$$\bar{V} = \frac{1}{V_n}\sum_{i=1}^{n} V_i$$

Where V is the observed variable selected in the CFA and n is the number of items.

** This code represents the mean of observed variables minus the mean of the construct. For example:

$$\bar{C} = \frac{1}{n}\sum_{i=1}^{n} n_i V_i \qquad VC = \bar{V} - \bar{C}$$

Where C is construct and n is the number of items.

*** This variables do not participate in the CFA process.

Table 11 – Variables selected for regression based on CFA
Source: elaborated by the author

	Code of the variables	Calculation formula
Potential Absorptive Capacity		
Exponential variable	MpacC2	$MpacC^2$
Interaction variables	IntMpacMplan	MpacC x MplanC
	IntMpacMtran	MpacC x MtranC
	IntMpacMcopi	MpacC x McopiC
Realized Absorptive Capacity		
Exponential variable	MracC2	$MracC^2$
Interaction variables	IntMracMplan	MracC x MplanC
	IntMracMtran	MracC x MtranC
	IntMracMcopi	MracC x McopiC

Table 12 – Exponential and interaction variable definitions
Source: elaborated by the author

	Methodology Summary	
	Qualitative Phase	**Quantitative Phase**
Unit of analysis	Project	
Type of research	Exploratory	Conclusive
Approach	Aims (1) to understand the technical and operational aspects of the project, the absorptive capacity, and performance, (2) to support the quantitative phase.	Aims to test the relationship between the constructs through hierarchical linear regression.
Data collection	Based on interviews: The number of interviews: 15 interviews (14 interviews in São Paulo/Brazil and 1 interview in Tennessee/USA) collected in a different industry (construction, energy, steel production, among others).	Based on survey questionnaire collected in São Paulo State: Site 1: CREA-SP (113 valid responses) Site 2: Social network (44 valid responses)
Data collecting period	From May 01 to July 02, 2014	From October 09 to December 07, 2014
Data analysis	Content analysis	ANOVA test, Harman's single-factor test, confirmatory factor analysis, and hierarchical linear regression.
Constructs	Project management practices (PMP): planning and monitoring, risk transparency, and risk coping capacity. Performance: budget and schedule, customer satisfaction, and business success. Absorptive capacity (AC): potential absorptive capacity and realized absorptive capacity.	

Chart 18 – Methodology summary
Source: elaborated by the author

5 RESULTS AND DISCUSSION

In this chapter, we offer the main findings and their discussion of this research. Initially, we start with qualitative research, and then we focus on quantitative research.

5.1 Qualitative Research Results

In this phase, we offer and discuss the main findings of each construct under study. First, we started discussing the absorptive capacity through potential and realized absorptive capacity. Then, the project management practices through planning and monitoring and risk management. Finally, the performance through technical and market performance.

In this phase, we listened a variety of professionals in different sectors in order to obtain an idea of the main terms under study and support the next phase, which is quantitative research. This phase also supports to understand how companies obtain the knowledge they need for their operations.

To analyze the data, we splitted performance into technical and market performance dimensions, and absorptive capacity into potential and realized absorptive capacity dimensions as well. In the next section, we discuss in detail their contributions.

5.1.1 Potential and Realized Absorptive Capacity

The sector acquires the technical knowledge in projects basically through the training process and hiring people from outside when they notice the lack of know-how or skill inside the company.

In order to meet these demands, some companies have partnerships with business schools for training their project team. The certification in projects and MBA courses in projects are means by which companies provide the necessary knowledge to the organization. Some companies have corporate universities to provide training and skilled labor for their internal projects.

This is consistent with the literature. For Raz, Barnes, and Dvir (2003), companies should invest massively in education at several levels of the organization to assimilate the new knowledge, for instance, the new methodology.

However, the lack of skill labor can influence on project performance. For company H, the investment in labor to improve its skill level generates benefits for the company as it improves the management in projects. In his words:

> Today there are projects that run and I see that there are many fails in these projects. For me is the lack of theoretical knowledge or qualifications for a correct project management. First, what I would do, work on the qualification. I would encourage the specialization courses in project management. I even do a bit of benchmarking with the company D. I think this company is very effective on it. Here, we have something like a university. (Company H).

The relevant knowledge acquisition also takes place through the procurement of human resources via the labor market. According to the managers of the companies B, C, and I, the most effective way of acquiring knowledge or replacing knowledge in the company would be through the networking or the labor market. Nevertheless, the professional and personal relationship also constitute an important basis for information exchange. The industry usually goes to the labor market when it detects a lack of expertise or know-how that needs to meet the certain internal position.

However, even important, it was not realized that experiences sharing in the company represents one of the most important practices to acquire knowledge internally. Among the companies surveyed, only the company D reported a willingness to encourage knowledge sharing in its internal structure. In the sector, it has no experience or policy to encourage exchanging both internal and external knowledge through relationships with other companies. When the company shares knowledge, it does through periodic positioning meetings for evaluating the progress of projects, evaluating deviations, taking corrective actions, or proposing solutions. This is the most common form of exchanging experiences. This is in line with Leal-Rodríguez et al. (2014) that pointed out that despite the knowledge sharing that is critical for project success, a few companies do it effectively. But the literature also pointed out that the knowledge sharing among members is the effective way to transform and exploit knowledge by companies (Spender, 1996).

Additionally, another important finding is that the construction industry has not a tradition in association with universities to develop the joint research. The companies seem to have no policies to encourage this work for the development of new materials or new products to the sector. Perhaps, there is a lack of interest in establishing the relationship that provides benefits for both. For the industry, new patents; for the universities, sponsorship for their researches. The company C argues that it is not common the relationship between companies and universities in this sector. This is in line with Gann (2001) that suggests a few companies, in the construction sector, acquire new knowledge from academic research or have joint research with universities.

The project management practice in some sectors is quite consolidated. The specific or adapted methodology from PMBOK® helps to improve processes in the industry, in which it operates. For example, some of them promote feedback sessions periodically to evaluate processes, opportunities to improve processes, process failures, among others. In terms of assimilation, this practice promotes the homogenization of the knowledge when socializes the positive and negative experiences. This collaborative process allows increasing the problem-solving that are occurring in other projects. A collegiate solution becomes important as it brings experiences from several project teams. This knowledge sharing tends to minimize possible risks as well as costs associated with a poorly implemented solution. The company D comments on how this process takes place in its project area:

> Every three months is made a revision of all project cost within the organization. Therefore, the project managers and project directors present their respective projects. Moreover, every three months we have to present at least five experience feedbacks, five learning due to experiences, five failures, and opportunities for improvement in the work process, and what happened in those three months of the project. So, this seems an interesting practice because it is a return of the project management team for the entire organization related to the identification of both strong and weak point. A strength to maintain this practice and to spread it to other projects. Additionally, the opportunity to correct and prevent that other projects are also punished or have an increasing cost, or a loss caused by that failure. This is a practice that I find interesting. (Company D).

This is consistent with Spender (1996) who suggests the knowledge sharing among members is important to enhance competence and improve the process.

As noted, the collaborative process between project teams is an important source of knowledge and experience exchanging. These interactions enable to compare how well the processes are and help in analyzing and proposing solutions to unusual problems. It also allows the improvement of internal skills, which are incorporated into the methodologies adopted by these companies. For example, to improve the implementation and monitoring of critical processes. However, few companies seem to use this mechanism. On the other hand, when they use it, they do because they have reached a degree of maturity in the project or by the definition of their methodology. This was pointed out by managers and directors of companies D and I. For example, the company I highlights:

> Knowledge management is done in two ways: by encouraging training courses and through weekly meetings. To improve the level of competence, the company encourages the study, for example, graduation, MBA courses, and through periodic departmental meetings when the procedures and forms are reassessed. The aim is to align the employee expectations with the management way. At these meetings, the problems and solutions were also discussed. (Company I).

In the regular and closure project meetings, professionals from other project teams are involved. The aim is to report problems and solutions implemented by them and hear the guest opinions. To hear what worked well and what not in other projects and how the problems were solved. Additionally, these meetings aim to provide information for project teams related to problems they faced and align the knowledge between them. In some companies, this process of regular meetings to evaluate and align knowledge is called project review. It also works as a project monitoring system.

Even though the literature indicates that exchanging internal experiences are the key to enabling the knowledge transformation, it was not possible to identify this practice in the companies in this sector. Apparently, in this industry, it does not have initiatives to support this practice. The information sharing is essential because it enables to compare performance (benchmarking), given that certain processes are crucial to projects. For example, to highlight how the implementation of a solution was able to assist the management of essential processes of projects (cost, schedule, and scope) can help to improve performance. The literature also emphasizes that efficient processes tend to influence performance indicators.

However, in the construction sector, it was not possible to identify if exchanging experiences between companies are a recurring practice. The interviewed companies have not shown this interaction capacity with industry peers. Apparently, companies are quite individualistic; however, this point requires further empirical studies. In our work, it was not the focus to study the relationship and the collaborative process between companies.

The knowledge sharing among companies is still little explored. Some companies have created platforms for people to access certain processes and get a response to their concerns. In projects, they call this platform as lessons learned; however, other issues may also be part of this environment.

In this database of lessons learned, it is possible to find problems, solutions, and decisions that the past project has faced for future reference. The managers and project teams have access and use this database available for consultation. Additionally, it is also a way of learning from mistakes and successes of past projects. In this case, any problem that occurred in projects such as the team bad decision, the exchanged e-mails, and the solutions for problems are reported in the database of lessons learned. This is a way to share and transmit knowledge inside the company.

The stock of prior knowledge is an important ally for understanding and analyzing of problems. This prior knowledge enables to foresee problems that may occur in similar situations that the company experienced in previous projects. Furthermore, the lessons learned, in which the problems and solutions are relevant knowledge that were stored, can help to find solutions. However, in the construction industry, few companies store the lessons learned in order to use them in future projects. This is the I company's director vision. For him, it is not a common practice in the industry to use the lessons learned. In his words:

> In the post-construction work, a few companies storage the lessons learned. This is the knowledge management. When you make a budget for selling a work, you create an expectation of resources, cost, profit, and sales. Then, it becomes a reality. It can be a good reality or a bad reality. The important thing is to have an understanding of the cause; if it was a good reality or a bad reality. You somehow must bring to your organization as a procedure or a new guideline for future reference in

> projects. The lessons learned are fundamental because they generate preventive actions for not making the same mistakes twice. (Company I).

This is consistent with Robertson and Williams (2006) that highlight that the lessons learned are rarely used by companies.

Additionally, another way to share knowledge in projects is through the formalization of procedures defined by the methodologies adopted by companies. Depending on the company's size and the degree of maturity in projects, this formalization may be the means by which knowledge is passed on to less experienced employees. For example, the company D argues that when the employees follow the procedures defined by well-structured methodology, they learn how to manage projects. These procedures are references that help in the homogenization of internal knowledge in projects.

The coaching programs were also mentioned by companies as one form of knowledge sharing. This process aims to prepare the potential talent for managerial positions, which it is also a form of knowledge transmission. For example, in company D, the talents are guided by participants from other areas. In this way, this talent management helps to homogenize and integrate procedures. It also makes the organization more solidarity and sensitive to the needs of developing mechanisms to improve its project management or other processes. However, no company in the industry tend to encourage this form of guidance and tacit knowledge sharing.

The information and experience sharing were highlighted by some project managers as an important source of knowledge sharing. For them, the senior managers have the relevant tacit knowledge and when the team members have access to this knowledge enables to run processes more efficiently. However, the construction sector lacks this share through access to experienced people. Perhaps the main causes are internal processes that released these people through restructuring, for retirements, strategic decisions, or even due to the lack of incentive or policy. The company D details how it manages these processes.

> We had a senior staff, who recently retired and others left the company. I especially missed this staff because they were personnel who had 20 years, 25 years of experience in projects. They were managers of large projects. They had white hair. That whole thing. They were a staff that when I had

> a question, or I was in a delicate situation, or anything related to the projects that I was working, I was there taking a coffee and explaining what was going on. I asked a council. I asked what they thought. If I was going to do this or that. If they thought the decision that I was taking was correct or not. In popular saying “exchanging an idea”. These people spent an experience, a guidance, a tranquility, and a calm. They spent a support that today I feel that no longer exists anymore. The team was very young. The team was very similar. So, that is one thing that I feel, that is the experience of the situation. You feel the pressure. You feel customer pressure. You feel company pressures, […] boss, […] CEO, and […] director. The whole exhausting situation and you started to think that something was wrong, and these people said: "No, calm, this is so easy, go here, take care here, take care of the customer because he is preparing to you a trap. this is strategy. Look at this.” They called attention to the point that when we are immersed in the situation and we are not seeing. Moreover, that ended up generating learning of soft skills, which is called in the literature. The learning, the new knowledge that is in the schedule. However, there is the knowledge of how to negotiate, how to behave, how to endure the pressure, stress. How to talk to the director when you have to report a situation, or when you are solving it the same here. I miss that. I really miss it. These were a very great loss for the company because they could not capture this know-how. (Company D).

In other commentary, the company D highlights:

> The company has tried to share this knowledge. It means that it learned. It has some initiatives. The first initiative was the experience of feedback that I explained a few minutes ago. This is to make an identification of what happened, what was done, what can be done to improve or avoid to repeat, or should be kept because it was very good. The second initiative was created, which we called evaluate academy. Evaluate academy is a multipurpose platform. How do films of five minutes for explaining some subject? There was some experience, or something like that, not only related to project management, but any subject. It is being encouraged in project management and sharing on a network where everyone has access within the company. The idea is that exist the practices. The other thing that is done is all of our procedures in project management are formalized. It is written. The procedures are formalized. It fully formalized. So, this knowledge, the way of doing thing is enshrined and is stored in the company. The professional who get there in project management, he quickly learns how to do, how to run a project to the approach the company has adopted and developed. So, it seems a knowledge management also has this aspect. Additionally, the company has started now with the mentor program. Therefore, what it has done. It takes a manager or a senior person and put them to make a mentorship for a professional who is in the same function, but in a moment of junior career, or full, for example, in order to prepare him for the next step. This has been done. Moreover, as the group is large, we have companies [...] you can see on the Internet. The company I work, it has several companies around the world. In Brazil, it has several segments, several companies, and all of them have project management. What are they doing? They take a person working in the area X, for example, to mentor for a person who works in the segment Z, which is where I am. Or you take someone from Z to make a mentor for a person in X, focused on project management. It is an idea that they are working to help knowledge management as well. (Company D).

On the other hand, companies also learn through their mistakes. A poorly evaluated problem causes dissatisfaction situations by both the client and the service provider. When this occurs, the performance of the project and business is affected. Typically, unskilled labor or even inaccurate information from the customer account for such problems. When the problem occurs due to the contractor’s incompetence, it increases the costs associated with problem-solving and affects business performance (technical and market performance).

One way to improve the internal level of expertise is to invest in training or even hire people from outside. This tends to improve the level of knowledge and internal expertise of the company. In addition, when the company clearly understands the customer's problem, evaluates more accurately the necessary resources (financial, material, labor, among others) and generates more consistent planning and budget. The company C reports a case where the bad understanding of the customer's problem almost leads to company bankruptcy. In his words:

> So, for example, for you to build a factory, you need a puff of electricity, a total power. This was the company K's information (contractor). The company participants of the bidding were the W, Y, and Z. The W won. At that time, the company Y contested the result and said that the W had budgeted wrong. It could not make the budgeting in that way as a power. It could not make the budgeting as a power because the energy came in as "X"[1]. The project was made by W and the power was delivered without quality, the final product. Therefore, what W learned from this project? In the end, it gave much problem to W and almost closed. At the end of the project, the W understood and learned that the quality of the product it sold to the same customer, the way it always did, it could be different. So what did the company do? It started investing and today it has a substation of engineering. It has mechanical engineer, electrical engineer, and a team for doing the budget. They study what the company will do, if the proposing is correct, if the price is correct, if the product will serve the customer. So, it has an engineering budget today in W. (Company C).

5.1.2 Planning and Monitoring

In terms of design methodology, the PMBOK® is preferred; however, it is usually adapted to the needs of the business. Some companies make this adjustment because the PMBOK® is very extensive and detailed. According to some project managers, the application of this methodology, as the way it is formatted, makes the process more extensive, toilsome, and time-consuming. Therefore, they prefer to adjust the PMBOK® methodology, but aligned to the main knowledge areas.

On the other hand, sometimes the methodology adaptation generates bureaucratic processes due to the need to ensure that all procedures are followed. According to the company D, the benchmarking between companies could help to make these less bureaucratic methods. In this vein, the company H also highlights that knowledge

[1] The energy comes in alternating, but with noise (e.g. voltage variation, harmonic disturbing, resonances, among others); therefore, it needs to use a harmonic filter to correct this distortion.

exchanging through benchmarking is important to enhance some processes. It is believed that the processes become more efficient and less time-consuming through information exchanges. In this process, the company recognizes that other companies could have interesting skills that deserve to be known and vice versa. The company D points out:

> On the other hand, our methodology is a world standard. It has all the features. I'm impressed how it is well structured. By contrast, it unfortunately caught my attention. I could capture in an informal survey the perception of people that the methodology is very bureaucratic. It is well documented. It is too heavy to follow this methodology. Perhaps, it's because the staff is very young and the company involuntarily tightens the controls to ensure that the implementation will achieve the necessary quality. (Company D).

For example, companies B and D work with the adapted PMBOK®. They adjust the methodology; however, keeping its primary structure. They establish checkpoints (monitoring) for the main project processes as suggested by the PMBOK®. These checkpoints are in the key project stages and help to monitor the fulfillment of what were previously defined in scope (planned). If occurs an event of noncompliance, the project team already suggests actions to bring the project on track. For example, it includes checkpoints in the sales phase, acquisition, assembly and execution, quality, commissioning, and closure. Some companies give different names for these checkpoints or monitoring, for example, gate review. However, the focus is to establish monitoring and adjustments mechanisms.

In company D, all monitoring of processes, following the methodology defined by the matrix, are usually done in spreadsheets (Excel). However, the financial planning of the project is done in an integrated system, for example, SAP, and in sequence controlled via Excel. As we noticed, even though an integrated system provides a great capacity of working, the company uses Excel to be more flexible and enable faster simulations. Which it is not possible to have all this flexibility via SAP.

In this planning, the company establishes checkpoints for approval the processes, which it allows to progress to the next step. However, for occurring this, the process under revision must receive a minimum score. Some companies call these processes as basis review or gate review. These processes under analyzes generate learning when enable to discuss any problems and ways to solve them. In this case, the company's knowledge stock and procedures defined by its methodology are important allies to solve the problem and advance to the following steps.

Normally, the planning process is assessed through reports, which in turn reports the evolution of costs, margins (gross margin), and other expenses. The spreadsheet (Excel) is normally used to generate these reports perhaps due to its flexibility. But some companies also use integrated systems. The deviations are analyzed and some corrective actions are taken. The company D comments what was discussed above:

> We use the PMI as a reference. Well, we make a schedule that we call business line early on and froze the business line, as required by the methodology. Then we have a schedule of execution. It reports what happens in the real and follows the improvement on the business line. We have some design practices, for example, when the schedule is established for each contract year, it must have at least 30 days off (buffer) in the business line. Therefore, in a three-year contract, It is required to have a schedule with 90 days off. Regarding the standard cycle, product manufacturing, we have certain tables. This is the first thing when we prepare the schedule. This schedule has the version for WBS, as sends more or less the PMI. I think I have a maximum of five levels. The risk of the project structure is placed inside this system. To have a reference, we have this process outside too. In practice, we end up watching more outside than inside, because due to the difficulty of scenario simulation. Therefore, it is very toilsome and then we end up using the Excel. We export to Excel and use it for analysis. Then we also prepare a list of margins because we follow the IFRS. Now we are required to recognize revenue on the basis of project progress and recognize the result. (Company D).

In some companies, planning management uses sophisticated methods to monitor and control projects. For example, the WBS with the support of an integrated management system, which can be a SAP, a SAS, or the other system that has the function to integrate the information into a single platform. This enables the management as a whole.

However, there are companies that prefer to manage the planning directly via the integrated system. This eliminates parallel systems (Excel). Moreover, it enables the accounting of expenses and revenues, the update data is real-time, which enables the analysis of technical indicators such as cost, time, quality scores, among others, because the processes are integrated into system. For example, it allows you to manage multiple projects, materials management, among others. Anyway, integrated processes also allow monitoring.

To company B, the monitoring can be done through reports of deviation and control. This report serves to control and monitor management actions on the project related to the cost.

However, time must be controlled taking into account the critical path (PERT) of the project. The delay of an activity on the critical path is preoccupying because all subsequent activities also would delay. The activities out of the critical path are more flexible and allow a more relaxed management. In company D, focused on projects, the critical path is reassessed every three months and at the end of the year. This is important because by identifying the project is out of track, corrective actions are immediately proposals to bring the project to the planning horizon previously defined. The following comment is related to company B. In its words:

> With respect to time basically you would have to make a critical evaluation of the project's critical path. In any schedule, you have a path that constitute the critical line. Therefore, it's a practice commonly adopted at the beginning of each project. You established the critical line. What activities pass through the critical line? This is formed the backbone for you to take control of time management. Because, let's suppose, if you delayed the activity within the critical line, then it highlights a yellow light. Because if it had within the critical line basically it pushes all the activities to the end. (Company B).

Regarding the monitoring plan:

> So, you have two situations. If it were below (cost) basically you would improve your margin. Because if you buy it at a lower price, of course, you would create a provision, a clearance. You would create an opportunity, one of the things I have said. On the other hand, if you had a situation previously identified by the buyer, and he said: “Look here, you gave this budget, but I cannot buy it (material) at this price.” In this case, we had a deviation from the original report. it is something that Company B does. We call it of deviation report. Therefore, you had to report for getting an approval for buying it (buy the material). Then, the project life would have to follow. So, this is a practice commonly adopted by us to make the scope management. (Company B).

The planning based on more sophisticated tools can help the project performance because it enables a greater understanding by the project team of all the processes to be executed and delivered. It also assists in monitoring and controlling project as well as performance indicators extraction. For example, technical and market indicators, depending on the degree of sophistication of these structures. For example, if the WBS is well done, it provides so much information as pointed out by companies.

In the construction sector, companies working with WBS perform the monitoring of works through various indicators taken from this tool. As the manager of the company C defined, they are called curves of indicators such as costs curve, materials curve, trend curve, among others. According to him, the cost analysis is the main indicator to assess the performance of the work based on this tool. However, the quality is achieved as the construction follows the technical criteria or procedures (norms) defined by the clients. Below, company C says it uses the WBS. In its words:

> Some WBS must have the name of the supplier. He has to maintain the same price. So as not to leave stored material and for several other reasons such as preservation reasons, and everything else. It is left to buy the material at the right moment. You know this moment through WBS. So, this is the WBS of materials. It also has the WBS of percentage, the physical generators. The tool also has activities with the three information: forecast, performed, and the trend. And it has the overall WBS. Therefore, the company provides for WBS how many man-hours go to use in each activity. Then you update the real, which is the HR (human resources) responsibility. They have an employee to do this work there. Well, it generates the curves such as work curve, the supply curve, and design curve. This is the tool that managers use to the most analyzes. They evaluate the performance of the construction, in conformance with the project, in conformance with calculus, in conformance with deviation. (Company C).

However, in industrial constructions, there are situations where the company needs to adapt to the customer requirement measures due to its quality system. When this happens, the construction company has little or no flexibility to negotiate its manner to perform processes. It just follows what has been determined by the customer's norms. Anyway, it just performs the processes following the customer’s performance indicators. Certainly, the client must also approve the implementation processes.

