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Cost and time project management success factors for information systems development projects

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Abstract

Successful development of Information Systems (IS) Projects has been a source of competitive advantage for many organizations. This paper proposes the Cost and Time Project Management Success – CTPMS, an essential measure in this context because projects must dynamically address cost and time success under an agreed scope. The goal of the paper is to identify the project management practices through which an organization can optimize the CTPMS of IS development projects. Because multiple factors can influence project management success, we analyze a real-world sample of 899 IS projects of a leading bank, using hierarchical models to account for the effects of predictors at four levels of analysis: portfolio network, project, project manager, and team. In addition to proposing and discussing a new measure of project management success for information systems development projects, we identified that project size, duration, postponement, and project manager formal power showed positive effects, whereas team size and team allocation dispersion presented negative effects. The results suggest guidance for factors such as team member allocation and prioritization, among others.

Keywords: IS success; Information Systems Project Management; Project management success; Agile

1. Introduction

Because some economic sectors are very dependent upon the proper use of information, they have attempted to grow their awareness of how to address technology. Organizations have found that developing Information Systems (IS) is the key to success in such sectors. However, even with the required specialization to develop information systems, this activity is not free of failure. In fact, according to a report based on the insights of 3234 project management professionals, 200 senior executives, and 510 PMO directors from many industries, 19% of all projects fail, and not <52% of the total have shown budget loss or scope creep (PMI, 2017).

Despite the fundamental importance of achieving project success, concerning how project management success is considered and measured, the literature does not address the interrelatedness of key related factors. For example, although many studies have shown that project success depends upon project manager characteristics, team motivation, project features and even portfolio prioritization (PMI, 2017), the literature as a whole has not explored the interrelationships of these many levels.

One possible reason for studies simultaneously omitting consideration of these multiple levels of the antecedents of project success is that studies are usually supported by survey data that are collected only at the project manager level. Although these perceptual data can help the researcher to focus on specific factors of project success, they rarely can be collected simultaneously for multiple projects, project managers or teams.

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The purpose of this paper is to analyze the antecedents of information systems development Cost and Time Project Management Success – CTPMS, considering the simultaneity of the variables at multiple levels of analysis: portfolio network, project, program manager, and team level. The goal is to identify the project management practices through which an organization can enhance its competence to achieve the success of information system development projects. This study also adds to the field by employing secondary data and thus avoiding the potential pitfalls of deriving conclusions from perceptual data.

The research used data from a leading financial service provider that develops > 3000 IS projects annually. The Financial Service Industry (FSI) is responsible for 13% (US$ 351 billion) of the world's total investments in IT. In Brazil, the country from which we collected the data, this percentage is even larger because the FSI is responsible for 14% (US$ 6 billion) of the country's total investments in IT (Deloitte, 2017). Technology is considered a major component for the performance of this industry, demanding significant attention from the agencies that regulate the FSI. For example, the Brazilian Central Bank requires the adoption of specific project management practices to ensure successful risk mitigation and realization of the benefits of IT projects (ISACA, 2013; Terlizzi et al., 2017).

The remainder of this paper is organized as follows. The paper first describes the related literature in Section 2. It then explains the methods in Section 3. Results are presented in Section 4, followed by discussion in Section 5. Finally, we conclude our findings in Section 6 with the theoretical contributions, practical implications, and limitations.

2. Literature review

IS project execution entails delivering or improving products and services that contribute to the realization of an organization's strategic goals. Therefore, achieving project success is of the utmost importance and frequently justifies the huge organizational investment.

Because attaining project success depends upon many factors, the success of a project can be evaluated using different forms; no single best method of measurement exists (Thomas and Fernández, 2008). Indeed, this topic has generated extensive discussion since the 1970s due to its various dimensions and interpretations (Ika, 2009). In this context, an analysis of the prior literature is necessary to clarify some differences between project success (PS) and project management success (PMS) and to clarify the different factors and perspectives that can contribute to IS PMS.

2.1. Project success and project management success

At least one consensus exists in the literature about PS, that is, overall success should be treated as about two different perspectives. On the one hand, PMS is considered the responsibility of the project manager and means delivering the outputs of the project on time, within the budget and with the required features and functions. Consequently, it is usually measured based on the iron triangle (time, budget and scope/quality). On the other hand, PS can be viewed as the responsibility of the project owner anticipating the benefits of the project (e.g., financial, quality, flexibility, and innovation) (Badewi, 2016; Chih and Zwikael, 2015; Cooper and Edgett, 1997; Doherty et al., 2012; Terlizzi et al., 2016; Tesch et al., 2009; Turner and Müller, 2005).

Interestingly, from the perspective of the IS projects literature, the concept of PS is massively employed as synonymous to PMS because the iron triangle is used in approximately two-thirds of the 26 publications addressing PS analyzed from 1997 to 2009 (De Bakker et al., 2010). Likewise, The Standish Group has also been monitoring IT project success worldwide since 1994 using the iron triangle as an indication of success; only in 2015 was this concept enhanced to consider other, additional dimensions of success (Hastie and Wojewoda, 2015).

To clarify how the current literature addresses this problem, we performed a systematic literature review of the top two project management journals from 2006 to 2016, seeking to complement De Bakker et al.'s study. This review identified 31 papers, with their main findings presented in Table 1.

First, in the area of information systems development, the most common consideration about project success is scope success (Agarwal and Rathod, 2006). In this type of project, many small changes are expected to be decided upon during the execution of the project. These decisions occur because the owner is not usually completely aware of the specific aspects involved in the system coding. Additionally, occasionally fulfilling the exact definition of a product by codification can result in a large number of hours of additional coding. Therefore, the information systems project manager is frequently compelled to negotiate small changes in scope between the project owner and the project team. This negotiation frequently addresses the unnecessary development time overrun needed to include a less important feature that might be too difficult to implement. Another situation occurs when, in contrast, negotiation is required to approve additional features that might become salient as the development teams develop new ideas that arise during the codification process as they achieve a better understanding of the client's needs.

The need to constantly negotiate small scope changes has even generated an IT phenomenon in the PM practices field, the agile approach for projects (Serrador and Pinto, 2015). This approach can be viewed as a procedure to improve communications and facilitate these small adjustments of scope, time and cost (Mastrogiacomo et al., 2014).

Despite these dynamics, PMS assessment has remained almost the same since the introduction of the iron triangle (Lech, 2013), that is, as though its components of scope, time and cost were independent. When addressing information systems projects, it would be of great value if new measures of PMS were proposed to better combine cost and time, given a scope agreement (Lech, 2013).

Another aspect is that, although project success appears to depend upon multiple interrelated aspects, only a few studies applied the multilevel approach to analyzing the antecedents of success in projects. Twenty papers, or 65% of the papers selected, analyzed only one antecedent level. We found that a substantive number of studies (14 articles – 45%) addressed the project manager antecedent, followed by project perspective

Table 1
Previous literature on antecedents' level and measurement of success.

Antecedents' Level					*Empirical Data*				*Measurement of Success*				***Reference*** *(in alphabetical order)*
Portfolio	*Project*	*Project Manager*	*Team*	*Other*	*Data collection*	*Quantity*	*Location*	*Industry*	*Time*	*Cost*	*Scope / Quality*	*Other*	
	X				Survey	105 Project managers	India	IT	X	X	X		(Agarwal & Rathod, 2006)
	X	X		Vision, organization, network	Documentation	4 Cases	United Kingdom	Government		X	X		(Alderman & Ivory, 2011)
				Project management software	Survey	497 participants	Worldwide	IT, Government, Construction			X		(Ali, Anbari, & Money, 2008)
		X	X	Vision	Survey	193 Project management members + 3 cases	United States of America	Several	X	X	X	Business benefits	(Aronson, Shenhar, & Patanakul, 2013)
		X		Governance, methodology	Survey	336 Project managers	Brazil	Several	X	X	X		(Berssaneti & Carvalho, 2015)
				Methodology	Survey	1387 projects	Argentina, Brazil, and Chile	Several	X	X			(Carvalho, Patah, & Bido, 2015)
X	X	X		Governance and support	Interviews	108 interviews	Australia, China, Europe, North America, and South Africa	N/D					(Crawford et al., 2008)
				Organizational dynamics	Literature review	None	United States of America	N/D	X	X	X	Team	(Creasy & Anantatmula, 2013)
	X	X			Survey	89 Project managers	Israel	High-tech, defense and educational	X	X	X	Business benefits	(Dvir, Sadeh, & Malach-Pines, 2006)
				Methodology	Interviews	4 Programs	United States of America	Aviation	X	X	X		(Eigbe, Sauser, & Felder, 2015)
		X			Survey	52 Project managers	United Kingdom	Financial Service	X	X	X	Business benefits and product adoption	(Geoghegan & Dulewicz, 2008)
		X	X		Survey	123 Team leaders 125 Team members	United States of America	N/D	X	X	X	Product adoption, customer satisfaction, commercial success, new market, new technology	(Hagen & Park, 2013)
				Culture	Survey	128 Project managers	China	Service, Manufacturing and Others	X	X	X	Business benefits, team satisfaction	(Hsu, Liang, Wu, Klein, & Jiang, 2011)
	X	X	X	Organization and environment	Survey	25 members of PMA	Finland	N/D					(Hyväri, 2006)
				Governance	Interviews	4 Interviews	Australia						(Ives, 2005)