Additionally, there are situations where the client requires the company's construction quality manual. In this case, for being analyzed and approved by him. The construction company must follow the work plan constant in this manual. The client assumes that what he agreed will be fulfilled. For example, the technical specifications will be met, which is one of the customer’s satisfaction requirements.

A comment of company I generates second thoughts. For its director, in the construction industry, some companies do not make planning in detail. They seek to act in the more aggregated way based on, for example, the ABC curve. The project monitoring is also managed in the more aggregated way by the top management. Periodically, they have meetings to assess deviations and look the trend curves. For example, according to the company I, the sector monitors the projects looking at the main physical quantities; it has worked well. For him, the company has to have an overview of the construction based on a maximum of five magnitudes. These magnitudes assist in monitoring the work as a whole. In his words:

> So, I have 60 thousand welds to do, and it was performed 40 thousand; thus, I have to do 20 thousand welds. I still have four months to work on the project, and then I have to do 5 thousand welds per month. (Company I).

However, the lack of accuracy with the planning makes the process more susceptible to uncertainties. Therefore, it is possible to increase the risk of rework, increased costs, neglects the quality, delays activities, and customer dissatisfaction. In addition, the outcome of the project may also be compromised. In short, it can take the project to failure.

5.1.3 Risk Management

To deal with the potential risks and opportunities identified during the planning phase that, in the case of occurrence, they could cause delays in activities or impacts on project margins. To safeguard against such risks that have great probabilities of occurrence, companies constitute a provision for contingencies. In the case of non-occurrence of the risk previously identified, the provision is reversed, which directly affects the project margin. However, even though it increases the margin, it does not mean because of operational efficiencies, but due to the accounting rules.

This provision may also give an indication that the company has no risk management. For example, the company needs to value all risks, but when it sets up 2% of the sales for contingency risk in its result without any deep analysis of the project risk, may also have an indication of the lack of risk management.

By contrast, a well-defined structure for risk assessment allows to better manage uncertainties and make quick decisions in order to minimize such impact. The company D supplies some interesting points regarding this subject. In its words:

> The risk management and opportunity are part of this standard spreadsheet that I said. It has tabs of risk and opportunities. We do a risk and opportunity section when the project comes from the commercial area. The business has done a list of risk and opportunity. The first thing we do soon after receive the project is to have a risk and opportunity section, where we try to map the maximum project risk, after the kick-off meeting. And the analysis and delivery of the agreement and delivery of the execution. That's where a new revision is made in the spreadsheet that came from commercial, and we create a new risk control and opportunity of the project. Most of them are likely to happen. They are taken for the project to the cost worksheet and is generated a contingency for risk. Which is launched in the margin. About 2% of our margin is the contingency for risks. And the opportunities we also value, but they are not

> taken into account in the margin. They are only eligible for edge effect when I can have a formal agreement with the client. In this case, the opportunity is recognized. So, I take to the margin. Out of this, they keep as an opportunity for a plan of action for both the risk and opportunity. This control is also done in the Excel spreadsheet. There is no mapping. Now we are moving to a base in the intranet. (Company D).

Conversely, by better structured that is the risk assessment policy in the company, it is impossible to list or identify all kinds of uncertainties or risks. For example, a source of uncertainty is the customers. They contribute to raising the level of uncertainty in projects as they suggest frequent changes. Although these adaptations contribute to their satisfaction, may raise costs for unforeseen executions or even delays in the schedule of activities. Anyway, customer requirements that were not identified in the planning stage, they lead to the change in scope and affect performance. In the construction sector, according to the company C, these changes are very common by the customers.

The process of monitoring risks and uncertainties should be very rigorous; otherwise, we will have an impact on performance. Normally, companies do regular meetings to evaluate such risks and propose actions to mitigate them. In addition to assessing the financial impacts, they also discuss the project progress. This has immediate effects on the project because enables a clear vision of the project progress; It encourages corrective actions when the project was out of planned activities. In this process, the top management involvement occurs when they perceive some imminent risk that indicate potential losses. Therefore, if any course correction was needed to mitigate such losses, the senior management should be aware.

All risks identified in the planning phase, which could impact on project performance should be valued. For example, in company D all risks that have a high probability of occurring are valued and launched in the project cost. This cost obviously has a direct impact on the project margin. In this company, we have a contingency margin up to 2% to deal with risks that could affect project performance. The company B comments its risk management mechanism:

> We did the management and mitigation of risks. This was something that was repeated every three months. The opportunities were the things you search within the project life. So, you can improve it in some way. For example, some with savings, with potential savings in certain items. Look, we instead of buying from A; we buy from B within the same specification. Additionally, we could have an

> agreement here. How do you talk? We would make an additional sale to the customer. To prospect a new sale, or add everything that would improve the project margin. (Company B).

On the other hand, other companies launch the risks valued in the Benefit Overhead (they say “Benefícios de Despesas Indiretas”, BDI in Portuguese). According to the company C, this is a common way in the construction to launch the risks. However, it was not identified sophisticated mechanisms for risk management in the sector.

By contrast, there are risks that invariably occur, but were not anticipated. In this case, there is a contingency action, which also affects costs and the project outcome. The risks associated with the project that were identified in the design phase are monitored periodically. However, there are some risks that are not in the risk map. These risks are handled in a very specific way; that is, the company defines a set of actions for unforeseen risks when they occur. According to the company B, there is no mechanism to deal with these kinds of risks because it is impossible to predict them. In company B’s words:

> Imagine you are delaying a GE turbine there in China, and the ship sinks. That is a risk that most likely it will not be on the project risk map. Because is that situation. Can it happen? Yes, but is more difficult to happen. However, when it occurs, the analysis of the problems was the same. What would be the first alternative for you to solve the problem? Because it would be very catastrophic to the project itself. Because the turbine would certainly be in the critical path, in the impediment. That it is not the case as well. Perhaps you would have to give another type of treatment. First, you analyze the problem. To preserve the people, of course, try to preserve. You try to treat in a way that is less onerous possible. (Company B).

In another passage, he also complements:

> Because when there is this kind of situation, it is clear that it will consume money. So, that is, the preliminary analysis would be. Let's say like that [...] the hypotheses that I have to solve a given problem. Look, it has here a problem that we were not expecting. There a risk that is not there in our map, or things that actually do not usually happen. I can even give you an example, very practical. We had a project in the past that was transporting and the truck had to come down the mountains of macaws to arrive in Rio de Janeiro and ended up damaging some equipment. This is a risk that exists, but I would tell you [...] if you will do the risk assessment, it basically would not enter on the risk map. Because it's a thing that happens, but not very often. (Company B).

Moreover, when this risk happens, the customer satisfaction is compromised and possible impacts on its performance. For example, affect the customer's time and; therefore, their operations. In this case, the adaptive corrective measures to mitigate such impact are necessary. In case of any delay of the activity, a reschedule is required in order to try to recover the time lost, which possibly lead to increased cost. The costs associated with risks, as far as possible, need to be recovered later through increased operational efficiency, for example. Otherwise, there will be an impact on the project outcome.

Additionally, another common problem is the contractual amendments. These are due to design changes and results in increasing costs, unforeseen time, among others. In this case, the client may have his part of the blame because sometimes he does not clearly define what he needs. The requirements are incomplete, or even he does last minute changes. This ends up compromising the planning and schedule.

Likewise, the contractor may also have his share of the blame for not doing his homework. Many causes may be related. For example, the lack of understanding of customer requirements, read error due to lack of staff qualification, the manager neglects the management processes (planning and execution), among others. This obviously leads to poor performance. Moreover, Aubry and Lièvre (2010) suggested that the lack of rigor in the application of practices and procedures lead to poor performance in projects.

In addition to the risks mitigation processes discussed above, companies try to protect themselves by adopting some kind of time gaps (buffers) in the project schedule. These buffers are putting in order to safeguard the process of unforeseen events. For example, in company D the buffers are defined periodically (annually) in order to safeguard against delays of suppliers, errors in planning, not meeting the deadlines of activities, the strike of operational staff, among others. These buffers aim to accommodate unforeseen events. Even though the company achieves a degree of maturity in the project due to its methodology that carries the knowledge acquired over several years and more established processes, the companies still work with some kind of buffers. According to the literature, the definition of buffers is common in projects (Goldratt, 1997).

For example, it is common for companies define some kind of buffers in the planning process particularly within the critical path. This strategy helps to deal with unforeseen risks. The company B commented its action:

> It is clear that the activities within the critical line, the planner that prepared the preliminary schedule, he also created some buffers on schedule for to be managed somehow. Because you

> can, if you have a delay of activity of the critical line, with buffers you can try to recover, perhaps, in another activity. Therefore, this is a common practice here for you to do the project time control. (Company B).

Although project managers understand that the planning process is one of the most important processes for the achievement of planned targets, the companies sometimes do not give much attention to it, especially in the project area. For them, the Brazilian professionals pay much attention to on execution than on planning. Which for other cultures, like American, this method is not well seen.

Additionally, to skip steps in this process generates future discomfort because invariably affects project performance, from the point of view of technical and market indicators. We present below two speeches from managers who have similar arguments as the way the Brazilian professional deals with the planning projects.

> You could see that the American culture was something like that. To invest more in design than in execution. On the other hand, the culture that we had here in Brazil, or rather, what we have today is the opposite. We have little spent on design and much more in execution. Therefore, we had conflicts. The American professionals had a tantrum with us because we spoke that we were faster than them. They spoke otherwise. You are faster, but in the end, you have more rework because you skipped steps. The incidence of error is much higher. (Company G).

> I would say internal, the one of the main problems that can generate failure is the lack of planning. It is real. I see like that, until the American Latino culture and I was watching a little bit out there as well, but here we end up being a very optimistic. Therefore, we just underestimating the risks. One does not want to bring bad news. Therefore, it tries to hide of the business and suddenly when the event explodes [...] oh, so we have this. We act differently from American who is a little more objective and brings in advance. For me, it is one of the main internal factors responsible for failure. This lack of transparency, this lack of thinking ahead. You look, what are the risks? What are the properties? Sometimes I see the behavior for not bring this for the organization that ends up accepting. (Company H).

For Williams (2008), this phase is very important because if the planning fails, the company can face a disaster in projects.

5.1.4 Technical and Market Performance

In the construction sector, from the operational point of view, the industry seeks to monitor the project taking into account three main indicators such as cost, time, and quality. Nevertheless, one should seek a balance of these indicators. For example, it is not enough to achieve the cost and fails on quality, or deliver on time and neglects on cost. Additionally, one should seek an understanding of what is important for people interested in the project, for example, its sponsors. For company I, the balanced management of these three technical indicators is important for project success.

For example, if the quality is an internal concern of the organization due to its client, then the process must be closely monitored by the project team. Normally, in large projects, one from the project team is responsible for managing the quality process. The customer is also involved in this process. For example, he assists in the inspection of the project executions. If there is any occurrence of the quality, it is taken corrective action to resolve the problem. The operations manager discusses how this process is managed in his company B. In his words:

> Well, another practice now with respect to quality. Well, besides establishing from the beginning a quality manual, which will prescribe your project. There was basically to follow up. Of course, you had one person dedicated inside the group to do this work. In Company D (he has worked there too), for example, it had a person in the project team to do so. That is, in the project team had a person dedicated to managing quality. Therefore, he was the one who was, for example, the management of the entire planning of the equipment inspections, along with the customer as well as the execution of inspections. Many times, the product did not pass by the quality control, and then it had to be redone. It had to be reworked, anyway. It was one of the concerns and practices that we had and was adopted to make good management. (Company B).

The projects are evaluated from the point of view of technical and market performance measures. From a technical point of view, project success is defined when costs, time, and quality are achieved. However, in the occurrence of non-fulfillment of goals previously set for the project (e.g., time), it is common to impute financial penalties in contracts.

Moreover, the noncompliance with deadlines, leads to increased costs. For example, labor costs, costs associated with maintenance, costs associated with equipment, among others. Therefore, according to the company B, one of the most important criteria to assess whether the project was a success or not is budget compliance. The two criteria mentioned above such as time and quality, according to the company B, are somehow associated with the cost indicator as well.

However, only the budget fulfillment is not enough. If other performance criteria are not in accordance, the customer satisfaction or even the stakeholders will not be ensured as a whole. This problem could affect future sales depending on how the process was conducted. In the case of customer satisfaction, the literature suggests that it is affected by noncompliance with contract specifications. For example, deadlines, quality aspects, cost, or technical specifications, depending on what it values. The company B puts this concern. In its words:

> It's because if you eventually have guilt in the civil registry, of course, the customer will want some compensation. Additionally, you'll have to give something for him. (Company B).
>
> So basically he comes back to the company's money. You still have an additional advantage, especially in the last two items because your profitability, of course, the customer is not aware. Moreover, he is also little interested. However, if you delivered on time, or if you handed with poor quality, surely this will influence future sales. So, it is with everyone. If you are treated poorly in any store, of course, you will not want to go to that shop to buy something more. Conversely, if you are well attended, if he sell you a product with good quality, sometimes you will even pay a little bit more expensive, but you will buy in that store because you know you will be well attended. (Company B).

Therefore, the project success also has a component of meeting expectations. According to some managers, it is not enough to achieve technical indicators (e.g., cost, time, quality, and scope) whether the customer satisfaction is not met. The project will not be considered a success. This concern was pointed out by managers from companies B, C, D, H, and I.

Additionally, this concern is consistent with the literature that pointed out the construction sector has discussed other forms to assess performance (Chan & Chan, 2004; Chan et al., 2002; Jin et al., 2013). For them, the sector is using both objective and subjective measures. For example, the traditional technical performance assessment such as cost, quality, and time (Chan & Chan, 2004; Chan et al., 2002), but some dimensions such as return on investment (ROI), profitability, sales, market share, customer satisfaction, among others (Tatikonda & Montoya-Weiss, 2001; Thieme, Song, & Shin, 2003).

Furthermore, according to the company I, the stakeholders need to be understood. For example, some of them favor the cost, and others the deadline or quality. Therefore, one must understand what stakeholders value in projects. We report below the concern of the company D. In its words:

> The success [...] I'm working today, which they consider is if I can meet the deadline that has agreed. If there are any changes agreed with the client, within the budget, and with good customer satisfaction. If he is satisfied with the project execution. These are the top three indicators. However, it is very difficult to achieve them. It lacked a key indicator that your question reminded me as well. We also

measured every six months customer satisfaction through a formal search. This indicator is also monitored. When you start the project is done an interview, a satisfaction survey, and every six months, on average, is made a new survey for each gate review, the know-how the project. If the project is different from the budget. Then, in project success, we search to be on cost. The cost is very important. I would say that perhaps the most important variable is the cost, after the deadline, and then scope. These are the three items that we take much care. I know one affects the other, or mutually. There is no way you change one without change the others. Usually, we measure these three items too hard. In addition, the part of the cost that effects on the cash flow and the cash flow is a company forecast. Therefore, it is very sensitive to the variation of the project margins. Especially when the change is negative, it is the loss of margin. (Company D).

In terms of market performance measures, the first evaluation criterion is the gross margin. This indicator is important because it evaluates the project management responsible for the processes. In other words, it is an indicator that captures the efficiency in managing processes. According to the company I, the project manager is evaluated by this criterion. However, other profitability criteria are also taken into account in evaluating the project as a whole. For example, indicators such as EBIT or EBITDA, which also capture the operational costs. The difference between these two indicators is that EBITDA does not take into account expenses that do not leave the cash flow (e.g., depreciation and provision). By contrast, the EBIT considers these expenses and looks at what is strictly operational as well; that is, the fruit of the company's core business. In other words, it disregards the financial expenses.

Likewise, other margin indicators are also important and assessed by the project team. For example, net margin. In the construction sector, this indicator is important because helps to analyze the company's growth. According to the company C, the sector works with a margin of 5% at least. If the margin is achieved, the project will be considered a success from the point of view of this indicator. However, other variables should compose the project assessment as a whole. For example, other technical and market indicators.

On the other hand, the companies do not consider the project as a success when the losses margins are resulting from the increase in costs or other factors. Because the customer satisfaction can be compromised as well as the technical and market performance. The company D point out:

Well, one of the most important indices we manage here is the project costs, but we cannot say that the project was a failure or partial success if we have significant loss of margins. Therefore, I participated in a project when I started the career, I was not the project manager, I was what we called

> at that time of assistant project manager engineer. I worked with the project manager, and I was his main assistant, let's say that. I was managing the operational work and the client's return. What happened with the project? The margin was 30% (negative), 40% (negative), it was a ball valve for Colombia. Therefore, the financial loss was very large, but it was the biggest ball valve in Latin America. It brought the technological challenge, but there was budget failures. There was execution failures as well. The client was very demanding and very faithful to the contract of the company. This project I remember well because we delivered the equipment. We received the final acceptance certificate (Certificate of guarantee). The customer was pleased to, but for the company had a significant financial loss. Therefore, it was a partial success. The other project was in Chile. I worked on a project in Chile that had a loss, which at that time was also very large. The most modifications were also large. It was very heavy. More than 10 million euros in lost. In terms of materials undersized, among others. It is a work that finished and delivered, we obtained all certificates straight, but there was a significant loss for the company. Therefore, what we call partial success. We do not want to talk about failure. I mean [...] we do not feel comfortable working on a project that it ends like that. Because you work too much and the profit, the result is not recognized by the margin. In this project, we had delay problems as well. It also delivered after the agreed original maturity. Despite everything that has been negotiated, talked, had others, had fines, had penalties, had questions, a whole discussion. (Company D).

Internal and external factors contribute to the unsatisfactory performance of projects. The main issues raised are failure to perform planning, incorrect budget estimates, inappropriate technical design, wrong strategic decisions, failure to execute the work, government bureaucracies to release approvals, among others. Sometimes, to sell the project, the company underestimates the costs of implementation, which will subsequently be felt in the performance assessment.

Moreover, once the contract is signed, any additive due to measuring errors will invariably be rejected by the customer, for example. In this case, the company will take the burden project. The failure to meet the terms of the contract generates fines and penalties and if not resolved efficiently, it causes discomfort to the customer, mistrust, and may harm future sales.

These factors impact on work run time because they can generate delays and influence the margins of the project as well. Therefore, they affect the project management as a whole. In another declaration, the company D commented these problems:

> At the time the company was selling this project, it had the low load and needed to win the bid (work). Then did the budget and started to negotiate with the customer, who spoke as follows: "If you do not lower this value, your offer of you, I'll buy from the competitor. The competitor is cheaper by X%." Then the problem arrived at the board. The director authorized. It has never been official, but said he authorized 10 million euros at the time, in the sales value of the contract (i.e. a linear discount on the budget). In the budget that was already tight. Moreover, adds up to some fails on the budget, and then identified during the implementation phase, it generated a financial disaster. In the project, the loss was more than 10 million euros at the time. In addition, it was basically strategic decisions that have never been recognized officially by the company. In informal conversation, I eventually

discovered these adjustments. However, in those years we had another culture. Therefore, the budget failures led to a significant financial loss. (Company D).

In the construction sector, it is common to noncompliance of the main technical performance criteria (e.g., cost, time, and quality) that results in future adjustments. If the customer does not accept the increase in costs, the company takes the burden and performance may be affected.

The risk assessment helps to minimize such impact because the company has already considered its effect on the result. To safeguard against this, the sector tries to involve the client when a change is requested. For example, when there is change request of the project scope by the customer, the company has a period to reassess and request approval.

5.2 Quantitative Research Results

In this section, we discuss in detail the results of quantitative research. Therefore, we start by providing a descriptive analysis of our data. Then, we discuss the results of confirmatory factor analysis. Finally, we discuss the results of hierarchical linear regression.

5.2.1 Descriptive analysis

The descriptive statistics analysis based on the Table 13, which we present the results, enables some considerations that we are discussed in this section.

Construct	Items	Minim.	Maxim.	Mean	Std. Dev.	Variance	Skewness	Kurtosis
Planning Monitoring	PLAN1R	1	5	2.83	1.057	1.118	0.153	-1.272
	PLAN2	1	5	4.07	0.726	0.527	-1.126	2.772
	PLAN3	1	5	3.92	0.829	0.686	-1.294	2.167
	PLAN4R	1	5	2.69	0.960	0.921	0.355	-1.160
	PLAN5	1	5	3.59	0.855	0.730	-1.104	0.454
Risk Transparency	TRAN1	1	5	2.92	1.056	1.115	0.233	-1.312
	TRAN2	1	5	3.64	0.848	0.720	-1.012	0.325
	TRAN3	1	5	4.07	0.680	0.463	-1.077	3.327
	TRAN4	2	5	4.03	0.693	0.480	-0.980	2.063

Construct	Items	Minim.	Maxim.	Mean	Std. Dev.	Variance	Skewness	Kurtosis
Risk Coping Capacity	COPI1	1	5	3.61	0.861	0.740	-0.912	0.085
	COPI2	1	5	3.83	0.758	0.575	-1.679	3.802
	COPI3	2	5	3.91	0.654	0.428	-1.161	2.579
	COPI4	2	5	3.62	0.747	0.558	-0.925	0.267
Project Management Practices	PMP1	5	10	9.29	1.013	1.026	-1.464	2.037
	PMP2	3	10	9.17	1.220	1.489	-1.963	5.078
	PMP3	5	10	8.86	1.112	1.237	-0.739	0.032
	PMP4	5	10	8.27	1.399	1.957	-0.429	-0.627
	PMP5	2	10	8.46	1.521	2.314	-1.099	1.500
	PMP6	3	10	8.27	1.566	2.454	-0.899	0.454
	PMP7	2	10	8.81	1.419	2.015	-1.646	3.535
	PMP8	4	10	8.82	1.174	1.378	-1.068	1.658
	PMP9	1	10	7.29	2.234	4.991	-1.146	0.972
	PMP10	1	10	8.19	1.703	2.899	-1.258	2.836
	PMP11	1	10	7.29	2.020	4.080	-0.757	0.680
	PMP12	1	10	8.03	1.704	2.903	-0.940	1.098
Budget Schedule	BUDG1	2	5	3.65	1.006	1.011	-0.552	-0.809
	BUDG2	1	5	3.59	1.019	1.038	-0.696	-0.279
	BUDG3	1	5	3.99	0.640	0.410	-1.472	5.058
	BUDG4	1	5	3.73	0.867	0.751	-1.111	0.920
Customer Satisfaction	SATI1	2	5	4.06	0.563	0.316	-0.637	2.879
	SATI2	3	5	4.31	0.505	0.255	0.356	-0.847
	SATI3	2	5	4.22	0.538	0.290	-0.373	2.586
	SATI4	3	5	4.30	0.548	0.301	0.025	-0.575
	SATI5	2	5	3.97	0.716	0.512	-0.813	1.284
Business Success	BUSI1	1	5	3.89	0.776	0.602	-0.798	1.171
	BUSI2	1	5	3.87	0.740	0.548	-0.561	0.978
	BUSI3	1	5	3.76	0.916	0.838	-1.022	1.040
	BUSI4	1	5	3.53	0.938	0.879	-0.580	-0.174
Potential Absorptive Capacity	PAC1	1	5	3.27	0.977	0.954	-0.184	-0.835
	PAC2	1	5	2.97	1.040	1.082	0.030	-0.939
	PAC3	1	5	3.36	0.947	0.898	-0.725	-0.230
	PAC4R	1	5	3.32	0.995	0.990	-0.454	-0.659
	PAC5	1	5	3.55	1.003	1.006	-0.538	-0.644
	PAC6	1	5	3.33	1.140	1.300	-0.417	-0.903
	PAC7	2	5	3.68	0.662	0.439	-1.004	0.872
	PAC8	2	5	3.69	0.724	0.524	-0.989	0.722
Realized Absorptive Capacity	RAC1	2	5	3.92	0.730	0.533	-0.883	1.284
	RAC2	2	5	3.76	0.671	0.451	-0.972	1.288
	RAC3R	1	5	3.62	0.957	0.916	-0.694	-0.229
	RAC4R	1	5	2.61	0.822	0.676	0.778	0.098
	RAC5	2	5	3.77	0.750	0.562	-0.981	0.930
	RAC6R	1	5	3.99	0.797	0.635	-1.067	1.720
	RAC7	1	5	3.79	0.825	0.680	-1.120	1.485
	RAC8	2	5	3.87	0.648	0.420	-1.163	2.421
	RAC9R	1	5	3.13	1.081	1.168	-0.332	-1.027
	RAC10	1	5	3.57	0.826	0.683	-1.183	0.889

Table 13 – Descriptive statistics

Source: elaborated by the author

As seen in Table 13, we notice that planning and monitoring received lower scores regarding PMP by the respondents in the constructor sector. The overall mean of this dimension is 3.42, near the cutoff scores of indifference. This is very interesting because it declared that planning and monitoring have received less attention in this sector. It also suggests difficulty in dealing with deficiencies in planning and monitoring because the mean of the item was the lower (PLAN4R = 2.69) in this dimension. The low mean also suggests delay in detecting deficiencies through planning and monitoring and, in turn, impact on cost. In Doloi (2013)'s study, he observed that deficiency in planning and monitoring was the most significance factor that was responsible for poor cost performance in construction sector.

However, when we look more carefully at specific items, the construction methods and techniques (PLAN2) emerge as the most important attribute in this sector. It makes sense because approximately 92.4% of projects are classified from medium to extremely complexity. Project complexity requires more attention in selection related to methods and techniques in constructions (Doloi, 2013). This result is in line with Doloi (2013)'s findings. He suggested that as increasing the complexity in modern construction, the selection of appropriate methods and techniques has become crucial. In his study, this attribute received more attention from the managers in the construction sector.

The next attribute related to the complexity of design was the second that managers claim as the most important. This result reinforces the use of good techniques in constructions by the sector. However, the increase in the project complexity affects performance (Doloi, 2013). As we see in Table 13, it seems that to maintain the project costs (BUDG2) in the construction sector is not unusual. The mean of this attribute was 3.59 near the cutoff point of indifference, which indicate a quite problematic situation in this sector. It happens the same to meet time goals (BUDG1). This last attribute provides low scores (3.65) as well. But these observations require more carefully analysis that is not possible only with this table.

In Doloi (2013)'s findings, the complexity of the design is responsible for the overall impact on project performance as a whole. According to him, the attribute has a directly influence on increasing cost performance. In terms of importance, the complexity of design received the fourth attention in his findings.

In sequence, we observe high scores (above 4.00) for risk information (TRAN3 and TRAN4), which means these attributes are relevant in managing risk in this sector. These attributes help in decision-making.

Teller and Kock (2013) suggested that the risk identification and the process of formalizing the risk have the significant impact on risk transparency dimension. However, in the construction industry of São Paulo State, the mechanism for risk identification (TRAN1) seems to be deficient. The item received the lower scores related to this dimension.

On the other hand, in a risk situation, the construction sector considers quick reactions (COPI2 and COPI3) very important for adopting adaptative measures. The scores were 3.91 and 3.83, respectively.

In customer satisfaction dimension, to meet the customer expectations and needs are considered the most relevant actions by the construction sector. The main scores are above 4.00, which means that customers are the central focus on this sector. But we shall return to this point later when discuss this dimension in regression analysis.

Turning our attention to business success indicators, the economic success received the median scores. This is interesting because it gives an idea that the sector has problem with profitability. Economic indicators are related to profitability and operating margins, for example. By contrast, the commercial indicator received the higher score. It means that projects have good performance in sales. If the sector has good commercial performance, but its profitability seems not adequate, the problem could be explained by the price, cost, or both, for example. Again, this discussion is not conclusive because requires a deeper analysis.

The next dimension is potential absorptive capacity (PAC). First, we turn our attention to knowledge assimilation. The process of analyzing and interpreting customer requirements (PAC8) as well as the new opportunity (PAC7) were acknowledged by project managers as the most relevant. On the other hand, the sector does not privilege exchanging experiences or informations (PAC1 and PAC2) as a way to improve knowledge acquisition. These attributes received the lower scores by the respondents.

However, in realized absorptive capacity (RAC), while the construction industry turns its attention to customer needs, the project team neglects its complaints (RAC6R). This is a paradox because it seems that the efforts are not aligned. The item received the higher score. The next item valorized by managers are the new knowledge acquired (RAC1) that help in managing projects or emergencies. However, as we noticed before in exchanging experiences, practical knowledge (RAC3R) are hardly shared by the project team as well. By contrast, although it valorizes new forms in exploring knowledge (RAC8), it has difficulties in implementing new ideas (RAC9R). As a result, this in turn can influence the way the routines are refined.

5.2.2 Confirmatory Factor Analysis

In sequence, we performed the confirmatory factor analysis (CFA) to assess the measurement model. Our factor model involve relations between eight constructs. Because of the sample size limitations, it was not possible to run the CFA with eight constructs jointly. Therefore, they were splitted into three groups of related constructs such as project management practice, performance, and absorptive capacity.

The first step was to fit the model by removing the indicators that had some fit problem. These indicators did not affect the model, and they could be replaced by the others. These procedures have taken into account the factor loadings and the modification indices. In this process, we remove some indicators from project management practices such as PLAN1R, PLAN4R, TRAN1, COPI4, from performance such as BUDG2 and SATI4, and from absorptive capacity such as PAC3, PAC4R, PAC6, PAC8, RAC1, RAC2, RAC4R, and RAC8. The final fit models are shown in Figures 12, 13, and 14. In Appendix J, we discuss in detail this procedure.

The latent variables of the conceptual model (Figure 10) were evaluated based on the suggestions of Fornell and Larcker (1981), Brown (2006), Hair Jr. et al. (2009), Byrne (2010), and Hair et al. (2011). In the next section, we discussed the measurement model assessment in detail.

5.2.2.1 Measurement Model Analysis

We assessed the measurement and structural model based on the indicators of CFA (Brown, 2006; Byrne, 2010; Hair, Ringle, & Sarstedt, 2011; Hair Jr. et al., 2009; Miller, Rainer Jr., & Harper, 1997). The measurement model was assessed through convergent validity, discriminant validity, and face validity. Initially, the face validity was done when we adapted the scales from previous researches and adjusted them by our qualitative pre-test with project managers. Therefore, this process enables to adjust the scales to measure the latent variables in construction industry.

Model Fit

The model fit is achieved when the difference between the estimated and observed covariance matrices is reduced (Byrne, 2010; Hair Jr. et al., 2009). In other words, the closer the matrices, the more adequate the model. In practice, it means our data represent the hypothesized model. In Table 14 below, we present the calculated indices.

We started the assessment of the measurement model adequacy by the overall fit index (χ^2). This statistic shows the discrepancy between those matrices; however, the indicator should be viewed with caution due to its statistic limitation associated to sample size (Hair Jr. et al., 2009).

To reduce the effect of sample size, Wheaton et al. (1977) suggest the χ^2/ degree of freedom ratio (CMIN/DF statistic), which enables to have an indication of the model fit based on degree of freedom. Even though the literature does not provide a consensus related to the critical value, some scholars suggest considering the critical value less than 2.00 and Blunch (2010, p. 113) near 1.00. All the statistics are between this range. We have a possible indication of a fit model.

The GFI and AGFI statistics were considered satisfactory. The most of them have higher cutoff value of 0.90 for adequate fit (Hair Jr. et al., 2009; Malhotra, 2012). The PGFI statistic is positive and near or above of 0.60. There is no consensus in the literature regarding its critical value; however, it points out that the parsimony index normally presents low value. Therefore, we accepted the statistics present in this table.

Moreover, other parsimony indices corroborated with this acceptance. The values of these statistics are PRATIO, PNFI, and PCFI are near or above the critical value of 0.60. The indices present satisfactory measures and indicate a good fit model.

	Goodness-of-fit statistics					
Overall fit	χ^2	**DF**	**P-value**			
Project Management Practices	36.686	24	0.047			
Performance	57.646	32	0.004			
Absorptive Capacity	41.912	34	0.165			
Absolute fit measures	**GFI**	**AGFI**	**PGFI**	**CMIN**	**CMIN/DF**	**P**
Project Management Practices	0.951	0.909	0.507	36.686	1.529	0.047
Performance	0.931	0.881	0.542	57.646	1.801	0.004
Absorptive Capacity	0.948	0.916	0.586	41.912	1.233	0.165
Relative fit measures	**NFI**	**TLI**	**CFI**			
Project Management Practices	0.871	0.923	0.949			
Performance	0.884	0.920	0.943			
Absorptive Capacity	0.815	0.942	0.957			
Parsimony measures	**PRATIO**	**PNFI**	**PCFI**			
Project Management Practices	0.667	0.580	0.633			
Performance	0.711	0.628	0.671			
Absorptive Capacity	0.756	0.616	0.723			
Fit measures based on the non-central chi-square distribution	**RMSEA**	**LO 90**	**HI 90**	**PCLOSE**		
Project Management Practices	0.058	0.007	0.094	0.331		
Performance	0.072	0.041	0.101	0.114		
Absorptive Capacity	0.039	0.000	0.073	0.666		
Information theoretic fit measures	**ECVI**	**LO 90**	**HI 90**	**MECVI**		
Project Management Practices	0.504	0.424	0.635	0.523		
Saturated model	0.577	0.577	0.577	0.616		
Independence model	1.934	1.614	2.303	1.942		
Performance	0.664	0.553	0.826	0.687		
Saturated model	0.705	0.705	0.705	0.759		
Independence model	3.301	2.866	3.784	3.311		

Information theoretic fit measures	Goodness-of-fit statistics			
	ECVI	**LO 90**	**HI 90**	**MECVI**
Absorptive Capacity	0.538	0.487	0.670	0.558
Saturated model	0.705	0.705	0.705	0.759
Independence model	1.584	1.306	1.910	1.593

Table 14 – Goodness-of-fit statistics
Source: elaborated by the author

The relative fit measures suggest the critical value of 0.90 for a good fit. The CFI and TLI statistics present values above 0.90, which indicate adequate fit model, and NFI is near 0.90, which is acceptable as well.

The most popular index is RMSEA that analyzes the level of complexity of the hypothesized model as well (Hair Jr. et al., 2009). This statistic is less than the critical value of 0.08. As a result, there is evidence of the good fit model as well.

Similarly, the information theoretic fit measures help to assess the complexity of the model in accordance with other indicators. The analysis is quite simple, if the ECVI and MECVI present the lower values in comparing with the saturated model and the independence model, they indicate best fit to the data. As we notice in Table 14, all indicators meet this rule. Therefore, we have evidence of the best fit to the data (Byrne, 2010).

We summarize below these analysis.

PMP Model Fit

All the statistics are summarized below.

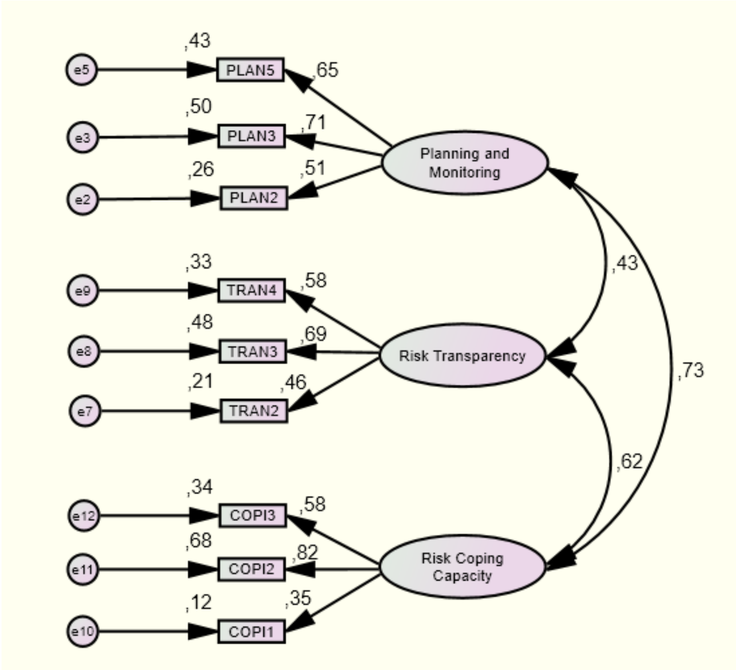

Figure 12 – CFA model of the project management practices
Source: elaborated by the author

Statistics	Observed value	Critical value	Indication
χ^2 *df* p-value	36.686 24 0.047	p-value > 0.05[1;3]	Considered satisfactory. It is near the critical value.
CMIN/DF	1.529	< 2.00[1;3]	Adequate
GFI	0.951	> 0.90[1;2]	Adequate
AGFI	0.909	> 0.90[1;2]	Adequate
PGFI	0.507	> 0.60[4]	Considered satisfactory with other indicators.
CFI	0.949	> 0.90[1;2]	Adequate
TLI	0.923	> 0.90[1;2]	Adequate
NFI	0.871	> 0.90[1;2]	Considered satisfactory. It is near the critical value.
PRATIO	0.667	> 0.60[4]	Adequate
PNFI	0.580	> 0.60[4]	Considered satisfactory. It is near the critical value.
PCFI	0.633	> 0.60[4]	Adequate
RMSEA	0.058	< 0.08[1]	Adequate
ECVI	0.504	Comparison other models[3]	Adequate. The value is below saturated model and independence model
MECVI	0.523	Comparison other models[3]	Adequate. The value is below saturated model and independence model

Note: [1]based on Hair Jr. at al. (2009), [2]based on Malhotra (2012), [3]based on Byrne (2010), [4]based on Blunch (2010)

Source: elaborated by the author

In conclusion, based on the analysis above, the PMP measurement model is adequate in terms of goodness-of-fit statistics. The Figure 12 presents the model fit.

Performance Model Fit

All the statistics are summarized below.

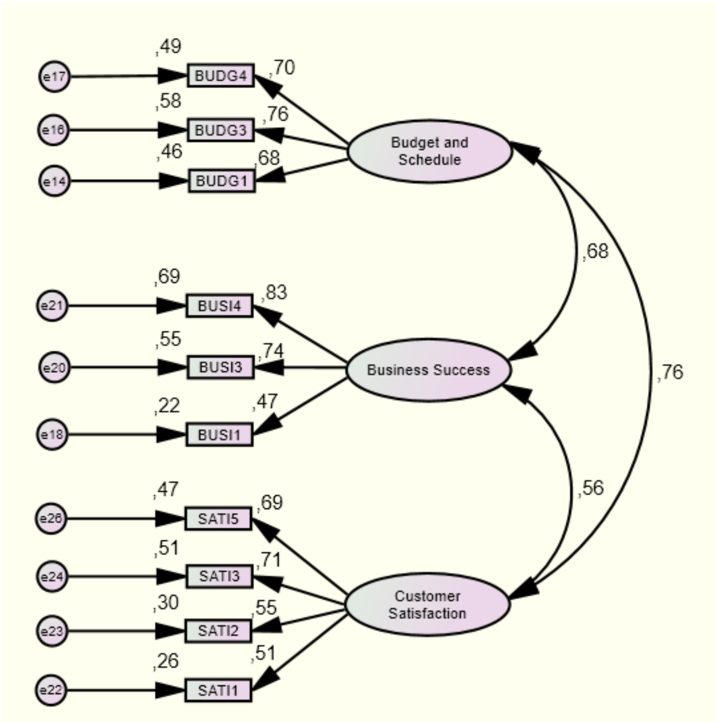

Figure 13 – CFA model of the performance
Source: elaborated by the author

Statistics	Observed value	Critical value	Indication
χ^2 *df* p-value	57.646 32 0.004	p-value > 0.05[1;3]	Considered unsatisfactory. But this indicator has limitations; therefore, it is better to consider CMIN/DF.
CMIN/DF	1.801	< 2.00[1;3]	Adequate
GFI	0.931	> 0.90[1;2]	Adequate
AGFI	0.881	> 0.90[1;2]	Adequate
PGFI	0.542	> 0.60[4]	Considered satisfactory with other indicators.
CFI	0.943	> 0.90[1;2]	Adequate
TLI	0.920	> 0.90[1;2]	Adequate
NFI	0.884	> 0.90[1;2]	Considered satisfactory. It is near the critical value.

Statistics	Observed value	Critical value	Indication
PRATIO	0.711	> 0.60(4)	Adequate
PNFI	0.628	> 0.60(4)	Considered satisfactory. It is near the critical value.
PCFI	0.671	> 0.60(4)	Adequate
RMSEA	0.072	< 0.08(1)	Adequate
ECVI	0.664	Comparison other models(3)	Adequate. The value is below saturated model and independence model
MECVI	0.687	Comparison other models(3)	Adequate. The value is below saturated model and independence model

Note: [1]based on Hair Jr. at al. (2009), [2]based on Malhotra (2012), [3]based on Byrne (2010), [4]based on Blunch (2010)

Source: elaborated by the author

In conclusion, based on the analysis above, the performance measurement model is adequate in terms of goodness-of-fit statistics. The Figure 13 presents the model fit.

Absorptive Capacity Model Fit

All the statistics are summarized below.

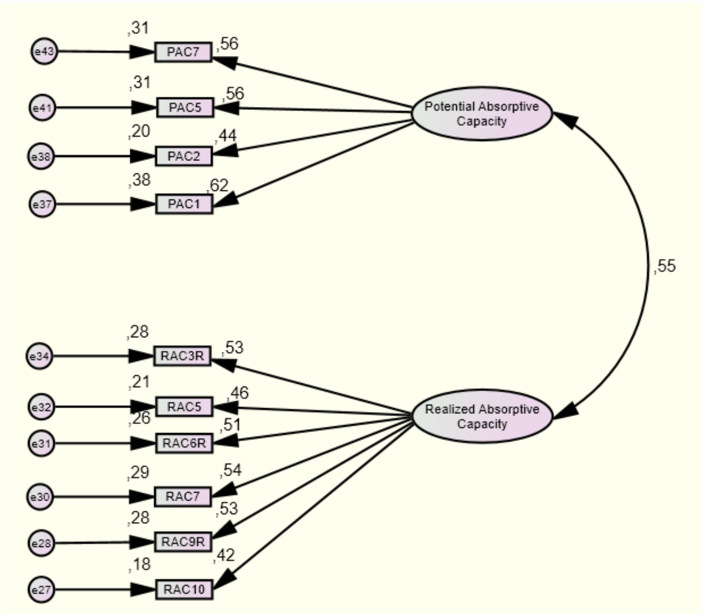

Figure 14 – CFA model of the absorptive capacity
Source: elaborated by the author

Statistics	Observed value	Critical value	Indication
χ^2 *df* p-value	41.912 34 0.165	p-value > 0.05(1;3)	Adequate
CMIN/DF	1.233	< 2.00(1;3)	Adequate
GFI	0.948	> 0.90(1;2)	Adequate
AGFI	0.916	> 0.90(1;2)	Adequate
PGFI	0.586	> 0.60(4)	Considered satisfactory. It is near the critical value.
CFI	0.957	> 0.90(1;2)	Adequate
TLI	0.942	> 0.90(1;2)	Adequate
NFI	0.815	> 0.90(1;2)	Considered satisfactory with other indicators.
PRATIO	0.756	> 0.60(4)	Adequate
PNFI	0.616	> 0.60(4)	Adequate
PCFI	0.723	> 0.60(4)	Adequate
RMSEA	0.039	< 0.08(1)	Adequate
ECVI	0.538	Comparison other models(3)	Adequate. The value is below saturated model and independence model
MECVI	0.558	Comparison other models(3)	Adequate. The value is below saturated model and independence model

Note: [1]based on Hair Jr. at al. (2009), [2]based on Malhotra (2012), [3]based on Byrne (2010), [4]based on Blunch (2010)

Source: elaborated by the author

In conclusion, based on the analysis above, the absorptive capacity measurement model is adequate in terms of goodness-of-fit statistics. The Figure 14 presents the model fit.

Additionally, we analyzed the model misfit through the standardized residual covariances and modification indices (Brown, 2006; Byrne, 2010). The results indicate evidence of no problem of misfit. In Tables 15, 16, and 17 are presented the standardized residuals of PMP, performance, and AC, respectively.

In these tables, we observed that the absolute values of standardized residuals are below the cutoff values suggested by Byrne (2010, p. 86), Malhotra (2012, p. 558), and (Brown, 2006, p. 118). That is, 2.58 for 0.01 alpha level, and 2.00 for 0.05 alpha level.

The modification indices also corroborate with the analyzes above. As In Appendix J (Table 27) presents no modification indices, all models are adequate.

		1	2	3	4	5	6	7	8	9
1	COPI3	0.000								
2	COPI2	0.093	0.000							
3	COPI1	0.224	-0.296	0.000						
4	TRAN4	-0.902	-1.048	-0.480	0.000					
5	TRAN3	1.012	0.101	1.052	0.368	0.000				
6	TRAN2	0.651	0.495	0.236	0.704	-1.017	0.000			
7	PLAN5	-0.830	-0.160	-0.265	-1.586	-1.216	1.881	0.000		
8	PLAN3	-0.647	0.618	0.787	-0.448	0.487	1.617	-0.073	0.000	
9	PLAN2	0.311	-0.350	-0.300	-0.509	-0.215	2.371	0.908	-0.601	0.000

Table 15 – Standardized residual covariances of project management practices
Source: elaborated by the author

		1	2	3	4	5	6	7	8	9	10
1	SATI5	0.000									
2	SATI3	0.467	0.000								
3	SATI2	-0.600	-0.115	0.000							
4	SATI1	-1.083	0.146	1.228	0.000						
5	BUSI4	0.558	-0.665	-1.238	-0.251	0.000					
6	BUSI3	0.250	0.299	-0.061	-0.681	0.075	0.000				
7	BUSI1	1.860	2.444	-0.819	0.386	0.067	-0.484	0.000			
8	BUDG4	-0.026	-0.934	0.301	0.033	-0.631	-0.628	0.698	0.000		
9	BUDG3	0.116	-0.126	0.184	0.345	0.757	1.250	-0.277	-0.198	0.000	
10	BUDG1	0.532	-0.636	0.757	0.602	-0.537	-0.982	-0.227	0.957	-0.496	0.000

Table 16 – Standardized residual covariances of performance
Source: elaborated by the author

		1	2	3	4	5	6	7	8	9	10
1	PAC7	0.000									
2	PAC5	-0.959	0.000								
3	PAC2	-0.031	0.357	0.000							
4	PAC1	-0.028	1.137	-0.749	0.000						
5	RAC3R	1.081	-0.322	0.567	0.218	0.000					
6	RAC5	-0.106	-0.287	0.742	-1.096	-0.473	0.000				
7	RAC6R	1.452	-1.181	-0.107	-0.283	0.694	-1.149	0.000			
8	RAC7	0.581	-0.411	0.489	0.070	-0.420	1.478	-0.030	0.000		
9	RAC9R	0.717	-1.238	0.352	-1.815	0.377	-0.347	0.548	-0.359	0.000	
10	RAC10	1.849	-0.047	1.483	-0.482	-0.877	0.998	-0.403	-0.733	0.623	0.000

Table 17 – Standardized residual covariances of absorptive capacity
Source: elaborated by the author

Validity and Reliability

The construct validity was also assessed through the standardized residual covariances, modification indices, reliability indices, and average variance extracted (AVE). The standardized residual covariances (Tables 15, 16, and 17) and modification indices (Appendix J - Table 27), discussed above, also corroborate with this analyzes of construct validity because the results indicate evidence of no problem of misfit. These indicators are more robust than AVE discussed below.