							Financial service and Project management services					
	X			Literature review	N/D	France and Sweden	N/D					(Joslin & Müller, 2015)
			Methodology	Survey	254 Project Managers	Worldwide	Several	X	X	X	Business benefits, stakeholder satisfaction	(Joslin & Müller, 2015)
			Sponsor Behaviors	Survey	109 PMI professionals	Worldwide	Several	X	X	X	Product adoption, customer satisfaction, commercial success, a new market, a new technology	(Kloppenborg, Tesch, Manolis, & Heitkamp, 2006)
	X	X	Rewards	Survey	202 PMI members	Worldwide	Several	X	X	X	Customer satisfaction	(Mahaney & Lederer, 2006)
	X	X	Governance, methodology	Survey	154 Project managers	United Arab Emirates	N/D	X	X		Business benefits, stakeholders satisfaction	(Mir & Pinnington, 2014)
	X			Survey	400 Project managers	United States of America	Several	X	X	X	Business benefits, stakeholders satisfaction	(Müller & Turner, 2007)
			Methodology	Survey	39 Project managers	Canada	Services, Manufacturing Public sector, Construction	X	X	X		(Raymond & Bergeron, 2008)
X				Literature review	7 articles	Finland and Ireland	Several				Business benefits, customer satisfaction,	(Savolainen, Ahonen, & Richardson, 2012)
			Methodology	Survey	859 Project managers	Worldwide	Several	X	X	X	Stakeholders satisfaction	(Serrador & Pinto, 2015)
	X			Interviews	15 Interviews	China, Sweden, The Netherlands and the UK	Several	X	X		Business benefits, stakeholders satisfaction, social effects	(Shao & Müller, 2011)
X			Governance, methodology	Survey	106 Project managers	USA, New Zealand and Australia	Financial service	X	X	X	System use, customer, and team satisfaction	(Sheffield & Lemétayer, 2013)
	X			Interviews	33 interviews	Canada	N/D					(Skulmoski & Hartman, 2010)
		X		Survey	168 Project managers	United States of America	Service, Manufacturing Others	X	X	X	Business benefits	(Tesch et al., 2009)
X				Interviews	36 Interviews	Australia	Financial serviceMining and Electricity, Gas and Water, Supply	X	X	X	Business benefits, stakeholders satisfaction, system use	(Thomas & Fernández, 2008)
X		X		Documentation	137 Organizations	United States of America	Several				Project success variable was coded on a 5-point Likert	(Thomas, Jacques, Adams, & Kihneman-Wooten, 2008)
			Human resources practices	Survey	99 Project managers	Israel	Several	X	X	X	Customer satisfaction	(Zwikael & Unger-Aviram, 2010)

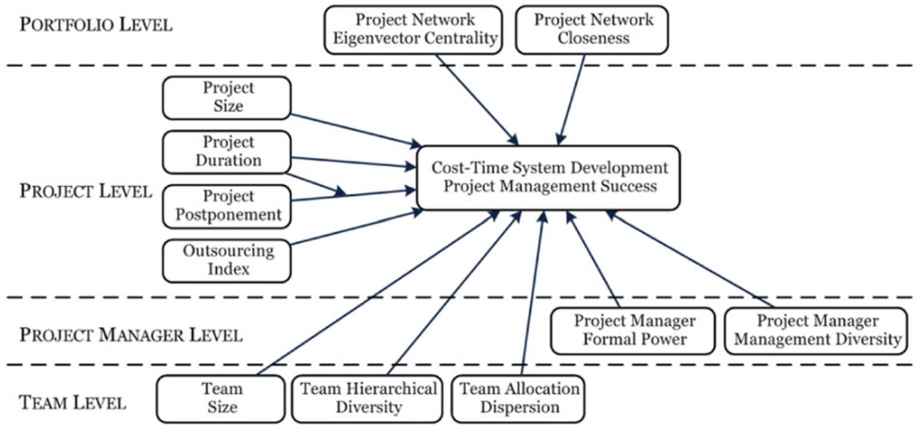

Fig. 1. Research model.

(9 papers – 30%) and team project perspective (7 papers – 22%). We found that this limitation represents a substantive gap in the literature because no papers analyzed the effects on success from the perspective of a multilevel combination of factors.

Second, the majority of the data used in research thus far was found to be collected based on surveys (20 papers – 65%) ranging from 25 to 1.387 respondents. The other data collection methods were interviews (6 papers – 20%) varying from 4 to 108 interviewees, literature reviews (3 papers – 10%), and finally documentation (2 articles – 5%). Additionally, concerning the respondent profiles, the studies essentially surveyed the perceptions of project managers. None of the studies employed real-world secondary data records, which we consider another major gap in the literature because perceptual responses can potentially carry respondent bias. Although all sources of data can show some positive aspects in the study, data records are considered more precise, allowing non-perceptual analysis (Yin, 2013).

Additionally, project management theoreticians recognize the importance of accumulating studies from various industries around the world to expand the research field (Turner and Ledwith, 2016). In the period analyzed, we observed a diversity of studies in the literature from some world regions and various sectors, but only four studies focussing specifically on the FSI. It is relevant that FSI invests in technology more than any other sector does and is thus expected to master superior IS management techniques (Berghout et al., 2011; Deloitte, 2017). Therefore, it is important to increase the focus on this industry.

2.2. Project management success – a multi-level perspective

In the study of organizations, it is common to adopt a multilevel approach to understand management problems because the use of a micro or a macro lens alone allows for only an incomplete understanding of the problem. Thus, the need for contextualizing the research theories recommends the use of a multilevel approach (Hitt et al., 2007). Although doing so adds complexity, multilevel research allows building theories that allow a deeper and richer portrait of organizational life (Klein et al., 1999). According to Burton-Jones and Gallivan (2007), theory integration across levels creates new research opportunities because this multilevel perspective represents a more natural and complete approach to examining phenomena.

From an information technology perspective, the multilevel approach offers an alternative approach to examining the phenomena by simultaneously accounting for the nature of the phenomena through which the study explores the interplay between technologies and human actors (Aubert et al., 2008). However, studies that examine the IS phenomena from a multilevel perspective remain scarce (Bélanger et al., 2014).

In last five decades, the project management literature has tried to depict the conditions that lead to a successful project from a multilevel perspective (Bendoly et al., 2010; Shenhar and Levy, 1997; Tatikonda and Rosenthal, 2000); nevertheless, few studies have considered the simultaneous approach as a relevant analysis of PMS. For example, the extent of usage of risk management practices, such as risk identification, probabilistic risk analysis, planning for uncertainty, trade-off analysis, and their relationship with various project success dimensions was examined by Raz et al. (2002). The study was based on data collected on 100 projects performed in Israel and showed that risk management, when used, can contribute to project success and that its effect is primarily on better meeting times and budget goals rather than on product performance and specification achievement. In another vein, Tatikonda and Rosenthal (2000) studied the relationship between product development project characteristics – technology, novelty and project outcomes – hypothesizing that technology novelty and project complexity characteristics contribute to project task uncertainty and consequently define the project execution outcomes. The results revealed that higher project levels of technical novelty or project complexity are not related to overall project failure.