Construct	Item	Loadings	AVE	Composite Reliability	Cronback's Alpha
Planning Monitoring	PLAN2	0.508	0.39	0.75	0.66
	PLAN3	0.706			
	PLAN5	0.652			
Risk Transparency	TRAN2	0.462	0.34	0.75	0.60
	TRAN3	0.690			
	TRAN4	0.578			
Risk Coping Capacity	COPI1	0.349	0.38	0.73	0.59
	COPI2	0.822			
	COPI3	0.582			
Budget and Schedule	BUDG1	0.678	0.51	0.75	0.76
	BUDG3	0.760			
	BUDG4	0.699			
Business Success	BUSI1	0.466	0.48	0.74	0.70
	BUSI3	0.739			
	BUSI4	0.830			
Customer Satisfaction	SATI1	0.511	0.38	0.80	0.71
	SATI2	0.547			
	SATI3	0.712			
	SATI5	0.687			
Potential Absorptive Capacity	PAC1	0.616	0.30	0.80	0.62
	PAC2	0.442			
	PAC5	0.555			
	PAC7	0.561			

Construct	Item	Loadings	AVE	Composite Reliability	Cronback's Alpha
Realized Absorptive Capacity	RAC3R	0.526	0.25	0.86	0.66
	RAC5	0.456			
	RAC6R	0.508			
	RAC7	0.539			
	RAC9R	0.528			
	RAC10	0.421			

Table 18 – Assessment of unidimensionality
Source: elaborated by the author

The convergent validity was assessed through the standardized factor loadings (Table 18). These indicators are positive and near or above the cutoff value of 0.50. As a result, we could say that the factor loadings presented convergence to a common point (Hair Jr. et al., 2009).

The reliability of the model (Table 18) was evaluated based on composite reliability and Cronbach's Alpha (Byrne, 2010; Hair et al., 2011; Hair Jr. et al., 2009; Henseler et al., 2009). The coefficient of composite reliability, which evaluates the convergence or internal consistency of the constructs are adequate and above the critical value of 0.70. Currently, the composite reliability is the most used indicator to analyze the reliability of measurement model.

By contrast, the Cronbach's Alpha was the indicator very used in the past, but the Alpha has not been the standard currently because it depends on much more the numbers of individual items to be adequate. Some values are near or above the critical value of 0.70, which indicate unidimensionality of the construct (Tenenhaus et al., 2005). For values around 0.60, Hair Jr. et al. (2009, p. 126) pointed out that in exploratory research is possible to work with the cutoff value of 0.60. Therefore, there is evidence of the unidimensionality of these blocks as well.

<u>Discriminant Validity</u>

We examined the discriminant validity through factor loadings (Fornell & Larcker, 1981). As we seen in Table 18, the most of them are positive and near or above the cutoff value of 0.50. Moreover, according to Hair Jr. et al. (2009, p.120), it is possible to work with the cutoff value of 0.45 based on sample size rule. As a result, there is evidence of discriminant validity.

Even though the Table 18 presents some AVE less than the cutoff value of 0.50 for some constructs and the square root of AVE on the diagonal of latent variable correlation matrix (Malhotra, 2012, p. 558), in Appendix J (Table 26), are less than the intercorrelations of the constructs, they are not a major problem because the other indices are quite robust. For example, standardized residual covariances, standardized factor loadings, and composite reliability discussed above, which mean also discriminant validity. Therefore, we can accept this values.

We performed the χ^2 difference test for one pair of constructs (Anderson & Gerbing, 1988; Bagozzi & Phillips, 1982). The test supplies the discriminant validity whether the χ^2 difference is above of χ^2 critical value in associated with p-value (Bagozzi & Phillips, 1982). The Table 19 depicts the results and we observe that the pair of constructs is significant; therefore, the discriminant validity is achieved.

Pair of constructs	χ^2 difference
Project Management Practices (PMP)	
Planning and monitoring versus Risk coping capacity	98.846*
Planning and Monitoring versus Risk transparency	71.607*
Risk transparency versus Risk coping capacity	84.906*
Performance	
Budget and Schedule versus Business success	66.930*
Budget and Schedule versus Customer satisfaction	108.839*
Business success versus Customer satisfaction	138.120*
Absorptive Capacity (AC)	
Potential AC versus Realized AC	39.128*

*p < 0.01, **p < 0.05, ***p < 0.10

Table 19 – Test of χ^2 difference
Source: elaborated by the author

Regarding all analyzes above and taken collectively, these indicate that our scales are valid and reliable as well as our models adequate.

5.2.3 Hierarchical Linear Regression

We use hierarchical regression models because this is the most common and appropriate technique to test hypotheses that require interactions assessment (Bedeian & Mossholder, 1994). Additionally, our independent variables (PMP and AC) were mean-centered due to we are interested to interpret the first-order effects under the presence of the interaction assessment (Aguinis & Gottfredson, 2010).

In the hierarchical linear regression model, we need to follow a sequence for adding variables for running regressions. Initially, we need to add the dependent variable. After that, to add the independent variables in three steps. First, to add the control variables (base model). Second, to add the explanatory variables to assess the direct effects (main model). Third, to add the set of interaction variables (model one) to evaluate whether AC leverages the relationship in relation to PMP and performance. These processes were done through SPSS. To test our hypotheses, we perform the regressions that provide three segregated results such as base model, main model, and model one (Table 20).

The control variables were selected taking into account their relevance and correlations with dependent and independent variables. In Appendix K (Table 28), we detail the procedures.

		Budget and Schedule			Customer Satisfaction			Business Success		
		Base	Main	1	Base	Main	1	Base	Main	1
DV	Absorptive capacity									
	Constant	3.704	3.819	3.827	3.880	3.935	3.900	3.782	3.848	3.869
Control variables	Classify the level of complexity of the completed project	0.032	0.010	0.013	-0.026	**-0.043*** **	-0.039	0.047	0.023	0.016
	Size of investment in the completed project (in R$)	0.057	0.071	0.072	**0.113****	**0.133***	**0.138***	-0.083	-0.063	-0.065
	Number of employees (last period)	-0.065	**-0.110****	**-0.108****	0.039	0.012	0.013	0.003	-0.022	-0.020
Direct effects	Planning and Monitoring (MplanC)		**0.320***	**0.289***		**0.145****	**0.181***		0.081	0.069
	Risk Transparency (MtranC)		0.081	0.086		-0.002	-0.011		0.047	0.095
	Risk Coping Capacity (McopiC)		0.022	-0.020		0.028	0.026		**0.259****	**0.224*****
	Potential Absorptive Capacity (MpacC)		0.072	0.093		0.057	0.081		0.049	0.026
	Realized Absorptive Capacity (MracC)		**0.334***	**0.298***		**0.273***	**0.270***		**0.336***	**0.361***
Interaction effects	MpacC x MplanC			0.108			-0.064			0.110
	MpacC x MtranC			-0.250			0.096			0.121
	MpacC x McopiC			0.008			-0.096			-0.031
	MracC x MplanC			-0.064			0.140			-0.030
	MracC x MtranC			0.087			0.071			-0.157
	MracC x McopiC			-0.126			-0.034			-0.109
	R^2	0.012	0.289	0.304	0.036	0.322	0.344	0.011	0.218	0.231
	ΔR^2	0.012	**0.276***	0.016	0.036	**0.286***	0.022	0.011	**0.207***	0.013
	F-value for ΔR^2	0.636	11.502	0.531	1.905	12.462	0.805	0.560	7.829	0.404

*p < 0.01, **p < 0.05, ***p < 0.10, (n=157)

All the regression coefficients reported are unstandardized

Table 20 – Ordinary least squares regression results

Source: elaborated by the author

In the regression model, the independent variables are elements, which contribute to affect the dependent variables. For example, lack of planning and monitoring affect budget and schedule in terms of cost overruns. If the construction company did not plan and control effectively its activities, we would expect that costs and delays leverage because more efforts would be required to run the activities. We discuss in more detail the implication of such problems.

In Table 20, we present the results for our dependent variables such as budget and schedule (BUDG), customer satisfaction (SATI), and business success (BUSI), from now BUDG, SATI, and BUSI, respectively. We discuss the regression results in the following sequence: (1) the control variables, (2) the explanatory variables, and (3) interaction variables. Furthermore, during these discussions, we are going to analyze different models.

As seen in Table 20, the base model presents no significance of the control variables in the regression when the dependent variables are BUDG and BUSI. However, when the dependent variables is SATI, we observe that the beta of “Size of investment in the completed project (in R$)” (INV) is positive and significant at $p < 0.05$, but “Classify the level of complexity of the completed project” (INC) and “Number of employees (last period)” (NEE) are not significant.

Although the INV in SATI regression is positive and significant, the R^2 explains not so much. The power of explanation of the coefficient is only 3.6% in the regression and leaving 96.4% (1 – 0.036) with no explanation. Therefore, the contribution of this control variable for the regression is not relevant.

Regarding the other control variables, they do not have any effect on the regression. It was expected because they do not have predictive power in our study. However, in association with other independent variables is expected that they can contribute to the regression.

On the other hand, the BUDG regression in the main model, the only variables chosen does not influence on BUDG. This is very interesting because it is expected that design complexity and size of the investment would have some implication on BUDG. A possible explanation may be that these control variables need to be associated with other attributes to produce the systematic effects.

The control variable of NEE is negative and significant at $p < 0.05$. The results revealed that, as the NEE increases, it has a negative impact on cost. The sector is acknowledged by common time overrun of its activities (Assaf & Al-Hejji, 2006). One possible explanation is that, in occurring delays of an important project, companies can hire experienced labor for maintain the project on track or reschedule the activities to recover the time lost.

The other explanation is related to project complexity. It depends on the magnitude (investment) and complexity of the project to deal with these situations. Therefore, companies need to hire more people in management and operational area, which affect cost.

5.2.3.1 Absorptive Capacity, Direct Effects, and Interactions Effects

As seen in Table 20 in main model and model one, the potential absorptive capacity (PAC) provides no significant coefficients. These results suggest no impact of this attribute on performance in the construction industry of São Paulo State. In these regressions, we aim to assess PAC as a moderator and direct factors and its relationship with performance. We expected that PAC at least affected directly on performance, which not occurred.

A possible explanation may be that the knowledge sharing between project teams is not the most important way of acquiring the new knowledge. It seems that the process to exchange experience is not encouraged by companies in the sector. The results also suggest that the relationship between the project team and senior managers in exchanging ideas, problem-solving, asking for orientation, or even discussing new opportunities proved to be not a good way of acquiring new knowledge.

Even though the knowledge acquisition can be through the relationship with clients, suppliers or third parties, in this sector, this is an incipient way of acquisition. These results supply evidence that this process is not a common practice in the construction industry.

Probably, the companies emphasize other ways to acquire new knowledge in construction projects. For example, the training courses, the lessons learned, among others.

However, although the companies are sensible to the process of assimilation new knowledge and opportunities that could be useful to clients, this process did not prove to be relevant for BUDG, SATI, and BUSI. In other words, it is not possible to say that this process has a significant impact on the technical and market performance. The results provided by the regressions did not capture this relevance. There is no evidence that PAC has a direct influence on performance in this sector. Therefore, the hypothesis H1 defined into specific relationships (1a, 1b, and 1c) was not supported. In short, we cannot confirm that PAC enhances performance directly.

Kim (1998), for example, sees the process of assimilation through exchanging knowledge among members or entities as relevant, which generates impact on internal tacit knowledge. However, as we noticed, in this industry this is not common.

Although we cannot confirm the positive relationship between PAC and performance, the results are in line with the literature. It suggests that PAC has influence on performance through RAC (Jansen et al., 2005; Yeoh, 2009). For Hughes et al. (2014), the network relationships are crucial to enhance the ability for assimilating and exploiting knowledge, which in turn affect performance. Therefore, as some scholars state, the performance is affected through RAC and not by PAC directly.

For Leal-Rodríguez et al. (2014), PAC has an important influence on RAC due to their complementarity, but have different roles. For instance, according to Jansen et al. (2005), the lack of company's ability affects the degree of response to the environment, which would impact on RAC on the long term. Additionally, these authors suggest that PAC helps to purify knowledge, but increases the costs in the process of knowledge acquisition. Moreover, Zahra and George (2002) state that PAC enhances the flexibility of the company, but does not guarantee the knowledge exploitation, which in turn would not affect performance.

Even though the important role of PAC, the literature suggests that performance is influenced by the knowledge when it puts in practice and enables to improve routines and processes. Therefore, PAC has indirect role regarding performance. In summary, the results support the previous research (Jansen et al., 2005; Leal-Rodríguez, Roldán, et al., 2014) that postulated that PAC has an important role, but not directly impact on performance.

On the other hand, as seen in Table 20 in main model and model one, the RAC coefficients are positive and highly significant at $p < 0.01$, and in expected direction. These results suggest that the most important mechanism to leverage performance is through the two dimensions of RAC; that is, transformation and exploitation. This is in line with previous researches from the literature. This mechanism enables the company to refine routines and processes, which impacts on technical and market performance.

A possible explanation would be when a company puts in place the new relevant knowledge or even its existing stock of knowledge and exploits them efficiently, it enhances the way the things are done. For example, the routines and processes purified enable to avoid waste of time, materials, labor time, among others. In this vein, they enhance the productivity.

However, our results suggest that the knowledge does not necessarily come from sharing practical experience by the project team. At the first moment, this generates a major concern because it seems that, in this sector, it is not normal to share relevant knowledge for operational enhancements. Furthermore, this individualism of project team affects the first dimension of RAC, the knowledge transformation. By contrast, the knowledge exploitation probably can have much more influence on performance than transformation. For example, the clearly definition of how activities should be performed enables the project team to understand what the company expects from them.

Additionally, when the company defines clearly the roles and responsibilities of each member of project team seems to be much more relevant for performance. The focus is to maintain a common language among team members for achieving the project goals. In summary, our results suggest that the exploitation dimension (a second dimension of RAC) is more important to leverage performance than transformation. In the construction industry, an operational enhancement through knowledge exploitation seems to be crucial for performance.

Therefore, the hypothesis H2 defined into specific relationships (2a, 2b, and 2c) was supported. Our results state there is evidence that RAC enhances performance directly.

These results are in accordance with Jansen et al. (2005)'s findings. For them, the RAC is the mechanism responsible for leveraging performance. In other words, they provide evidence that RAC has much more to do with performance than PAC. Hughes et al. (2014) also provide evidence that absorptive capacity has significant and positive impact on market performance. Their findings suggest impact on the market and economic indicators.

However, even though the literature states that knowledge sharing improve performance (Hughes et al., 2014; Zahra & George, 2002), it was not possible to confirm these findings in the construction industry. The future studies could explore the reasons for which they occur.

We tested the interaction effects of PAC and RAC in the relationship in relation to PMP and performance. The idea was to capture whether PAC or RAC leverages this relationship and then maximizes performance. The results showed no influence. Therefore, the hypotheses H3 and H4 defined by specific relationships (3a, 3b, 3c, 3d, 3e, 3f, 3g, 3h, 3i, 4a, 4b, 4c, 4d, 4e, 4f, 4g, 4h, and 4i) were not supported. This result cannot confirm that PAC and RAC enhance performance indirectly; that is, through operational practices.

Regarding to AC, a possible explanation would be that the construction industry has not acquired relevant knowledge capable to refine its operation practices. In other words, the knowledge stock are not purified sufficiently to enhance routines and processes. This is interesting because it would suggest that the sector incurs in the lack innovation. Furthermore, this also can be explained by the prior knowledge that helps the company to select the knowledge from the environment that could have some influence on its operations (Lane & Lubatkin, 1998). The results raise doubts whether this knowledge is important and impact on operations. Even though this is an indicative, other practices should be added in future studies to confirm or disconfirm these findings.

When the relevant knowledge is incorporated into routines and processes by the exploitation dimension, it is expected that the efficiency is improved, which in turn contributes to performance. However, our results indicated that this did not happen. Neither PAC nor RAC proved to be relevant in favor of these practices, despite what the literature suggests.

Our study stated that AC did not affect planning and monitoring because possibly these processes are already consolidated in construction projects. Perhaps the knowledge gained by these companies did not improve enough to make a difference. In conclusion, it was not possible to confirm that AC maximizes the relationship between planning and monitoring and performance.

Additionally, it was not possible to confirm that AC maximizes the relationship between risk management and performance as well. A possible explanation for this result is the lack of understanding of the importance of this practice for enhancing operations in the sector (Baloi & Price, 2003). Moreover, our finding is also supported by previous research when highlights the lack of attention to the construction sector when it transfers unskilled employees to manage risk management (Akintoye & MacLeod, 1997). In short, the interaction effects of AC proved not to produce the desired results when worked with these practices.

5.2.3.2 Planning and Monitoring and Performance

However, in main model and model one regressions, the beta of planning and monitoring are positive and highly significant at $p < 0.05$ for BUDG regressions and at $p < 0.05$ and at $p < 0.01$ for SATI regressions. The signs of beta coefficients are in the expected direction. It is interesting because even though cost and time overrun are common in this sector (Assaf & Al-Hejji, 2006), the evidence suggests that these practices are really important to control them and improve the efficiency in monitoring the activity execution. This occurs because the project team recognizes that when emphasizes these practices, it improves performance. The results are in line with Doloi (2013) that shows, in the construction industry, this practice has a positive influence on cost performance. In this case, positive influence means to maintain cost on budget or if possible reduce it through an efficient execution and activities on time.

Additionally, a possible explanation for such influence may be that when companies enhance the planning and monitoring abilities through appropriated mechanisms affect BUDG and SATI through technical performance (e.g., on cost, on time, in accordance specifications). To execute activities as planned, companies need to use good methods/techniques in construction to achieve technical performance. As a result, the evidence suggests that these methods/techniques enable companies to meet time goals, execute activities as planned, meet specifications previously defined, enhance the customer satisfaction through avoiding delays, and perform the project as planned.

The other problematic situation is how to deal with project complexity. There is evidence that the use of good methods/techniques by the construction helps to cope with project complexity because execute the planned activities more efficiently. These results corroborate with Doloi (2013)'s findings. For him, the use of good methods/techniques in construction correspond to one of the most important attributes in execution and; therefore, deal with project complexity.

On the other hand, the monitoring execution becomes crucial because any delay or cost overrun can affect performance. Therefore, companies should define appropriated mechanism to execute this process. In the construction industry of São Paulo State, it appears that the mechanism defined for monitoring execution and planned activities contributes to technical performance. If the process of monitoring is efficient, it is expected that the cost, time, and specifications are under control by the company.

In a complex project, this process is critical due to the amount of activities that must be managed. This process affects not only BUDG, but customer satisfaction because enable to meet the specifications and needs. Dvir, Raz, and Shenhar (2003) found a significant positive relationship between the amount of efforts in defining project goals and functional requirements and technical specifications, which in turn affects the customer satisfaction.

Additionally, our findings are in line with Doloi (2013). According to him, the accurate planning and monitoring prepare companies to work more efficiently by using the appropriate mechanism of execution and cope with the complexity of project. Which in turn contribute to maintain the project on track, on budget, and within technical specifications.

However, to deal with the complexity of design, companies need to enhance their technical competence. Moreover, complexity requires an accurate planning and monitoring where resources are clearly defined as well as responsibilities. Therefore, the results suggest that, in the construction industry of São Paulo State, this factor (technical competence) is relevant and influence on performance. For example, Doloi (2013) provides evidence that the lack of competence and responsibilities leads to affect projects in a bad way.

By contrast, Doloi (2013) also provides evidence that planning and monitoring enhance the technical competence of project team in defining feasible planning activities duration and mechanisms for monitoring the project execution. To use refined planning tool, for example, the work breakdown structure (WBS), which deploys effectively the activity and cost in a planning horizon to enhance the management; The experience people in planning is an important factor. Furthermore, skilled people are crucial to deal with a sophisticated mechanism for effective monitoring process of the project as well as its complexity.

Trost and Oberlender (2003) found positive significant evidence of human factor (team experience) and cost information that are the relevant factors of the accuracy of estimates. Even though the literature emphasizes that in the early stages of the project is difficult to have the whole information or definition for a proper estimation, the experience team can minimize such problem. For example, providing direction for acting in this situation.

Therefore, the result reveals that another important characteristic is the emphasis on avoiding delays. The lack of attention to planning and monitoring is one of the causes for time overrun in the construction industry (Assaf & Al-Hejji, 2006), which affects negatively the project schedule and in turn customer satisfaction. This last dimension expects to receive the project in accordance with planned and agreed.

As expected, this practice has a positive influence on BUDG and SATI; therefore, the hypotheses H5a and H5b were supported. As a result, the evidence suggests a positive relationship between planning and monitoring and BUDG and planning and monitoring and SATI.

However, the planning and monitoring in BUSI regression is not significant. This is a surprise because as we said above, this attributes impact on cost, which in turn affect at least profitability and margins. On the other hand, when we look at more carefully to BUSI's indicators, most of them are related to market performance where the most commons are sales, market share, profitability, and margins.

A possible explanation may be that the Brazilian economic situation has affected the construction industry in recent years. The sector has suffered retraction of activities (Alegretti, 2014) due to some restrictions by the market. For example, weak demand, unskilled labor, and economic factors such as inflation, interest rate, government policies, among others. Added to this an unfavorable economic scenario in 2014, the corruption reported by the Federal Police in this sector in 2014, and industry stagnation forecast for 2015 (Ayres, 2014) causes some dissatisfaction and pessimism in this business. These scenarios have affected the degree of confidence in this industry, which achieved the lower level since started be measured in mid-2010 (Braga, 2015). In conclusion, the economic factors, labor shortage, and corruption have affected the business performance in the construction industry in recent years.

This is in line with Assaf and Al-Hejji (2006) that suggest labor shortage and unqualified workforce as the relevant factors to impact on performance. Moreover, Wang, Dulaimi, and Aguria (2004) studying international construction projects in developing countries identified twenty-eight critical risks that affect performance, among them, corruption and economic factors. Akinci and Fischer (1998) provide evidence that economic instability impact on cost overburden. For them, economic factors affect not only unit cost, but the total cost of construction as well. However, planning and monitoring indicators do not influence on BUSI directly, when the economy does not provide the proper conditions for the business.

Additionally, Dvir, Raz, and Shenhar (2003) pointed out that planning does not lead to project success; however, if a company does not pay much attention to this practice there is a high probability of project failure.

In short, the hypothesis H5c was not supported. The result provides evidence that under insufficient or unfavorable economic conditions the planning and monitoring do not affect BUSI directly.

5.2.3.3 Risk Management and Performance

In a sequence, we observed that risk transparency (main model and model one) is not significance for BUDG, SATI, and BUSI regressions. Similarly, the risk coping capacity is also not significance for BUDG and SATI regression. Even though the sector provides a good understanding of risk transparency and risk coping capacity because in survey questionnaire the respondents provide reasonable scores, the results suggest that these mechanisms do not affect technical and market performance as a whole. We only observed significant impact between risk coping capacity and BUSI regression.

The risk transparency is related to the process of risk identification and its causes, which in turn generates planning actions to deal with it. By contrast, as the risk was identified, the risk coping capacity uses an internal mechanism to act against it in order to reduce potential losses. A possible explanation may be that the sector does not pay much attention to these processes as valuable techniques in order to mitigate the impact of risk factors on technical and market performance. In short, there is a lack of understanding of their potential benefits.

Additionally, the literature emphasizes that the risk management practices are relegated to unskilled employees to manage them (Abdou, 1996), which in turn neglected their potential value. Moreover, Akintoye and MacLeod (1997) provide evidence that, in the construction industry, fewer techniques are used in risk analysis due to the lack of ability with them or time restrictions. For them, even though the high evolution of software packages and techniques over the years, these mechanisms seem not have much impact on risk analysis in this sector.

Conversely, in construction industry of São Paulo State, although the companies recognize the importance of risk transparency and risk coping capacity due to the high scores provided by the respondents in survey research, the evidence suggests deficient perceptions by the companies regarding their potential value. I If these practices were used properly, they would help to achieve technical performance and, in turn, customer satisfaction.

Furthermore, these technical indicators affect this last dimension mainly through technical specifications and customer needs. For customers, these are the main goals. The evidence suggests that the mechanism the company uses to manage risk does not affect customer satisfaction directly. The customers want that the project be delivered on time, on cost, and respects technical specifications. However, they do not pay much attention to which mechanism the company uses to achieve them. The results suggest that this is not important for them.

The other possible explanation may be that the risk management is an internal mechanism used for managing internal activities such as risk identification, risk monitoring, risk coping, among others. Perhaps the customers have little influence on this process; therefore, their satisfactions are more related to practices that influence their goals. For example, planning and monitoring discussed above.

Therefore, the hypothesis H6 defined into specific relationships (6a, 6b, and 6c) was not supported. The results cannot confirm a positive relationship between risk transparency and performance (BUDG, SATI, and BUSI). Additionally, the hypotheses H7a and H7b were not supported either. Similarly, the results cannot confirm a positive relationship between risk coping capacity and BUDG and risk coping capacity and SATI as well.

However, the risk coping capacity is positive and highly significant at $p < 0.05$ for BUSI regression and the sign is in the expected direction. This result arouses attention because when a company has the good mechanism to react to unforeseeable or identified risks affect the market performance dimension. On the other hand, as we discussed above, the construction industry of São Paulo State is deficient in providing the good mechanism to cope with risk properly. Perhaps the freedom to act against risks properly is restricted by the lack of mechanism or knowledge. The low score received in survey questionnaire was a previous indicative.

By contrast, to react to unforeseeable and identified risks and carry out the necessary adaptive measures, which received reasonable scores in the survey questionnaire. However, in the regression for technical dimension, these proved to be irrelevant, but not in the regression for market dimension. A possible explanation may be that the sector is not proactive regarding risk, but reactive. It may be not efficient in preventing or predicting the potential risks that cause losses in the project. The result suggests that the sector only take some actions when the risk is imminent and requires adaptive measures quickly.

Therefore, the hypothesis H7c was supported, which means a positive relationship between risk coping capacity and market performance (BUSI).

Even though the hypothesis H7c was supported, this finding still needs attention because the sector does not use the risk management an adequate way. Which means, to be able to influence not only market performance, but technical performance as well. Our findings support partially such influence on performance in this industry. Perhaps as previous research in construction industry pointed out, the sector did not understand the value of risk management for its operations (Baloi & Price, 2003).

As seen in Table 20, in the main model of BUDG regression, the significant parameters provide a R^2 of 28.6%, with ΔR^2 of 27.6% significant at $p < 0.05$. It means that, in this regression, 28.6% of the impact on budget and schedule come from the significant parameters such as planning and monitoring, realized absorptive capacity, and control variables (NEE). The power of explanation of this regression leaves 71.4% (1 – 0.286) with no explanation. Therefore, there is a relevant contribution of these significant parameters for explaining budget and schedule.

Similarly, in the main model of SATI regression, the significant parameters provide a R^2 of 32.2%, with ΔR^2 of 28.6% significant at $p < 0.05$. It means that 32.2% of the impact on customer satisfaction come from the parameters such as planning and monitoring, realized absorptive capacity, and control variables (INC and INV). However, the regression leaves 67.8% with no explanation; even so, there is a relevant contribution of these parameters for explaining customer satisfaction.

Finally, in the main model of BUSI regression, the significant parameters provide a R^2 of 21.8%, with ΔR^2 of 20.7% significant at $p < 0.05$. It means that 21.8% of the impact on business success come from the parameters such as risk coping capacity and realized absorptive capacity. Even though the regression leaves 78.2% with no explanation, it provides a good contribution in explaining business success.

When we turn our attention to model one when the interaction effects are added, in BUDG regression, the R^2 increases to 30.4%, with ΔR^2 of 1.6%. It happens the same with the SATI regression that its R^2 increases to 34.4%, with ΔR^2 of 2.2%, and in the last regression (BUSI) its R^2 increases to 23.1%, with ΔR^2 of 1.3%. However, these changes in R^2 are not significant, which indicate that the moderation effects, in our model, do not have a relevant impact on performance (BUDG, SATI, and BUSI) although the R^2 had increased.

The multicollinearity was analyzed under two indicators such as the variance inflation factor (VIF) and the tolerance. The maximum values we observed in the regression were 3.953 for VIF and 0.890 for tolerance (IntMracMplan). These mean that multicollinearity is not a problem for our regression. According to Fávero et al. (2009, p. 359), if VIF is less than the critical value of 5.0, it means acceptable multicollinearity. For Corrar et al. (2009, p. 188), if tolerance is less than the cutoff point of 1.0, it means no multicollinearity. In conclusion, there is evidence of no problem due to the multicollinearity in our regression and no correction is needed. In Appendix L, we provide the full regressions of our dependent variables.

In the chart below, we summarize all the hypotheses and their results.

Code	Hypothesis.	Result
H1	**Potential absorptive capacity has a positive relationship with success measure.**	**Not supported**
H1a	Potential absorptive capacity has a positive relationship with budget and schedule.	Not supported
H1b	Potential absorptive capacity has a positive relationship with customer satisfaction.	Not supported
H1c	Potential absorptive capacity has a positive relationship with business success.	Not supported
H2	**Realized absorptive capacity has a positive relationship with success measure.**	**Supported**
H2a	Realized absorptive capacity has a positive relationship with budget and schedule.	Supported
H2b	Realized absorptive capacity has a positive relationship with customer satisfaction.	Supported
H2c	Realized absorptive capacity has a positive relationship with business success.	Supported
H3	**Potential absorptive capacity moderates the relationship between project management practice and success measure.**	**Not supported**
H3a	Potential absorptive capacity moderates the relationship between planning and monitoring and budget and schedule.	Not supported
H3b	Potential absorptive capacity moderates the relationship between planning and monitoring and customer satisfaction.	Not supported
H3c	Potential absorptive capacity moderates the relationship between planning and monitoring and business success.	Not supported
H3d	Potential absorptive capacity moderates the relationship between risk transparency and budget and schedule.	Not supported
H3e	Potential absorptive capacity moderates the relationship between risk transparency and customer satisfaction.	Not supported
H3f	Potential absorptive capacity moderates the relationship between risk transparency and business success.	Not supported
H3g	Potential absorptive capacity moderates the relationship between risk coping capacity and budget and schedule.	Not supported
H3h	Potential absorptive capacity moderates the relationship between risk coping capacity and customer satisfaction.	Not supported
H3i	Potential absorptive capacity moderates the relationship between risk coping capacity and business success.	Not supported
H4	**Realized absorptive capacity moderates the relationship between project management practice and success measure.**	**Not supported**
H4a	Realized absorptive capacity moderates the relationship between planning and monitoring and budget and schedule.	Not supported
H4b	Realized absorptive capacity moderates the relationship between planning and monitoring and customer satisfaction.	Not supported

Code	Hypothesis.	Result
H4c	Realized absorptive capacity moderates the relationship between planning and monitoring and business success.	Not supported
H4d	Realized absorptive capacity moderates the relationship between risk transparency and budget and schedule.	Not supported
H4e	Realized absorptive capacity moderates the relationship between risk transparency and customer satisfaction.	Not supported
H4f	Realized absorptive capacity moderates the relationship between risk transparency and business success.	Not supported
H4g	Realized absorptive capacity moderates the relationship between risk coping capacity and budget and schedule.	Not supported
H4h	Realized absorptive capacity moderates the relationship between risk coping capacity and customer satisfaction.	Not supported
H4i	Realized absorptive capacity moderates the relationship between risk coping capacity and business success.	Not supported
H5	**Planning and Monitoring have a positive relationship with success measure.**	**Supported partially**
H5a	Planning and Monitoring have a positive relationship with budget and schedule.	Supported
H5b	Planning and Monitoring have a positive relationship with customer satisfaction.	Supported
H5c	Planning and Monitoring have a positive relationship with business success.	Not supported
H6	**Risk transparency has a positive relationship with success measure.**	**Not supported**
H6a	Risk transparency has a positive relationship with budget and schedule.	Not supported
H6b	Risk transparency has a positive relationship with customer satisfaction.	Not supported
H6c	Risk transparency has a positive relationship with business success.	Not supported
H7	**Risk coping capacity has a positive relationship with success measure.**	**Supported partially**
H7a	Risk coping capacity has a positive relationship with budget and schedule.	Not supported
H7b	Risk coping capacity has a positive relationship with customer satisfaction.	Not supported
H7c	Risk coping capacity has a positive relationship with business success.	Supported

Summary of the hypotheses
Source: elaborated by the author

6 FINAL CONSIDERATIONS

In this chapter, we conclude this research by reporting the main findings, and the academic and managerial contributions. Additionally, we also offer the limitations of this research and suggestions for future researches.

6.1 Considerations about the research

This research addresses the question of the absorptive capacity moderating the relationship between practices and performance, which means that the influence of AC would maximize this relationship. As a result, we expect that the influence of the existing knowledge or the new knowledge on practices leverages performance. Furthermore, the research also proposes to confirm that the better use of project management practice enhances performance. Finally, we also expect to contribute to the understanding of which performance indicators are relevant to evaluate projects in the construction industry of São Paulo State.

Our findings permit some considerations related to the main constructs under study. First, even though we expected to confirm that PAC influences on performance, our results suggest that this construct has no effects directly. However, this finding is consistent with the literature that suggests no effect of PAC in performance (Jansen et al., 2005).

In this construction industry of São Paulo State, the main findings related to PAC are that the company does not have habitude to acquire knowledge from its members. It means that knowledge exchanging is not a good way of knowledge acquisition between project teams or even other members or partners. Even the lessons learned they do not use so much. Therefore, the main source of knowledge acquisition is in the training program (MBA, PMI courses, among others). This in turn indicates that the companies privilege the individual knowledge.

In the assimilation process, the company concerns about new knowledge and opportunity for clients; however, it does not show relevance to performance directly. But it not means that PAC is not important. Initially, the company needs to recognize and assimilate the knowledge and then apply it, which in turn influences on performance through RAC (Hughes et al., 2014; Jansen et al., 2005; Yeoh, 2009; Zahra & George, 2002). In short, PAC is relevant to performance by RAC indirectly.

Second, the application of specific knowledge has proved to be the most influential to performance in the construction sector. In all cases, our findings show the RAC impacts directly on technical and market performance in construction sector. This is in line with Jansen et al. (2005)'s study. Therefore, the two dimensions of RAC; that is, transformation and exploitation, are important mechanisms for company to refine routines and processes. These in turn affect directly on technical and market performance. However, these not occur through knowledge sharing. According to some managers, the sector does not have experience or policy to encourage exchanging both internal and external knowledge through relationships with other companies.

Our findings also suggest that when a company puts in place its knowledge stock and efficiently exploits it, it improves routine and processes. In this case, the exploitation is more important than transformation dimension. Therefore, it affects directly performance when enhances the productivity. Additionally, these findings are consistent with the literature and provide evidence that RAC has much more to do with performance than PAC. In short, the most important is the knowledge application.

Third, the interactions effect of AC (PAC and RAC) have not proven relevant to enhance the relationship between project management practices and performance. A possible explanation would be that the sector neither has acquired nor assimilated the relevant knowledge that enable to refine its routines and processes. Perhaps, in this sector, some routines and processes are quite consolidated. For example, planning and monitoring, which means a lack of innovation, and risk management suffers from the lack of attention by the construction sector. The literature has emphasized that this sector did not still understand the importance of this practice (Baloi & Price, 2003). However, this is an indicative and suggests that future studies should evaluate other practices to confirm or disconfirm these findings.

Fourth, regarding PMP such as planning and monitoring and risk coping capacity, our findings suggest a positive relationship with performance. For example, planning and monitoring impact directly on budget and schedule and in customer satisfaction while risk coping capacity has more influence on business success. However, it was not possible to confirm that risk transparency has any impact on performance.

Regarding the planning and monitoring, when project team emphasizes this practice properly, it enables to plan and monitor the activity execution effectively. Moreover, the company's abilities by using it through appropriate mechanisms affect positively the technical performance such as cost, time, and in accordance with specifications. This in turn enhances the customer satisfaction. This result is in line with Doloi (2013) that suggests this practice has a positive influence on cost performance and prepares companies to work more efficiently. Therefore, they contribute to maintain the project on track, on budget, and within technical specifications.

Additionally, our results also suggest that good methods/techniques employed by companies enhance performance. They enable to meet technical performance such as cost, time, quality, and specifications, and market performance such as customer satisfaction by avoiding delays, and perform the project as planned.

However, some managers concern that the Brazilian professional does not pay much attention to the planning process, which according to the literature leads to project failure. Therefore, our findings provide evidence that the company should put more efforts on this practice.

Fifth, considering the risk transparency, the fact of a company identifies the risks as well as their causes, it does not impact on performance directly. However, for acting against risks, which implies in risk coping capacity, the company initially should identify them. But our findings provide evidence that the performance is affected only by market performance in the business success dimension. This means that risk management does not have any effect on technical performance and customer satisfaction. In other words, these processes do not affect cost, time, quality, scope, and specifications, which generate surprises. Perhaps, the process or the mechanism for managing risk management is not adequate in this sector. For example, which involving people and risk analysis procedures. Additionally, some companies establish 2% of the sales for contingency risk in its result. This provides an indication of the lack of risk management when it neglects a deep risk analysis of the project. The other possibility is when the company does not emphasize the risk management process, in this case, it transfers to price all risks associated with projects. This is a way to deal with the lack of planning as well.

A possible explanation may be that the sector is not proactive, but reactive. The sector only acts against risk when it is imminent or when it occurs the problem. It is not efficient in preventing or predicting the potential risks that cause losses in the project. Therefore, the result is in line with the literature that emphasizes that the sector does not pay much attention to or neglect the potential benefits of risk management (Abdou, 1996; Akintoye & MacLeod, 1997).

The investment in the training program would help to improve the consciousness of the potential benefits of risk management as an important technique to influence on performance.

Finally, in terms of performance in construction industry of São Paulo State, we have also confirmed that technical performance such as cost, time, quality, and scope are the most relevant indicators to assess project performance. Moreover, two additional indicators have emerged as the most used to evaluate project performance from the perspective of market performance such as profitability and customer satisfaction. Regarding profitability, the gross margin is the indicator that the sector looks at carefully because it is responsible to measure the project management as a whole. In short, the manager is normally responsible for this indicator because it measures whether he leads the project effectively.

These findings are consistent with the literature. According to Chan and Chan (2004) and Chan, Scott, and Lam (2002), even though technical dimensions are important in construction industry such as cost, time, and quality, other dimensions have gained attention, among them, stakeholder satisfaction. Additionally, Tatikonda and Montoya-Weiss (2001) also propose other dimensions of market performance such as sales, customer satisfaction, profitability, and market share.

6.2 Academic contributions

In academic terms, this research enables a better understanding of the importance of absorptive capacity in the construction sector and confirms that the realized absorptive capacity is the most important dimension to enhance performance. This means the knowledge application through transformation and exploitation. Therefore, RAC influences directly technical and market performance. By contrast, we also indicate that PAC, through the knowledge acquisition and assimilation, does not impact directly on performance.

Furthermore, the interaction effects of absorptive capacity on the relationship between project management practices and performance have proven irrelevant. This means that absorptive capacity does not maximize this relationship.

This research also confirms that project management practices lead to performance. We have proved that planning and monitoring and risk coping capacity have positive effects on technical and market performance. This is in line with the literature of operations that have studied the relations between operation practices and performance. Moreover, it contributes to the project management literature by understanding what practice influence on performance. Some authors argue that the multidimensional perspective of performance contributes to this concern.

Additionally, it was possible to confirm that the technical performance dimensions are the most important to assess project performance such as cost, time, quality, and scope. Additionally, the cost dimension has considered as the most relevant to some managers in our qualitative research. In terms of market performance, even though the literature is not clear yet which dimensions are relevant to assess project performance, our research suggested that the profitability and customer satisfaction are the most important. For this sector, if the customer is not satisfied with the project results, the sector does not consider that a project was a success although technical dimensions have been achieved. Furthermore, although the sector looks at some dimensions of profitability, the gross margin has been emphasized as the most relevant to assess project performance. Other indicators such as sales and productivity also have been mentioned by the managers in this sector.

6.3 Managerial contributions

For management, this research enables to confirm the importance of running carefully some practices because they are relevant to performance. This means that the construction sector must pay attention to it and enhance its skills for better run its routines and processes. For example, in planning and monitoring, managers demonstrated some concerns related to these practices. For them, they are relevant for project success; however, some of them understand that the construction sector does not pay much attention to them. They compared the Brazilian way to the American way of doing things, and they understand that we need to put more efforts on these practices. Our findings also emphasize this importance because we show their positive impact on performance.

Furthermore, the literature also emphasizes that the lack of attention to planning and monitoring leads to project failure. In short, the construction sector possibly has seen these practices as basic and no relevant knowledge has influenced on them.

On the other hand, regarding the risk management, the literature has suggested that the sector has neglected these practices, which would justify the lack of influence on performance.

Finally, in risk management, our findings also suggest an important mechanism for performance. Therefore, the managers should improve their abilities to deal with uncertainties and risk; otherwise, the project success would be compromised.

6.4 Limitations of this research and suggestions for future researches

This dissertation also has many limitations, which provides opportunities for future research. Initially, the qualitative phase was done based on interviews only to understand how managers run projects, their difficulties, and problems, and how they understand the main terms under study for quantitative phase. The strategy provides great understanding about construction sector; however, the limited number of interviews and because of some of them were not done in the construction sector, it does not allow generalizations. Perhaps, for future research based on case study strategy can be used to understand the main relations between those constructs under study. For example, deepen the understanding of how AC interacts between practice and performance.

Another suggestion would be to extend this research to Brazil because we focus on São Paulo State, and it is not possible to say that this work can be generalized to the country. This would be another limitation. Additionally, we work with different types of project in both qualitative and quantitative phase. Future research can focus on project complexity to extend these findings because this type of project requires more skills and knowledge from the project team.

Regarding data collection, although we required at least three respondents per companies to participate in this research, we had only one respondent per company; hence, this is another limitation of this work.

However, even though the literature states that network knowledge sharing improves performance (Hughes et al., 2014), our findings suggest that the construction sector does not provide a good mechanism for knowledge sharing. Future research can focus on understanding why it occurs in this sector, and how the social integration mechanisms interfere with these internal and external relationships.

Regarding the absorptive capacity (AC), we evaluated only four dimensions of this construct in the construction sector. For example, acquisition and assimilation for PAC, and transformation and exploitation for RAC; however, we have not assessed other dimensions provided by the literature. In Appendix A, we offer a large chart with these dimensions that could be explored in future research.

Likewise, it was not our focus to analyze all project management practices. We have chosen two important practices that emerged from the qualitative phase. Therefore, another limitation of this research is the reduced number of practices used. Future research can explore other practices not covered by this work.

Additionally, future research can analyze more clearly, why the construction sector has not used the risk management properly. Even though some literature have emphasized this problem, it is not clear yet the lack of interest by this sector, and why the construct has a low impact on performance.

In performance terms, the focus of this research was to evaluate project performance from the point of view of the company. Therefore, we have not assessed it from the customer's perspective or other stakeholders. This is another point for future research.

In this research, we have tested the interactions through linear and non-linear models. In the non-linear model, we have used only the exponential effect. For future research, it can explore different ways in which non-linear effects can be modeled. For example, using logarithms to test other interaction effects.

Although our findings have demonstrated that interactions of AC have no effect on the relationship in relation to PMP and performance, future research can explore other project management practices to assess this relationship.

Finally, in our qualitative sample, not all companies adopt all the methodologies described in our literature review, for example, critical chain. Therefore, it may be an opportunity for further studies to evaluate the absorptive capacity together with critical chain in projects.