Conversely, in Bendoly et al. (2010), data collected to multiple levels of analysis helped the understanding of multilevel interdependencies in project management settings from the perspective of social factors. The authors analyze the role of individual behavior in driving project dynamics and performance, providing critical insights into the decisions made by both project team members and project managers. In the same vein, Loufrani-Fedida and Missonier (2015) contest the idea of the "ideal" project manager and focus on critical competencies (functional and integrative) based on individual, collective, and organizational levels.

Despite the efforts of the academic and practical worlds, the rate of success in projects remains low. Although the general factors related to project failure have already been identified (PMI, 2017), they are rarely studied together and interrelated. In this study, we grouped the elements that influence PMS in organizations into four levels: the first, Portfolio Network-Level Effects, consists of project network closeness and project network eigenvector. The second comprises Project-Level Effects such as project size, project duration, project postponement, and project outsourcing level. The third level is related to Project Manager-Level Effects and consists of project manager formal power and project manager diversity. The fourth level involves Team Project-Level Effects using team size, hierarchical group diversity, and team allocation dispersion. Prior studies do not deeply investigate these combined correlated levels, and there is a lack of empirical studies showing how these four-factor levels might work together.

We present in the following the research model (Fig. 1), review the IS and PM literature, and elaborate the rationale behind each hypothesis concerning the potential effect of each factor on Cost and Time Project Management Success (CTPMS). In doing so, we believe we can analyze the consequences of each level of factors more comprehensively.

2.3. Portfolio network-level effects

Portfolio management studies stem from seminal academic papers published by Gear et al. (1971). However, information technology portfolio management gained more attention through McFarlan (1981), who applied the concepts developed by Markowitz (1952). In the 1990s, with the development of business plans that provide a framework for the categorization of projects, there was an increase in the volume of literature related to analysis and planning portfolios (Wheelwright and Clark, 1992), in addition to the development of selection models and project portfolio management (Archer and Ghasemzadeh, 1999). Project portfolio management is a process that aims to ensure that the correct project will be done to achieve the goals desired by the organization (Turner, 2014).

Project portfolio management has gained the attention of practitioners and executives as a means to enable organizations to align needed projects with organizational strategy and ensure adequate human resources for projects at the right time (Killen and Hunt, 2013). Because of its particular importance, the cost of human resources is frequently well controlled (Acuna et al., 2006), and allocating the right people determines the quality and productivity of a project (Chan et al., 2008). Therefore, the process of allocating team members based on the best composition of cost and skills is crucial to project management success (Walter and Zimmermann, 2016). We considered as portfolio network factors two characteristics related to the interactions among team members across the portfolio of projects in the organization: project network closeness and project network eigenvector.

2.3.1. Project network closeness and project network eigenvector

A social network approach aims to describe patterns of interactions among people using a graph of connections, wherein persons within a network are called nodes, and relationships between actors are called ties (Newman, 2002). Nodes and ties form the structure of a network, and social network theory describes the network structure regarding resources for social action (Baker, 1990). Social network theories can highlight how network-enabled exposure to a wider variety of information affects learning and productivity (Reagans and Zuckerman, 2001).

Two of the indices most commonly used in the social network analyses are closeness centrality (Beauchamp, 1965) and eigenvector centrality (Bonacich, 1972). Whereas closeness centrality measures how close a node is to all other nodes in the network, eigenvector centrality measures how close a node is to well-connected (popular) nodes in the network. In other words, it is important to connect to nodes, but which node is connected to matters.

IS projects comprise multiple team members, and each team member can participate in multiple projects. Because team members can exchange ideas (Zika-Viktorsson et al., 2006) and share knowledge on software development techniques between multiple project teams (Ozer and Vogel, 2015), the network of projects functions as a conduit for knowledge and expertise flow across the connected IS projects (Xu et al., 2006). The relationships in which members and projects are embedded can lead to improved outcomes and performance (Burt, 2009), influencing the success of projects due to the decreased cost of coordination among members (Peng et al., 2013).

However, not all relationships matter. In fact, for a specific skilled team member, being allocated to a myriad of projects can reduce his/her productivity and hinder the proper spread of his/her knowledge because a variety of team memberships increases the information complexity a skilled team member must address. Additionally, too many connections can slow the speed of project development (Colazo, 2010) because building and maintaining relationships with others takes time and effort and consumes resources (Adler and Kwon, 2002).

Thus, an increased number of generic ties can improperly create information overload and enhance the managing cost, consequently reducing outcome and performance (O'leary et al., 2011). Therefore, we posit the following:

Hypothesis 1. Higher project network closeness has an adverse effect on the Cost and Time Project Management Success (CTPMS) of IS development projects.

Conversely, establishing connections with individuals who can exchange useful information allows team members to reach others with the same level of skills (Ozer and Vogel, 2015). Software requirements' volatility and technological novelty increase the simultaneous use of multiple software development frameworks within a single project, which requires specialized information (Ramasubbu et al., 2015). Moreover, managers can cooperate in the use of the management controls (Korhonen et al., 2014), which can improve the performance of IS projects that they are managing.

Having good-quality ties grants quick access to specialists and similar projects. The performance of collaborative but equitable tasks between team members nurtures the social capital formation by which knowledge, trust, and mutual respect are fostered, which contributes to granting improved productivity to individuals (Wagner et al., 2014). We, therefore, propose the following:

Hypothesis 2. A higher project network eigenvector has a positive effect on the Cost and Time Project Management Success (CTPMS) of IS development projects.

2.4. Project-level effects

Considering that there is a need to develop project and program management to promote organization success (Martinsuo and Hoverfält, 2017), the literature identifies many specific characteristics that projects can assume and that should be considered when analyzing CTPMS. We considered as project factors Project size, Project duration, Project postponement, and Project Outsourcing level.

2.4.1. Project size and duration

The literature presents different postulates concerning the effect of project size and duration on PMS. According to Wallace et al. (2004), longer-duration projects tend to carry greater risks along the following dimensions: team, organizational environment, requirements, planning and control, user, and project complexity. Equally, as mentioned by Martin et al. (2007), larger IS projects with longer duration have more difficulty meeting project budgets and quality due to the cost of the technology, increased staff allocated, the greater number of vendors hired and the higher complexity of coordination and control.

Similarly, Taylor et al. (2012) posit that large projects tend to be more complex and riskier; such projects require larger teams and better communication, leading to higher organizational complexity and decreasing the likelihood of success. Therefore, splitting long projects into shorter sub-projects can reduce the complexity, mitigate the risks and increase the chances of success.

Conversely, longer projects, usually those lasting more than one year, have a positive effect on team skills development, showing a subsequent positive influence on PMS. Managers have the appropriate time to invest in practices for team development that positively affect project success; for example, ‘pay and reward’ contributes to reduced schedule overrun, whereas ‘coordination’ has a major effect on improved customer satisfaction (Zwikael and Unger-Aviram, 2010). In the same vein, Liu et al. (2016) concluded that in crowdsourcing projects, the complexity risk associated with larger projects can be easily mitigated because crowdsourcing can recruit a group of trained individuals to accomplish the project tasks.

Adding to this view, Cho et al. (2009) have found that short-term projects are associated with higher cost overruns. Accordingly, Gefen et al. (2016) argue that larger projects with longer duration are more likely to be successful because they are supposed to be minutely described, with a higher chance of being understood correctly and estimated more precisely. It is very common in software development that unexpected problems occur, for example, misunderstood specifications, technical difficulties, inconclusive testing, and a host of related problems. In longer projects, there is ample time for the team to address these unexpected problems, minimizing any effect on costs and time performance.

Therefore, in line with the argumentation, we state that the following:

Hypothesis 3. Increased project size enhances the Cost and Time Project Management Success (CTPMS) of IS development projects.

Hypothesis 4. Increased project duration enhances the Cost and Time Project Management Success (CTPMS) of IS development projects.

2.4.2. Project postponement

Project postponement refers to the flexibility to postpone the start of a project execution and part of its resources commitment. This decision can be based on the necessity of learning about the nature of uncertain payoffs and can result in prioritization changes (Benaroch et al., 2007). Making this decision at the beginning of an IS project can avoid additional investment and even cash flow losses. Examples include delaying until a new, less-costly technology is available and proven feasible or waiting for an appropriate modification in legislation that might justify a drastic redefinition of the project scope (Benaroch and Kauffman, 2000).