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APPENDIX

Appendix A – Dimensions and subdimensions of absorptive capacity (AC)

Construct	Dimension (D) and Subdimension (SD)		Definition	It is achieved from	References
Absorptive Capacity (AC)	Acquisition (recognizing the value, knowledge scanning)	D	This is the capacity of firms identify or maps and acquire external knowledge through experience and investment that is important for them.	Hiring personnel skilled, hiring experience people from outside, hiring of foreign engineer, contracting for consulting services, through corporate acquisitions, research labs, universities, with other firms (e.g., equipment and material suppliers), continued training, learning by doing, learning by using, ability to learn, job rotation.	Cohen and Levinthal (1989, 1990, 1994), Kim (1998), Zahra and George (2002), Jansen et al.(2005), Narasimhan et al. (2006), Todorova and Durisin (2007)
	Assimilation	D	This is the firms' capability to understand what really interest to them from the knowledge captured externally.	Comprehension, analyzing, processing, understanding.	Cohen and Levinthal (1989, 1990, 1994), Zahra and George (2002), Narasimhan et al. (2006), Todorova and Durisin (2007)
	Transformation	D	This is the firm's ability to improve existing routines and combine the both internally and externally knowledge.	Through development of new schema or changes to existing process, problem-solving, modified knowledge, knowledge sharing, lessons learned, recodifications, synergy, auditing, and bisociation.	Kim (1998), Zahra and George (2002), Jansen et al. (2005), Todorova and Durisin (2007), Gluch, Gustafsson, and Thuvander (2009)
	Exploitation	D	This is the firm's ability to apply the knowledge acquired and assimilated and generated new forms of doing things.	Improve the organizational competencies and better use of knowledge into its operations.	Cohen and Levinthal (1989, 1990, 1994), Kim (1998), Zahra and George (2002), Todorova and Durisin (2007)

Construct	Dimension (D) and Subdimension (SD)		Definition	It is achieved from	References
	Integration	D	Correspond the content and process of a firm's knowledge absorption.	Efficiency, scope, and flexibility	Van den Bosch et al. (1999)
	Intensity of efforts	D	Represents the amount of energy expended by organizational members to solve problems.	Constructed crises, resolve crises, interaction among members.	Kim (1998)
	Prior relevant knowledge	D	Represents the managers and employees competencies, practices, and the organization know-how of doing things.	Basic skills, general knowledge, recent scientific and technological knowledge, shared language, knowledge, job skills, problem-solving methods, learning capabilities, observation technology in operation, technology licensing, management practices, hiring experienced people from outside, extensive literature review, hiring of foreign engineer, lessons learned.	Cohen and Levinthal (1990), Brown (1997), Kim (1998), Tu et al. (2006), Hughes et al. (2014)
	Communications network	D	The firm's capability of transfer the knowledge through their channels between organizational units.	The level of connections that permit the flows of information and knowledge.	Cohen and Levinthal (1990), Brown (1997), Tu et al. (2006)
	Communications climate	D	The organization's environment that recognizes communication behavior.	The degree of centralization or decentralization of the communication, Degree of interactions of transferring knowledge, Degree of confidence, openness, and supportiveness.	Brown (1997), Tu et al. (2006)

Construct	Dimension (D) and Subdimension (SD)		Definition	It is achieved from	References
	R & D capability	D	The AC comes from the lengthy process of investment and knowledge accumulation.	R&D expenditure impacts on a production of technological know-how, the more R&D expenditures the more know-how absorbs more innovations.	Cohen and Levinthal (1990), Tsai (2001), Narasimhan, Rajiv, and Dutta (2006)
	Interorganizational learning within the alliance	D	Correspond the learning alliance of firms (both students firms and teachers firms) for exchanging information to develop their capabilities in order to recognize the value of new information, assimilate and use it aiming commercial purpose.	R & D alliances, firms' scientific knowledge-base, research capabilities, joint venture.	Kim (1998), Lane and Lubatkin (1998)
	Marketing skills	D	The excellence marketing capability in converting marketing expenditure (a resource) in terms of metrics as sales or customer satisfaction.	The more marketing expenditure in interacting with customers, the more is the ability to understand their problems and choose from a variety technological assets.	Narasimhan, Rajiv, and Dutta (2006)
	Operational competencies	D	Correspond the ability of integration and coordination of a complex set of tasks.	Combining materials and components, manage the material flow to enhance output economically, efficiency in utilizing technological assets.	Narasimhan, Rajiv, and Dutta (2006)
	Contingent factors	SD	Correspond to the contingent conditions under which AC influences on the competitive advantage.	Activation triggers, social integration mechanisms, appropriability regimes, and power relationships.	Kim (1998), Zahra and George (2002), Todorova and Durisin (2007)

Construct	Dimension (D) and Subdimension (SD)		Definition	It is achieved from	References
	Activation triggers	SD	Events that stimulate the firm to respond to internal or external factors	Organizational crises, proactive crises, bad performance, the event that affects firm's strategy.	Kim (1998), Zahra and George (2002), Todorova and Durisin (2007)
	Social integration mechanisms	SD	Correspond to the both mechanisms formally (coordination) and informally (social network) that influence AC.	Sharing of relevant knowledge/information through the organization members, organizational processes.	Kim (1998), Zahra and George (2002), Todorova and Durisin (2007)
	Appropriability regimes	SD	Level of incentives required to influence AC and sustainable competitive advantage	The more appropriability regime, the more is the impact on knowledge absorbed, protection of products and processes, and patents.	Cohen and Levinthal (1990), Zahra and George (2002), Todorova and Durisin (2007)
	Power relationships	SD	The relationships that involve the use of power in order to obtain target results.	Permit better understanding of the performance due to external knowledge, interactions among employees, cognitive process, and learning.	Kim (1998), Todorova and Durisin (2007)

Chart 19 – Dimensions and sub dimensions of absorptive capacity

Source: elaborated by the author

Appendix B – Data collection questions used in interviews (qualitative phase)

The questions below for semi-structured interviews was used as a reference for conducting the process of qualitative phase. Other questions, not included in this section, like opinions related to factors, occurrences, explanations, and meanings could be inquired to clarify some specific point that were not cleared yet (Yin, 2014). This strategy was required for deepen understanding the construct that was inquired.

a) The project management practices

1) Describe in detail, how projects are managed in your company (e.g., methodology, planning, managerial control, management style, policies, structure, and so on), and how their performance is assessed.

2) Describe in detail, the characteristics your company has better (or should have) than other companies in terms of project management. Are there some that worse than other companies?

3) Describe in detail, the project management practices your company uses to run projects.

b) The assessment of performance

1) How do you assess project performance (technical performance and market performance)?

2) Describe in detail, the process of assessment of the project success in your company (indicators to assess the project). How do you know that this process is adequate?

3) Describe in detail, the process of your company assess if the project is contributing to the organization goals (the outcome measures being used). In the sector of your company, are there other different indicators being used?

c) The assessment of absorptive capacity

1) Describe in detail, in what ways the knowledge helps problem-solving in project management when you face contingency factors.

2) Describe in detail, how improve the learning in project management. How does it happen?

3) In what ways, as project manager and team members, you obtain knowledge that helps to improve project performance?

4) How this new knowledge is using that impact on project performance?

Appendix C – Coding chart used for the interview analysis (qualitative phase)

All the structures for coding of the interviews were based on Miles et al. (2013).

MASTER CODE: PROJECT MANAGEMENT PRACTICES	**ABBREVIATION:** PMP
CATEGORY: PLANNING AND MONITORING	PMP-PCM
PMP-PCM: CONSTRUCTION TECHNIQUES	PMP-PCM: TECHNIQUES
PMP-PCM: DESIGN	PMP-PCM: DESIGN
PMP-PCM: ESTIMATING PROCESS	PMP-PCM: ESTIMATING
PMP-PCM: MONITORING PROCESS	PMP-PCM: MONITORING
PMP-PCM: PLANNING PROCESS	PMP-PCM: PLANNING
CATEGORY: RISK TRANSPARENCY	PMP-RST
PMP-RST: HELPING DECISION	PMP-RST: DECISION
PMP-RST: RISK IDENTIFICATION	PMP-RST: IDENTIFICATION
PMP-RST: RISK INFLUENCE	PMP-RST: INFLUENCE
CATEGORY: RISK COPING CAPACITY	PMP-RCC
PMP-RCC: ADAPTIVE MEASURES TO RISK	PMP-RCC: ADAPTIVE
PMP-RCC: REACTION TO RISK	PMP-RCC: REACTION
PMP-RCC: RISK NEUTRALIZATION	PMP-RCC: NEUTRALIZATION

Chart 20 – Codifying of the dimensions of project management practices
Source: elaborated by the author

MASTER CODE: SUCCESS MEASURES	**ABBREVIATION:** SME
CATEGORY: BUDGET AND SCHEDULE	SME-BUG
SME-BUG: MANAGING COST	SME-BUG: COST
SME-BUG: MANAGING QUALITY	SME-BUG: QUALITY
SME-BUG: MANAGING SCOPE	SME-BUG: SCOPE
SME-BUG: MANAGING TIME	SME-BUG: TIME
CATEGORY: CUSTOMER SATISFACTION	SME-CUS
SME-CUS: CUSTOMER SATISFACTION	SME-CUS: SATISFACTION
SME-CUS: TECHNICAL CHARACTERISTICS	SME-CUS: TECHNICAL

MASTER CODE: SUCCESS MEASURES	**ABBREVIATION:** SME
CATEGORY: BUSINESS SUCCESS	SME-BSU
SME-BSU: COMMERCIAL SUCCESS	SME-BSU-SALES
SME-BSU: MARKET SHARE	SME-BSU-SHAR
SME-BSU: PROFITABILITY AND RETURN	SME-BSU-PROFIT
SME-BSU: SATISFACTION STAKEHOLDERS	SME-BSU-STAKE

Chart 21 – Codifying of the dimensions of performance

Source: elaborated by the author

MASTER CODE: ABSORPTIVE CAPACITY	**ABBREVIATION:** AC
CATEGORY: POTENTIAL ABSORPTIVE CAPACITY	AC-PAC
AC-PAC: ACQUISITION INFORMATION AND KNOWLEDGE	AC-PAC: ACQUISITION
AC-PAC: COMPREHENSION AND ANALYZING THE PROBLEM	AC-PAC: COMPREHENSION
AC-PAC: HIRING EXTERNAL WORKFORCE AND CONSULTING	AC-PAC: HIRING
AC-PAC: PROJECT TEAM COLLABORATIONS	AC-PAC: COLLABORATION
AC-PAC: SCANNING ENVIRONMENT AND RECOGNIZING THE VALUE	AC-PAC: SCANNING
AC-PAC: TRAINING WORKFORCE	AC-PAC: TRAINING
CATEGORY: REALIZED ABSORPTIVE CAPACITY	AC-RAC
AC-RAC: APPLICATION OF NEW KNOWLEDGE AND IDEAS	AC-RAC: APPLICATION
AC-RAC: PROJECT STRUCTURES WELL DEFINED	AC-RAC: STRUCTURES
AC-RAC: KNOWLEDGE SHARING, INFORMATION, AND LANGUAGE	AC-RAC: SHARING
AC-RAC: STORAGE LESSONS LEARNED AND NEW KNOWLEDGE	AC-RAC: STORAGE

Chart 22 – Codifying of the dimensions of absorptive capacity

Source: elaborated by the author

Master Code: Project Management Practices: PMP	
Category: Planning and Control: PMP-PCM	
Controlling process: PMP-PCM: MONITORING	Reported the processes or indices of impact of the monitoring and controlling process involved in the project (e.g., activity durations, cost, resources, investments, scheduling, feedback process, deficiency in monitoring, project implementation, and so on).
Controlling process: PMP-PCM: TECHNIQUES	Reported the methods/techniques used in the construction process or indices of the impact of the methods/techniques involved in the project that improve efficiency in terms of cost, time, resources, investments, and so on.
Design process: PMP-PCM: DESIGN	Reported the process or indices of the impact of the process design involved in the project (e.g., activity durations, cost, resources, investments, scheduling, communications, complexity, and so on).
Estimating process: PMP-PCM: ESTIMATING	Reported the process or indices of the impact of the process of estimating all activities in project (e.g., costs, times, delivery, deficiency in estimating, and so on).
Planning process: PMP-PCM: PLANNING	Reported the process or indices of the impact of the planning process involved in the project (e.g., activity durations, resources, investments, scheduling, deficiency in planning, project implementation, and so on).
Category: Risk Transparency: PMP-RST	
Helping decision: PMP-RST: DECISION	Reported the risk information that help decision-making or improve the decision-making process in the project (e.g., faster decision-making, impact on activity durations, on cost, on resources, on investments, on scheduling, on project implementation, and so on).
Risk identification: PMP-RST: IDENTIFICATION	Reported the process of risk identification, the recognition of sources that influence on risks, or the impact of the process of risk identification in project in terms of costs, times, delivery, deficiency in estimating, quality problem, and so on.

Master Code: Project Management Practices: PMP	
Risk Influence: PMP-RST: INFLUENCE	Reported the events that influence the risk in projects or indices of impact that influence the risk in projects (e.g., organizational culture, management process, formalization process, planning process, and so on).
Category: Risk Coping Capacity: PMP-RCC	
Adaptive measures: ADAPTIVE MEASURES TO RISK	Reported the process of reacting to identified risks or unforeseeable risks and how quickly the process is to use adaptive measures in projects.
Reaction to risk: PMP-RCC: REACTION	Reported the process of risk reaction or the impact of the process of risk reaction in the project in terms of costs, times, delivery, deficiency in estimating, quality problem, and so on.
Risk neutralization: PMP-RCC: NEUTRALIZATION	Reported the neutralization process of risk in projects (e.g., actions, methods used, decision-making, and so on).

Chart 23 – Definitions of the coding dimensions of project management practices

Source: elaborated by the author

Master Code: Success measures: SME	
Category: Budget and Schedule: SME-BUG	
Managing cost: SME-BUG: COST	Reported the process of management cost to deliver the project on budget (e.g., controlling problems (cost overrun, unit cost)), and situations of interventions to bring the cost as estimated.
Managing quality: SME-BUG: QUALITY	Indices of defects, problems of specifications or the degree of fulfillment the technical specifications, on-time delivery, budget compliance, the degree of conformance to predetermined standard of performance, performance of cost, the schedule and safety.
Managing scope: SME-BUG: SCOPE	Reported the activities to manage all the required process to deliver the project with success (e.g., measurement, estimation activities, controlling, and productivity), detailed the situations of misunderstanding, difficulties in planning, controlling phases under which influenced on performance.
Managing time: SME-BUG: TIME	Reported the controlling process of the time of activities to deliver the project on time (e.g., time overrun, construction time speed, speed of construction). Detailed the situations of misunderstanding, difficulties in planning, controlling phases under which influenced on performance.
Category: Customer Satisfaction: SME-CUS	
Customer satisfaction: SME-CUS: SATISFACTION	Reported the degree of the customer satisfaction in terms of attending the specifications, adequacy, customer needs, expectations, design utility, and technical measures.
Technical characteristics: SME-CUS: TECHNICAL	Indices of achieving the technical and operational performance (e.g., characteristics in terms of satisfaction, agreement, the adequacy with technical specifications).

Master Code: Success measures: SME	
Category: Business Success: SME-BSU	
Commercial success: SME-BSU-SALES	Indices of measuring sales (e.g., volume, revenue, mix of products).
Market Share: SME-BSU-SHAR	Indices of measuring market share, market expansion.
Profitability and return: SME-BSU-PROFIT	Indices of measuring profitability through margins, profitability, cost reduction (time of activities, waste material, workforce, others), improving operational efficiency, speed process, in accordance with budget, improving the material flow, improving management process that impacted on efficiency.
Satisfaction stakeholders: SME-BSU-STAKE	Indices of fulfillment the stakeholders needed (e.g., specifications, adequacy, meeting the needs, expectations, and market measures).

Chart 24 – Definitions of the coding dimensions of performance

Source: elaborated by the author

Master Code: Absorptive Capacity: AC	
Category: Potential Absorptive Capacity: AC-PAC	
Comprehension and analyzing the problem: AC-PAC: COMPREHENSION	Reported the ability to recognize the problem, understanding, interpreting, analyzing, and propose feasible solution for changing client requirements.
Exchanging information and knowledge: AC-PAC: ACQUISITION	Reported the benefits of acquisition information and knowledge with senior people (colleagues, project managers, among others), external professionals such as project managers, project team or project consultants, meeting with clients, meeting with suppliers or third parties, acquisition by informal means (e.g., lunches with project colleagues, talks with senior project managers).
Hiring external workforce and consulting: AC-ACQ: HIRING	Reported recruiting, sectioning, and hiring experienced human resources, as well contracting for consulting services for improving their capabilities (e.g., routines, skills, managing process, controlling, and so on).
Project team collaborations: AC-PAC: COLLABORATION	Reported the benefits from collaboration activities through the organization (project teams, entities (universities, agencies of research, suppliers, and other firms), the degree of interaction among team members and between areas.
Scanning environment and recognizing the value: AC-PAC: SCANNING	Reported the ability for mapping the environment and recognizing the value of new information to serve clients (e.g., searching for new trends, new materials, new technological assets, other innovative practices, and management process).
Training workforce: AC-PAC: TRAINING	Reported the main forms of improving the workforce skills to assimilate knowledge in the sector (e.g., courses, workshop, lectures, exchanging information with partners, suppliers, learning by doing, and learning by using (e.g., new technology, new materials, and new process), learning through problems, knowledge sharing, feedback of experience, coaching).

Master Code: Absorptive Capacity: AC	
Category: Realized Absorptive Capacity: AC-RAC	
Application of new knowledge and ideas: AC-RAC: APPLICATION	Reported the application of new forms of doing things (e.g., new processes more efficient, management practices, operational know-how, generate new operational capabilities, and so on), how the new knowledge and ideas is applied internally, how to better exploit knowledge or take the new opportunities, the performed activities.
Project structures well defined: AC-RAC: STRUCTURES	Reported the project structures in terms of division of roles and responsibilities, the communication with employees (formal or informal), for attending clients requirements, bureaucratic structure, rigid formal, emphasizes hierarchy, obedience to rules or flexible, autonomy of people, and so on.
Knowledge sharing, Information, and Language: AC-RAC: SHARING	Reported how the explicit knowledge (e.g., technical specifications, information systems, intranet, practical experiences, and so on) and tacit knowledge (e.g., imitation, observation, practice, and training) are sharing for improving efficiency, the process of transferring relevant knowledge and informations between partners.
Storage lessons learned and new knowledge: AC-RAC: STORAGE	Reported how the project team recorded and stored newly acquired knowledge or information for future reference.

Chart 25 – Definitions of the coding dimensions of absorptive capacity

Source: elaborated by the author

Appendix D – Survey questionnaire (quantitative phase)

Even though we present the survey questionnaire in English, it was applied in Portuguese. The survey questionnaire was translated into Portuguese and the translation was assessed by a specialist in the survey. The questionnaire has three main blocks to assess the constructs. The first block aims to assess project management practices (PMP) through the dimensions such as planning and monitoring, risk transparency, risk coping capacity, and project management practices. The second block aims to assess the project success through the dimensions such as budget and schedule, customer satisfaction, and business success. The third block aims to assess the absorptive capacity (AC) through the dimensions such as potential absorptive capacity (acquisition and assimilation), and realized absorptive capacity (transformation and exploitation).

Block	**Project Management Practices**
Title	Planning and Monitoring
Source	Doloi (2013)
Rationale	The scale aims to assess the main aspects of schedule in project management such as deficiencies, complexity, and monitoring. The dimension has been operationalized through planning and monitoring practices.
Respondents	Project manager
Sector focus	Construction industry
Perception measures	Thinking about the last completed project, please assign how much you agree or disagree regarding the statements below. **1**-strongly disagree **2**-disagree **3**-neither agree nor disagree **4**-agree **5**-strongly agree

Code	**Reverse scale**	**Assertive**
PLAN1	*	We had planning and scheduling deficiencies.
PLAN2		We used good methods/techniques of construction.
PLAN3		We deal well with the complexity of design.
PLAN4	*	We early detected deficiencies in planning and scheduling of subcontractors.
PLAN5		We had an effective monitoring process of the project.

Block	**Project Management Practices**
Title	Risk Transparency
Source	Teller and Kock (2013)
Rationale	The scale aims to measure the relevant risks that influence decisions and goals. The dimension has been operationalized through risk transparency.
Respondents	Project manager
Sector focus	Construction industry
Perception measures	Thinking about the last completed project, please assign how much you agree or disagree regarding the statements below. **1**-strongly disagree **2**-disagree **3**-neither agree nor disagree **4**-agree **5**-strongly agree

Code	**Reverse scale**	**Assertive**
TRAN1		We always identify all relevant risks of the project.
TRAN2		We had a good understanding of the scope in which the risks could influence our goals.
TRAN3		Risk informations helped implement decisions.
TRAN4		Risk informations helped to decide better.

Block	**Project Management Practices**
Title	Risk Coping Capacity
Source	Teller and Kock (2013)
Rationale	The scale aims to measure the actions to respond quickly to risks in project management. The dimension has been operationalized through risk coping capacity.
Respondents	Project manager
Sector focus	Construction industry
Perception measures	Thinking about the last completed project, please assign how much you agree or disagree regarding the statements below. **1**-strongly disagree **2**-disagree **3**-neither agree nor disagree **4**-agree **5**-strongly agree

Code	**Reverse scale**	**Assertive**
COPI1		We had enough freedom of action to react to risks adequately.

Code	Reverse scale	Assertive
COPI2		We reacted to identified risks and carry out the necessary adaptive measures quickly.
COPI3		We reacted to unforeseeable risks and carry out the necessary adaptive measures quickly.
COPI4		The recognized sources of risk could be neutralized.

Block	**Project Management Practices**
Title	Project Management Practices
Source	Besner and Hobbs (2006, 2008a, 2008b, 2012)
Rationale	The scale aims to capture what are the most important project management practices that influence on project success. The dimension has been operationalized through some project management practices that appear in the qualitative phase and in the literature review.
Respondents	Project manager
Sector focus	Construction industry
Perception measures	In this section, please assign the degree of importance of each management practice to achieve project success. **1-** not important **2**- … **3-** … **4-** … **5-** … **6-** … **7-** … **8-** … **9-** … **10-** critically important

Code	Reverse scale	Assertive
PMP1		Alignment of customer needs
PMP2		Communication with our crews
PMP3		Control process
PMP4		Customized project management methodology
PMP5		Customer feedback
PMP6		Gate review process
PMP7		Lessons learned
PMP8		Planning process
PMP9		PMBOK methodology
PMP10		Risk monitoring
PMP11		Training (MBA, specialization course in projects, PMI courses, other courses in projects)
PMP12		Work Breakdown Structure (WBS)

Block	Success Measures
Title	Budget and Schedule
Source	Shenhar et al. (1997)
Rationale	The scale aims to capture whether some technical performance indicators (time, cost, and goal) as a whole provides the results in accordance with expected. The dimension has been operationalized budget and schedule.
Respondents	Project manager
Sector focus	Construction industry
Perception measures	Thinking of the last completed project, please assign the degree of compliance of each assertion to achieve project success. **1**-strongly disagree **2**-disagree **3**-neither agree nor disagree **4**-agree **5**-strongly agree

Code	Reverse scale	Assertive
BUDG1		We met time goals
BUDG2		We met budget goals
BUDG3		We complied the project goals. **
BUDG4		We performed the project as planned. **

(*) We have included with a derivation of the two originals scales.

Block	Success Measures
Title	Customer Satisfaction
Source	Shenhar et al. (1997)
Rationale	The scale aims to capture whether the project attends its specifications and provides the results in accordance with expected by the customers. This a technical performance indicator for assessing project management. The dimension has been operationalized through customer satisfaction.
Respondents	Project manager
Sector focus	Construction industry
Perception measures	Thinking about the last completed project, please assign how much you agree or disagree regarding the statements below. **1**-strongly disagree **2**-disagree **3**-neither agree nor disagree **4**-agree **5**-strongly agree

Code	Reverse scale	Assertive
SATI1		We met operational specifications.
SATI2		We met technical specifications.
SATI3		We met customer needs.
SATI4		The project was useful for customers.
SATI5		Our customer is fully satisfied.

Block	Success Measures
Title	Business Success
Source	Shenhar et al. (1997)
Rationale	The scale aims to capture if the project provides adequate return to the stakeholders as a whole. This scale is associated to market performance indicator for assessing project management. The dimension has been operationalized through business success indicators.
Respondents	Project manager
Sector focus	Construction industry
Perception measures	Thinking about the last completed project, please assign how much you agree or disagree regarding the statements below. **1**-strongly disagree **2**-disagree **3**-neither agree nor disagree **4**-agree **5**-strongly agree

Code	Reverse scale	Assertive
BUSI1		The project was a commercial success.
BUSI2		The project helped the company to gain market share.
BUSI3		The project gave adequate return to investors. **
BUSI4		The project was an economic success. **

(*) We have included with a derivation of the two originals scales.

Block	Absorptive Capacity
Title	Potential Absorptive Capacity
Source	Leal-Rodríguez et al. (2014), Jansen et al. (2005)
Rationale	The scale aims to capture the potential absorptive capacity (PAC) translated into both acquisition and assimilation in a different ways in project management. The dimension of absorptive capacity has been operationalized through PAC suggested by Zahra and George (2002).
Respondents	Project manager
Sector focus	Construction industry

Block	**Absorptive Capacity**
Perception measures	Thinking about the last completed project, please assign how much you agree or disagree regarding the statements below. **1**-strongly disagree **2**-disagree **3**-neither agree nor disagree **4**-agree **5**-strongly agree

Code	**Reverse scale**	**Assertive**
PAC1		We had frequent meetings with senior managers to acquire new knowledge.
PAC2		Our team members regularly visited other project teams.
PAC3		We collected project informations through informal means (e.g., lunches with project colleagues, talks with senior project managers).
PAC4	*	Project colleagues did not visit other units or project teams.
PAC5		We periodically organized special meetings with clients, suppliers or third parties to acquire new knowledge.
PAC6		We regularly contacted external professionals such as project managers, project team or project consultants.
PAC7		New opportunities to serve our clients were quickly acknowledged.
PAC8		We quickly analyzed and interpreted changing client requirements.

Block	**Absorptive Capacity**
Title	Realized Absorptive Capacity
Source	Leal-Rodríguez et al. (2014), Jansen et al. (2005)
Rationale	The scale aims to capture the realized absorptive capacity (RAC) translated into both transformation and exploitation in a different ways in project management. The dimension of absorptive capacity has been operationalized through RAC suggested by Zahra and George (2002).
Respondents	Project manager
Sector focus	Construction industry
Perception measures	Thinking about the last completed project, please assign how much you agree or disagree regarding the statements below. **1**-strongly disagree **2**-disagree **3**-neither agree nor disagree **4**-agree **5**-strongly agree

Code	Reverse scale	Assertive
RAC1		Our project team recorded and stored newly acquired knowledge for future reference.
RAC2		We quickly understood the usefulness of new external knowledge for existing knowledge in projects.
RAC3	*	Our project team hardly shared practical experiences.
RAC4	*	We laboriously grasped the opportunities for our division from new external knowledge in projects.
RAC5		We knew how activities within our unit should be performed.
RAC6	*	Clients' complaints fell on deaf ears in our project team.
RAC7		Our project team had a clear division of roles and responsibilities.
RAC8		We constantly considered how to better exploit knowledge.
RAC9	*	We had difficulties implementing new ideas.
RAC10		Our employees had a common language regarding our works.

Block	Respondent identification
Respondent name: (Code: NAM)	
Age of respondent: (Code: IDA)	( ) 20 to 25 years ( ) 25 to 30 years ( ) 30 to 35 years ( ) 35 to 40 years ( ) 40 to 45 years ( ) 45 to 50 years ( ) 50 to 55 years ( ) 55 to 60 years ( ) 60 to 65 years ( ) above 65 years
Gender: (Code: GEN)	( ) Male ( ) Female
Position of respondent: (Code: CAR)	( ) Engineering director ( ) Engineering manager ( ) Leader project ( ) Project consultant ( ) Project controller ( ) Project coordinator ( ) Project director ( ) Project engineering ( ) Project manager

Block	Respondent identification
	( ) Project manager contracts ( ) Project supervisor ( ) Risk manager projects ( ) Others (please specify):
Experience in project management: (Code: EXP)	( ) until 3 years ( ) 3 to 5 years ( ) 5 to 10 years ( ) 10 to 15 years ( ) 15 to 20 years ( ) 20 to 25 years ( ) 25 to 30 years ( ) 30 to 35 years ( ) 35 to 40 years ( ) above 40 years
E-mail to be sent the research results (optional): (Code: EMA)	
Telephone (optional): (Code: TEL)	

Block	Project identification
Classify the type of construction referred to the completed project: (Code: TCC)	( ) Commercial construction (sheds, buildings, and among others) ( ) Industrial construction (plant, structures, and among others) ( ) Heavy construction (airports, stadiums, roads, highways, power plants, bridges, ports, tunnels, and among others) ( ) Residential construction (houses, buildings, condominiums) ( ) Land (digging, pipes, channels) ( ) Geotechnical (foundations and structures) ( ) Others (please specify):__________________
Size of investment in the completed project (in R$): (Code: INV)	( ) until 5 million ( ) 5 to 10 million ( ) 10 to 50 million ( ) 50 to 100 million ( ) 100 to 500 million ( ) 500 million to 1 billion ( ) 1 to 5 billion ( ) above 5 billion

Block	Project identification
Number of employees allocated to the completed project: (Code: NEP)	( ) until 50 ( ) 50 to 100 ( ) 100 to 500 ( ) 500 to 1.000 ( ) 1.000 to 5.000 ( ) above 5.000
Duration of the completed project: (Code: TDP)	( ) until 1 year ( ) 1 to 3 years ( ) 3 to 5 years ( ) 5 to 7 years ( ) 7 to 9 years ( ) 9 to 10 years ( ) above 10 years
Classify the level of complexity of the completed project: (Code: INC)	( ) Low ( ) Medium ( ) High ( ) Extremely

Block	Company identification
Company name: (Code: IEM)	
Number of employees (last period): (Code: NEE)	( ) until 100 ( ) 100 to 500 ( ) 500 to 1.000 ( ) 1.000 to 5.000 ( ) 5.000 to 10.000 ( ) above 10.000

Appendix E – Missing values analysis

We started the analysis of our data from missing values. As we have a few responses with missing values and distributed in random way, these are not a major problem. Below we detailed this analysis.

The missing values were observed in the group of PMP variables (PMP9, PMP10, PMP11, and PMP12) and in the group of identification (e.g., of the respondent, of the project, and of the company), in only two and four responses, respectively. These groups of PMP variables do not have an impact on measuring our hypotheses. These variables only serve to analyze which practices lead to project success by project managers. However, in four responses that did not provide the identification of the respondent, the project, and the company. Even though the main groups of project management practices, performance, and absorptive capacity were answered, we did not know nothing about their respondents and projects. For not losing these four responses (2.55% = 4/157) from our sample, the decision was to replace the missing values by the average of their original variables (Corrar, Paulo, & Dias Filho, 2009, p. 38; Hair Jr. et al., 2009, p. 65) through SPSS. Kline (2011, p. 55) pointed out that the missing values less than 5% on a single variable for a large sample may not be a major problem. As a result, we used these responses in our analysis.

We had other 20 responses in our sample (Chart 17) that respondents started to answer, but stopped at the beginning of first block (Project Management Practice). The decision was to eliminate them from the sample.

Appendix F – Outlier analysis

The outliers were analyzed by univariate and multivariate detection. We have evidence that potential outliers are not a major problem. Therefore, we did not remove them from the sample. Below we discuss this in detail.

In univariate detection through the boxplot graph (more visual) and the Chebyshev's theorem (Sweeney, Williams, & Anderson, 2013, p. 114). In the group of variables, we observed 33 potential cases of outliers. However, the maximum outliers detected in variables based on the rule ± 3 standard scores (Clark-Carter, 2004; Corrar, Paulo, & Dias Filho, 2009; Kline, 2011, p. 54) were 7 cases in BUDG3, representing 4.6% of all cases of this variable. If we would use the rule ±4 standard scores, as suggested by Hair Jr. et al. (2009, p. 79) and Blunch (2010, p. 95), the maximum proportion was 1.3% in only two cases: variables PMP10 (2 cases) and SATI3 (2 cases).

However, we have in our data collection the PMP variables for some specific purpose related to practices. They do not enter in measuring the hypotheses. We asked to project managers to evaluate, in project management, what is the most important practices for project success? We used this block for selecting the most important practices that affect project success. As a result, our data show less than 5% of potential outliers; however, some scholars have second thoughts in saying these are outliers when Likert scales are used.

Additionally, we analyzed the Mahalanobis d-squared based on the suggestion of Hair Jr. et al., (2009, p. 79) by using the measure D^2 / *df*. In this case, the maximum value in our data is 1.974 (Table 22), but below the cutoff value of 2.5 for a small sample and 3.0 or 4.0 for a large sample. Therefore, there is evidence that no potential outliers in our data.

Variables	**Potential cases of outliers**	**Number of cases**	**Percent**	**Statistics techniques**
PLAN1R	No outliers		0,0%	Chebyshev's theorem
PLAN2	100	1	0,7%	Chebyshev's theorem

Variables	Potential cases of outliers	Number of cases	Percent	Statistics techniques
PLAN3	30, 100	2	1,3%	Chebyshev's theorem
PLAN4R	No outliers		0,0%	Chebyshev's theorem
PLAN5	30, 100	2	1,3%	Chebyshev's theorem
TRAN1	No outliers		0,0%	Chebyshev's theorem
TRAN2	32	1	0,7%	Chebyshev's theorem
TRAN3	9, 18, 38, 40, 152	5	3,3%	Chebyshev's theorem
TRAN4	No outliers		0,0%	Chebyshev's theorem
COPI1	30	1	0,7%	Chebyshev's theorem
COPI2	18, 30, 100	3	2,0%	Chebyshev's theorem
COPI3	No outliers		0,0%	Chebyshev's theorem
COPI4	No outliers		0,0%	Chebyshev's theorem
PMP_1	43, 136, 140	3	2,0%	Chebyshev's theorem
PMP_2	21, 24, 140,152	4	2,6%	Chebyshev's theorem
PMP_3	140	1	0,7%	Chebyshev's theorem
PMP_4	No outliers		0,0%	Chebyshev's theorem
PMP_5	21	1	0,7%	Chebyshev's theorem
PMP_6	112	1	0,7%	Chebyshev's theorem
PMP_7	1, 112	1	0,7%	Chebyshev's theorem
PMP_8	1, 34 ,127	3	2,0%	Chebyshev's theorem
PMP_9	No outliers		0,0%	Chebyshev's theorem
PMP_10	18, 74	2	1,3%	Chebyshev's theorem
PMP_11	74, 104, 107	3	2,0%	Chebyshev's theorem
PMP_12	74	1	0,7%	Chebyshev's theorem
BUDG1	No outliers		0,0%	Chebyshev's theorem
BUDG2	No outliers		0,0%	Chebyshev's theorem
BUDG3	3, 31, 57, 66, 100, 112, 139	7	4,6%	Chebyshev's theorem
BUDG4	100, 139	2	1,3%	Chebyshev's theorem
SATI1	45, 46, 80	3	2,0%	Chebyshev's theorem
SATI2	No outliers		0,0%	Chebyshev's theorem
SATI3	1, 153	2	1,3%	Chebyshev's theorem
SATI4	No outliers		0,0%	Chebyshev's theorem
SATI5	No outliers		0,0%	Chebyshev's theorem
BUSI1	139	1	0,7%	Chebyshev's theorem
BUSI2	13	1	0,7%	Chebyshev's theorem
BUSI3	13, 100, 112, 144	4	2,6%	Chebyshev's theorem
BUSI4	No outliers		0,0%	Chebyshev's theorem
PAC1	No outliers		0,0%	Chebyshev's theorem
PAC2	No outliers		0,0%	Chebyshev's theorem
PAC3	No outliers		0,0%	Chebyshev's theorem
PAC4R	No outliers		0,0%	Chebyshev's theorem
PAC5	No outliers		0,0%	Chebyshev's theorem
PAC6	No outliers		0,0%	Chebyshev's theorem
PAC7	No outliers		0,0%	Chebyshev's theorem
PAC8	No outliers		0,0%	Chebyshev's theorem
RAC1	No outliers		0,0%	Chebyshev's theorem
RAC2	No outliers		0,0%	Chebyshev's theorem
RAC3R	No outliers		0,0%	Chebyshev's theorem
RAC4R	No outliers		0,0%	Chebyshev's theorem
RAC5	No outliers		0,0%	Chebyshev's theorem
RAC6R	123	1	0,7%	Chebyshev's theorem
RAC7	44, 112	2	1,3%	Chebyshev's theorem
RAC8	No outliers		0,0%	Chebyshev's theorem
RAC9R	No outliers		0,0%	Chebyshev's theorem
RAC10	40, 100, 112	3	2,0%	Chebyshev's theorem

Table 21 – Outlier analysis through Chebyshev's theorem
Source: elaborated by the author

Observation number	Mahalanobis d-squared	p1	p2	d-squared / *df*
100	86.874	0.000	0.019	1.974
40	85.156	0.000	0.000	1.935
46	76.902	0.002	0.002	1.748
44	75.394	0.002	0.000	1.714
18	75.070	0.002	0.000	1.706
139	74.426	0.003	0.000	1.692
112	73.563	0.003	0.000	1.672
30	71.734	0.005	0.000	1.630
3	70.685	0.007	0.000	1.606
149	68.735	0.010	0.000	1.562
153	68.525	0.010	0.000	1.557
14	67.455	0.013	0.000	1.533
155	66.970	0.014	0.000	1.522
60	66.642	0.015	0.000	1.515
38	66.216	0.017	0.000	1.505
6	65.596	0.019	0.000	1.491
80	65.465	0.019	0.000	1.488
19	64.726	0.023	0.000	1.471
83	63.079	0.031	0.000	1.434
120	61.267	0.043	0.000	1.392
13	61.136	0.044	0.000	1.389
23	61.098	0.045	0.000	1.389
152	60.396	0.051	0.000	1.373
16	59.923	0.055	0.000	1.362
66	58.770	0.067	0.000	1.336
10	58.364	0.072	0.000	1.326
45	58.331	0.073	0.000	1.326
144	58.303	0.073	0.000	1.325
102	57.798	0.079	0.000	1.314
49	57.605	0.082	0.000	1.309
1	57.156	0.088	0.000	1.299
99	57.155	0.088	0.000	1.299
111	56.352	0.100	0.000	1.281
129	55.756	0.110	0.000	1.267
57	55.718	0.111	0.000	1.266
138	55.206	0.120	0.000	1.255
91	55.158	0.121	0.000	1.254
124	54.410	0.135	0.000	1.237
33	53.974	0.144	0.000	1.227
39	53.809	0.148	0.000	1.223
150	53.034	0.165	0.001	1.205
59	52.849	0.169	0.001	1.201
24	52.747	0.172	0.001	1.199
15	52.115	0.188	0.003	1.184
17	51.807	0.196	0.004	1.177
156	51.757	0.197	0.003	1.176
27	50.962	0.219	0.011	1.158
61	50.898	0.221	0.008	1.157
90	50.893	0.221	0.005	1.157
116	50.568	0.230	0.007	1.149
31	50.498	0.232	0.005	1.148
117	50.252	0.240	0.006	1.142
68	50.201	0.241	0.004	1.141
123	50.094	0.244	0.003	1.139
21	50.079	0.245	0.002	1.138

Observation number	Mahalanobis d-squared	p1	p2	d-squared / *df*
94	50.027	0.246	0.001	1.137
11	49.330	0.269	0.006	1.121
146	48.228	0.306	0.052	1.096
104	47.970	0.315	0.062	1.090
43	47.969	0.315	0.044	1.090
70	47.674	0.326	0.057	1.084
54	47.547	0.330	0.052	1.081
130	47.509	0.332	0.040	1.080
142	47.222	0.342	0.052	1.073
52	47.074	0.348	0.050	1.070
81	46.844	0.357	0.058	1.065
89	46.738	0.361	0.051	1.062
34	46.289	0.378	0.090	1.052
51	46.192	0.382	0.081	1.050
74	46.156	0.383	0.064	1.049
5	45.954	0.391	0.070	1.044
77	45.940	0.392	0.052	1.044
73	45.590	0.406	0.077	1.036
12	45.446	0.412	0.076	1.033
113	44.929	0.433	0.146	1.021
134	44.839	0.436	0.131	1.019
108	44.803	0.438	0.107	1.018
28	44.758	0.440	0.088	1.017
82	44.747	0.440	0.066	1.017
148	44.239	0.462	0.130	1.005
7	43.644	0.487	0.258	0.992
141	43.574	0.490	0.231	0.990
157	43.435	0.496	0.228	0.987
101	43.134	0.509	0.281	0.980
118	42.315	0.544	0.559	0.962
105	41.982	0.558	0.638	0.954
119	41.659	0.572	0.708	0.947
53	41.319	0.587	0.777	0.939
25	41.223	0.591	0.760	0.937
92	40.748	0.612	0.858	0.926
115	40.278	0.632	0.924	0.915
32	39.774	0.653	0.967	0.904
140	39.619	0.660	0.968	0.900
20	39.594	0.661	0.956	0.900
106	39.479	0.666	0.953	0.897
85	39.167	0.679	0.969	0.890
110	38.828	0.692	0.981	0.882
9	38.691	0.698	0.981	0.879
151	38.583	0.702	0.978	0.877
55	38.344	0.712	0.983	0.871

Number of variables involved in the model, n = 44

Table 22 – Outlier analysis through Mahalanobis d-squared

Source: elaborated by the author

Appendix G – Data normality analysis

We performed the analysis of the normality of our data by univariate and multivariate analyzes. However, the literature indicates that is no major problem when Likert scale is used for collecting data in this type of research.

With the univariate test based on the Kolmogorov-Smirnov test (p-value < 0.05) (Corrar et al., 2009; Hair Jr. et al., 2009), there is evidence that our data are not normally distributed.

We also assessed the normality using skewness and its standard error as suggested by Leech et al.(2005, p. 28). For results less than 2.5, there is evidence in favor of normality. We performed the calculus and in only 25% (11 observable variables) the skewness was less than 2.5 (Table 13). The results indicate that the data are not normally distributed.

Following the suggestions by Leech et al. (2005, p. 16) and Hair Jr. et al. (2009, p. 83), we analyzed the histogram and the normal probability plot for each variable. Visually, the variables appeared to be approximately normally distributed by the histogram. But non-normally distributed by the normal probability plot.

Thereafter, the univariate distribution was assessed following the suggestions of Kline (2011, p. 60) and Byrne (2010), respectively. Kline suggested cutoff value of 3.0 for absolute skew and 10.0 for absolute kurtosis. However, Byrne is stricter. She suggested cutoff value of 7.0 for absolute kurtosis. It means that when values are greater than cutoff point, there are evidence in favor of the nonnormality of data. In our data, the maximum of the absolute value of skew and kurtosis we found were 1.963 and 5.078 (Table 13), respectively. Therefore, there are evidence that our data are approximately normally distributed.

In sequence, we proceed the analysis of multivariate distribution with the Mardia's (1970) normalized coefficient suggested by Bentler (2006). If the multivariate critical value (i.e., z-value) is greater than 5.0, we have indicative in favor of nonnormality (Byrne, 2010, p.

104). In our sample, the Mardia's coefficient calculated was 17.149. It suggests the data are nonnormally multivariate distributed.

Although the normality of multivariate distribution was violated, Hair Jr. et al. (2009, p. 566) offer counterarguments to address such concerns. They pointed out that is not a major problem when it works with MLE in structural equation modeling (SEM) programs. According to them, in the occurrence of this violation, the statistics provided through MLE are still quite robust. Thus, we can work with multivariate analysis and calculate the statistics through MLE without damage to the validity of results.

Appendix H – The analysis of variance (ANOVA) and Test of homogeneity

Average of observable variables		Sum of Squares	df	Mean Square	F	Sig.
MPLAN	Between Groups	0.054	1	0.054	0.249	0.618
	Within Groups	33.321	155	0.215		
	Total	33.375	156			
MTRAN	Between Groups	0.047	1	0.047	0.148	0.701
	Within Groups	49.042	155	0.316		
	Total	49.089	156			
MCOPI	Between Groups	0.081	1	0.081	0.309	0.579
	Within Groups	40.597	155	0.262		
	Total	40.678	156			
MPMP	Between Groups	0.289	1	0.289	0.282	0.596
	Within Groups	159.120	155	1.027		
	Total	159.409	156			
MBUDG	Between Groups	0.786	1	0.786	1.655	0.200
	Within Groups	73.632	155	0.475		
	Total	74.418	156			
MSATI	Between Groups	0.000	1	0.000	0.003	0.956
	Within Groups	23.818	155	0.154		
	Total	23.818	156			
MBUSI	Between Groups	0.070	1	0.070	0.188	0.665
	Within Groups	57.848	155	0.373		
	Total	57.918	156			
MPAC	Between Groups	0.008	1	0.008	0.034	0.853
	Within Groups	37.073	155	0.239		
	Total	37.081	156			
MRAC	Between Groups	0.304	1	0.304	1.903	0.170
	Within Groups	24.783	155	0.160		
	Total	25.087	156			

Table 23 – The analysis of variance (ANOVA)
Source: elaborated by the author

	Levene Statistic	df1	df2	Sig.
MPLAN	2.866	1	155	0.092
MTRAN	1.401	1	155	0.238
MCOPI	1.979	1	155	0.161
MPMP	2.519	1	155	0.114
MBUDG	0.164	1	155	0.686
MSATI	0.045	1	155	0.833
MBUSI	0.438	1	155	0.509
MPAC	4.411	1	155	0.037
MRAC	0.044	1	155	0.835

Table 24 – Test of homogeneity of variance
Source: elaborated by the author

Appendix I – The assessment of CVM through Harman's single-factor test

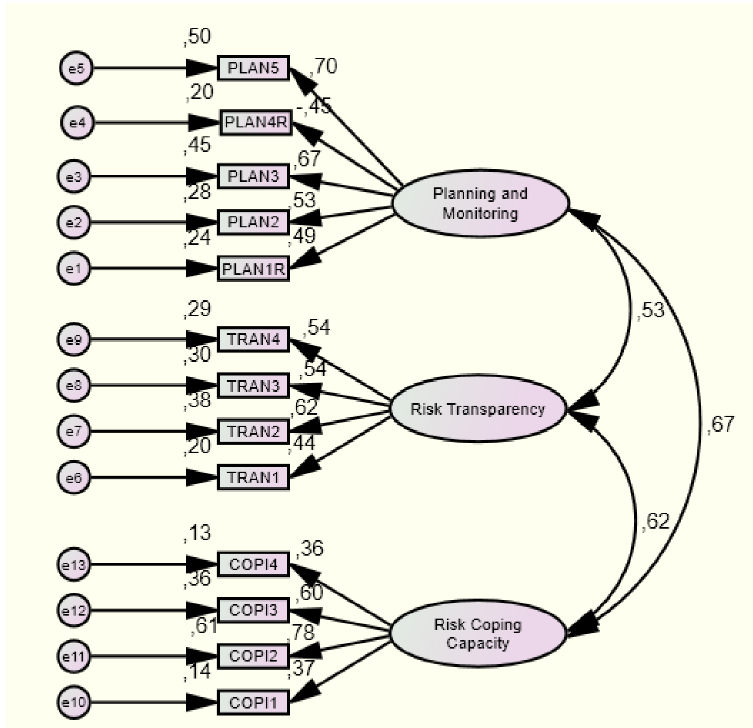
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.41	19.11	19.11	8.41	19.11	19.11
2	2.50	5.68	24.79			
3	2.37	5.39	30.18			
4	2.16	4.91	35.09			
5	1.78	4.05	39.14			
6	1.71	3.88	43.03			
7	1.56	3.54	46.57			
8	1.45	3.30	49.86			
9	1.38	3.13	52.99			
10	1.32	3.01	55.99			
11	1.17	2.65	58.64			
12	1.09	2.47	61.11			
13	1.04	2.36	63.47			
14	0.96	2.18	65.65			
15	0.95	2.16	67.81			
16	0.91	2.07	69.88			
17	0.87	1.98	71.86			
18	0.83	1.88	73.74			
19	0.82	1.86	75.59			
20	0.80	1.83	77.42			
21	0.74	1.68	79.10			
22	0.67	1.53	80.63			
23	0.64	1.46	82.10			
24	0.63	1.44	83.53			
25	0.61	1.39	84.93			
26	0.56	1.27	86.19			
27	0.54	1.22	87.42			
28	0.50	1.15	88.56			
29	0.49	1.11	89.67			
30	0.46	1.05	90.72			
31	0.42	0.95	91.67			
32	0.41	0.93	92.60			
33	0.38	0.87	93.47			
34	0.36	0.81	94.28			
35	0.34	0.78	95.06			
36	0.30	0.68	95.74			
37	0.29	0.65	96.39			
38	0.27	0.62	97.01			
39	0.26	0.58	97.59			
40	0.25	0.58	98.17			
41	0.23	0.53	98.70			
42	0.22	0.50	99.20			
43	0.19	0.44	99.63			
44	0.16	0.37	100.00			

Extraction Method: Principal Component Analysis.

Table 25 – Total variance explained through Harman's single-factor test
Source: elaborated by the author

Appendix J – The CFA model before respecification and analysis

The Figures 15, 16, and 17 represent the model before respecification.