Project postponement is one of the project portfolio management decisions comprising decisions to start, stop or accelerate projects (Cooper and Edgett, 1997). On the one hand, the decision to postpone an IS project can reduce the project benefits, particularly when the project involves the launching of an innovative technology that can bring competitive advantage only to first movers. On the other hand, organizations must also evaluate the risk of potential losses that uncertainty can cause and adopt a defensive posture of postponing the project beginning (Fichman et al., 2005). In other words, although the postponement option should contemplate the cost of not making a decision (Lewis et al., 2004), a project start delay can be worthwhile if the future information is expected to decrease the execution risks (Benaroch et al., 2007).

Based on these elements and considering that the agencies that regulate the financial service industry in Brazil require the adoption of project management controls to avoid the inherent risks of IS projects (Terlizzi and Biancolino, 2014; Terlizzi et al., 2016), we agree with the positive influences argumentation and state the following:

Hypothesis 5. The longer the Project Postponement is, the higher is the Cost and Time Project Management Success (CTPMS) of IS development projects.

A postponement option allows decision makers to collect additional information to cope with the potential risks of the project. However, the perceived risks are expected to be mitigated in longer projects because opportunities will likely arise to consider solutions for them in the future. Moreover, some risks in longer projects tend to be emphasized less because less complete information is available ex-ante (Benaroch et al., 2007). Therefore, we extend the previous hypothesis as follows:

Hypothesis 6. Project Duration moderates and reduces the direct effect of Project Postponement on the Cost and Time Project Management Success (CTPMS) of IS development projects.

2.4.3. Project outsourcing level

Outsourcing the IS functions has been widely discussed in the literature in recent years (Lacity et al., 2010; Liang et al., 2016), and cost reduction emerges as one of the major factors that lead a corporation to consider outsourcing (Schwarz, 2014). Companies list many motivators for outsourcing their IS activities such as the rapid introduction of new products, the need to focus on their core business, increased productivity, improved access to technical expertise, and a lack of the required internal resources (Gorla and Somers, 2014).

Specifically, from an IS project perspective, outsourcing is considered a crucial decision due to its effects on project costs and times (Gorla and Somers, 2014). Several studies point to a positive relationship between IS project outsourcing and PMS. For example, Mao et al. (2008), in their study about trust and control in IS outsourcing, indicate that client control over the vendor has a significant effect on cost control, helping the vendor to prevent cost overruns. In their study with 57 outsourced and 79 internal IT projects, Tiwana and Keil (2009) concluded that because control mechanisms are effective in internal projects but not effective in outsourced projects, managers could reduce control when outsourcing projects. Srivastava and Teo (2012) posit that when IS activities are performed by a supplier rather than internally, client governance can be better performed, coordination costs are low, and quality can be enhanced. Han et al. (2013), in their study with 267 project managers, found that complementary client and vendor IT capabilities are significant factors of IS project success. Liu and Wang (2014) argue that outsourcing a project is the best option for organizations whose internal IT units do not possess sufficient technical expertise and knowledge; and Gefen et al. (2016) mention that to avoid problems in project execution, risk management usually considers outsourcing to ensure project success. In summary, we propose the following:

Hypothesis 7. The higher the project outsourcing level is, the higher is the Cost and Time Project Management Success (CTPMS) of IS development projects.

2.5. Project manager-level effects

A project manager (PM) is responsible for overseeing the project and the project team (DuBois et al., 2015). The PM must also be concerned with the business interests (Martinsuo and Lehtonen, 2007) to guarantee PMS. Millhollan and Kaarst-Brown (2016) mention a list of soft and hard skills required for a PM to perform his/her activities with mastery: project management, business, management, knowledge of the project technical disciplines, interpersonal, managing the project sponsor, situational awareness, and integrating previous skills and knowledge. The literature includes many factors related to project manager characteristics that can influence PMS; therefore, we considered as PM factors two characteristics related to the organization: PM formal power and PM management diversity.

2.5.1. PM formal power

To be able to inspire people, project leaders must be able to influence others to act to achieve project goals. However, in leadership, it is important not only to achieve good business results but also to create a culture in which people are empowered and inspired by a common purpose (DuBois et al., 2015). However, to achieve project management success, the project manager needs not only the soft skills to motivate team member contributions but also to access the hard skills (tools and techniques) necessary to monitor and control the project activities (Singh and Tan, 2010). Additionally, the PM must have the authority to delegate, control and monitor team member activities (PMI, 2013) and should be formally empowered to act flexibly in unforeseen circumstances (Jugdev and Müller, 2005).

Formal control is essential to mitigate the risks (Terlizzi and Biancolino, 2015; Tiwana and Keil, 2007) and improve the performance of both internal (Keil et al., 2013; Liu and Wang, 2016) and outsourced IT projects (Liu et al., 2017). In some organizations, formal power is transferred from the sponsor to the project manager in a limited manner. Such a transfer is not a real problem for experienced project managers because they can accomplish tasks and minimize the need for formal power, but less experienced ones find it difficult to manage a project in a scenario with low formal power. This imbalance of authority between the organization and the project manager can affect PMS (Ives, 2005).

Petro and Gardiner (2015) identified that a project manager's degree of influence in the organization, translated into his formal power, has a positive effect not only on PMS but also on portfolio success, client satisfaction, and strategic alignment. Based on these statements, we propose the following hypothesis:

Hypothesis 8. The higher the PM Formal Power is, the higher is the Cost and Time Project Management Success (CTPMS) of IS development projects.

2.5.2. PM management diversity

The management of projects of different sizes requires diverse approaches, leadership styles, and skills (Müller and Turner, 2010). At one end of the scale, the management of small to medium-sized projects requires a focus on prioritizing resource allocation across several projects, whereas on large projects, the emphasis is on the coordination of a complex sequence of activities, balancing resources across the activities, but focussing on the enablement of the critical activities (Payne and Turner, 1999). In general, the knowledge and skills of the project manager are key to effectively solving project crisis and maximizing the likelihood of project success (El-Sabaa, 2001). For example, expertise in problem-solving, skills in communication and leadership, an ability to correctly identify the context conditions, and expertise in planning and monitoring scope, timelines, and budgets are deemed of fundamental importance (Müller and Turner, 2010).

One approach to obtain the knowledge and develop the experience and skills needed is to be engaged in projects of diverse sizes, in which multiple situations can require the PM to exert multiple abilities. Being assigned to manage small projects can serve as a training ground for managers of later large projects (Payne and Turner, 1999). Companies adopt this approach to leverage their resources more effectively and to promote knowledge transfer, enhancing both productivity and learning (Milgrom and Roberts, 1992). Based on the above, we formulate the following:

Hypothesis 9. Higher levels of PM Management Diversity are associated with higher levels of the Cost and Time Project Management Success (CTPMS) of IS development projects.

2.6. Team-level effects

A team consists of two or more individuals who socially interact when aiming to perform organizational tasks. These individuals are characterized by (1) common goals; (2) interdependencies related to activities, workflow, goals, and outcomes; (3) different roles and responsibilities; and (4) being embedded in an organizational system. Teamwork can be characterized by recurring cycles of mutually dependent interaction. Currently, many organizations use some form of team-oriented work to obtain greater efficiency (Kozlowski and Bell, 2003). However, staffing projects is challenging (Walter and Zimmermann, 2016) because project teams comprise members with different skills and disciplines and who are difficult to bring together (Zwikael and Unger-Aviram, 2010). We considered as team factors Size, Allocation dispersion, and Hierarchical Diversity.

2.6.1. Team size

Considering the specific context of the development of Open Source Systems (OSS), increasing the number of developers is not necessarily a problem for the project budget because individuals are accepted to work based on voluntary affiliation. Studies of OSS dynamics and team productivity have shown that larger group size positively affects project outcomes due to developer engagement. To address other motivations, OSS developers can find opportunities in the main projects for learning, knowing people and improving their reputation if they can be associated with good performance (Chengalur-Smith et al., 2010; Ghapanchi and Aurum, 2012).

However, the general literature supports the premise that large project team size can require increased coordination effort and can decrease the motivation of the team members. For example, a large team can adversely affect the budget (Martin et al., 2007) and result in productivity losses (Ingham et al., 1974; Walter and Zimmermann, 2016). In the same vein, there is empirical evidence that as team size increases, productivity per person decreases due to the effect of social loafing, wherein team members achieve less than their potential (Chidambaram and Tung, 2005). Taylor et al. (2012) have also posited that larger teams require higher levels of communication and lead to organizational complexity, whereas Balliet (2010) argues that a small team eases communication both within the team and to project stakeholders, improving cohesion and cooperation. Based on these statements, we propose the following hypothesis:

Hypothesis 10. The larger the project team size is, the lower is the Cost and Time Project Management Success (CTPMS) of IS development projects.

2.6.2. Team allocation dispersion

Team allocation in IS projects is based on a combination of the technical project requirements and the specialties and abilities of the developer. Currently, the required specialties have been increasingly defined by a fast technological evolution scenario in which knowledge of numerous technologies and simultaneous use of multiple software development process frameworks is a reality within a single project (Ramasubbu et al., 2015).

To enhance project performance, projects should be accomplished by relatively small teams, and developers should be assigned to a preferably limited number of project teams. This approach also mitigates the fact that team member allocation ideally requires individuals with multiple skills, but employing such professionals is costly (Walter and Zimmermann, 2016).

Consequently, teams can be elaborated in a manner that groups individuals with strategically defined complementary abilities and knowledge. Adding to this elaboration work, collaboration is also needed, and matching team members' corresponding values is a key to fostering the required connections and communication. However, deploying the team member collaboration strategy is also complex (Narayanaswamy et al., 2013).

The alternative approach to this complex scenario is to share a precious resource between multiple projects and attempt to use it productively. In some companies, it is common for people to be members of five, ten, twelve or even more teams at one time (O'leary et al., 2011). Considering that this resource is a skilled team member who will be allocated for a few hours to each of multiple projects with diverse teams, it is reasonable to infer that this individual would be unlikely to develop shared interests and affinities with any particular project team. Therefore, we posit the following:

Hypothesis 11. The higher Team Allocation Dispersion is, the lower is the Cost and Time Project Management Success (CTPMS) of IS development projects.

2.6.3. Team hierarchical diversity

The literature on group diversity provides hints about the possible adverse effect that functional diversity can have on the organization and project performance. One reason is associated with the difficulty of inculcating a spirit of teamwork in all members. Team members tend to have lower group cohesiveness and job satisfaction and higher turnover and job stressors than do members of homogeneous groups (Ancona and Caldwell, 1992).

Functional diversity in the project team has no direct effect on technical quality, a rather strong, negative direct effect on

Table 2
Characteristics of some projects selected in the sample.

Description	Planned			Actual			Category
	Start date	End date	Hours	Start date	End date	Hours	
Coding COBOL II (old version) components for COBOL Enterprise (new version)	02/03/2014	01/30/2015	45,167	02/03/2014	02/06/2015	46,181	Corporate IT
Personal loan with a guarantee of investment funds (new product)	02/01/2014	03/31/2015	19,726	02/03/2014	05/05/2015	15,169	Business
Personal loan with life insurance on the CORBAN channel (correspondent banking)	01/02/2014	03/31/2015	4608	07/07/2014	05/13/2015	3809	Business
Audit finding – fix security vulnerability in the authentication process of the call center	06/14/2014	09/20/2014	820	06/13/2014	10/10/2014	840	Support
Regulatory – change calculation of private pension plans according to law #11.053	03/03/2014	04/24/2015	1364	08/18/2014	07/17/2015	1304	Support

budget performance, and no direct effect on meeting schedules (Keller, 2001). Accordingly, Mannix and Neale (2005) claim that homogeneous teams are better to profit from existing knowledge. However, considering other types of diversity, it has been argued that groups with different expertise, experience, and education background benefit creativity and problem-solving in complex systems (Page, 2010). In line with the previous view, we propose the following:

Hypothesis 12. Higher levels of project Team Hierarchical Diversity are associated with lower levels of the Cost and Time Project Management Success (CTPMS) of IS development projects.

3. Methods

3.1. Sample and data collection

The organization is a Brazilian company in the Financial Service Industry. The organization is present in 15 countries and is one of the largest in the world in its field, with more than US$ 400 million in assets and over 80,000 employees. It is included in a list of the top 50 worldwide most valuable banking brands for 2015 (Brand Finance, 2015). The IT department numbers approximately 5000 employees and the capacity of external collaborators is flexible, depending upon demand, whereas the IT Project Management Office (PMO) has 50 employees. The project portfolio reaches > 3000 annually initiated IS projects that are controlled with a Project Management Information System (PMIS). The projects can receive any of the following statuses: (1) Draft – project not yet approved (specification and estimate in progress); (2) in execution – project under development by the IT team; (3) concluded – total scope delivered and accepted by the user; or (4) canceled – project not approved or terminated unexpectedly before completion, usually due to reprioritization of the project portfolio or a change in the political/economic scenario.

An initial dataset of 3778 IS projects was extracted from the PMIS on February 2016. The extract contained IS projects launched in the period from December 2013 to December 2014 and concluded within the period of January 2014 to December 2015. The manager in charge of the PMO explained that canceled projects could not be considered failures because there was no record justifying the reason for the cancellation or explaining whether there was a partial delivery of the scope. At the time of data extraction, the cancellation process of IT projects was under review by the organization; thus, it was not possible to select those projects in the study.

We excluded 2636 IS projects with fewer than 501 h of development, reducing the dataset to 1142 projects. This reduction was necessary because these projects were deemed small projects according to the project management methodology (PMM) established by the organization. Small IS projects are conducted by separate teams and budgets using a simplified PMM, based on FIFO (First-In, First-Out) order. Therefore, given the very diverse nature of the project management processes, we decided that small IS projects should be examined in a separate study.

Later, we further deselected cases that were considered an extreme case of success, which we found unlikely. For example, cases that succeeded in time by using < 33% of the baseline time or cases that succeeded in cost by costing < 33% of the baseline cost were segregated. Those cases were deemed as likely having a faulty initial process or involving a major scope change not incorporated into the baseline. To apply this criterion, we developed additional indicators for Cost Project Management Success (CPMS) and Time Project Management Success (TPMS) that were calculated based on the percentage of cost deviance incurred from the baseline cost and percentage of time deviance incurred from the baseline time, respectively. Cost or time unsuccessful projects, however, were included at any percentage of deviance. Based on this criterion, 243 projects were isolated from the dataset, resulting in 899 valid scope successful IS projects; thus, it was not necessary to calculate the Scope Project Management Success indicator.

In the studied organization, IT projects are classified and organized into three different categories: corporate IT projects (usually infrastructure projects with high investments), business projects (creation of new products and services or improvement of existing ones) and support (maintenance of legacy systems, operational risk, and regulatory issues). Table 2 presents the characteristics of some IT projects selected in the sample.

3.2. Measures

We operationalize all variables as follows:

3.2.1. Dependent variable

In contrast to the traditional measures of PMS found in the literature, we propose an incremental-marginal perspective for the CTPMS indicator. This approach presumes that small increments in the values relative to the baseline of each dimension (cost or time) are mutually dependent. This aspect is an important consideration because the project management success literature focusses largely on aggregate (and usually perceptual) measures, as though one dimension could be fulfilled without considering the effects on the others. Consequently, we operationalize CTPMS as the relationship of the baseline cost to actual cost that a successful scope and cost project incurs, multiplied by the relationship of the baseline time to the actual time expended that a successful scope and time project incurs. This approach is consistent with the classic philosophical logic that considers an attribute of existence when satisfying the necessary and sufficient conditions to fit it into a specific category (MacKenzie et al., 2011). In the case of CTPMS, cost and time success measures are both necessary and sufficient to characterize the focal attribute, and the mathematical product operation corresponds to the simultaneity condition (Goertz, 2005).