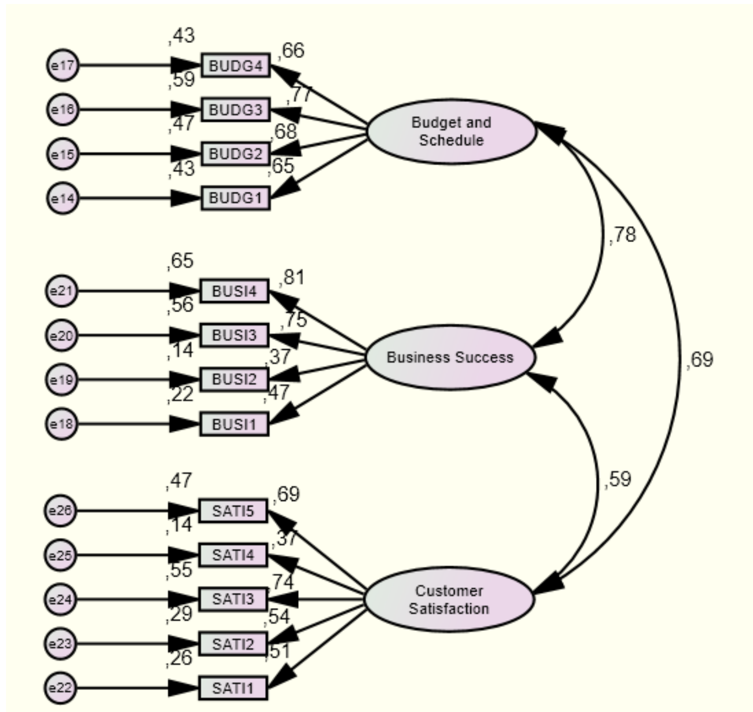
Number of distinct sample moments: 91
Number of distinct parameters to be estimated: 29
Degrees of freedom (91 - 29): 62

Minimum was achieved
Chi-square = 91.733
Degrees of freedom = 62
Probability level = .008

Figure 15 – CFA model of the project management practices before respecification
Source: elaborated by the author

The procedure of removing the indicators

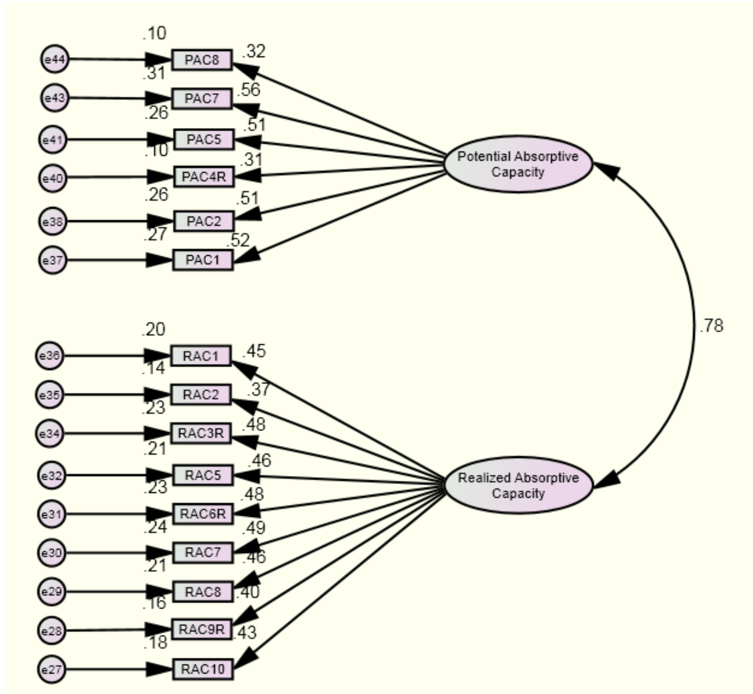
Initially, the observed variables that exhibited factors loading less than 0.50 were removed from the model. For example, we removed from PMP model the observed variables PLAN1R and PLAN4R of planning and monitoring, TRAN1 of risk transparency, and COPI4 of risk coping capacity. Additionally, we removed from performance model the observed variables BUDG2 of budget and schedule, and SATI4 of customer satisfaction. Finally, we removed from AC model the observed variables PAC3, PAC4R, PAC6, and PAC8 of potential absorptive capacity, and RAC1, RAC2, RAC4R, and RAC8 of realized absorptive capacity.



Number of distinct sample moments: 55
Number of distinct parameters to be estimated: 23
Degrees of freedom (55 - 23): 32

Minimum was achieved
Chi-square = 138.164
Degrees of freedom = 62
Probability level = .000

Figure 16 – CFA model of the performance before respecification
Source: elaborated by the author



Number of distinct sample moments:	120
Number of distinct parameters to be estimated:	31
Degrees of freedom (120 - 31):	89

Minimum was achieved
Chi-square = 142.820
Degrees of freedom = 89
Probability level = .000

Figure 17 – CFA model of the absorptive capacity before respecification
Source: elaborated by the author

The procedure to remove each variable was done one by one after checking the factor loadings for the cutoff value of 0.50 and the modification indices. However, in Table 18, we observed some factor loadings less than 0.50 such as TRAN2, COPI1, BUSI1, PAC2, RAC5, and RAC10. Regarding the observed variables of PMP (TRAN2 and COPI1) and performance (BUSI1), these items were not removed because Hair Jr. et al. (2009) suggest working with at least three indicators per construct. According to these authors, for a decision of removing them, the sample size should be larger than we have.

Even though PAC2, RAC5, and RAC10 presented factor loadings less than 0.50, these were maintained in the model based on the analysis of the sample size and fit indexes. Therefore, we decided to preserve them for two reasons. First, according to Hair Jr. et al. (2009, p. 120), for a sample size of 150, the factor loadings of 0.45 can be acceptable. As we observe, some of them are near or above the cutoff value of 0.45. Second, the model goodness-of-fit presented satisfactory indices. This last commentary is analyzed below. In short, we could say that the factor loadings presented convergence to a common point (Hair Jr. et al., 2009). The Figures 12, 13, and 14 show the respecified CFA models of PMP, performance, and AC, respectively.

	1	**2**	**3**
Project Management Practices			
1 Planning and Monitoring	**0.628**		
2 Risk Coping Capacity	0.734	**0.615**	
3 Risk transparency	0.428	0.616	**0.584**
Performance			
1 Budget and Schedule	**0.713**		
2 Business Success	0.675	**0.696**	
3 Customer Satisfaction	0.756	0.557	**0.620**
Absorptive Capacity			
1 Potential AC	**0.750**		
2 Realized AC	0.554	**0.498**	

Square root of the AVE on the diagonal of the construct
Table 26 – Latent variable correlation
Source: elaborated by the author

	Group number 1 - Default model		
	Covariances	Variances	Regression Weights
Project Management Practices	MI Par Change	MI Par Change	MI Par Change
Performance	MI Par Change	MI Par Change	MI Par Change
Absorptive Capacity	MI Par Change	MI Par Change	MI Par Change

Table 27 – Modification Indices
Source: elaborated by the author

Appendix K – Correlation between variables under study

Initially, we selected the control variables based on the correlations between variables under studies (Table 28). The control variables that present more correlations with the variables under study were chosen. From this analysis, three control variables emerged such as “Size of investment in the completed project (in R$)” (INV) significant at 0.01 alpha level (0.248), “Classify the level of complexity of the completed project” (INC) significant at 0.05 alpha level (0.198), and “Number of employees (last period)” (NEE) significant at 0.05 alpha level (0.170).

We observed in Table 28 other control variables that are significant and could participate in the study. For example, “Duration of the completed project” (TDP) significant at 0.05 alpha level (0.176) and “Number of employees allocated to the completed project” (NEP) significant at 0.10 alpha level (0.131). However, these variables were not chosen for two reasons: (1) they presented correlations with only one variable, and (2) more important, due to the number of variables that should be assessed in regression analysis and considering the number of responses (discussed in methodology chapter) it was not possible to work with all significant control variables. Therefore, only three control variables were chosen for regression analysis.

In this table, we also observed high significant positive correlations between all the independent variables and dependent variables. The most significant associations occur with two independent variables, for example, the planning and monitoring (MplanC) and realized absorptive capacity (MracC) with performance indicators (MBUDG, MSATI, and MBUSI). These constructs presented the higher correlations with performance, which are very important for regression technique. For Hair Jr. et al.(2009, p. 156), the higher the correlation, the better the forecast.

		1	2	3	4	5	6	7
1 MBUDG	Pearson Correlation	1						
	Sig. (2-tailed)							
2 MSATI	Pearson Correlation	0.563**	1					
	Sig. (2-tailed)	0.000						
3 MBUSI	Pearson Correlation	0.479**	0.436**	1				
	Sig. (2-tailed)	0.000	0.000					
4 MplanC	Pearson Correlation	0.445**	0.431**	0.326**	1			
	Sig. (2-tailed)	0.000	0.000	0.000				
5 MtranC	Pearson Correlation	0.224**	0.187*	0.180*	0.318**	1		
	Sig. (2-tailed)	0.005	0.019	0.024	0.000			
6 McopiC	Pearson Correlation	0.274**	0.260**	0.355**	0.453**	0.387**	1	
	Sig. (2-tailed)	0.001	0.001	0.000	0.000	0.000		
7 MpacC	Pearson Correlation	0.271**	0.284**	0.237**	0.377**	0.211**	0.311**	1
	Sig. (2-tailed)	0.001	0.000	0.003	0.000	0.008	0.000	
8 MracC	Pearson Correlation	0.415**	0.478**	0.385**	0.518**	0.160*	0.324**	0.355**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.045	0.000	0.000
9 EXP	Pearson Correlation	0.001	0.023	-0.018	-0.024	0.034	-0.003	0.065
	Sig. (2-tailed)	0.990	0.772	0.823	0.767	0.669	0.971	0.420
10 INV	Pearson Correlation	0.025	0.025	0.075	0.090	0.041	0.053	0.248**
	Sig. (2-tailed)	0.756	0.753	0.350	0.260	0.611	0.512	0.002
11 NEP	Pearson Correlation	0.045	0.030	-0.002	0.028	0.042	0.105	0.131***
	Sig. (2-tailed)	0.578	0.710	0.979	0.732	0.606	0.189	0.101
12 TDP	Pearson Correlation	-0.035	-0.130	0.067	0.106	0.023	0.106	0.176*
	Sig. (2-tailed)	0.667	0.104	0.407	0.188	0.770	0.187	0.027
13 INC	Pearson Correlation	0.053	0.162*	-0.043	0.005	0.198*	-0.014	0.091
	Sig. (2-tailed)	0.507	0.043	0.592	0.948	0.013	0.861	0.255
14 NEE	Pearson Correlation	-0.069	0.096	0.042	0.156*	0.036	0.016	0.129
	Sig. (2-tailed)	0.392	0.230	0.602	0.050	0.653	0.842	0.108

		8	9	10	11	12	13	14
8 MracC	Pearson Correlation	1						
	Sig. (2-tailed)							
9 EXP	Pearson Correlation	0.010	1					
	Sig. (2-tailed)	0.903						
10 INV	Pearson Correlation	0.14***	0.046	1				
	Sig. (2-tailed)	0.080	0.564					
11 NEP	Pearson Correlation	0.111	0.055	0.705**	1			
	Sig. (2-tailed)	0.168	0.497	0.000				
12 TDP	Pearson Correlation	0.046	-0.008	0.492**	0.292**	1		
	Sig. (2-tailed)	0.563	0.921	0.000	0.000			
13 INC	Pearson Correlation	-0.013	0.133***	0.331**	0.34**	0.101	1	
	Sig. (2-tailed)	0.876	0.097	0.000	0.000	0.210		
14 NEE	Pearson Correlation	0.170*	-0.083	0.522**	0.424**	0.057	0.189*	1
	Sig. (2-tailed)	0.033	0.301	0.000	0.000	0.476	0.018	

* p < 0,05, ** p < 0,01, *** p < 0,10, (n = 157)

Table 28 – Correlation between variables under study
Source: elaborated by the author

Appendix L – Full regression coefficients of dependent variables

odel		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	3,704	0,212		17,503	0,000	3,286	4,122					
	INV	0,032	0,046	0,067	0,683	0,496	-0,060	0,123	0,025	0,055	0,055	0,671	1,490
	INC	0,057	0,092	0,053	0,618	0,537	-0,125	0,238	0,053	0,050	0,050	0,890	1,124
	NEE	-0,065	0,054	-0,114	-1,207	0,229	-0,172	0,042	-0,069	-0,097	-0,097	0,727	1,376
2	(Constant)	3,819	0,188		20,350	0,000	3,448	4,189					
	INV	0,010	0,041	0,022	0,251	0,802	-0,071	0,092	0,025	0,021	0,017	0,637	1,570
	INC	0,071	0,082	0,066	0,868	0,387	-0,091	0,232	0,053	0,071	0,060	0,839	1,192
	NEE	**-0,110***	0,047	-0,192	-2,327	**0,021**	-0,204	-0,017	-0,069	-0,188	-0,161	0,705	1,419
	MplanC	**0,320****	0,100	0,286	3,185	**0,002**	0,121	0,518	0,445	0,253	0,221	0,596	1,677
	MtranC	0,081	0,099	0,064	0,817	0,415	-0,115	0,277	0,224	0,067	0,057	0,777	1,288
	McopiC	0,022	0,103	0,018	0,216	0,829	-0,181	0,226	0,274	0,018	0,015	0,696	1,437
	MpacC	0,072	0,087	0,066	0,825	0,411	-0,100	0,243	0,271	0,068	0,057	0,760	1,316
	MracC	**0,334****	0,108	0,258	3,082	**0,002**	0,120	0,549	0,415	0,246	0,214	0,686	1,457
3	(Constant)	3,827	0,193		19,868	0,000	3,446	4,208					
	INV	0,013	0,042	0,027	0,300	0,765	-0,071	0,096	0,025	0,025	0,021	0,617	1,620
	INC	0,072	0,084	0,066	0,853	0,395	-0,094	0,238	0,053	0,071	0,060	0,808	1,238
	NEE	**-0,108***	0,048	-0,189	-2,245	**0,026**	-0,204	-0,013	-0,069	-0,185	-0,157	0,694	1,440
	MplanC	**0,289****	0,108	0,259	2,671	**0,008**	0,075	0,503	0,445	0,219	0,187	0,523	1,913
	MtranC	0,086	0,106	0,068	0,811	0,419	-0,123	0,294	0,224	0,068	0,057	0,699	1,431
	McopiC	-0,020	0,112	-0,016	-0,174	0,862	-0,242	0,203	0,274	-0,015	-0,012	0,595	1,681
	MpacC	0,093	0,096	0,085	0,967	0,335	-0,097	0,283	0,271	0,081	0,068	0,636	1,573
	MracC	**0,298****	0,117	0,230	2,537	**0,012**	0,066	0,530	0,415	0,208	0,178	0,596	1,678
	IntMpacMplan	0,108	0,184	0,061	0,590	0,556	-0,255	0,472	-0,188	0,049	0,041	0,457	2,186
	IntMpacMtran	-0,250	0,187	-0,131	-1,341	0,182	-0,619	0,119	-0,171	-0,112	-0,094	0,510	1,960
	IntMpacMcopi	0,008	0,200	0,004	0,040	0,968	-0,388	0,404	-0,102	0,003	0,003	0,445	2,246
	IntMracMplan	-0,064	0,175	-0,051	-0,367	0,714	-0,410	0,281	-0,282	-0,031	-0,026	0,253	3,953
	IntMracMtran	0,087	0,223	0,034	0,388	0,698	-0,355	0,528	-0,035	0,033	0,027	0,635	1,575
	IntMracMcopi	-0,126	0,221	-0,078	-0,570	0,570	-0,564	0,312	-0,243	-0,048	-0,040	0,262	3,811

Table 29 – Full regression of dependent variable budget and schedule
Source: elaborated by the author

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	3,880	0,128		30,348	0,000	3,628	4,133					
	INV	-0,026	0,028	-0,089	-0,918	0,360	-0,081	0,030	0,025	-0,074	-0,073	0,671	1,490
	INC	**0,113****	0,056	0,171	2,027	**0,044**	0,003	0,222	0,162	0,162	0,161	0,890	1,124
	NEE	0,039	0,033	0,111	1,188	0,237	-0,026	0,104	0,096	0,096	0,094	0,727	1,376
2	(Constant)	3,935	0,112		35,106	0,000	3,713	4,156					
	INV	**-0,043*****	0,025	-0,149	-1,758	**0,081**	-0,092	0,005	0,025	-0,143	-0,119	0,637	1,570
	INC	**0,133****	0,049	0,202	2,727	**0,007**	0,037	0,230	0,162	0,219	0,185	0,839	1,192
	NEE	0,012	0,028	0,033	0,409	0,683	-0,044	0,068	0,096	0,034	0,028	0,705	1,419
	MplanC	**0,145***	0,060	0,212	2,423	**0,017**	0,027	0,264	0,431	0,195	0,164	0,596	1,677
	MtranC	-0,002	0,059	-0,003	-0,039	0,969	-0,119	0,115	0,187	-0,003	-0,003	0,777	1,288
	McopiC	0,028	0,061	0,037	0,454	0,650	-0,094	0,149	0,260	0,037	0,031	0,696	1,437
	MpacC	0,057	0,052	0,086	1,101	0,273	-0,045	0,160	0,284	0,090	0,075	0,760	1,316
	MracC	**0,273****	0,065	0,344	4,212	**0,000**	0,145	0,401	0,478	0,327	0,285	0,686	1,457
3	(Constant)	3,827	0,193		19,868	0,000	3,446	4,208					
	INV	0,013	0,042	0,027	0,300	0,765	-0,071	0,096	0,025	0,025	0,021	0,617	1,620
	INC	0,072	0,084	0,066	0,853	0,395	-0,094	0,238	0,053	0,071	0,060	0,808	1,238
	NEE	**-0,108***	0,048	-0,189	-2,245	**0,026**	-0,204	-0,013	-0,069	-0,185	-0,157	0,694	1,440
	MplanC	**0,289****	0,108	0,259	2,671	**0,008**	0,075	0,503	0,445	0,219	0,187	0,523	1,913
	MtranC	0,086	0,106	0,068	0,811	0,419	-0,123	0,294	0,224	0,068	0,057	0,699	1,431
	McopiC	-0,020	0,112	-0,016	-0,174	0,862	-0,242	0,203	0,274	-0,015	-0,012	0,595	1,681
	MpacC	0,093	0,096	0,085	0,967	0,335	-0,097	0,283	0,271	0,081	0,068	0,636	1,573
	MracC	**0,298****	0,117	0,230	2,537	**0,012**	0,066	0,530	0,415	0,208	0,178	0,596	1,678
	IntMpacMplan	0,108	0,184	0,061	0,590	0,556	-0,255	0,472	-0,188	0,049	0,041	0,457	2,186
	IntMpacMtran	-0,250	0,187	-0,131	-1,341	0,182	-0,619	0,119	-0,171	-0,112	-0,094	0,510	1,960
	IntMpacMcopi	0,008	0,200	0,004	0,040	0,968	-0,388	0,404	-0,102	0,003	0,003	0,445	2,246
	IntMracMplan	-0,064	0,175	-0,051	-0,367	0,714	-0,410	0,281	-0,282	-0,031	-0,026	0,253	3,953
	IntMracMtran	0,087	0,223	0,034	0,388	0,698	-0,355	0,528	-0,035	0,033	0,027	0,635	1,575
	IntMracMcopi	-0,126	0,221	-0,078	-0,570	0,570	-0,564	0,312	-0,243	-0,048	-0,040	0,262	3,811

Table 30 – Full regression of dependent variable customer satisfaction
Source: elaborated by the author

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	3,782	0,213		17,726	0,000	3,360	4,203					
	INV	0,047	0,047	0,098	0,995	0,321	-0,046	0,139	0,075	0,080	0,080	0,671	1,490
	INC	-0,083	0,093	-0,076	-0,897	0,371	-0,266	0,100	-0,043	-0,072	-0,072	0,890	1,124
	NEE	0,003	0,055	0,005	0,056	0,955	-0,105	0,111	0,042	0,005	0,005	0,727	1,376
2	(Constant)	3,848	0,198		19,409	0,000	3,456	4,240					
	INV	0,023	0,043	0,048	0,523	0,601	-0,063	0,109	0,075	0,043	0,038	0,637	1,570
	INC	-0,063	0,086	-0,057	-0,724	0,470	-0,233	0,108	-0,043	-0,059	-0,053	0,839	1,192
	NEE	-0,022	0,050	-0,038	-0,433	0,665	-0,121	0,077	0,042	-0,036	-0,032	0,705	1,419
	MplanC	0,081	0,106	0,072	0,766	0,445	-0,128	0,291	0,326	0,063	0,056	0,596	1,677
	MtranC	0,047	0,105	0,037	0,449	0,654	-0,160	0,254	0,180	0,037	0,033	0,777	1,288
	McopiC	**0,259***	0,109	0,208	2,383	**0,018**	0,044	0,474	0,355	0,192	0,173	0,696	1,437
	MpacC	0,049	0,092	0,045	0,535	0,594	-0,132	0,231	0,237	0,044	0,039	0,760	1,316
	MracC	**0,336****	0,115	0,257	2,930	**0,004**	0,109	0,562	0,385	0,234	0,213	0,686	1,457
3	(Constant)	3,869	0,204		18,962	0,000	3,465	4,272					
	INV	0,016	0,045	0,033	0,353	0,724	-0,072	0,104	0,075	0,030	0,026	0,617	1,620
	INC	-0,065	0,089	-0,060	-0,727	0,468	-0,241	0,111	-0,043	-0,061	-0,054	0,808	1,238
	NEE	-0,020	0,051	-0,034	-0,388	0,698	-0,121	0,081	0,042	-0,033	-0,029	0,694	1,440
	MplanC	0,069	0,115	0,061	0,603	0,548	-0,157	0,296	0,326	0,051	0,044	0,523	1,913
	MtranC	0,095	0,112	0,075	0,848	0,398	-0,126	0,316	0,180	0,071	0,062	0,699	1,431
	McopiC	**0,224*****	0,119	0,179	1,878	**0,062**	-0,012	0,459	0,355	0,156	0,138	0,595	1,681
	MpacC	0,026	0,102	0,023	0,253	0,801	-0,175	0,227	0,237	0,021	0,019	0,636	1,573
	MracC	**0,361****	0,124	0,277	2,904	**0,004**	0,115	0,607	0,385	0,237	0,214	0,596	1,678
	IntMpacMplan	0,110	0,195	0,062	0,566	0,572	-0,275	0,495	-0,102	0,047	0,042	0,457	2,186
	IntMpacMtran	0,121	0,198	0,063	0,614	0,540	-0,269	0,512	-0,017	0,051	0,045	0,510	1,960
	IntMpacMcopi	-0,031	0,212	-0,016	-0,147	0,883	-0,451	0,388	-0,092	-0,012	-0,011	0,445	2,246
	IntMracMplan	-0,030	0,185	-0,023	-0,161	0,873	-0,396	0,336	-0,253	-0,013	-0,012	0,253	3,953
	IntMracMtran	-0,157	0,237	-0,061	-0,662	0,509	-0,624	0,311	-0,018	-0,056	-0,049	0,635	1,575
	IntMracMcopi	-0,109	0,235	-0,067	-0,464	0,643	-0,573	0,355	-0,255	-0,039	-0,034	0,262	3,811

Table 31 – Full regression of dependent variable business success
Source: elaborated by the author