This perspective allows simultaneously considering small deviations from planned cost and time while controlling for the scope. The reason we propose the measurement model in this manner is that, as discussed in the literature review, it is usual for project managers to dynamically negotiate and adjust project requirements between development and business/client teams. Consequently, multiplying both scores results in an efficient measure of the combined CTPMS, considering a scope, cost and time success. For example, a project manager can reduce a project's cost by allocating a smaller number of developers, which would result in a partial advantage from a cost reduction relative to the budget. By acting in this manner, however, it will most likely take longer for the project to be finished, which leads to a time disadvantage. Such articulation of resources during development is very common because it can provide necessary portfolio management and team allocation flexibility. Consequently, if the adjustments occurred proportionally during the project, meaning that proportional variations in time compensate for variations in cost, and if the overall project is deemed successful by the client in scope, cost and time, the consequences of such adjustments on the indicator score should represent the same level of success as if the project met both the cost and time baseline. Remember that all projects in the sample are considered successful in scope, time and cost. Therefore, this indicator is measuring variations in the composite PMS, for which we are studying the antecedents.

Consistent with our proposition, deviations from either cost or time (or both) baselines result in a score that can depart from the gold maximum of "1". This operationalization also compensates for managerial decisions that might proportionally combine the use of resources. For example, the managerial team might decide to reduce time by 10% and use an increment of 10% in cost, with the resulting maximum score. Eq. (1) is the Cost-Time PMS formula:

$$Cost\,and\ \ Time\ \ PMS_i = \left(\frac{Baseline\ \ Cost_i}{Actual\ \ Cost_i}\right) \cdot \left(\frac{Baseline\ \ Time_i}{Actual\ \ Time_i}\right) \tag{1}$$

3.2.2. Independent and control variables

3.2.2.1. Project size. We operationalize project size by the total number of labor units required to complete the project (Calisir and Gumussoy, 2005; PMI, 2013), expressed in hours.

Table 3
Descriptive statistics and correlations.

Variable	Mean	s.d.	1	2	3	4	5	6	7	8	9	10	11
1 - Cost and Time PM Success	0.987	0.287											
2 - Project size (Hs)	2931	7674	−0.005										
3 - Team size (members)	9.71	10.00	0.006	0.643 **									
4 - PM formal power	0.055	0.229	−0.009	0.028	0.015								
5 - Project duration (Days)	261.7	143.8	0.320 **	0.223 **	0.275 **	0.026							
6 - Outsourcing index (% Hs)	0.272	0.287	−0.132 **	0.112 **	−0.096 **	0.021	−0.134 **						
7 - Project postponement (Days)	3.5	15.1	0.146 **	−0.008	0.004	0.003	0.051	0.098 **					
8 - Team time allocation dispersion	384.0	648.4	−0.051	0.808 **	0.334 **	0.070 *	0.229 **	0.342 **	0.037				
9 - Team hierarchical diversity	1.199	0.642	−0.105 **	−0.033	−0.174 **	0.074 *	−0.106 **	0.602 **	0.035	0.079 *			
10 - Project network closeness	0.318	0.088	−0.038	0.133 **	0.283 **	−0.035	0.120 **	−0.054	0.028	0.057	−0.047		
11 - Network eigen. centrality	0.094	0.211	0.025	0.157 **	0.457 **	−0.024	0.053	−0.042	0.045	0.041	−0.196 **	0.238 **	
12 - PM management diversity	0.171	0.267	0.096 **	0.030	0.086 **	−0.019	0.096 **	−0.007	0.011	0.029	−0.041	0.058	0.000

Note: n = 899.
* p < 0.05.
** p < 0.01.

3.2.2.2. Project duration. Project duration is the time required to complete the project (Calisir and Gumussoy, 2005; PMI, 2013), expressed in days and calculated by the difference between the actual finish date and the actual start date of the project.

3.2.2.3. Outsourcing index. The outsourcing index is the relationship between the total number of hours outsourced and the total amount of labor (work hours).

3.2.2.4. Project postponement. We operationalize project postponement by the difference of days between the planned start date indicated in the project baseline and the actual start date. A positive number means that the project started late and that it might incur additional costs (Olaniran et al., 2015).

3.2.2.5. Team size. Team size is defined as a set of individuals who support the project manager in performing the work of the project to achieve its objectives (Calisir and Gumussoy, 2005; PMI, 2013), and was operationalized by the project's headcount. Outsourced resources and employees of the business departments do not register time sheets on the PMIS; thus, the variable team size considers only the employees that work in the IT department.

3.2.2.6. Team allocation dispersion. Team allocation dispersion is defined as the intensity with which a project combines analysts with an hourly allocation that departs from the typical allocations of the majority of the other team members. The best case is to allocate the developer to complete a task or deliver a feature according to its capacity (PMI, 2013). We operationalize team allocation dispersion by the standard deviation of the hourly allocation of the team members within each team.

3.2.2.7. Team hierarchical diversity. We operationalize hierarchical team diversity as a measure of the spread of the hierarchical position (H) of team member (m) within each project (i) according to their position in the organization. The formula calculates the variance of a binomial distribution as follows:

$$Team\ Hierarchical\ Diversity_i = \sum_1^m \left[\left(H_m - \overline{H} \right)^2 \cdot P(Hm) \right] \quad (2)$$

3.2.2.8. Project network closeness. We operationalize project network closeness with network analysis using the team allocation as measures of the edges. Consequently, the nodes were set as the projects, and in this case, network closeness is a measure of how central a project is considering all other projects in the network portfolio because of multiple allocations of developers (Beauchamp, 1965). The use of the Social Network Theory is new in the project management research field, and it has been recently used in studies of open source projects (Peng et al., 2013).

3.2.2.9. Project network eigenvector centrality. We operationalize project network eigenvector centrality with network analysis using the team membership as measures of the edges. Consequently, the nodes were set as the projects, and in this case, network eigenvector centrality is a measure of how central the project to other central projects in the portfolio network because of multiple allocations of developers (Bonacich, 1972).

3.2.2.10. Project manager formal power. This variable is defined as a measure of the formal authority given to the project manager to apply organizational resources to project activities (Lee et al., 2000; PMI, 2013). The variable was operationalized based on the project manager role (1 = system analyst junior, 2 = system

Table 4
Results of fixed-effects regression analysis predicting Cost-Time Project Management Success.

	Controls: model 1	Project factors: model 2	Team factors: model 3	Portfolio factors: model 4	PM factors: model 5	Interaction: model 6
Project size (Hs)	−0.015	−0.006	0.242 **	0.251 ***	0.261 ***	0.257 ***
Team size (members)	0.016	−0.091 *	−0.172 ***	−0.187 ***	−0.198 ***	−0.193 ***
PM formal power	−0.009	−0.014	0.001	−0.001	0.001	−0.001
Project duration (days)		0.326 ***	0.360 ***	0.368 ***	0.362 ***	0.362 ***
Outsourcing index (% Hs)		−0.111 ***	−0.009	−0.020	−0.024	−0.031
Project postponement (days)		0.140 ***	0.143 ***	0.142 ***	0.142 ***	0.171 ***
Team time allocation dispersion			−0.270 ***	−0.269 ***	−0.274 ***	−0.272 ***
Team hierarchical diversity			−0.067 +	−0.053	−0.049	−0.047
Project network closeness				−0.071 *	−0.074 *	−0.076 *
Project network eigenvector centrality				0.061 +	0.066 +	0.066 +
PM management diversity					0.080 *	0.080 *
Project duration × project postponement						−0.074 *
Constant	−0.003	−0.004	−0.002	−0.002	−0.002	0.002
R^2	0.0%	13.9%	15.6%	16.2%	16.8%	17.2%
R^2 change	0.0%	13.8%	1.7%	0.6%	0.6%	0.4%
Adjusted R^2	0.0%	13.3%	14.8%	15.2%	15.8%	16.1%
F change	0.074	47.735 ***	9.003 ***	3.300 *	6.583 *	4.667 *
Model F	0.074	23.910 ***	20.505 ***	17.149 ***	16.286 ***	15.380 ***

Note: n = 899.
+ $p < 0.10$.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

Table 5
Summary of the results of hypothesis testing.

Level of analysis	Hypothesis		Result
Portfolio network	H1	Higher project network closeness has a negative effect on CTPMS	Supported
	H2	Higher project network eigenvector has a positive effect on CTPMS	Supported
Project	H3	Greater project size has a positive effect on CTPMS	Supported
	H4	Greater project duration has a positive effect on CTPMS	Supported
	H5	Longer project postponement has a positive effect on CTPMS	Supported
	H6	Project duration moderates and reduces the direct effect of project postponement on CTPMS	Supported
	H7	Higher level of project outsourcing has a positive effect on CTPMS	Not supported
Project manager	H8	Higher PM formal power has a positive effect on CTPMS	Not supported
	H9	Higher level of PM management diversity has a positive effect on CTPMS	Supported
Team	H10	Larger project team size has a negative effect on CTPMS	Supported
	H11	Higher team allocation dispersion has a negative effect on CTPMS	Supported
	H12	Higher levels of project team hierarchical diversity have a negative effect on CTPMS	Not supported

analyst medium, 3 = system analyst senior, 4 = coordinator, and 5 = manager) using a dummy variable set to zero if manager role is 1 to 3, and assume value = 1 if manager role is 4 to 5 (Sandhu et al., 1996).

3.2.2.11. PM management diversity. This variable represents a project manager that coordinates projects of different sizes (Müller and Turner, 2010). We operationalize PM management diversity as a measure of the spread of the size of the managed project (Ps) of the project manager (PM) within each managed project (i). The formula calculates the incremental project variance of a binomial distribution as follows:

$$PM\ \ Management\ \ Diversity_i = \sum_1^{pm}\left[\left(Ps_{pm}-\overline{Ps}\right)^2\cdot P(Ps_m)\right]\Big/\sum i \tag{3}$$

3.3. Analytical procedures

To test for simultaneous effects of multilevel predictors on CTPMS, we performed a hierarchical regression analysis, which is an incremental variance partitioning technique. The technique is adequate when the dependent variable nature is continuous, and the study is intended to analyze multiple variables, ruling out effects already addressed in the model (Cohen et al., 2003). This technique is used not to achieve a high explanation power but rather to evaluate the relative importance of some variables added to variables already in the model, allowing the researcher to understand any effects of the predictors on the dependent variable (Pedhazur and Schmelkin, 1991).

First, for theoretical reasons, we started by adding to model 1 (Table 4) the variables frequently noted in the literature as showing the effects of PMS: Project size, Team size, and PM formal power. These variables are then used to create the null model from which we seek statistically significant changes in R^2 that would be presented in the subsequent models, set up by adding other blocks of variables (Cohen et al., 2003). Per our research purpose, to check for the effects of different levels of analysis, the additional blocks used to create subsequent regression models are related to the levels of analysis, from the lowest to the highest level, considering the project as a starting point. Therefore, the Project (model 2) was considered the lowest level, and then subsequently the Team, Portfolio and PM levels were analyzed. Additionally, interactions that would have theoretical support were also tested in model 6.

We mean-centered all variables to avoid any potential for multicollinearity and specifically examined the threat of multicollinearity by calculating the variance inflation factor (VIF) for each predictor (Cohen et al., 2003) in the complete model.

4. Results

4.1. Descriptive statistics

Table 3 provides descriptive statistics and Pearson and Kendall's tau correlations of our variables. The descriptive statistics indicate that the sampled Project Size met an average of 2931 h, with a wide standard deviation. On average, a team size counts on 9.71 members, and a project duration averaged 261.7 days. Outsourcing represents, on average, 27.2% of the size of the projects, whereas project managers are responsible for managing projects that differ on average by 17.1% in size. Our measure of Cost and Time Project Management Success is significantly positively correlated with project duration, project postponement, and PM management diversity, but significantly negatively correlated with outsourcing and team hierarchical diversity. Variance inflation factors (VIFs) and a linear dependency test were used to test for collinearity. We found some significant correlations among predictors, but none of the multicollinearity statistics estimated in conjunction with our regression models reached the point at which multicollinearity is a concern. All VIF coefficients were individually estimated at any regression stage and resulted in <5, well below the threshold of 10, indicating that multicollinearity was not a likely threat to the parameter estimation (Cohen et al., 2003). Additionally, we analyzed the maximum Condition Index (CI) for each block of predictors, and the result shows the highest value of 5.2, less than the threat value of 15 (Belsley et al., 2004). These results suggest that multicollinearity is not a concern for our model.

4.2. Regression analysis results: antecedent's factors on PMS

H1 suggested that higher project network closeness has a negative effect on the CTPMS of IS development projects. The results reveal that project network closeness had a negative, small effect on CTPMS [B = −0.074, t (886) = −2. 160, p < 0.05]. Thus, H1 is supported.

H2 indicated that a higher project network eigenvector has a positive effect on the CTPMS of IS development projects. The results reveal that project network eigenvector had a small positive effect on CTPMS [B = 0.066, t (886) = 1.83, p < 0.10]. Thus, H2 is supported.

H3 stated that project size increments increase the CTPMS of IS development projects. The results reveal that project size had a strong positive effect on CTPMS [B = 0.261, t (261) = 3.48, p < 0.001]. Thus, H3 is supported.

H4 suggested that increasing project duration increases the CTPMS of IS development projects. The results reveal that project duration had a strong positive effect on CTPMS [B = 0.362, t (886) = 10.791, p < 0.001]. Therefore, H4 is supported.

H5 indicated that longer project postponements have a strong positive effect on the CTPMS of IS development projects. The results reveal that project postponement had a strong positive effect on CTPMS [B = 0.142, t (886) = 5.08, p < 0.001]. Thus, H5 is supported.

H6 postulated that Project Duration moderates and reduces the direct effect of Project Postponement on the CTPMS of IS development projects. The results reveal that this interaction is significant, showing a negative, small effect [B = −0.074, t (886) = −2.160, p < 0.05], thus supporting H6.

H7 posited that the higher the level of project outsourcing is, the higher is the CTPMS of IS development projects. The results reveal that project outsourcing had a marginally negative non-significant effect on CTPMS [B = −0.024, t (886) = −0.683, ns]. Thus, H7 is not supported.

H8 posited that the higher the PM Formal Power is, the higher is the CTPMS of IS development projects. The results reveal that PM Formal Power had no significant effect on CTPMS [B = 0.001, t (886) = −0.032, ns]. Thus, H8 is not supported.

H9 suggested that higher levels of PM Management Diversity are associated with higher levels of IS development project CTPMS. The results reveal that PM Management Diversity had a small, positive effect on CTPMS [B = 0.080, t (886) = 2.581, p < 0.05]. Thus, H9 is supported.

H10 suggested that the larger the project team size is, the lower is the CTPMS of IS development projects. The results reveal that project team size had a strongly negative effect on CTPMS [B = −0.198, t (886) = −3.729, p < 0.001]. Thus, H10 is supported.

H11 indicated that the higher the Team Allocation Dispersion is, the lower is the CTPMS of IS development projects. The results reveal that Team Allocation Dispersion had a strongly negative effect on CTPMS [B = −0.274, t (886) = −4.188, p < 0.001]. Thus, H11 is supported.

Finally, H12 posited that higher levels of project Team Hierarchical Diversity are associated with lower levels of IS development project CTPMS. The results reveal that Team Hierarchical Diversity had a nonsignificant negative effect on CTPMS [B = −0.049, t (886) = −1.17, ns]. Thus, H12 is not supported.

Table 4 presents the results of fixed-effects regression analysis predicting Cost-Time Project Management Success.

We also analyzed the data robustness against the possibility of omitted variable bias. In our study, Team Time Allocation and Outsourcing Index are likely to be proxies for unmeasured organizational factors such as software development methodologies, Project Management Office policies or even organization policies concerning the development of sensitive codes as in financial sector; information systems are of strategic value. We applied the Ramsey RESET test for omitted variables, a series of robustness measures to obtain our estimates. The results support the null hypothesis that the omitted variable bias is not a major concern in the study [F (3883) = 2.017, ns].

5. Discussion

Expanding upon past research that emphasized the role of only some levels to consider the antecedent's factors on project management success, we recognized factors spread across four different levels of analysis – portfolio network level, project level, project manager level and team level. We drew on projects in the IS literature to study how related multilevel factors affect project management success. In addition to assembling multiple levels into one piece of research, we added the network analysis approach to convey factors that are intensely present in organizations that address large software portfolios and in which multiple teams are shared between multiple projects. Table 5 summarizes the results of the hypothesis testing.

5.1. Project-level effects

Considering that a large number of IS projects are concurrently executed in the studied organization, it is not shocking that larger projects with long duration positively influence PMS and, accordingly, project success. That effect occurs because, in a bank, larger projects are usually strategic and prioritized by an executive committee. Furthermore, a project that requires large investments of resources has one or more senior executives as sponsors, and the successful benefits realization of such a project is directly linked to the sponsors' goals. Consequently, a more robust control structure is organized to ensure PMS of a large and critical project. For example, although the project is monitored by the project management office and the best team members are allocated to the project, the evolution of the project is regularly presented to the executive committee. These findings corroborate previous studies (Cho et al., 2009; Gefen et al., 2016; Keegan et al., 2012; Liu and Wang, 2016; Terlizzi et al., 2017; Zwikael and Unger-Aviram, 2010).

Postponing the beginning of a project is closed related to project risk management. As mentioned by Benaroch and Kauffman (2000), making this decision at the start of an IS project can avoid additional investments and even cash flow losses. Our empirical study showed that postponing the start of a project has a positive effect on PMS. In a large finance organization with many IS projects being executed simultaneously, it is necessary to have an organized queue of prioritized projects to maximize IT resources. In other words, the beginning of a project is usually heavily dependent upon the conclusion of other projects that will release necessary resources. Nevertheless, in such a situation, it is common for a delay in a previous project to influence the subsequent project. Thus, a well-known practice used by project managers is to delay the beginning of the project until the majority of the resources are available, ensuring delivery of the project on time, on budget and satisfying the expectations of the involved stakeholders. This practice can delay the planned delivery of the project and affect the initial date of the project benefits capture (Fichman et al., 2005); however, it minimizes the risks of not meeting the new baseline schedule or exceeding the project budget. These findings corroborate previous studies (Benaroch et al., 2007; Fichman et al., 2005; Lewis et al., 2004).

Although some previous studies affirm that outsourcing IS projects has a positive effect on project cost and time (Gefen et al., 2016; Gorla and Somers, 2014; Schwarz, 2014; Srivastava and Teo, 2012), our study did not show the same result. Our hypothesis that a higher level of project outsourcing has a positive effect on PMS was not supported. Perhaps this effect does not occur because some important motivators for outsourcing IS activities such as a lack of required internal resources, a focus on their core business (Gorla and Somers, 2014), or insufficient technical expertise and knowledge (Liu and Wang, 2014) are not valid for a large financial institution. In a large bank with a large IT department of > 5000 employees, the IS activities must be a core activity because the company is heavily technology dependent, and the internal IT resources are more trained and specialized than are outsourced resources. Thus, outsourcing a project in this scenario does not mean enhancing project performance; however, more research is needed to validate our proposition.

5.2. Project manager-level effects

Although a more experienced project manager with formal power has the flexibility to address unforeseen circumstances and positively influence PMS and client satisfaction (Ives, 2005; Jugdev and Müller, 2005; Petro and Gardiner, 2015; PMI, 2013), our study could not be conclusive on this aspect. Our hypothesis that higher PM formal power has a positive effect on PMS was not supported. This result might occur because the formal authority that is given to the project manager based on his/her role no longer influences team members due to the more empowered agile teams and their familiarity with new technologies, products and agile methodologies (Serrador and Pinto, 2015). We believe that further research is needed to understand this phenomenon.

Our study shows that high levels of project manager diversity have a positive effect on PMS. Specialization is an important economic concept that influences the performance of an employee; however, this concept is not valid for an IT project manager. A project manager who can be exposed to projects of different sizes and types during his/her career is better prepared to address unexpected situations that could affect PMS. This conclusion corroborates the previous literature (El-Sabaa, 2001; Müller and Turner, 2010; Payne and Turner, 1999).

5.3. Team and portfolio network-level effects

The results also show that group allocation is a critical PM issue because team size, team time-allocation dispersion, and project network closeness all reduce cost-time project management success. Consequently, smaller, focussed and less-disperse teams can present better results than multiple, larger and sparse teams addressing a multiplicity of projects. This conclusion contributes to the recent literature about agile IS development, which indicates that this model of management improves PMS (Lee and Xia, 2010).

Expanding upon the past IS research, we analyzed the team allocation into the portfolio. Two types of resulting networks emerge, leading to opposite effects. Having individuals originally allocated in central projects sharing hours with multiple projects reduces PMS, whereas having individuals sharing hours with other central projects increases PMS. As we mentioned above, central projects are usually strategic projects that are better controlled and have the best technical teams. Thus, team members are naturally more worried about the project's results when working on central projects than when working on peripheral projects. This observation aligns with previous studies (Colazo, 2010; O'leary et al., 2011; Peng et al., 2013).

6. Conclusions

6.1. Contributions

This study contributes to the academic literature by confirming and extending the main aspects of Project Success from a multilevel perspective. This approach allows the richest analysis of a project environment that has become increasingly complex and addresses much uncertainty.

Furthermore, project management theoreticians recognize that different versions of project management are required in different circumstances according to the country, industry sector, and size of the organization. To expand this research field, it is important to accumulate studies from various industries around the world (Love et al., 2005; Turner and Ledwith, 2016). A myriad of factors can positively affect the success of IT projects and reduce their probability of failure. Many researchers have been individually studying how to improve the practices related to portfolio selection and prioritization, project techniques of monitoring and control, project manager hard and soft skills and even team motivation. However, recent numbers collected worldwide by some project management institutes continue to show that 52% of the IT projects have been challenged (scope creep and lost budget) and that 19% failed (deemed failures) (PMI, 2017; Standish, 2015). Therefore, there is a need to start exploring the interrelations of these many levels of factors to develop theories that are more robust and help the practitioners to achieve the best levels of project performance.

Project management theory has been developed in the context of controlling the time, cost and scope of projects. However, the theory must be expanded beyond this frontier and consider that the project's value must be proven, particularly in financial organizations that make intensive use of IT in their operations and in which the success of IT projects is a strategic issue.

6.2. Practical implications

It is the researchers' hope that the findings reported here will complement existing research in the area of internationally recognized project management success and will be of interest to practitioners.

This study has shown the existence of many project management practices in the literature, but merely adopting these individual practices is not sufficient to ensure the project management success of IS projects. Ensuring the combined use of these practices to maximize PMS is crucial.

Exploring the causes of a problem can enrich the understanding of a given theory and allow readers to make more sense of complex organizational phenomena (Whetten, 1989). Therefore, the authors recognize that any discussion of the practical implications of this study would be incomplete if it only identified a multilevel model rather than proposing its actual use.

The findings of this study identify several managerial contributions for a better understanding of the antecedent factors of IS success concerning multiple levels. From a project and portfolio perspective, the results can help project and portfolio decision makers to allocate their resources strategically to pursue a better balance among team members and across projects. The results show that larger IS projects have better rates of PMS because they are strategic investments to the company and adopt efficient and effective mechanisms of control. Moreover, postponing the beginning of a project until the removal of uncertainties is also a best practice that can positively influence project performance.

Furthermore, the model presents valuable advice for team staffing related to group size and hierarchical diversity that can improve project success. The study also provides guidance on how to spread team members across multiple projects, seeking a positive effect on overall portfolio success. Additionally, it helps to understand the benefits of allowing project manager diverseness by experiencing interaction with a multiplicity of project sizes. Surprisingly, the results showed that the authority of a project manager based on his/her role did not influence project performance, demonstrating that senior employees will not necessarily be the best project managers. Finally, the findings indicate that it is more efficient to have smaller, concise and focussed teams on an IS project than to have larger teams working simultaneously on a variety of projects.

6.3. Limitations and avenues for future research

This study is not free of limitations. First, although we were able to gather data from a highly relevant organization in the financial service industry, some organizational policies and cultural aspects might heavily influence the results. Second, despite the extensive research literature concerning the factors that can contribute to project management success, not all factors could be included in our research model. Third, this study has focussed on project management success, whereas the quality of the ultimate software artifact is to be analyzed to evaluate the overall project success. Fourth, we did not have access to the scope-failed projects; therefore, our sample considered only the scope-successful projects. Fifth, because we measured project management success with an indicator aggregating scope, cost and time dimensions, relative success in one dimension can alleviate relative failure in others.

Consequently, further research can analyze what factors might influence the success of management from each dimension's perspective, and PMS can be analyzed in each dimension concerning PS. Additionally, there is a field open to study the influence of methodologies, e.g., agile, on PMS and PS from the governance perspective.

Conflict of interest

This manuscript has not been published and is not under consideration for publication elsewhere; we have no conflicts of interest to disclose.

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